54th Annual Meeting of the Association for Tropical Biology and Conservation

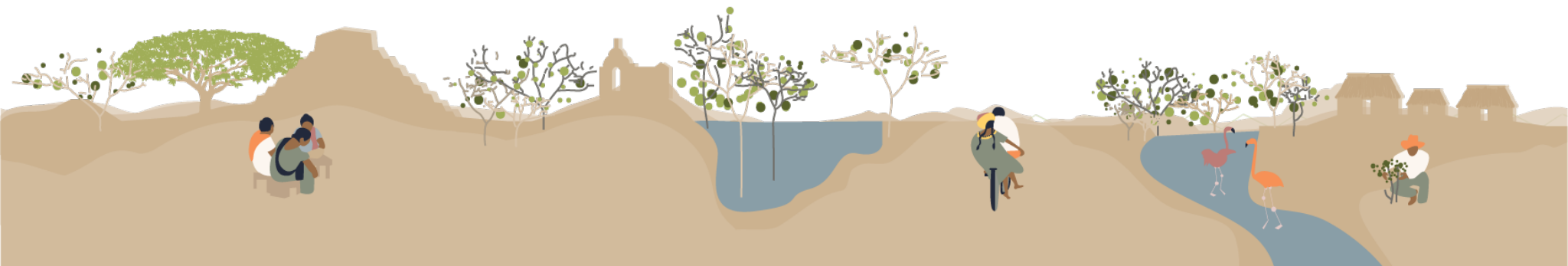
Merida • Yucatan • Mexico

July 9-14, 2017

Ecological and social dimensions of tropical biodiversity conservation

PROCEEDINGS

www.atbc2017.org



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Welcome

We welcome all of you to the 2017 ATBC meeting held in Merida, Yucatan, Mexico. We hope you have fruitful interactions with colleagues, old friends, and new collaborators, mentees and mentors amidst the beautiful surroundings that blend culture, history, and nature.

Founded in 1963, the Association for Tropical Biology and Conservation (ATBC) is a membership corporation, international in scope, membership, and objectives, functioning as an international body to foster scientific understanding and conservation of tropical ecosystems by supporting research, collaboration, capacity building, and communication among tropical biologists and conservationists. The ATBC, currently with members from over 65 countries, composes a broad community of tropical biology professionals and provides outlets for research dissemination, educational and funding opportunities, particularly for early career scientists working across the tropics. As a diverse community of science professionals, the ATBC provides a credible, collective, and authoritative vision of tropical biology and conservation issues that underpin public policy and management action. Our journal, Biotropica, is the leading international journal on tropical biology, and publishes six issues per year on-line.

Starting with the Asia-Pacific and Student and Early Career Scientist Chapters, new regional and thematic chapters are being formed to provide more outlets for collaboration, communication, and regional networking. The Africa chapter is becoming established and the Latin America chapter will soon be born. The ATBC also offers a Mentoring program, Skills Workshops and Short Courses. The Conservation Chapter works actively to focus on important issues where ATBC resolutions and declarations can have an impact on decision making and mobilizing conservation actions around the tropics. We offer many ways to become involved.

ATBC provides tiered membership options for students and regular members regardless of economic status, and provides a limited number of travel grants to annual meetings. We aim to be supportive, inclusive, participatory, transparent, and multidisciplinary in all of our activities and events.

Please join us as a member to receive the maximum benefits of our global society.

Please visit our website for more information (http://tropicalbiology.org) as well as our Facebook pages ATBC and Tropical Biology and Conservation Forum) and Twitter feed (@tropicbiocon).

Dr Robin Chazdon
ATBC- Executive president

Dr. Marielos Peña Claros
ATBC- President 2017

WELCOME TO THE ATBC 2017!

It is with great pleasure and joy that we extend to all of you the warmest welcome to the 54th meeting of the Association of Tropical Biology and Conservation (ATBC) in the splendid city of Merida, Yucatan, Mexico. Four of the most important academic entities in Mexico (the Instituto de Investigaciones en Ecosistemas y Sustentabilidad de la Universidad Nacional Autónoma de México, the Centro de Investigación Científica de Yucatán, La Facultad de Biología of the Universidad Autónoma de Yucatán and the Instituto de Investigaciones Naturales of the Universidad Michoacana de San Nicolás de Hidalgo), which teach and carry out research in tropical biology and conservation, have joined efforts to host the 2017 ATBC annual meeting in Merida, a world-class location.

Merida is a great venue for this meeting for several reasons. First, the city is located inside the Chicxulub crater that was formed by the impact of the asteroid that led to one of the six mass extinctions of species recorded in the history of Earth. This reminds us of the current massive species extinction driven by another global phenomenon: the increasing consumption and unsustainable use of natural resources by humans. The negative impacts of human activity on the biosphere, hydrosphere, and lithosphere are of such nature and magnitude that there is a growing consensus that a new geological epoch in the history of Earth has emerged, appropriately named the Anthropocene. Second, Merida is part of an ancient and living culture built upon the management of tropical biodiversity and ecosystems. Both ancient and contemporary Mayans adopted socio-ecological ways of living that made possible great past civilizations, and today these practices inspire ways to solve the challenges imposed by the coexistence between nature and societies. These examples of coexistence efforts are found across the tropical world, especially in traditional human communities, and they call for alternatives to the unsustainable modes of development that prevail in much of today's societies, especially in urban areas. These aspects define the theme of the Merida meeting: Ecological and social dimensions of the conservation of tropical biodiversity. In addition, Merida is a city rich in history (with pre-Hispanic, colonial and contemporary episodes), culture (including unique regional food dishes) and folklore, surrounded by countless natural, archaeological and ethnical attractions, which make a magnificent context for a special ATBC meeting.

Based on the mission, objectives and principles of ATBC, the meeting in Merida will pursue research topics on the origin, evolution, and maintenance of the extraordinary tropical life diversity, on the anthropogenic impacts on biodiversity and ecosystems, on the human factors (societal, cultural, political, and economical) driving such impacts, and on conservation, restoration and planning issues. The Merida meeting has attracted an important number of delegates. More than 750 contributions, divided into 31 symposia, 39 sessions of free oral presentations, and 4 poster sessions conform the skeleton of the meeting program. Delegates are coming from more than 40 countries and more than 380 academic institutions. We are particularly pleased that 50% of the delegates are bachelor and graduate students, which indicates the great "regenerative potential" that the ATBC community has. Of course, the origin of delegates participating in ATBC meetings varies from year to year, depending on the region of the planet where the meeting is held. Therefore, it is not surprising that in Merida more than 75% of the delegates come from the American continent, particularly from the United States (25%), Mexico (20%), and Brazil (19%). However, delegates from the Asian (India, China, Indonesia), African (Benin, Nigeria), Australian (Australia, New Zealand) and European (Germany, Great Britain, Netherlands, Spain, Italy, Czech Republic, Switzerland, among others) continents are attending the Merida meeting.

A particular effort has been made to enrich the meeting with special events that, in addition to keynote lectures, will provide diverse perspectives on critical issues in tropical biology and conservation through

debates and panel discussions. Four lectures will address topics such as: i) the collaboration required to better face scientific challenges and to search for solutions to environmental problems, ii) the need for trans-disciplinary work to cope with new diseases emerging from human impacts on biodiversity and natural ecosystems, iii) the history of extinctions of mammal fauna since the arrival humans to America (analyzed through extraordinary and unique paleontological records), and iv) the importance of tropical mangroves as complex ecosystems supplying ecosystem services of local, regional and planetary relevance.

Debates and panel discussions will be held for the first time on key topics with the participation of scientists and experts from different regions of the planet. One debate will address the advantages and disadvantages of conserving biodiversity through land-sharing versus land-sparing strategies. A second debate will discuss to what extent inter-governmental agreements on the international trade of animal and plant specimens (e.g. CITES) have fostered or hampered the conservation of endangered species. Regarding the panel discussions, a first one will address the extent to which the decline of the Mayan civilization was associated with an unsustainable management of their environment, and the lessons emerging from this socio-ecological history for present societies. A second panel will identify societal and ecological questions and issues emerging from the intersection of tropical ecology, conservation and society in the Anthropocene. Finally, a third panel will address the role of second-growth forests for conservation and restoration in the tropics analyzed from ecological, social and economic points of view. We hope that the audience will participate interactively in these events. To assess coincidences and divergences in the opinions of tropical biologists and conservationists, during the debates and panels the audience will respond to pre-defined questions using an electronic voting system.

Besides these special events, there will be a series of expositions, workshops, courses, meetings of working groups, and a variety of field trips, among other activities. In particular, we would like to highlight the scientific coffee sessions where delegates will be able to freely exchange ideas and points of view with leaders in tropical biology and conservation on hot scientific topics. Furthermore, ATBC will have the presence of the general public in Merida. During the days of the meeting a series of scientific coffee sessions will be open to the public in the splendid house of the National University of Mexico in Merida. Finally, we have prepared cultural activities that will bring delegates closer to the history, folklore and present life of the Yucatan Peninsula. Thus, on the day of inauguration, we will visit the Great Mayan World Museum, where you can visit rooms related to the impact of the asteroid that produced the Chixchulub crater and the extinction of dinosaurs and the history of the Mayan civilization. After this tour, we will offer a welcome cocktail with traditional Yucatecan food snacks and typical music of the region. For the banquet and closing party, delegates will enjoy a rich dinner of Yucatecan food, and will be able to experience and dance to the music typical of Mexico and Latin America.

All these activities, will give you the opportunity to enjoy the academically rich and friendly atmosphere typical of ATBC annual meetings.

Dr Miguel Martínez Ramos
ATBC 2017 Program Chair

Dr Juan Manuel Dupuy Rada
ATBC 2017 Program Co-chair

ORGANIZING COMMITTEE

Miguel Martínez-Ramos

Program Chair

Miguel Martinez-Ramos is an ecologist dedicated to the study of factors, processes and mechanisms that determine the dynamics of tropical forests in natural and modified environments in the dry and humid regions of Mexico and in some regions of Central and South America. His research focuses on the understanding of ecological principles involved in the coexistence of plant species at local and landscape scales, establishing the scientific basis for the sustainable use of tropical forest products and providing knowledge about regeneration and restoration of forests in landscapes shaped by activities human. His ultimate goal, is the establishment of frameworks for sustainable management of ecosystems, improving the conservation of biodiversity and the welfare of people who manage tropical forests.

Juan Manuel Dupuy Rada

Program Co-chair

Juan Manuel Dupuy is an academic dedicated to the research of the patterns, processes and factors that determine the structure, diversity and composition of tropical forests in human-perturbed habitats. Specially he is interested in the regeneration, succession and forest-dynamics at the community and landscape levels. Recently, his research projects have been focused to the carbon measurement and monitoring in the tropical forest to implement climate change mitigation strategies.

Victor Parra-Tabla

Victor Parra-Tabla is an ecologist at the Universidad Autónoma de Yucatán. His research has been focused on the study of multiple interactions that occur between parasitoids-herbivores-plants and pollinators. His research interest has been expanding to the study of plant local adaptation and phenotypic plasticity of interespecific interactions, using molecular tools and ambitious field experiments in large geographic scales. He is also interested in the implications of my studies in the conservation biology and management of some species.

Ireri Suazo-Ortuño

Ireri Suazo-Ortuño is an ecologist and herpetologist at the Instituto de Investigaciones sobre los Recursos Naturales of the Universidad Michoacana of San Nicolás of Hidalgo in Michoacán, México. Her research is focused on the ecology and conservation of wildlife, mainly in the dry tropical forest of Western Mexico. For the last 15 years she has been studying the effects of anthropogenic activities on ecological and functional aspects of amphibians and reptiles in order to recommend sustainable agricultural management practices.

ASSOCIATION FOR TROPICAL BIOLOGY AND CONSERVATION

The Association for Tropical Biology and Conservation (ATBC) is an international professional society formed in 1962 to promote awareness, research, education, and communication in all aspects of tropical biology and conservation. ATBC publishes a scholarly journal, Biotropica, hosts a website, and organizes an annual meeting each year. The activities of ATBC and its members promote the understanding, education, and conservation of tropical biology diversity for posterity, for its intrinsic worth and for aesthetic and tangible values to humanity.

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BSc. Mariana Soto, Universidad Nacional Autónoma de México
PCO Ana Osorio, Intermeeting
PCO Piéride Correa, Intermeeting

ORGANIZERS

INSTITUTO DE INVESTIGACIONES EN ECOSISTEMAS Y SUSTENTABILIDAD-
UNIVERSIDAD NACIONAL AUTÓNOMA DE MÉXICO

The Institute for Ecosystem and Sustainability Research (IIES-UNAM) mission is to conduct scientific research, human resources training and links with society, aimed at understanding environmental problems related to the management of socio-ecological systems, from disciplinary, multidisciplinary, interdisciplinary and transdisciplinary approaches. They contribute to building sustainable societies capable of providing fair and just, material and cultural satisfactions without affecting the capacity for renewal of ecosystems and respecting the natural processes that sustain life on the planet.
http://www.iies.unam.mx/

UNIDAD DE RECURSOS NATURALES-
CENTRO DE INVESTIGACIÓN CIENTÍFICA DE YUCATÁN

The Natural Resources Unit (URN) of the Center for Science Research of Yucatán (CICY) conducts research on conservation and sustainable use of natural resources in the Yucatan Peninsula, Central America, and other American regions. Also, URN carries out trans-disciplinary research and outreach activities with communities, producers, private agencies, government agencies and other academic institutions. URN is actively involved in training of graduate students in areas of Conservation Biology, Reproductive Biology, Biosecurity, Bio-productivity, Plant Ecology, Ecology of Communities and Ecosystems, Evolution, Systematics, Phylogeny, Physiology, Interactions, Landscape Ecology, and Ethnobotany, among other disciplines.
http://www.cicy.mx/unidad-de-recursos-naturales

DEPARTAMENTO DE ECOLOGÍA TROPICAL-
UNIVERSIDAD AUTÓNOMA DE YUCATÁN

The Department of Tropical Ecology (DET) of the Autonomous University of Yucatán (UADY) was created in 2000 as part of the Bachelor in Biology offered by UADY. In 2006, this BSc program received the award as "consolidated" by the Ministry of Education of Mexico, thanks to the important training labor of students and the scientific research done by the academics of the DET. The mission of DET is the generation of original knowledge in basic and applied areas of tropical ecology, as well as the training of students at high academic standards.
http://www.uady.mx/

INSTITUTO DE INVESTIGACIONES SOBRE RECURSOS NATURALES-UNIVERSIDAD MICHOACANA DE SAN NICOLÁS DE HIDALGO

The Research Institute of Natural Resources (INIRENA-UMSNH) is a unit of the Universidad Michoacana de San Nicolás de Hidalgo dedicated to scientific research, training human resources, and the transfer and dissemination of knowledge and technology generated for the benefit of society. The scientific community of INIRENA contributes to the understanding, management and conservation of natural resources of Mexico and in particular of the state of Michoacan.
http://www.inirena.umich.mx/

OUR PROFESSIONAL CONGRESS ORGANIZER (PCO)
INTERMEETING

This agency is expert in planning, promotion, and organization of congresses, exhibitions and conventions. Nineteen years of experience support them as one of the best PCO in Mexico. The success of this agency is due to their effective working method, experience, a reliable network of specialized suppliers and the best team of work, offering an integral service.

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SPONSORING

We are grateful for all institutions that offered financial support, donations or contributed to the organization of the meeting

Coordinación de la Investigación Científica, UNAM

Secretaría de Desarrollo Institucional, UNAM

Escuela Nacional de Estudios Superiores, Unidad Morelia UNAM

Posgrado en Ciencias Biológicas, UNAM

Gobierno del Estado de Yucatán

Secretaría de Fomento Turístico Gobierno del Estado de Yucatán

Oficina de Congresos y Convenciones Gobierno del Estado de Yucatán

Secretaría de Desarrollo Urbano y Medio Ambiente Gobierno del Estado de Yucatán

People and Reforestation in the Tropics, a network for education, research and synthesis

Comisión Nacional para el Conocimiento y Uso de la Biodiversidad

The Rufford Foundation

International Union of Biological Sciences

EXHIBITORS

Acknowledgements to our sponsors

Association for Tropical Biology and Conservation

Center for International Forestry Research

British Ecological Society

The Field Museum

Bruja de Monte

Wildlife Acoustics

GENERAL INFORMATION

ATBC MEMBERSHIP

As a member you will:

- benefit preferential prices to register at the ATBC annual meetings
- be allowed 10 free published pages in BIOTROPICA annually
- get access to member-only conference registration rates
- be elegible for presentation awards during annual meetings
- be elegible for travel grants to assist to annual meetings
- have a webpage for your field site promoted at tropicabio.org
- have your BIOTROPICA paper highlighted at our FaceBook page

For more information please visit Wiley or email cs-membership@wiley.com

SOCIAL NETWORKS

ATBC

https://twitter.com/tropicbiocon

https://www.facebook.com/TropicalBiologyConservation

ATBC Europe Group

https://www.facebook.com/groups/806472452717639/

ATBC. SECSCI (Student and Early Career Scientist Chapter)

https://www.facebook.com/groups/1429717710644455/

ATBC Africa Chapter

https://www.facebook.com/groups/1606854326244847/

ATBC 2017

https://twitter.com/atbc2017

https://www.facebook.com/atbc2017/

SOCIAL PROGRAM

WELCOME COCKTAIL
Sunday July 9th
18:30
Gran Museo del Mundo Maya

ATBC BANQUET
Thursday July 13th
20:30
Quinta Montes Molina

INFORMATION FOR PARTICIPANTS

BADGES
Your name badge is entry to all sessions, the exhibition, events & all catering services
Please wear your name badge at all times.

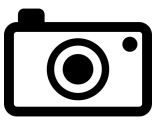
CATERING
Full registration fees included:
- Welcome Cocktail
- Coffee breaks
- 4 day lunch

Breaks will be served each day in the morning (at 10:30 hrs) and in the afternoon (at 16:00 hrs) in the Holiday Inn Hotel and in the corridors of Fiesta Americana Hotel.

EMERGENCY PROCEDURES AND FIRST AID
In the case of an emergency, please inform at 01 999 942 1111 (Hotel FA) or 911 (Emergency number in Mexico). Traveling and time zone differences can affect the body so feel free to stop in for medications,diagnosis, rest, minor injuries, or even to nurse for new mothers.

WIFI
Free wireless internet is available at no cost.

INTENTION TO PHOTOGRAPH
Delegates and others are advised that photographs may be taken during the conference and reproduced for promotional purposes.



SERVICES DEDICATED TO ATTENDEES

WELCOME PACK

We are delighted to welcoming you in Mérida during the 54th ATBC 2017. After your check-in at your arrival, go to our Welcome Desk (located in the Fiesta Americana Hotel, see map) to get your Welcome Pack.
Pack including: Delegate's bag, congress program, notebook and touristic information.

CHILD CARE

The ATBC 2017 organizers are please to make available to our attendees Child Care in the venue. You have to drop your child at the child care room (Salón Izamal, Fiesta Americana Hotel).

INFORMATION FOR AUTHORS

PREVIEW (Fiesta Americana Hotel)
All speakers are requested to check-in their presentation to the ATBC technical team at least a half day prior to their presentation. All presentations will be networked from the upload desk to the presentation rooms. The presentation upload desk will be open each day from 9:00 to 19:00.

ORAL PRESENTATION

Participants are advised to prepare PowerPoint presentation **using widescreen format (16:9)** with a time slot of 15 minutes, chich includes approximately 12 minutes for the presentation and 3 minutes for question and discussion.

POSTER PRESENTATION

The size of Poster Board is 100 X 120 cm (Width x Height) size maximum.
Poster should then be 96 X 117 cm (Width x Height) max and it should be labeled and laid out in a clear and logical format to effectively communicate the results of your work. Posters will typically be read from 1m away, hence, the text and graphics used should be able to be read from at least this distance. We suggest that written materials displayed on the panels should be no less than 24 point bold lettering

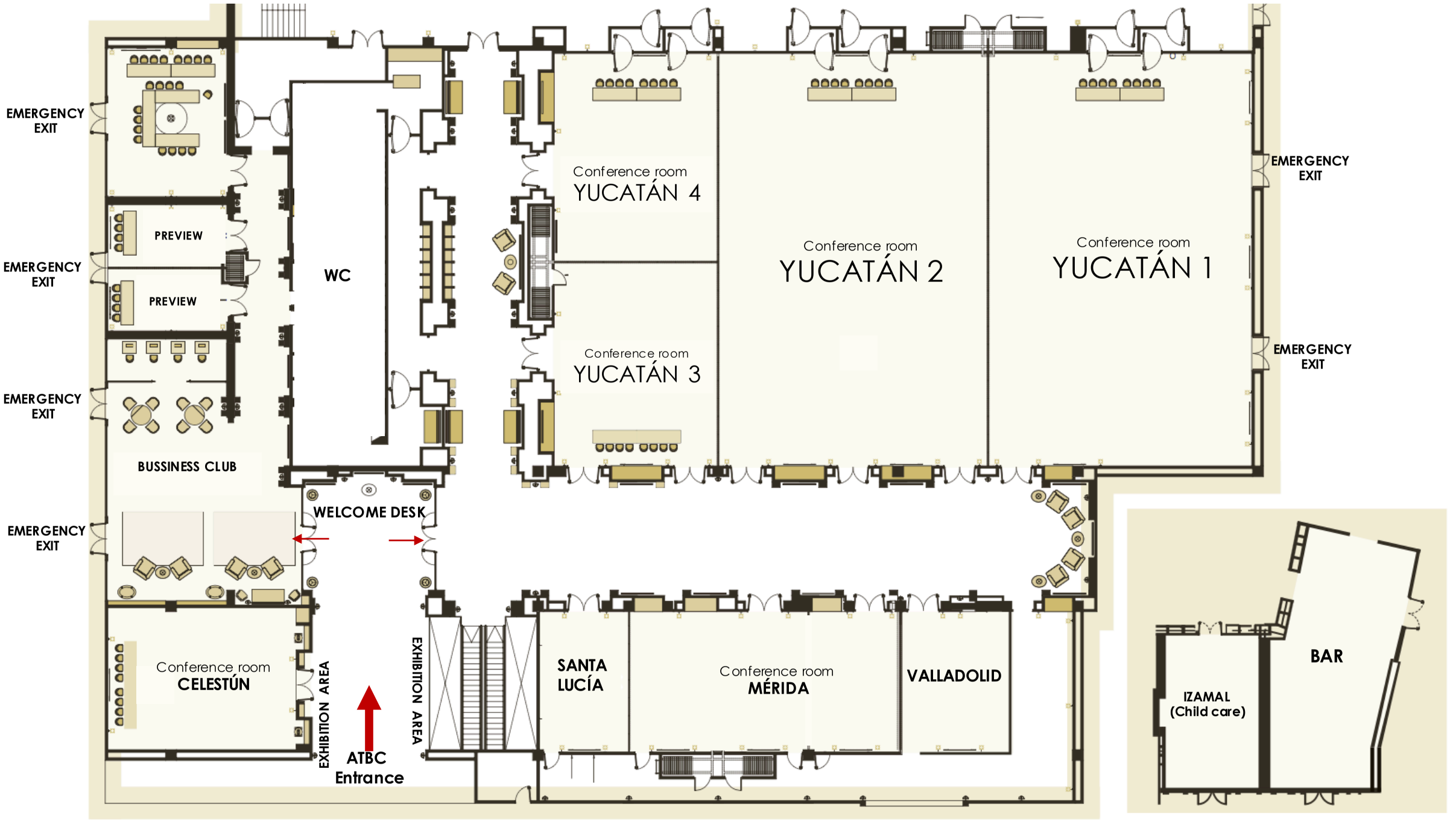
Each selected author have to give a presentation of their poster during their dedicated poster session day.
The scientific committee advise each selected author to be present at each poster sessions during ATBC 2017.

MAP OF MERIDA & ATBC 2017 LOCATIONS

ATBC 2017

Quinta Montes Molina

VENUE MAP: FIESTA AMERICANA (FA)



VENUE MAP: HOLIDAY INN (HI)

TIME	SITE	SUNDAY July 9th, 2017	MONDAY July 10th, 2017	TUESDAY July 11th, 2017
8:00-9:00	Welcome desk (FA)		**REGISTRATION**	
9:00-9:30	Yucatán 1 & Yucatán 2 (FA)		Opening welcome	**[PS]** Panel discussion The future Beyond Paradise: Frontiers in tropical ecology, conservation and society in the Anthropocene Rodolfo Dirzo, Sandy Andelman, José Sarukhán & Lucia Lohmann
9:30-10:30			**[PS]** Keynote lecture Hoyo Negro: Terminal Pleistocene Megafauna and the First Human of the Yucatan James Chatters	
10:30-11:00	Corridors of FA & HI		**COFFEE BREAK**	
11:00-13:00	Yucatán 1 (FA)	**ARRIVALS** **REGISTRATION** Welcome Desk (FA) From 10:00 hrs **WELCOME CEREMONY** Yucatán 1 & Yucatán 2 (FA) 16:15 hrs **PRESIDENTIAL ADDRESS** Marielos Peña Yucatán 1 & Yucatán 2 (FA) 17:00 hrs **WELCOME COCKTAIL** Gran Museo del Mundo Maya 18:30 hrs ***Please check details in highlights***	**[SYMP]** Trends in plant-pollinator interactions in the tropics	**[SYMP]** Multiple-use forests: can forest conservation and socio-economic development be combined?
	Yucatán 2 (FA)		**[SYMP]** Tropical biotic interactions in the Anthropocene	**[SYMP]** Using functional diversity to understand community and ecosystem processes in tropical dry forests
	Yucatán 3 (FA)		**[SYMP]** Trees outside forest for biodiversity conservation, ecosystem services and livelihoods	**[SYMP]** Insect-Plant interactions: patterns and processes in a changing world
	Yucatán 4 (FA)		**[SYMP]** Tropical leaf phenology: field, remote sensing and modelling	**[SYMP]** The impacts of agrarian change on local communities: sharing experience from the field
	Mérida (FA)		**[SYMP]** Advancing Bamboo Ecology, Systematics, and Conservation in the Neotropics	**[SYMP]** Tropical Pollination Services in the Anthropocene
	Celestún (FA)		**[SYMP]** Biodiversity responses to landscape structure	**[SYMP]** Primate conservation in human-disturbed habitats
	Uxmal (HI)		**[SYMP]** Eliminating a false dichotomy: the importance of human-modified landscapes for conservation plans	**[SYMP]** Biogeography, ecology and sustainability in Caatinga: the largest dry forest in South America
	Tulum (HI)		**[SYMP]** The impact of the El Niño on tropical ecosystems	**[SYMP]** Participatory modeling and games to engage people in science based conservation ecology and planning
	Kabah (HI)		**[SYMP]** Origins and consequences of genetic and functional variation in tropical oaks under global change	**[SYMP]** Modeling Tropical Forest Dynamics and Element Cycles in an Era of Global Change
	Maya (HI)		**[SYMP]** Socio-Ecological dimensions of changing fire regimes for tropical biodiversity conservation	**[SYMP]** Working with others for carnivore conservation: interdisciplinary, participatory and action research
13:00-14:30	Restaurants of FA & HI		**LUNCH**	
	San Jacinto (HI)		**[SE]** Soft-skills workshop- Getting published in the sciences	**[SE]** Soft-skills workshop- Presentation skills
	Santiago (HI)		**[SE]** Panel: Lessons in conservation	----------
14:30-16:00	Yucatán 1 (FA)		**[OS]** Biotic interactions in tropical ecosystems I	**[SYMP]** Multiple-use forests: can forest conservation and socio-economic development be combined?
	Yucatán 2 (FA)		**[SYMP]** Tropical biotic interactions in the Anthropocene	**[SYMP]** Using functional diversity to understand community and ecosystem processes in tropical dry forests
	Yucatán 3 (FA)		**[OS]** Seedling and sapling ecology	**[OS]** Functional aspects of tropical ecosystems
	Yucatán 4 (FA)		**[OS]** Ecology, genetics, and evolution of tropical systems I	**[OS]** Ecology, genetics, and evolution of tropical systems II
	Mérida (FA)		**[SYMP]** Advancing Bamboo Ecology, Systematics, and Conservation in the Neotropics	**[OS]** Biotic interactions in tropical ecosystems II
	Celestún (FA)		**[OS]** Soil ecology in tropical systems	**[OS]** Seed and seedling ecology
	Uxmal (HI)		**[OS]** Human influences on tropical ecosystems and landscapes	**[SYMP]** Biogeography, ecology and sustainability in Caatinga: the largest dry forest in South America
	Tulum (HI)		**[OS]** Structure, function, and diversity of tropical ecosystems	**[OS]** Tropical biodiversity and conservation in human modified landscapes
	Kabah (HI)		**[OS]** Plant-soil-fungi interactions	**[OS]** Restoration of degraded tropical ecosystems
	Maya (HI)		**[OS]** Biodiversity inventories in tropical ecosystems I	**[OS]** Invasive species
	CIS (FA)		**[SE]** Oaks of the Americas Conservation Network Meeting on Research and Conservation of Tropical Oaks	**[SE]** Exploring Collaboration Between Africa and Latin America for Ecology and Conservation Biology
	San Juan (HI)		----------	**[SE]** Neotropical Bamboo Research working group
16:00-17:00	Corridors of Holiday Inn		**COFFEE BREAK & POSTERS**	
	Uxmal (HI)		Audiovisual session	Audiovisual session
	Tulum (HI)		Audiovisual session	Audiovisual session
	Kabah (HI)		**[SC]** Scientific café	**[SC]** Scientific café
	CIS (FA)		----------	**[SE]** Exploring Collaboration Between Africa and Latin America for Ecology and Conservation Biology (continuation)
	San Juan (HI)		----------	**[SE]** Neotropical Bamboo Research working group (continuation)
17:10- 18:10	Yucatán 1 & Yucatán 2 (FA)		**[PS]** Panel Discussion The human-environment interactions of the Ancient Maya: lessons from the past to future sustainability Anabel Ford, David Lentz, Gerald islebe,Javier Caballero	**[PS]** Keynote lecture The skin of our coasts: Mangrove services in a rapidly changing environment Exequiel Ezcurra
18:10 - 18:40				**[PS]** Town Hall Meeting
18:40-19:10			----------	
19:10-19:40				----------
20:30	Quinta Montes Molina			

(FA): Fiesta Americana Hotel (HI): Holiday Inn Hotel

[PS]: Plenary session [SYMP]: Symposium [OS]: Oral session [SE]: Side event [SC]: Scientific Café

WEDNESDAY July 12th, 2017	THURSDAY July 13th, 2017	FRIDAY July 14th, 2017	SITE	TIME
REGISTRATION		FIELD TRIPS	Welcome desk (FA)	8:00-9:00
[PS] Debate Land Sparing and Land Sharing: Can we have both? Ivette Perfecto & Ben Phalan	**[PS]** Debate Are trade and hunting bans on endangered tropical species a "perfect storm" for poaching or an effective conservation strategy Annecoos Wiersema & Duan Biggs		Yucatán 1 & Yucatán 2 (FA)	9:00-9:30 9:30-10:30
COFFEE BREAK			Corridors of FA & HI	10:30-11:00
[SYMP] Conservation challenges in the agro-forest frontier; past, present and future	**[SYMP]** The dry tropics: vulnerability and resilience		Yucatán 1 (FA)	11:00-13:00
[SYMP] Defaunation and ecosystem services	**[SYMP]** Ecological drivers of succession in human-modified landscapes, from local to meta-communities		Yucatán 2 (FA)	
[SYMP] Quantitative acoustic ecology: using sound in tropical biodiversity research and conservation	**[OS]** Plant-hebivore interactions		Yucatán 3 (FA)	
[SYMP] A landscape perspective on biodiversity conservation and management in oil palm mosaics	**[OS]** Tree and liana responses to drought and other factors		Yucatán 4 (FA)	
[SYMP] Bridging conservation ecology and genomics in the study of species with Crassulacean Acid Metabolism	**[OS]** Biodiversity inventories in tropical ecosystems II		Mérida (FA)	
[SYMP] Exploring the fate of tropical forests under drier climates: linking mechanisms to models	**[OS]** Ecology and conservation of tropical vertebrates		Celestún (FA)	
[SYMP] Structure, function, and dynamics of tropical ecosystems	**[OS]** Structure, function, and dynamics of tropical ecosystems		Uxmal (HI)	
[SYMP] Lightning talks and networking in tropical science: ATBC-SECSCI Chapter symposium	**[OS]** Fragmentation effects on ecology of plants and animals		Tulum (HI)	
[SYMP] New Views of Structural Complexity and Tropical Ecosystem Function	**[OS]** Ecosystem services and tropical systems		Kabah (HI)	
[SYMP] Leaf cutter ants and forest ecosystem processes	**[OS]** Social and economical drivers of tropical ecosystem change		Maya (HI)	
Mentoring circles (Restaurant: Café Montejo; FA)			Restaurants of FA & HI	13:00-14:30
LUNCH			San Jacinto (HI)	
----------	**[SE]** Workshop- Conservation in practice		Santiago (HI)	
----------	----------		Yucatán 1 (FA)	14:30-16:00
[SYMP] Conservation challenges in the agro-forest frontier; past, present and future	**[SYMP]** The dry tropics: vulnerability and resilience		Yucatán 2 (FA)	
[SYMP] Defaunation and ecosystem services	**[OS]** Functional diversity and functional traits in tropical systems		Yucatán 3 (FA)	
[OS] Tropical forests and climate change	**[OS]** Tropical forest dynamics and functioning		Yucatán 4 (FA)	
[OS] Ecology, genetics, and evolution of tropical systems III	**[OS]** Morphological, physiological and structural traits of tropical forest plants: from leaves to forest canopy		Mérida (FA)	
[SYMP] Bridging conservation ecology and genomics in the study of species with Crassulacean Acid Metabolism	**[OS]** Ecology of tropical secondary forests		Celestún (FA)	
[OS] Effects of hurricane and fire disturbances on tropical ecosystems	**[OS]** Population and community dynamics		Uxmal (HI)	
[OS] Ecology of plant growth	**[OS]** Biological and social bases for sustainable use of non timber forest products		Tulum (HI)	
[OS] Diversity changes in environmental gradients	**[OS]** Conservation iniciatives and tropical biology research		Kabah (HI)	
[OS] Ecosystem functioning in secondary and mature tropical forests	**[OS]** Human development and tropical ecosystems		Maya (HI)	
[OS] Biotic interactions in tropical ecosystems III	**[OS]** Coral and other aquatic systems		CIS (FA)	
[SE] Game salon: hands-on demonstration of role-playing games for ecology and conservation	**[SE]** Workshop: How to publish in high quality scientific journals		San Juan (HI)	
----------	----------		Corridors of Holiday Inn	16:00-17:00
COFFEE BREAK & POSTERS			Uxmal (HI)	
Audiovisual session	Audiovisual session		Tulum (HI)	
Audiovisual session	Audiovisual session		Kabah (HI)	
[SC] Scientific café	----------		CIS (FA)	
[SE] Game salon: hands-on demonstration of role-playing games for ecology and conservation (continuation)	----------		San Juan (HI)	
----------	----------		Yucatán 1 & Yucatán 2 (FA)	17:10- 18:10 18:10 - 18:40 18:40-19:10 19:10-19:40
[PS] Panel discussion The role of secondary forests in restoration and biodiversity conservation Robin Chazdon, Thomas Rudel, Laura C. Schneider, Bernardo B. Neves & Manuel R. Guariguata	**[PS]** Keynote lecture conservation Medicine and One Health: Addressing the Changing Threats of Disease Emergence, Globalization and Climate Change to Tropical Biodiversity Alonso Aguirre			
----------	**[PS]** Closing ceremony, The Merida Declaration			
	ATBC Banquet		Quinta Montes Molina	20:30

**** The “Game salon” side event starts at 14:00 hrs

Plenary sessions

SUNDAY

July 9th, 2017 (17:00 hrs)

Collaboration in Science
(Presidential address)

Dr Marielos Peña

Presenter: Dr Frans Bongers

The way we do science has changed over time from an individualistic endeavour to a group undertaking. Does collaboration in science allows coping better with the environmental and scientific challenges that society is confronted with? And how do we organize our collaboration? What are the formulas for success and failure? In this presentation I will explore these questions and will highlight some example of successful collaboration that can enhance science, capacity building, and impact on the ground.

MONDAY

July 10th, 2017 (9:30 hrs)

Hoyo Negro: Terminal Pleistocene Megafauna and the First Human of the Yucatan

Dr James Chatters

Presenter: Dr Ek del Val

Biological communities of Central America, although under threat, retain among the highest levels of medium-to-small animal diversity of any ecosystems on earth. They were formerly even more diverse, including a complex megafaunal assemblage as well. Paleontological records of such environments tend to be rare, however, because warm temperatures and acid soils lead to rapid destruction of skeletal remains. The limestone caves of the Yucatan peninsula are proving to be an exception to this pattern, offering an almost unmatched skeletal record of large mammals dating to the time of humans' first arrival in the Americas. Most large mammal discoveries are being made underwater in the submerged caves of Belize and the Mexican state of Quintana Roo. The most spectacular and informative of these is the site of Hoyo Negro.

Located at the confluence of three >600 meter-long tunnels, Hoyo Negro is a 60 meter-diameter collapse chamber that falls 30-45 meters below the tunnel floors and 40-55 meters below the water surface. Before sea level rose at the end of the last glaciation, it was a perfect natural trap. At its bottom, among boulders, heaps of calcite raft sediment, and piles of bat guano, lie the remains of 27 large animals. Others are found in the connecting tunnels.

At least eight extinct species are included among the almost perfectly-preserved skeletons: saber tooths, highland gomphotheres, three species of giant ground sloth, the south American bear Arctotherium, and a large canid. One of the sloths is a new genus; the South American carnivores have not been previously documented in Central America. Along with tapirs, peccaries, pumas, and a coati, which remain in the region today, are bobcats and coyotes, which are far outside their modern ranges. Additional tunnels contain remains of glyptodont, extinct llama, and horse. The image is of a highly diverse megafaunal community or closely spaced communities in a complex, dynamic mosaic.

At least some of these many species were extant after 15,000 years ago, when humans first arrived. Among their bones on the floor of Hoyo Negro floor are remains of one of those earliest people, Naia, an adolescent girl. Her nearly complete ~13,000 year-old skeleton is the earliest currently known in the Americas and is providing extraordinary information about the activities, health, and livelihood of the first people of Meso America.

Investigation and, in some cases, recovery of these skeletons from deep under water, in the dark, has posed major technical challenges. Dating them has been problematic. However, their study, together with paleoecological analysis of the calcite raft sediment, stalagmites, guano deposits, and abundant sticks and charcoal, offers an unparalleled opportunity to understand the ecosystems of the terminal Pleistocene Yucatan and the initial impact of people on them.

MONDAY

July 10th, 2017 (17:10 hrs)

The human-environment interactions of the Ancient Maya: lessons from the past to future sustainability

Participants: Dr Anabel Ford, Dr David Lentz, Dr Gerald Islebe, Dr Javier Caballero

Moderator: Dr Jorge Soberón Mainero

The Ancient Maya civilization developed and persisted during more than 3000 years managing a large extension of the Mesoamerican tropical forest, extending, at its peak, from Yucatan peninsula, Guatemala, Belize to Honduras. The flourishing of this civilization accounts for great scientific, cultural and technological advances. Tree farming, biodiversity management in orchards, sophisticated irrigation and soil conservation systems, all indicated continuous adaptive forest management in response to population growth and climate changes during 3000 years (Fedick 2010). The collapse and rapid depopulation of Maya civilization occurred more than 1000 years ago, and these events are the subject of long-standing debates about human-environment dynamics among the Maya and their forest. Did Maya managed or destroyed their forest? Did this human-environment system reach a tipping point? What is the role of climate change (drought) and the interaction with land-stress factors and forest fragmentation? what is the role of social, economical and political drivers? Responses to these questions have generated dozens of influential publications from multiple disciplines, pointing to an emerging consensus on causes resulting from complex and reinforcing coupled human-environment systems interactions (Turner 2012). The evidence suggesting a rapid recovery of forest cover (80-280 years) and soil stabilization (120-280 years) (Mueller et al. 2010), and the large extant diversity of the Maya forest (1000 years after, considered a biodiversity hotspot) (Ford 2015), give us light on the tropical rain forest resilience and the time frame involved. The elevated proportion of the current flora corresponding to plants used by the Maya people, points to the growing evidence that actual tropical rain forest in high diverse regions are not pristine, but managed forests (Barlow et al. 2012). Overall, understanding the Maya socio-ecosystem history will give us lessons on the factors driving biodiversity and sustainability in the face of current and future climatic changes.

TUESDAY

July 11th, 2017 (09:00 hrs)

The future beyond paradise: Frontiers in tropical ecology, conservation, and society in the Anthropocene

Participants: Dr Rodolfo Dirzo, Dr Sandy Andelman, Dr José Sarukhán, Dr Lucia Lohmann

Moderator: Dr Patricia Balvanera

More than a decade ago the influential paper "Beyond Paradise—Meeting the Challenges in Tropical Biology in the 21st Century" [Biotropica, 2004, 36(4): 437-446] was published. In that paper major research challenges and gaps in tropical biology and conservation were identifies, including the understanding of (1) the evolution, structure and functioning of tropical ecosystems; (2) the nature and magnitude of anthropogenic effects on tropical ecosystems; and (3) the socio-economic drivers of these anthropogenic effects. It was envisaged that in order to reach effective strategies for conservation, restoration, and sustainable management of tropical ecosystems, scientific perspectives must be integrated with social necessities, under three principles: (1) broadening the set of social and biological concerns; (2) integrating biological knowledge with the social sciences and traditional knowledge; and (3) linking science to policy and action. Four broad recommendations were proposed for immediate action in tropical biology and conservation that were thought to be fundamental to all biological and social disciplines in the tropics: (1) assemble and disseminate information on life's diversity in the tropics; (2) enhance tropical field stations and build a worldwide network to link them with tropical field biologists at their field sites; (3) bring the field of tropical biology to the tropics by strengthening institutions in tropical countries through novel partnerships between tropical and temperate zone institutions and scientists; and (4) create concrete mechanisms to increase interactions between tropical biologists, social scientists, and policy makers. In this discussion panel these research challenges, principles and recommendations will be revisited by senior scientific researchers, economists and policy makers from different disciplines to assess the degree to which tropical biology, conservation, and major social and economic issues have develop during the last decade.

TUESDAY

July 11th, 2017 (17:10 hrs)

The skin of our coasts: Mangrove services in a rapidly changing environment

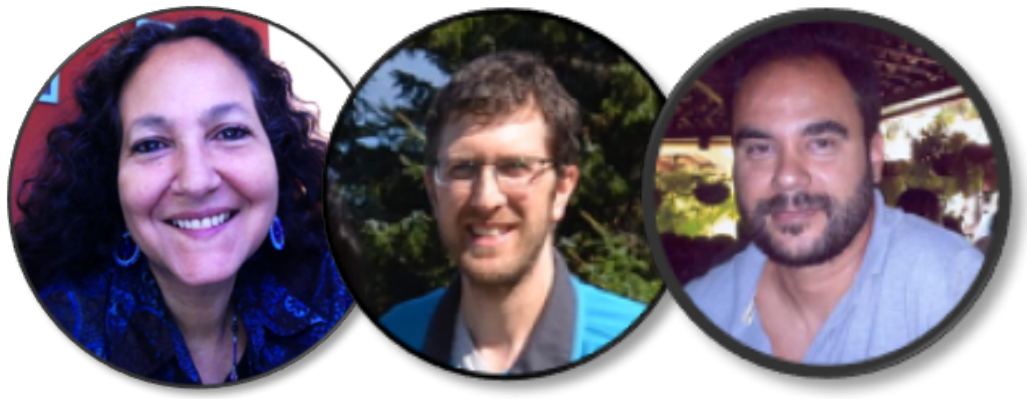
Dr Exequiel Ezcurra

Presenter: Dr Patricia Balvanera

Despite their comparatively small area, globally, mangroves have a disproportionate importance in providing environmental services in the tropics. Recent decades have seen dramatic advances in our ability to quantify the services of coastal lagoons, including (a) coastal protection and risk reduction from extreme weather, (b) fisheries, (c) habitat for migratory waterfowl and birds in general, and (d) mitigation of the effects of sea-level rise. Thanks to these studies, significant progress has been made in advancing conservation efforts in coastal lagoons despite strong opposition from coastal developers. More recently, a number of studies have highlighted the importance of mangroves in sequestering and storing carbon within their sediments. While some mangrove forests accumulate carbon as amorphous organic matter mixed with clay, others form deep layers of peat (partially decomposed but recognizable root tissues). Peat-forming mangroves have been accumulating root remains for thousands of years and harbor belowground carbon contents that can reach many thousand tons in one hectare. Their depth–age curves are invaluable records of sea-level rise during the Holocene. Retention of belowground peat allows some mangroves to accrete vertically and keep pace with sea level rise by growing on their own root remains, and in doing so they have been storing large amounts of carbon in their sediments. The quantification of total belowground carbon allows us to assess the importance of mangroves as carbon sinks, but, perhaps more importantly, radioisotope dating of peat fragments allows us to estimate the long-term rate of carbon sequestration in coastal lagoons.

WEDNESDAY
July 12th, 2017 (09:00 hrs)

Land-sparing and land sharing:
Can we have both?



Participants: Dr Ivette Perfecto & Dr Ben Phalan

Moderator: Dr Marcello Tabarelli

How to simultaneously provide food and energy for people whilst conserving biodiversity and ecosystem services is one of the most important questions facing ecologists and conservation biologists in the 21st Century. Of particular concern is whether biodiversity ill benefit more from natural ecosystems embedded into, or isolated from productive (agricultural and pastoral) lands. The former strategy, usually termed 'land sharing', involves the retention of small elements of native ecosystems in the agricultural mosaic. This can enable some biodiversity to be maintained within the agricultural landscape, but, some argue that it is often lower-yielding, thus requiring a larger area of farmland to produce a given amount of food. The latter strategy, termed 'land sparing', requires farming at higher yields on a smaller area of land, potentially preventing the conversion (or enabling restoration) of natural ecosystems. The relative effectiveness of the two approaches for biodiversity conservation depends on how individual species respond to changes in agricultural management. If species are relatively resilient to habitat conversion, but are highly sensitive to practices that increase yields of livestock and crops, they will do least badly with a land sharing approach that limits intensification at the potential cost of increased habitat conversion. Alternatively, if species are highly sensitive to habitat conversion (e.g. forest loss) a land sparing approach will be more effective as it maximizes natural habitat conservation whilst concentrating production elsewhere. Because the land sparing approach usually requires a smaller area of land to attain the same yield, and therefore leaves greater areas of natural habitat untouched, it may have the best potential to preserve net biodiversity. Yet, increasing per-hectare productivity, especially in large-scale monocultures, is not likely to solve the hunger and malnutrition in the world, which is largely a consequence of limited access to food and not the overall quantity of food available. Furthermore, increasing yields can often result in a 'rebound effect', accelerating rather than slowing down deforestation, at least locally. Thus, there are still many issues that need to be clarified, and the debate is still open. Some propose that both land sparing and land sharing are needed to promote biodiversity conservation, but others counter that this perspective downplays the clear tension between the two strategies. Is this win-win vision little more than wishful thinking, or can we really combine both?

WEDNESDAY

July 12th, 2017 (17:10 hrs)

The role of tropical secondary forests in conservation and restoration

Participants: Dr Robin Chazdon, Dr Thomas Rudel, Dr Laura Schneider, Dr Bernardo Baeta Strassburg, Dr Manuel Guariguata

Moderator: Dr Frans Bongers

Since the middle of the last century, understanding the effects of human disturbances on the resilience of tropical forests has been central to the study of tropical biology and conservation. In the XXI century, this area of research has grown and broadened, as second-growth forests are becoming the dominant vegetation in tropical regions around the globe due to increasing pressures imposed by human activities on forest ecosystems (e.g., land use change, climate global change, introduction of exotic species). New approaches (functional, phylogenetic, socio-ecological) have emerged to understand the influence of biophysical and human factors on forest regeneration and on the structure, dynamics, and functions of secondary forests. Further, strong concern is mounting regarding the importance of secondary forests for biodiversity conservation, for large-scale reforestation programs, and for the role of these forests in carbon sequestration and mitigating effects of global climate change. This panel will address key questions about the state of the art of the ecology and economics of secondary tropical forests and the role these forests can play for conservation and restoration in the Anthropocene. The panel will include researchers from different disciplines of natural and social sciences that will discuss these aspects and pin-point guidelines for future research and policies for conserving biodiversity and to restore degraded lands in human modified landscapes across the world's tropics.

THURSDAY
July 13th, 2017 (09:00 hrs)

Are trade and hunting bans on endangered tropical species a "perfect storm" for poaching or an effective conservation strategy?

Participants: Dr Annecos Wiersema & Dr Duan Biggs

Moderator: Dr Exequiel Ezcurra

The trade in wildlife threatens more than one third of birds and mammals worldwide, and has driven close to extinction more than 1000 species of trees for timber. Trade bans implemented locally or internationally are intended to curb the loss of these species so that conservation strategies can be implemented that allow the species to recover to viable and robust population levels.

Despite international agreements to ban the trade in numerous species at threat of extinction, in the last five years, illegal trade in highly threatened and endangered iconic species such as elephants, rhinoceros and tigers has risen exponentially questioning the effectiveness of trade bans and sparking heated debate about whether bans are a viable conservation strategy. Strong evidence exists suggesting that bans may actually fuel illegal trade by inflating retail prices and making poaching the only way to acquire the species. For example, at prices of up to $65,000 per kilo of rhino horn, the stakes for poachers are high and protecting of endangered species has become increasingly more difficult and dangerous. Unwavering demand by consumers for the parts or whole of threatened species despite awareness raising and education campaigns suggest that neither these are viable strategies or that they do not work at the scale or speed required.

To date, the trade or not to trade debate has largely focused on the illegal trade of ivory, tigers and rhino horns. We will ask out debaters to venture beyond trade bans on 'luxury' items, however, so as to explore a highly linked but less-explored discussion - on whether the ban on consumption and trade of bushmeat and wildfoods of threatened species is 'correct' given the importance of this food source and income to impoverished rural families in the tropics. These are delicate and controversial discussions that tropical biologists, conservation scientists and practitioners must have if we are to identify viable conservation solutions that take into consideration the highly complex and intertwined dimensions of ecology and society.

THURSDAY

July 13th, 2017 (17:10 hrs)

Conservation Medicine and One Health: Addressing the Changing Threats of Disease Emergence, Globalization and Climate Change to Tropical Biodiversity

Dr Alonso A. Aguirre

Presenter: Dr Luis Daniel Ávila

According to WWF's Global Living Planet Report 2016, declines in vertebrate populations averaged 58% between 1970 and 2012, including losses of 36%, 38%, and 81% in marine, terrestrial, and freshwater ecosystems, respectively. Humanity has much more to learn about the critical roles that these species play in both complex ecological processes and health, and thus much to lose letting them go extinct. Wildlife is increasingly impacted by encroachment, malnutrition, toxicants, and emerging diseases shared with domestic animals and humans. Indeed, diseases can be catastrophic to already stressed populations becoming leading factors in species declines and extinctions. Recent examples include chytridiomycosis in amphibians, white nose syndrome in bats, Tasmanian devil facial tumors, Ebola virus in great apes, multiple pathogens and neonicotinoids linked to honeybee declines, and nutrient-driven hypoxic dead zones impacting fisheries. Much more should be done to monitor diseases in wildlife in the tropics. Many sylvatic cycles of pathogens are unknown or poorly understood and there is no one international governmental agency that conducts comprehensive ecological surveillance and monitoring of diseases in animals across countries. Even worse, many wild animals are exported to countries that conduct little or no surveillance.

Conservation Medicine and more recently One Health have emphasized the need to bridge disciplines, thereby linking human health, animal health, and ecosystem health under the paradigm "health connects all species in the planet". Transdisciplinarity, integrative research, and capacity building are core elements in establishing interventions that address extant, emerging, and re-emerging pathogens and toxicants that harm humans, wildlife, and other components of biodiversity. Efforts to intervene will need to be both "bottom/local up" and "top/national/international down." Developing practical, sustainable and effective solutions requires a keen understanding of local socio-economic factors and a solid grasp of complex national and regional health and environmental policies. Efforts should begin within each country by developing strategies by the Ministries of Health, Agriculture and Wildlife to work together in common databases and emerging issues. In turn, federal agencies should rely on local scientists who are intimately familiar with these complicated, on-the-ground realities. Consistent with this philosophy and goals, we need to strive to ensure lasting local conservation impacts with global health solutions with every project by training community leaders, volunteers and school children, in addition to professional, in-country experts. Conservation Medicine and One Health offer time-sensitive opportunities to the conservation, veterinary and public health community to reach out for new collaborations with simultaneous benefits for humans, animals, plants and the environment.

SIDE EVENTS

Satellite Meeting
Oaks of the Americas Conservation Network Meeting on Research and Conservation of Tropical Oaks

Organizer: Audrey Denvir

Monday July 10th
14:30 hrs
C.I.S. (Fiesta Americana)

Oaks act as keystone species in a number of tropical systems, including Southeast Asian subtropical broad-leaved evergreen forests, Mesoamerican oak-pine forest, and montane cloud forests. In fact, the two centers of diversity and endemism for oaks are tropical and subtropical regions of China and Mexico.

The Oaks of the Americas Conservation Network (OACN) was founded at the International Workshop for Oak Conservation in Morelia, Mexico in March of 2016. OACN is an interdisciplinary group of experts from botanical gardens, arboreta, universities, conservation NGOs, and government agencies that recognizes the importance of oaks to both temperate and tropical ecosystems in the Americas, as well as the threats to extinction and knowledge gaps that persist surrounding oak species. We are focused on facilitating collaboration across sectors and catalyzing both research and conservation action in order to translate scientific knowledge into effective protection of oaks in the Americas.

Since its founding meeting, the OACN Network has begun to develop a number of oak-focused conservation projects and workshops. For example, we initiated a project that integrates ex situ and in situ conservation actions for Quercus brandegeei, a narrow endemic in south Baja California, Mexico. We are also planning a meeting in Honduras this fall to facilitate the development of an international conservation strategy for Quercus insignis, a species whose distribution spans from Mexico to Panama but that is rare and threatened in some countries. We are also building capacity to improve taxonomic knowledge of oak species in Mexico, one of the world's two centers of oak diversity.

At this OACN Satellite Meeting, we will give updates on these projects and invite input and collaboration in these efforts moving forward. We will also ask attendees to highlight their own oak research or conservation work in order to identify opportunities for further collaboration towards our goals of filling knowledge gaps and conserving threatened oaks in the Americas. In this way, the OACN Satellite Meeting at ATBC will grow and strengthen the OACN network, identify critical research needs, prioritize conservation objectives, and strategize next steps.

All ATBC conference delegates with an interest in oak research and conservation are encouraged to attend, even if they are not formally a member of OACN. OACN welcomes new members as well as researchers interested in learning more about the network.

Workshop

Exploring Collaboration Between Africa and Latin America for Ecology and Conservation Biology

Organizer: Tuyeni Mwampamba

Tuesday July 11th
14:30 hrs
C.I.S. (Fiesta Americana)

Africa and South & Central America contain the largest surface area of the tropical world, each housing the largest remaining continuous tracks of tropical forests and together, more than 65% of the world's biodiversity. Although they harbor very dissimilar recent mammal fauna, they share many landscape similarities, including the presence of extensive rain forests, savannas, steppes and deserts. Interesting and intriguing commonalities exist in the use and transformation of these landscapes partially due to social, political and historical commonalities, such as, highly natural resources dependent rural communities, poverty, civil war, and dictatorships. These seemingly divergent continents share a plethora of conservation and development challenges that represent opportunities for cross-learning and valuable interchange. Yet, there are very few collaborations in place between ecologists, conservation biologists and conservation practitioners from the 'old' and 'new' tropics. Where of a bounty of studies and exchanges could be happening, a vast vacuum of untapped potential exists. This two-hour workshop, organized by the newly-formed ATBC Africa Chapter, is aimed at exploring potential research topics and collaborations between Africa and Latin America. After hearing from a set of 3 to 4 panelists who have been able to work in both regions, participants will break out in groups to identify potential research topics and collaborative work that could immediately be implemented, and research grants that could fund such work. Our hope is for some of the collaborations formed in Mérida will develop into research, conservation, and capacity building outputs that can be presented in a symposium at the ATBC 2019 meeting in Madagascar.

Working group

Neotropical Bamboo Research working group

Organizer: Belen Fraderique

Tuesday July 11th, 2017
14:30 hrs
San Juan (Holiday Inn)

The limited knowledge about neotropical bamboos is scattered and poorly integrated. The Neotropical Bamboo Symposium will be the perfect set up to showcase recent research and present results on the individual projects. However, many of the objectives that we want to pursue regarding neotropical bamboo research would highly benefit from a follow-up meeting where researchers can synthesize knowledge, express their opinions, and engage on further discussion.
On this working group we propose to review some of the main topics discussed at the symposium and address some of the risen debates. The main objectives that will be addressed during the symposium and this follow-up workshop are 1) the distribution of neotropical bamboo ecosystems and species; 2) the linkages between bamboo taxonomy and ecology; 3) anthropogenic influences on bamboo conservation status; and 4) the influence of bamboo on forest dynamics. For example, on the symposium, several researchers will be presenting studies on the influence of bamboo in forest dynamics in Argentina, Brazil, Peru and Bolivia; on the

working group, we will offer time to discuss what are the similarities and differences between these forests and the bamboos that inhabit them, and to consider the possibility of stablishing some collaborative projects that enlarge our understanding on this topic.
This meeting will provide a great opportunity to integrate current information, identify knowledge gaps, determine future directions and stablish and strengthen collaborative relations.

Workshop
Game salon: hands-on demonstration of role-playing games for ecology and conservation

Organizer: Trevor Caughlin
Wednesday July 12th
14:00 hrs
C.I.S. (Fiesta Americana)

The complexity of global environmental challenges will require interdisciplinary research that engages stakeholders and results in environmental advocacy and policy change. Role-playing games represent a powerful tool to involve stakeholders in research across a range of fields, including behavioral economics, complex systems analysis and natural resource management. In this workshop we demonstrate five role-playing games designed to exchange information, promote discussion, and solicit feedback from multi-stakeholder groups. These games present land-use scenarios, natural resource management scenarios, and ecological dynamics in a form that can engage a broad audience, and all have been implemented in tropical Latin American countries. This workshop will complement Symposium 6-11, titled "Participatory modeling and games to engage people in science-based conservation," by providing conference attendees an opportunity to actually play the board games presented in the symposium. The workshop will encourage participants to think about using role-playing games through fun, hands-on activities

Workshop
How to publish in high quality scientific journals:

Organizer: Emilie Aimé, Managing Editor, British Ecological Society
Thursday, July 12th
14:30 hrs
C.I.S. (Fiesta Americana)

Submitting to international journals is an important part of a scientist's career. This interactive workshop is designed to introduce early career researchers to the process of publishing in international journals, including how to select the right journal for your work, how to prepare your manuscript, what happens during the review process and how to respond to decision letters and reviews. It will also briefly cover some common policies and practices such as data archiving, open access, ethical practices and authorship issues.

Workshop

Strengthening facilitation skills for conservation: working with others on the case of jaguar management in Calakmul

Organizer: Sophie Calmé & Lou Lecuyer

Saturday July 8th - Sunday July 9th

This is a one-of-its-kind two-day workshop on facilitation aimed at conservation biologists and local actors involved in jaguar management. It will have two facets: (1) responding to the lack of training for conservation biologists and practitioners in group facilitation in order to improve their capacity to work with others, and (2) providing an opportunity for local actors to get involved by using the real case study of jaguar management in Calakmul, Mexico, and to work collaboratively on this issue. Jaguar management will be the common thread of this workshop that will allow actors from diverse sectors to experience integrated learning to develop future collective actions.

The workshop will be hosted by Yorck Graf von Korff, PhD in political science, a certified facilitator by the International Association of Facilitators, a mediator (2 years of continuing education at the University of Bochum/ Germany), and a consultant with 15 years of experience in the design and implementation of participatory methods. He has designed and implemented participatory processes in international cooperation, ecosystem and water management, urban planning, scientific cooperation, intra-organizational change, as well as urban and land planning. For more information, consult http://flow-ing.fr/projects/.

Workshop

Fundamentals of GIS for ecology, and species distribution modeling

Organizer: Alice Hughes

July 15th-19th

Centro de Investigaciones Científicas de Yucatán (CICY)

GIS skills are essential to modern day ecologists. No matter what their specialism ecologists have had to acknowledge that species, and ecological phenomena occur in the real world, and that the relationships exist between environmental factors and other species can only be properly understood by acknowledging the spatial relationships and therefore by using GIS techniques.

Species distribution modeling techniques also represent powerful and popular tools to extrapolate from the known records of a species distribution to predict the potential distribution of a species under various conditions, and better understand factors underlying these distributions.

The workshop aims to; A) train students in fundamental GIS tools and techniques using a number of different available software programs; B). teach students how to design and implement studies that utilize GIS techniques, and avoid potentially confounding biases; C). discuss the use of predictive modeling techniques to spatially project species distributions, using various approaches. D). use predictive approaches to project species distributions under changing conditions and: E). use various approaches and spatial statistics to interpret and analyse the results. Further information on the course schedule and structure is available at the base of this document).

During each part of the workshop students will be asked to reflect on how the approaches can directly be used in their own studies, and the final ½ day of the workshop will be available for students to start working with their own data so they have something they can continue to work on following the workshop.

All students will receive a digital booklet compiled for the course that provides explanations for all tasks, background theoretical material and suggested further reading. Students are also encouraged to bring their

own data-sets as there will be the opportunity to start developing their own research using the techniques covered (and any others of interest) in the final afternoon of the four day workshop, or too extend this on for a final two days for advanced students with data.
By the end of the workshops all participants should have the skills to develop and competently use GIS and species distribution modeling techniques in their own research.
Each evening during the workshop students can choose to attend a GIS Clinic: and go through their own study with the instructor on a one to one basis, to design, develop and analyze their own studies-further work on this will also occur on the final day of the workshop, but these appointments will enable students to advance their work further in the final day.

Scientific Cafés

The Scientific Cafés are part of a movement promoted by Duncan Dallas in 1998 in England. Currently, scientific coffees are made in more than 52 countries of the world to generate a spontaneous and more open discussion with non-specialized public about the way scientific research is done.

Within the framework of the ATBC 2017 Meeting, the Scientific Cafés aim to open a space for informal talks on various science and conservation issues. These sessions will promote dialogue between students and academics with diverse interests and points of view for enriching current debates on conservation in the world's tropics.

The Science Cafés are dedicated to an hour and are open to the public, from 16:00 to 17:00 hrs at **KABAH** Conference Room.

•ECOLOGICAL ASPECTS OF MANAGED FORESTS
Monday, July 10th
Marielos Peña-Claros

•CONSERVATION IN THE ANTHOPOCENE
Tuesday, July 11th
Rodolfo Dirzo

•ECO-HEALTH AND CONSERVATION MEDICINE
Wednesday, July 12th
Alonso Aguirre

•ECOLOGY OF ISLANDS
Thursday, July 13th
Ana Traveset

Soft-skills workshops

•GETTING PUBLISHED IN THE SCIENCES
Monday, July 10th
San Jacinto (Holiday Inn)
Steve Turton

•PANEL: LESSONS IN CONSERVATION
Monday, July 10th
Santiago (Holiday inn)

•PRESENTATION SKILLS
Tuesday, July 11th
Santiago (Holiday inn)
Alice C. Hughes

•CONSERVATION IN PRACTICE
Thursday, July 13th
Santiago (Holiday inn)
Tony Lynam

Business meetings and special group meetings *(By invitation only)*

•ATBC COUNCIL MEETING
Saturday, July 8th & Sunday, July 9th
Details sent to the ATBC officers, councilors and additional invited participants.

•BIOTROPICA EDITORS MEETING
Tuesday, July 11th
Invitation to this lunch and discussion event will be sent to all relevant editors of Biotropica.

•2ndFOR WORKSHOP
Organizers: Francisco Mora, Lourens Poorter, Frans Bongers & Danaë Rozendaal
Saturday July 15th – 16th
Centro de Investigaciones Científicas de Yucatán (CICY)

2ndFOR is a collaborative research network on secondary forests. It focuses on the ecology, dynamics, and biodiversity of secondary forests, and the ecosystem services they provide in human-modified tropical landscapes. To date, the network involves up to 100 researchers from 15 different countries, and has compiled data from up to 1630 plots in 56 sites across Latin America. After two years of work, the network has published two articles in high impact journals (Nature, Science Advances), with two more under review now.
The aim of this workshop is to define a formal organization of the 2ndFOR network. Network structure and strategy, data sharing process, funding opportunities, among other organizational topics will be discussed. The program includes also a discussion of ongoing research collaborations, as well as the identification and framing of new ones. The meeting will take place after the ATBC meeting, between 15-16 July, at the Centro de Investigaciones Científicas de Yucatán (CICY), located in Mérida, Yucatán.
Attendance is by invitation given space constrains. However, if you want to be part of the network by sharing data, or if you have a nice idea you want to test using the network' dataset, please do not hesitate to contact network coordinators, Prof. Lourens Poorter (lourens.poorter@wur.nl), Prof. Frans Bongers (frans.bongers@wur.nl) or Dr. Danaë Rozendaal (danaerozendaal@gmail.com).

HIGHLIGHTS

WELCOME CEREMONY & OPENING CONFERENCE
Sunday July 9th, 16:15 - 18:00 hrs
YUCATÁN 1 & YUCATÁN 2 (FA)
Please join us for our welcome ceremony

WELCOME COCKTAIL
Sunday July 9th, 18:30 hrs
GRAN MUSEO DEL MUNDO MAYA

OPENING WELCOME
Monday July 10th, 09:00 - 09:30 hrs
YUCATÁN 1 & YUCATÁN 2 (FA)
Please join us for the official opening of the meeting.

ATBC TOWN HALL MEETING
Tuesday July 11th, 18:10 - 19:10 hrs
YUCATÁN 1 & YUCATÁN 2 (FA)
ATBC members are kindly invited to meet and discuss various topics such as Conservation, Biotropica, Chapters, Capacity Building Initiatives, etc. We will have break-out groups and it will be a great opportunity for members to learn more about what ATBC is doing and how they can get involved.

GROUP PHOTOGRAPH
Wednesday July 12th, 14:10 hrs
Site to be announced.

CLOSING CEREMONY
Thursday July 13th, 18:10 - 19:40 hrs
YUCATÁN 1 & YUCATÁN 2 (FA)
In this plenary ending session very special and emotive events will take place, including decoration of 2017 ATBC Honorary Fellows, student awards (Alwyn Gentry Award, Luis F. Bacardi Award, Navjot Sodhi Award), the ATBC Merida declaration, presentation of the ATBC 2018 Meeting, and goodbye of the Merida Meeting.

CARBON NEUTRALITY

ATBC members voted at the ATBC Morelia 2007 meeting that their meetings should be carbon neutral, through providing a fee dedicated to supporting regional forest restoration and / or conservation projects. However, this resolution has not been applied at all subsequent meetings. After the Merida meeting, the delegates of future ATBC meetings will be encouraged to contribute with mandatory fees to offset carbon emissions. In Merida, the contribution will be voluntary and the contribution fees have been established based on a carbon emission analysis (including the projected energy expenditure during the meeting, as well as the emissions due to travel of delegates). The Edinburgh Centre for Carbon Management Ltd (http://www.eccm.uk.com/) carried out this analysis for the Morelia meeting. For the Merida meeting, we will have very similar carbon emissions to the ones we had in Morelia. The carbon-offset fee will be **US $ 20 for delegates coming from outside Mexico** and **US $ 5 for people coming within this country**. The money collected will be allocated to an inter-municipal project in Yucatán managed by the civil organization JIBIOPUUC that, among several communal activities, is dedicated to conserving and restoring the largest tract of old-growth tropical forest remaining in the center of the Yucatan Peninsula (https://www.youtube.com/watch?v=PQUE9Av49ts, videoclip in Spanish).

JIBIOPUUC

AWARDS

AWARDS FOR STUDENTS AND RECENT PHD DEGREE RECIPIENTS

The **Bacardi Awards** are open to those who have received a PhD, within 5 years of the meeting dates.
To be eligible for the Bacardi Award, an applicant must be a non-student member for 2017 or have just
completed the PhD in Spring 2017. For more information on the award, please see:
http://tropicalbiology.org/luis-f-bacardi-award/

The **Alwyn Gentry Award** is presented to a student presenter (one each – oral or poster). Minimum
qualification is to be a paying student member of the ATBC for 2017. For details of the award, please see:
http://tropicalbiology.org/alwyn-gentry-award/

Every year the Association for Tropical Biology and Conservation presents the **Navjot Sodhi Conservation Research Award** to a student from a developing country conducting research in tropical conservation biology. This award is in remembrance and recognition of the contributions of our colleague and friend Navjot Sodhi, who inspired many students and colleagues with his passion for research and the conservation of tropical biodiversity. The selected recipient will receive a cash award (typically up to $500) to be used towards research-related expenses.

NEW PHYTOLOGIST

News Phytologist Poster Prize will be presented to the Best Poster.

HONORARY FELLOWS

In 1963, the Council of the Association for Tropical Biology and Conservation (then known as the ATB) established the selection of Honorary Fellows — "persons of long distinguished service to tropical biology." This is the highest award given by the Association; to date more than 80 Honorary Fellows from over 15 countries have been elected by the Council. For the ATBC 2017 Meeting, two world-wide recognized tropical biologists will be honored with this distinction: Dr. Ariel Lugo and Dr. Rodolfo Dirzo.

Dr. Ariel Lugo

Dr. Ariel Lugo, currently the Director of the International Institute of Tropical Forestry, Puerto Rico, has been calling attention to the dynamic nature of tropical forest ecosystems throughout his career. Dr. Lugo is a tour-de-force in tropical biology with more than 500 publications and more than 25,000 citations to his work. He has been at the forefront of a shift in tropical biology–transporting it from a focus on "pristine" primary forest sites to a recognition that people profoundly shape and influence tropical ecosystems. His most recent work has emphasized the Anthropocene, novel ecosystems, and urban ecology, based on his experience with forest recovery in Puerto Rico. At one time, these ideas felt controversial, but he was not afraid to stir the pot and address controversial subjects head-on. While some may disagree with his perspectives, he engages all in a civil discourse based on evidence. Now most tropical ecologists fully recognize the Anthropocene, and it is clear that Dr. Lugo was ahead of his time. This forward-thinking approach not only occurred with his more recent global change work, but in his earlier emphasis on tropical secondary forests, the role of plantations in restoration, introduced species, and even his systems-level approach to ecology which was catapulted by measuring biomass in tropical forests. He has consistently chosen subjects and study sites that have not been viewed as glamorous (dry forests, mangroves, secondary forests) and shown their enormous ecological value.

As Director of the International Institute of Tropical Forestry, he threw the USDA Forest Service into the international spotlight combining the best of basic science with application, seamlessly. He provided tremendous opportunities to his staff, university faculty and students, and the general public. Dr. Lugo has spearheaded the development of the excellent infrastructure available at the International Institute of Tropical Forestry (IITF, USDA) and has mentored the staff into an impressive team. He is also a strong advocate for women and minorities within science. If there is someone who he believes has potential, he will work tirelessly and often behind the scenes to bolster that person's career. He believes in making investments in people. One of the main characteristics of Dr. Lugo is that he is driven by the quest for knowledge. He challenges others in this vein for a deep understanding of ecology. He is a deep thinker who has advanced tropical ecology into a 21st century perspective. He has been strongly involved in ATBC, having served on the ATBC Council in 1986-1986 and as ATBC president in 1991, and continues to attend meetings regularly.

Dr. Rodolfo Dirzo

Dr. Rodolfo Dirzo is currently the Bing Professor in Environment Science and the Director for the Center for Latin American Studies at Stanford University. He is well known for demonstrating the importance of trophic interactions for the ecosystem functions of tropical forest ecosystems. He has published prolifically. Through 15 edited volumes, more than 125 articles in peer-reviewed journals and more than 50 book chapters, Dr. Dirzo has made fundamental contributions to basic research into plant-animal interactions in tropical forests and explored the consequences when human activities disrupt those interactions. His research contributions have been recognized in his appointments as Member of the Mexican Academy of Sciences, Foreign Associate of the US National Academy of Sciences and Foreign Member of the American Academy of Arts and Science. In 1992, he was one of the key promoters of creation of the National Commission for Knowledge and Use of Biodiversity (CONABIO) of the Federal Government of Mexico, which presently has become a world reference in promoting basic and applied science research, compilation and informatics of biodiversity, public outreach of information and knowledge to society as a whole, among other activities.

Dr. Dirzo is an extraordinary teacher and mentor. Overall, he has served as the major advisor of 32 BSc students, 10 MSc students and 21 PhD students. Thirty students worked in his lab in the National Autonomous University of Mexico (UNAM) simultaneously in the early 2000s. Besides the high number of regular courses he has tough in UNAM, Stanford University and other academic institutions, Dr. Dirzo has participated in 29 courses with the Organization for Tropical Studies, generously helping to train a generation of tropical biologists. In outreach activities, Dr. Dirzo has published more than 20 popular articles that make tropical forest science accessible to a wider audience and made more than 550 presentations in Mexico and more than 200 presentations in the USA and other countries. This public outreach is a crucial contribution in our troubled political times. We can no longer assume that science will inform public policy. In this context, Dr. Dirzo continues to reach out to the public to counter misinformation. Finally, it should be noted that Dr. Dirzo has been a long-time supporter of ATBC. He served as Program Chair for the 1991 and 1994 ATB meetings held in San Antonio, Texas (Unites States) and Guadalajara, Mexico, respectively, served as President of ATBC in 1994, served as member of the ATBC Council in 1991-1992, and continues to attend ATBC meetings regularly.

Field trips

July 14th, 2017
For more information and booking visit:
https://www.atbc2017.org/field-trips

Uxmal and San Antonio Mulix, Yucatán

Just 48 miles from Merida sits one of the most majestic pre-Hispanic ruins of Mexico: Uxmal, considered by many archaeologists the epitome of late Mayan architecture. For its monumental structures, the exquisite details of its façades, and excellent state of preservation, this ancient city was declared a World Heritage Site by UNESCO in 1996.

The ruined hacienda of San Antonio Mulix is not far from Mérida around 49 kms after leaving The Periferico. There are two cenotes: X-Batún and Cenote Dzonbacal. A cenote is a natural pit, or sinkhole, resulting from the collapse of limestone bedrock that exposes groundwater underneath. Especially associated with the Yucatán Peninsula of Mexico, cenotes were sometimes used by the ancient Maya for sacrificial offerings.

The objective of the trip is to combine the rich cultural past of the area (Uxmal) and the typical landscape of the northern region of the Peninsula and especially its karstic landscape and its cenotes.

Xcambó Archaeological site and surrounding ecosystems

The northernmost portion of the Yucatan peninsula is an island of dry ecosystems surrounded by the sea to the north, east and west, and humid ecosystems to the south. Such isolation means the region is home to many endemic taxa and interesting vegetation associations. From N to S we first encounter the coastal dune, then saltmarshes, mangroves and coastal lagoon, which is home to rich and beautiful bird communities that include flamingos, herons, and storks and endemics like the Yucatan Wren and Mexican Sheartail Hummingbird. The Yucatan Calichal follows; it is the driest ecosystem in the Peninsula and occurs over a sheet of impermeable rock. It is the home of an alternating extremely dry/partially flooded ecosystem. Further south is tropical dry forest. Arguably, the most interesting of all these ecosystems is the Calichal, where about one-half of the Peninsula's endemic plant species occur. On this field trip, we will visit the Xcambó Archaeological Zone and surrounding areas, where we will see examples of all the aforementioned habitat types. Xcambó dates from the Maya classical period (250-900 AD) and was an important center of salt production and distribution. It is surrounded by salt marshes, mangrove, and water springs. Along the way, we will see the coastal lagoon with its teeming bird life. Then we will head south approximately 5 km to explore tropical dry forest with populations of the endemic Beaucarnea pliabilis (Despeinada) and the locally endangered Guaiacum sanctum (Guayacán, Hollywood lignum vitae). Then we will return ca. 4 km northbound to a site where the Calcichal is well-developed with most of the succulent plant species of the Yucatán Peninsula. We will end the tour with a delicious seafood lunch in the nearby village of Chichxulub, which gave its name to the meteor that is suspected to have caused the extinction of the dinosaurs. Accompanying you on the trip will be experts on the region's botany and avifauna.

El Cuyo- Ria Lagartos Biosphere Reserve

The trip will visit the birding hotspot of El Cuyo inside the Ria Lagartos Biosphere Reserve. Our birding site is known as "Paraiso Escondido" or "Hidden Paradise," an ecotourism and conservation ranch adjacent to the reserve. The ranch's bird list includes 189 species; you will have the possibility of seeing all of the Peninsula's non-island endemics and quasi-endemics like the Mexican Sheartail Hummingbird, Yucatan Wren, Orange Oriole, and Black Catbird. The rancho includes 8km of birding trails that cover three major vegetation types: mangrove, semi-flooded lowland forest, and medium subdeciduous forest. There is also a wetland with two observation towers. On the trip, we will be accompanied by a certified guide. In addition to birding at the ranch, we will take a boat tour of the coastal inlet where are almost guaranteed to see flamingos and other waterbirds. There will also be free time to spend in the village of El Cuyo and at its beautiful beach. Housing will be in very comfortable cabañas on the ranch, with private bathrooms and 24 hour electricity. On the way back to Merida, we will have time to go for a swim in a "cenote" or water-filled sink hole. The trip is co-organized with Pronatura Peninsula de Yucatan (www.pronatura-ppy.org) a local conservation organization.

Kaxil Kiuic Biocultural Reserve

The Kaxil Kiuic Biocultural Reserve is an area of 1800 ha with little recent human influence located in the Puuc region of Yucatan. However, there is evidence of human settlements which date back 3,000 years and there is a great diversity of flora and fauna, all of which makes it an important area in which humans can learn about both the Mayan civilization and nature.

The reserve harbours an important archaeological site (Kiuic), and constitutes an Environmental Management Unit, managed by Kaxil Kiuic A.C. It is a living laboratory where research and education are carried out to disseminate knowledge and to help sustain the reserve's biological and cultural resources.

The vegetation is classified as seasonally dry (semi-evergreen) tropical forest, most of it old secondary (> 60 y of abandonment after traditional shifting agriculture), with a 10-15 m-tall canopy. The reserve is part of an intensive carbon-monitoring site which harbors an eddy-covariance flux tower, as well as forest inventroy and carbon monitoring plots managed by the Scientific Reserach Center of Yucatan (CICY).

The objective of the trip is to visit and learn about both the past and present Mayan cultural background (there is an active and ongoing archaeological research program in the reserve, which is surounded by living Mayan communities), and the biodiversity it harbours, as well as about the long-term biological research carried out in it, including plant physiological, botanical and ecological studies on forest structure, diversity, composition, successional dynamics, and carbon dynamics.

Cenotes

The diversity and biomass of the underwater cave restricted fauna (stygofauna) in the Yucatan Peninsula (YP) is dominated by 45 crustacean species out of a total of 47 freshwater and anchialine species described at the time (Álvarez & Iliffe 2008; Álvarez et al. 2015). The trophic structure of anchialine systems is simple and composed by a small number of levels with few species. Pohlman et al (2011) suggest only three trophic levels: Producers, including: photosynthetic, aphotic chemosynthetic and detrital organisms, primary consumers and generalist or opportunistic predators and scavengers.
Nutrients and organic matter can reach the anchialine systems by several processes: lixiviation and filtration of the surrounding soil into the cenote and aquifer (Pohlman et al. 2000), brought into the cenotes by other external organisms, or may be produced in the cenotes or caves. Primary production in caves is limited and is generated by photosynthetic organisms that thrive exclusively in the sunlit cenotes or by chemosynthetic prokaryotes that occur in caves. Primary consumer stygofauna in the YP is mainly composed of crustacean species (Álvarez & Iliffe 2008) which have specialized filtering or scavenging feeding strategies, either on the benthos or the water column. Predators in these ecosystems are the larger crustaceans and fish.

TOURISTIC TOURS

Merida City tour & foodie experience Mérida, Mérida

Discover the main historical buildings of Mérida, such as: the Cathedral of San Ildefonso, Governors Palace, home of the founder of Mérida Francisco de Montejo and the majestic Avenue of Paseo de Montejo making stops along the way to enjoy the traditional Yucatecan gastronomy through its delicious fresh bread, fresh water and a yucatecan craft beer accompanied with typical snacks.

Izamal Magic town of Mexico

Izamal is a beautiful colonial town founded in the middle of the 16th century on the vestiges of an ancient Mayan city; Its most important building, the Convent of Our Lady of Izamal, was built on the ruins of a Mayan shrine called Pap-hol-chac. In 1992, Izamal received the visit of St. John Paul II, who celebrated a memorable mass in the great atrium that precedes the temple of the Immaculate Conception and the former Convent of San Antonio de Padua.

Uxmal & lunch at Hacienda Ochil

Visit to the archaeological site of Uxmal, one of the most powerful and beautiful Mayan cities. Its name means "the three times built" thanks to the fact that it had to be rebuilt three times during its time. The guided tour of the archaeological site is approximately 2 hours where you will admire the architecture made up of palaces and buildings with multiple details. After the visit you will enjoy a delicious lunch at Hacienda Ochil where you will be able to enjoy a great variety of our Yucatecan gastronomy.

Chichen Itza & Cenote Ikkil

The pre-Hispanic city of Chichen Itza was the most outstanding capital of the Maya area, at the end of the Classic period and the beginnings of the Postclassic period. The cenotes were sacred places for the Mayas, representing the gateway to the underworld (place where their gods lived).

Hacienda & Cenote Experience

During the visit to the Hacienda Viva, visitors will be able to travel in time, transported on wooden platforms called "trucks" which are pulled by "mules" on rails of Decauvillem as originally used by workers. You will be able to witness every step of the transformation process of the Henequén (also called Green Gold in the region), from the fiber plant, and from the fiber to the finished product.

Pink Flamingos & bird watching at Celestún

One of the best beaches in Yucatan with the particularity and color that gives you more than 300 species that inhabit the reserve, especially pink flamingo. Enjoy a tour of the celestun estuary aboard a boat managed by a guide of the biosphere who will take you to see the pink flamingo and the freshwater eye that emerges as an oasis in the middle of the salt water. At the end of the tour you will enjoy a delicous meal in front of the sea.

SYMPOSIA

Symposium
Trends in plant-pollinator interactions in the tropics

Science for the Conservation of Mexican Hummingbirds

Maria Del Coro Arizmendi[1*], Humberto Berlanga[2], Claudia Isabel Rodríguez-Flores[1], Victor Vargas Canales[2], Leobardo Monroy Leyva[1], Rafael Lira Saade[1]

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Background: Hummingbirds represent an avian family restricted to the Americas that feed mainly on nectar obtained from ornithophilous plants. In North America (Mexico-USA-Canada) 58 species have been reported out of the 330 total hummingbird species, all of them occurring in Mexico. **Methods:** In this work we analyzed the distribution of hummingbirds in relation to the coverage of the natural protected area system in Mexico using a complementarity analysis to assess the minimum set of areas needed to protect all species. We focused our search mainly to biosphere reserves as these areas have complete bird lists. **Results:** Six biosphere reserves included 93% of the hummingbird species. Four species were not included in any biosphere reserve or other natural protected area. To preserve those species three important bird areas (AICAS as they are known in Spanish) are needed. With these 9 areas all hummingbird species are included. Hummingbird distributions can be classified in six groups that distribute following the major biogeographic regions described for Mexico including groups using i) the main mountain ranges, the tropical dry forests in both ii) Pacific and iii) Gulf of Mexico slopes, iv) the humid tropical forest in southern Mexico, and both v) Yucatan and vi) Baja California peninsulas.

Keywords: hummingbirds, protected areas, Mexico, Conservation

ID:1117
Monday Yucatan-1
Symposium: Trends in plant-pollinator interactions in the tropics

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Bees as pollinators, conservation policies and their management in Mexico

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Bees (*Hymenoptera*: *Apoidea*) represent an important group of pollinators, which in recent decades has been affected by a combination of factors, reaching serious levels in some parts of the world. Globally, about 20000 species of bees are known. In Mexico are known six families, 141 genera and 1908 species, a number that can reach 2500 species. In the last 30 years, bee studies have been increasing in Mexico, with research on taxonomy, bees fauna, biology and pollinators, but most of these in the center of the country and areas with tropical dry forest. However, more work is needed on ecological aspects and pollination, considering that the management of bees as pollinators in greenhouse, has been increased in the last 15 years, especially with the use of *Bombus* species, introduced in Mexico. Representing an important economic entrance for the country, with crops as tomato, eggplant, green pepper among others. However, there are still many Mexican bee species with potential to be used in agricultural pollination, as *Bombus*, *Megachile*, *Osmia*, *Xylocopa* and *Melipona*. But *Apis mellifera*, is still the most important pollinator, and is currently facing a crisis in Mexico, after the use of neonicotoids and the arrival of diseases such as Varroa, Nosema, AcarApis, American loach (*Paenibacillus larvae*) and beetle of hives (*Aethinia tumida*). In natural communities, management strategies are required to promote the conservation of native bee fauna, especially in areas with agriculture, and when crops require natural pollinators, as many *cucurbitaceae*, *Solanaceae* or various fruit trees (Apple, avocado, mango, coconut, etc.). In Mexico, more than 100 plant species are cultivated and many of them are native, and closely related with their pollinators. Mexico is also affected by the crisis due to loss of pollinator diversity, which is a result of changes in land use, deforestation, use of insecticides and diseases. With this, both communities of native bees, as well as species managed in agriculture, or with potential for their use, of the genera *Bombus* or *Melipona* and *NannoTrigona*, and of *Apis mellifera*, this last, in the previous two years, has suffered serious losses in Mexico, after the use of new insecticides was approved, with catastrophic effects, which result in the loss of honey bee colonies. In addition, in southwestern Mexico beekeepers already face the problem, using transgenic crops, which affects the export of apiculture products

Keywords: Bees, Bumblebees, Pollinators, pollination

ID:1113
Monday Yucatan-1
Symposium: Trends in plant-pollinator interactions in the tropics

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Save our bats, save our tequila. Industry and science working for pollinators

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Background: Plants of the genus *Agave* are very diverse and heavily used by humans to produce alcoholic beverages such as tequila and mezcal. *Agave* has coevolved with nectar-feeding bats, and in several cases, bats are the main functional pollinators in this ecological relationship. But with growth in the demand of *Agave*-derived products, management practices have reduced dependence on bat pollination, using instead clonal shoots to replant fields and harvesting plants before flowering, thereby negatively affecting both bats (by decreasing food availability) and *Agave*s (by deleting pollination and thus lowering their genetic diversity). **Methods:** We approached the industry to explain the risks incurred in these practices and describe bat-friendly practices to explore possibilities to incorporate them into the production system. We compiled data about the pollination biology of *Agave* to infer how many bats could use the available resources, if Mezcal and Tequila producers allowed 5-10% of *Agave* crop inflorescences to flower based on a linear projection using *Agave angustifolia* (a sister group of *A. tequilana*). The idea was well-received and we developed a proposal to producers to allow only 5% of the plants to flower in their fields per hectare (approximately 222 individuals in one hectare). If the producers adopt these practices, then the University of Mexico (UNAM) and the Tequila Interchange Project (TIP) will provide a label indicating that the distilled was produced using bat friendly practices. **Results:** Several producers agreed to our proposal and we launched 300,000 bottles of bat friendly tequila. Depending on nectar concentration and total volume, 222 *Agave*s in one hectare would allow a minimum of 89 individual bats to feed every night during the flowering period. **Discussion:**. If we extrapolate this percentage to the total area of the Tequila Denomination of Origin, allowing 5% of the current total population of A. *tequilana* reproductive *Agave*s to flower could feed over 2 million nectar feeding bats per month. This process may well turn into the industry standard given the reaction obtained from several producers and more are joining the program. An even better system in terms of their impact on biodiversity is that of some mezcals in which these are not produced in a monoculture system.

Keywords: bats tequila *Agave* pollination Mexico

ID:1118
Monday Yucatan-1
Symposium: Trends in plant-pollinator interactions in the tropics

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Resilient pollinators mitigate effects of disturbance in the most important Amazonian fruit crop

Alistair John Campbell[1*], Marcia Motta Maues[2], Luisa G. Carvalheiro[3], Rodolfo Jaffe Ribbi[1], Tereza C. Giannini[4], Madson A.B. Freitas[5], Cristiano Menezes[2]
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Background: Scientific knowledge underpins sustainable land use but is often lacking in tropical regions. In the Amazon estuary, large areas of native floodplain forest, and increasingly, upland habitats are being converted into intensive production units of the açaí palm (*Euterpe oleracea* Mart.) to meet growing demand for its fruit. However, the impacts of these changes on pollinators and pollination services remain critically understudied. To address knowledge gaps, we identify effective pollinators among flower visitors, and assess impacts of anthropogenic disturbance at different scales on pollinators. **Methods:** We studied 18 areas (9 floodplain forest, 9 upland plantation) being managed for açaí production across a gradient of local management intensity (açaí stems per ha) and surrounding forest cover (33-86% at 1 km radius) in Pará state, Brazil. Visual observation of flower-visiting insects was used alongside assessments of insect pollen loads and fruit set to isolate effects of pollinators on fruit set. **Results:** The inflorescences of *E. oleracea* were visited by 197 insect morphospecies ('ms'), mainly from the orders *Hymenoptera* (100 ms, 78.2% of visits), Diptera (38, 17.8%) and Coleoptera (56, 2.6%). Fruit set was positively related to curculionid beetle visits, and overlap between visitor communities of male and female inflorescences (similarity, shared visitor abundance = other pollinators). We found no difference between management systems, or any effect of forest cover on overall visitor abundance, but observed a negative effect of açaí density. In contrast, beetles (low pollen loads) and other pollinators (high pollen loads) were unresponsive effects at either scale, but visitation by the most abundant bee pollinator, *Trigona branneri* (13% of total visits), was both negatively related to açaí density and positively related to forest cover at 1 km radius. **Discussion:** Açaí palm is pollinated by a diverse array of insects including bees, wasps, flies and beetles, that when considered together, are resilient to changes in management intensity at both local and landscape scale. However, loss of important bee pollinator taxa at both local and landscape scales due to anthropogenic disturbance demonstrates both the pervasive impacts of intensive açaí cultivation on tropical entomofauna and the need to preserve surrounding undisturbed forest habitats to maintain pollinator diversity in land parcels being managed for açaí production.

Keywords: pollination; sustainable agriculture; Amazonia

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Monday Yucatan-1
Symposium: Trends in plant-pollinator interactions in the tropics

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Land sharing and agricultural investments: to conserve pollination services and crop yields

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Background: Sustainable livelihoods and human well-being depend on multiple anthropogenic and natural assets (stock of materials or information that exists in a point in time). However, the simultaneous and multiple impacts of land-use decisions on these assets are often ignored specially when evaluating agricultural efficiency in agricultural production. Effective methods to assess ecosystem services could increase the potential to detect "win-win" scenarios considering nature security and farmers profit. Moreover these methods could convince and persuade multiple audiences specially those unwilling to change. **Methods:** In this study, we focus on pollinator-friendly practices (PFP: practices that intend to increase the abundance and diversity of natural pollinators) to quantify the multi-dimensional value of land-use decisions and to address potential synergies and trade-offs among assets. We combined socio-economic and ecological methods (with questionnaires and field data on flower visitors) to quantify natural (pollinator richness) and anthropogenic (human, physical, social, and financial) assets in 30 coffee plantations with a gradient in the number of PFP in eastern Brazil. Result. We found that farms with greater PFP exhibited higher flower visitor richness and yield (productivity). Furthermore, larger coffee crop areas on the other hand, had lower number of PFP. We also found that in farms were owners working actively on the land a greater number of PFP were exhibited than those farms in which farmers were working in the management of the farm. **Discussion:** Our results reveal how the abundance of PFP enhances flower-visitor species richness in coffee, and detected the most important physical, financial and human assets that increased these. Our results highlight that land-use decisions oriented toward enhancing natural assets can also provide the highest levels of financial assets generating synergies between biodiversity and crop yield. Cumulative knowledge acquired by producers should also be important and results are independent from the size of the farm, as large farms could increase the number of PFP without a decrease in production. In that manner it is possible to generate win-win scenarios between biodiversity, crop production, and farmers' profitability. PFP could be used as a general framework to achieve sustainable crop intensification.

Keywords: Conservation, Pollinators, Crop-yield, Socio-economic, Pollinator-friendly

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Coffee pollination: pollinator diversity and ecological intensification.

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Coffea canephora or *Robusta* and *C. arabica* are grown in Mexico. *Robusta* coffee requires cross-pollination, while *C. arabica* is self-fertile, but yield and quality increase with entomophilous pollination. Four aspects of coffee pollination were studied: 1. Effects of insect pollinator diversity on fruit production along a gradient of management systems from low-impact to high-impact. Pollinator diversity should be higher in low-impact systems and fruit production is positively related to pollinator diversity, so low-impact plantations should have higher fruit production than high-impact plantations. Low-impact systems have higher species richness and relative diversity of pollinators than high-impact systems. Fruit production was positively related with species richness and diversity of pollinators and it was higher in low-impact than in high-impact systems. Diversity of insect pollinators is influenced by the management system and has strong consequences on fruit production. 2. Potential impacts of *A. mellifera* on the diversity of coffee native pollinators and on production. The abundance of *A. mellifera* and diversity of native pollinators were assessed at shade coffee plantations and pollination experiments were conducted to determine the impacts of pollinators on fruit production. Regression analyses were used to assess whether the abundance of honey bees was related to native pollinator diversity, and whether fruit production was influenced by the diversity of pollinators and the abundance of *A. mellifera*. Native pollinator diversity decreased as the number of honey bees increased. An increasing abundance of A. *mellifera* was correlated with a decrease in fruit production. Native pollinator diversity is better preserved if beekeepers reduce the number of hives they bring to plantations. 3. Bee fauna of flora associated with organic coffee. Bees were collected visiting 56 herbaceous plant species in 4 sites of a shade coffee farm, 182 bee species were found. This high diversity of bees emphasizes the importance of low-impact management in the preservation of insect pollinators. 4. Potential use of bees as biovectors to control insect pests in coffee. Honey bees have been used as vectors of entomopathogenic fungi in different crops. The results of preliminary trials being conducted in different countries in order to use bees to help control the coffee bean borer through the use of *Beauveria bassiana* and *Metarhizium anisopliae* are reported.

Keywords: Coffee pollination, management systems, biovectoring

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Symposium
Tropical biotic interactions in the Anthropocene

Exposure to the leaf litter microbiome of healthy adults protects seedlings from pathogen damage

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Microbiome research is increasingly showing linkages with host health, but it is unclear what factors shape community assembly of microbiomes in nature, and how differential outcomes of assembly affect hosts. Every plant species examined to date hosts a diverse, environmentally-acquired fungal microbiota. Experiments in which one or a few of these component fungi are artificially inoculated into host plants show that individual members of the fungal microbiome can affect host physiology and fitness. Here we show that manipulating community assembly of the fungal microbiome in a tropical forest, by varying local sources of colonizing spores and vertical stratification of microsites, has pronounced consequences for host health. Specifically, our results indicate that exposing seedlings to leaf litter derived from healthy conspecifics enriches seedlings with component microbial species that enhance host pathogen resistance, comparable to maternal transmission of a healthy microbiome in human infants. Using both Next-Generation Sequencing and Sanger sequencing methods, we found large differences in fungal microbiome community structure, diversity, and species dominance, caused by highly localized changes in leaf litter and canopy position. Taken together, our results suggest that variation in microbiome assembly can drive positive feedbacks in hosts. Ecologically, this produces a "reverse Janzen-Connell" effect, where exposure to the microbiome of healthy conspecific adults increases seedling fitness. More broadly, our results suggest agricultural strategies that have the potential to reduce crop losses with smaller economic and environmental costs than current practices.

Keywords: endophytic fungi; Janzen-Connell; Theobroma cacao

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Monday Yucatan-2
Symposium: Tropical biotic interactions in the Anthropocene

The effects of drought on tropical dry forest shelter-building caterpillars

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Background: Neotropical dry forests have been heavily impacted by human activities such as forest degradation and fragmentation. Anthropogenic climate change is also affecting the El Niño-Southern Oscillation and therefore the frequency, amount, and variation of precipitation available to tropical dry forests. Here, we investigated how the host plant use, abundance and parasitism of three common shelter-building caterpillars differed between drought (El Niño) and non-drought years at Palo Verde Biological Station (PVBS) in Guanacaste, Costa Rica. Shelter-building caterpillars, which build shelters using silk and leaves, are abundant and diverse group of herbivores, particularly in the dry tropics. **Methods:** Data on three common shelter-building caterpillar species (*Calpodes ethlius*, *Urbanus dorantes*, and *U. proteus*; all *Hesperiidae*) were collected May-August, 2013-2016 at PVBS. Caterpillars were collected and reared until they either eclosed or died. If caterpillars were killed by emerging parasitoids, the parasitoids were also reared. Natural history data, including host plant phenology and the oviposition activity of adults, were also collected. Dead caterpillars and parasitoids were preserved in 95% ethanol. All apparently unparasitized caterpillars were dissected to check for immature parasitoids, and all caterpillars and parasitoids were DNA barcoded to confirm their identities and parasitism status. Precipitation data from PVBS were downloaded and the effects of precipitation and caterpillar species on parasitism were analyzed using logistic regression. **Results:** There was no significant effect of precipitation on parasitism, although there were significant species-specific differences in parasitism ($p < 0.001$). While the ENSO-related droughts affected the caterpillars and their parasitoids equally, they did alter host plant phenology and use, as well as decreasing caterpillar abundance ($p = 0.001$) and delaying their appearance. **Discussion:** The consistency of parasitism regardless of drought suggests that these caterpillar and parasitoid populations are tightly linked and their relationship is unlikely to be altered by climate change. However, the abundance and success of the shelter-building caterpillars are likely affected both directly by drought and indirectly though their host plants. Some caterpillar shelters may provide protection from environmental factors, but they cannot protect caterpillars from changes in phenology and host plant availability.

Keywords: plant-insect; Lepidoptera; butterfly; natural enemies

ID:1153
Monday Yucatan-2
Symposium: Tropical biotic interactions in the Anthropocene

Thermal tolerance of plant - insects interactions: implications for global warming

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Background: The critical thermal maximum (CT_{max}), the temperature at which motor control is lost in animals, has the potential to determine if species will tolerate global warming. CT_{max} estimates the relative tolerance of insect species to high temperatures. However, CT_{max} values do not represent the actual temperatures at which insects will be able to survive. To determine the effects of temperature increase on population dynamics, we need to estimate how vital rates such as survivorship and fecundity are affected at multiple temperatures. **Methods:** Combining physiology experiments, demographic analyses, and DNA barcoding, this study explored how CT_{max}, survivorship, and fecundity varies among species and populations of a group of diverse tropical insect herbivores, the rolled-leaf beetles, across elevational gradients. Data from 6,948 field observations and 8,700 museum specimens were used to map the elevational distributions of rolled-leaf beetles on two mountains in Costa Rica. CT_{max} was determined for 1,252 individual beetles representing all populations across the gradients. DNA barcodes (CO1) revealed significant cryptic species diversity. **Results:** In general, species found at middle elevations and on mountaintops are less tolerant to high temperatures than species restricted to lowland habitats. Species with broad elevational distributions display high CT_{max} throughout their ranges. We found no significant phylogenetic signal in CT_{max}, geography, or elevational range. **Conclusion:** Ongoing demographic experiments suggest that a small increase in temperature reduces egg, larval, and adult survival in insects at both low and high elevations. The narrow variance in critical thermal maxima for most rolled-leaf beetles, especially high-elevation species, suggests that the risk of extinction of insects may be substantial under some projected rates of global warming.

Keywords: Insect herbivores, global warming

ID:1157
Monday Yucatan-2
Symposium: Tropical biotic interactions in the Anthropocene

Wildlife diets and microbiota: climate and African megaherbivores shape ecological networks

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Background: Understanding how anthropogenic perturbations alter species-interaction networks is vital for predicting changes to ecological functions. However, it has been traditionally difficult to characterize complex species interaction networks. This presentation integrates large-scale field experiments with DNA-based analyses of interactions between African large herbivores (>5 kg), their food species, and their gut microbiota. How do these interactions differ within and among herbivore species, how do they depend on local climatic conditions, and how does the exclusion of large herbivores "rewire" the interaction networks of smaller species? **Methods:** The responses of plants and small herbivores to the exclusion of large herbivores have been characterized using a large-scale experiment across a natural climatic gradient in a Kenyan savanna since 2008. The diets and gut microbiota of 40 mammalian herbivore species from this savanna were characterized. Food plants were identified in ~2000 fecal samples using DNA metabarcoding. The gut microbial communities associated with a subset of these fecal samples (~600) were compared using 16S rRNA sequencing. **Results:** Experimental large-herbivore exclusion increases the abundance and alters the composition of both plant and smaller herbivore communities, the effects of which differ along a natural climatic gradient. Among herbivore species, differences in foraging strategies and digestive physiologies are associated with strong differences in the composition of their diets and gut microbiota. Within herbivore species, variation in diet and gut-microbiota observed to date is more closely associated with spatiotemporal variability than the presence of large mammals. **Discussion:** Human-induced large mammal declines alter plant-herbivore interaction networks. Mechanistically, the results to date suggest that these changes arise primarily from differences in the abundance and identity of interacting species, and less so from the role that megaherbivores play in shaping the diets of smaller co-occurring species (e.g., competitive displacement). By combining DNA-based technologies with large-scale field experiments, this research illuminates fine-grained changes in species-interaction networks due to major types of anthropogenic perturbations in African savannas.

Keywords: Savanna, herbivores, metabarcoding, microbiome, networks

ID:1158
Monday Yucatan-2
Symposium: Tropical biotic interactions in the Anthropocene

The insidious effects of global warming on tropical plant-animal interactions

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Background: Many tropical plants rely on seed dispersers to colonize new environments they may face under climate change. In a warming world, tropical biota will rely on elevational migrations to locate habitats that fit their ecological and physical requirements. The objectives of our study are to determine (1) if upslope barriers currently exist to prevent plant range expansions, (2) if seed dispersers can move seeds into novel habitats to track or outpace global warming, and (3) how elevational changes affect subsequent seedling survival. **Methods:** We are investigating if pre- and post-dispersal barriers exist to delimit the ranges of plants on a tropical mountain in the Los Tuxtlas Biosphere Reserve, Mexico and Braulio Carillo National Park, Costa Rica. Using upslope transplant experiments of natural and artificial seeds and seedlings at multiple elevations, we are assessing seed dispersal/predation, seed germination success (in the field and lab), and seedling survival in native and novel habitats. **Results:** Fates of artificial seeds were not affected by size at either elevation, but artificial seeds had higher survival in lowland forest compared to pre-montane forest, where terrestrial rodents (*Peromyscus mexicanus*) consumed most seeds. *Astrocaryum mexicanum* seeds were preferentially removed and eaten by squirrels and mice in lowland forests, but not in highland forests. *Nectandra ambigens* seeds and seedlings suffered high mortality via rodent seed predation in the highlands compared to their natural habitat in the lowlands. Field germination of seeds in transplanted, upslope habitat did not differ from germination success in the lowlands. Lowland seeds were able to germinate in high temperatures (up to 35° C in lab incubators), but were not able to germinate at temperatures below 20° C. **Discussion:** The results of this study have implications for understanding plant ranges in a changing world. Some species do not face post-dispersal barriers to upslope migration and may be able to colonize this habitat to outpace global warming. However other species face pre-existing biotic barriers to survival at high elevations. If they are unable to colonize novel highland habitats as biomes shift upward, these barriers will prevent successful elevational migration, resulting in lowland biotic attrition. Altered plant-animal interactions, especially seed dispersal and predation, will play major roles in redefining tropical plant communities as the world warms.

Keywords: mammal, plant migration, seed dispersal

ID:1154
Monday Yucatan-2
Symposium: Tropical biotic interactions in the Anthropocene

Seed disperser loss affects community assembly, species diversity, and forest structure

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Background: Small-scale disturbances in forests are hotspots of recruitment and set the stage for changes in forest composition. In addition, the rate of disturbance and recovery determines forest structure, or the proportion of forest in a disturbed state. Since 75-90% of trees in tropical forests have seeds dispersed by vertebrates, dispersal by vertebrate frugivores likely affects regeneration in these areas. However, we lack a mechanistic understanding or ability to predict how dispersal affects post-disturbance community assembly and recovery. We propose that frugivores promote colonization by non-local species, increasing local species richness, but decreasing turnover between gaps. In addition, we hypothesize that the pace of recovery and overall forest structure depends on dispersal of quick-growing pioneer species. **Methods:** The Mariana Islands offer a unique opportunity to examine the effect of frugivores on gap dynamics. Most tree species, including all pioneers, rely on frugivorous vertebrates to disperse their seeds, but an invasive snake was introduced to one island (Guam) and caused the functional extirpation of all native vertebrate frugivores. In contrast, the nearby islands of Saipan and Rota support similar forest to Guam yet still have frugivores. We created experimental treefall gaps across three islands, and used seed additions or seedling removals in a portion of the gaps to simulate either dispersal or lack of dispersal. We followed the regenerating seedling community and gap closure for 3.5 years. **Results:** We found that gaps with dispersal had higher seedling species richness but lower species turnover between gaps than those that lacked dispersal. Gap regeneration was faster in gaps with dispersal than those without primarily because gaps with dispersal contained more pioneer species. Preliminary results suggest gaps are closing more quickly in the presence of dispersers, suggesting that a forest without frugivores will have a more open structure. This is consistent with the observation that there are two to four times more natural gaps on Guam than on islands with dispersers. **Conclusion:**: We demonstrate that vertebrate seed dispersal increases species richness, decreases turnover, and can influence the physical structure of forests, with gap regeneration slowing in its absence. These results suggest that the ongoing loss of biotic dispersers could result in forests that have lower diversity and more open forest structure.

Keywords: seed dispersal; treefall gaps; frugivory

ID:1159
Monday Yucatan-2
Symposium: Tropical biotic interactions in the Anthropocene

Phylogenetic diversity loss does not capture functional diversity loss

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Background: The loss of species during the Anthropocene is likely to affect trait composition in local communities, possibly disrupting species interactions, ecosystem processes and services. However, as trait features are often hard to measure, specially for multiple species across vast regions, a common solution is to use surrogates for such features. In this scenario, it has been assumed that conserving phylogenetic diversity (PD) should yield concomitant conservation of functional diversity (FD). Although this assumption has faced recent criticisms, it remains seldom verified. **Methods:** Here, we integrate distribution, phylogeny and trait data for the majority of amphibians globally to test whether future extinctions are likely to remove similar amounts of PD and FD. Following the IUCN threat status, we simulated scenarios of future extinctions and estimated expected future loss of PD and FD. We further used a null model to examine whether these losses would disproportionately depart relative to random species extinction. Using spatial and non-spatial regressions, we tested whether the loss of PD can predict the loss of FD. **Results:** The extinction of all threatened amphibians would cause a higher loss of PD then expected by random extinctions, but FD loss would be similar to random extinctions, regardless of the simulated extinction scenario. However, at regional scales, PD loss and FD loss were highly variable depending on geographic region. Although current PD was positively correlated with current FD across assemblages, high levels of PD loss in the Neotropical region caused a decoupling with FD loss. **Discussion:** Our results challenge the validity of using PD loss as a surrogate for FD loss. Species may not be equivalent in the amount of unique evolutionary history and ecological functions that would be lost if they become extinct. If arguments for conserving PD are centered on maintaining FD and ecosystem services, we suggest that future studies should consider whether PD and FD are associated.

Keywords: Conservation, biodiversity, risk, scenarios

ID:1152
Monday Yucatan-2
Symposium: Tropical biotic interactions in the Anthropocene

Robustness of mutualistic networks to cascading effects

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Perturbations, from natural disasters to anthropogenic disturbances, can reshape the structure and dynamics of entire communities, potentially affecting a number of existing species, their abundances, and interaction patterns. Because particular species play major roles for ecosystem functioning and the services on which society depends, perturbations that affect these species may alter the functioning of ecosystems. Given the current biodiversity crisis that has been triggered by anthropogenic impacts, such as habitat loss and climate change, it is crucial to deepen our understanding on the robustness of ecological assemblages to the spread of perturbations if we are to predict and ameliorate these changes. Here, we use three datasets (empirical data on weighted mutualistic networks, empirical data on assembling plant-pollination communities, and model networks) to explore the robustness of ecological assemblages to cascading effects. We explore whether structural metrics associated with network robustness can enhance or dampen cascading effects in mutualistic networks. To do that, we create a perturbation spreading model and record how long a perturbation takes to spread across the network as a proxy of network robustness to cascading effects. We also evaluate how metrics related to information flow in networks can assist in the prediction of cascading effects magnitude. Additionally, we investigate if incorporating interaction strengths affects the magnitude of cascading effects by exploring different extinction driver models. We found a positive relationship to perturbation spreading time and metrics related to information flow in networks. Thus, metrics related to information flow in networks might help us predict how perturbations will spread in ecological communities. Additionally, networks are more robust than they first appear when we compare the results we get from the interactions presence/absence model versus incorporating interaction strengths. And finally, assembling communities seem to be as robust to cascading effects as more mature, established communities. We discuss the implications of these results to the conservation and restoration of ecological communities.

Keywords: Modularity, nestedness, pollination, complex networks.

ID:1156
Monday Yucatan-2
Symposium: Tropical biotic interactions in the Anthropocene

Vertical stratification: a new gradient in biogeography

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Background: Biodiversity is spatially organized by climatic gradients across elevation and latitude. But do other gradients exist that might drive biogeographical patterns? **Methods:** In the field, we conducted vertical ground-to-canopy surveys across four continents and then performed a global analysis on vertical stratification for over 5000 amphibian species. **Results:** Using data from tropical rainforests of SE Asia, Madagascar and Australia, we will show that rainforests vertical strata provide climatic gradients steeper than those offered by elevation and latitude. Communities vertically organize along this gradient, which affects current biogeographic patterns through its interaction with current climate variability as well as historical environmental stability since the Last Glacial Maximum (c. 20,000 years ago). **Conclusion:** Using outputs from our local to global analyses, I will explain how canopy science offers 1) new insights for understanding patterns of species richness and abundance globally, 2) inference about species interactions and community assembly, and 3) a novel biogeographic dimension for predicting organismal vulnerability to climate change.

Keywords: canopy, climate change, biogeography, arboreal

ID:1155
Monday Yucatan-2
Symposium: Tropical biotic interactions in the Anthropocene

Seed disperser loss affects community assembly, species diversity, and forest structure

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Background: Small-scale disturbances in forests are hotspots of recruitment and set the stage for changes in forest composition. In addition, the rate of disturbance and recovery determines forest structure, or the proportion of forest in a disturbed state. Since 75-90% of trees in tropical forests have seeds dispersed by vertebrates, dispersal by vertebrate frugivores likely affects regeneration in these areas. However, we lack a mechanistic understanding or ability to predict how dispersal affects post-disturbance community assembly and recovery. We propose that frugivores promote colonization by non-local species, increasing local species richness, but decreasing turnover between gaps. In addition, we hypothesize that the pace of recovery and overall forest structure depends on dispersal of quick-growing pioneer species. **Methods:** The Mariana Islands offer a unique opportunity to examine the effect of frugivores on gap dynamics. Most tree species, including all pioneers, rely on frugivorous vertebrates to disperse their seeds, but an invasive snake was introduced to one island (Guam) and caused the functional extirpation of all native vertebrate frugivores. In contrast, the nearby islands of Saipan and Rota support similar forest to Guam yet still have frugivores. We created experimental treefall gaps across three islands, and used seed additions or seedling removals in a portion of the gaps to simulate either dispersal or lack of dispersal. We followed the regenerating seedling community and gap closure for 3.5 years. **Results:** We found that gaps with dispersal had higher seedling species richness but lower species turnover between gaps than those that lacked dispersal. Gap regeneration was faster in gaps with dispersal than those without primarily because gaps with dispersal contained more pioneer species. Preliminary results suggest gaps are closing more quickly in the presence of dispersers, suggesting that a forest without frugivores will have a more open structure. This is consistent with the observation that there are two to four times more natural gaps on Guam than on islands with dispersers. **Conclusion:** We demonstrate that vertebrate seed dispersal increases species richness, decreases turnover, and can influence the physical structure of forests, with gap regeneration slowing in its absence. These results suggest that the ongoing loss of biotic dispersers could result in forests that have lower diversity and more open forest structure.

Keywords: seed dispersal; treefall gaps; frugivory

ID:1159
Monday Yucatan-2
Symposium: Tropical biotic interactions in the Anthropocene

Symposium
Trees outside forest for biodiversity conservation, ecosystem services and livelihoods

Tropical ecosystem services

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Background: The implications of tree cover expansion for tropical and subtropical grassland ecosystems are hotly debated but insufficiently understood. The mostly treeless grasslands of subtropical South America have fascinated ecologists for centuries because these regions have high levels of precipitation potentially enabling high tree cover. Yet, tree expansion on these grasslands is often perceived as a threat to the provision of ecosystem services, particularly livestock productivity. **Methods:** We assessed the effects of tree cover on cattle movement and behaviour, grass forage provision, plant and animal diversity, rates of organic matter accumulation and decomposition, soil fertility, and microclimate conditions in grasslands in Uruguay. We used a combination of field surveys, field experiments and monitoring of individual cows using GPS collars. **Results:** Grasslands are mostly colonized by thorny *Acacia caven* trees. Under the shade of these trees, we found a higher abundance of palatable C3 grasses with higher nitrogen content compared to herbaceous communities of the adjacent unshaded grassland. In addition to forage, trees also provide shelter from harsh environmental conditions. We found that cattle actively seek tree shade especially during hot and windless days or during cold and windy conditions. Interestingly, solitary trees also facilitate successful recruitment of forest tree species by reducing abiotic stress. Tree cover expansion from the closed riverine forests into adjacent grasslands forms an ecotone of tree patches. As tree patches increase in size, microclimate becomes cooler and moister, soils get richer in organic matter, and the community of soil invertebrates becomes dominated by litter decomposers. This ecotone of tree patches is characterized by a higher diversity of bird and mammal species than those found under the closed forest and treeless grasslands. **Conclusion:** Our results suggest that patchy tree cover would most likely benefit biodiversity as well as animal welfare and production in grasslands allowing the combination of a diversity of ecosystem services.

Keywords: ecosystem services; grasslands; tree expansion

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Monday Yucatan-3
Symposium: Trees outside forest for biodiversity conservation, ecosystem services and livelihoods

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Trees outside forest: biodiversity conservation, ecosystem services

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Taxonomic tree diversity in different land use types of family farming systems in Nicaragua. Loss of biodiversity due to meet the demand of food production is negatively affecting ecosystem functions and consequently key ecosystem service. Under this scenery to find productive systems that meet food demand and conservation becomes a priority, agroforestry systems could fulfill both demands. This study evaluated taxonomical diversity of the woody component (trees and palms) of family farms comparing sites with different agricultural development and six most dominant productive systems (coffee = CF, cacao = CC, live fences = CV, basic grains = GB, pastures = PA and patios = PT). The inventory of the woody component was carried out in 171.6 ha using sampling transects of 0.2 ha in a total of 344 land use from 90 farms in the municipalities of El Tuma - La Dalia and Waslala in Nicaragua. A total of 16 579 individuals belonging to 235 woody species with a diameter at breast height ~ 10 cm and trees of ~ 5 cm for the genus Citrus were recorded. Sites had a 60% of similarity, Bray-Curtis index, sharing 144 species. Between land uses the similarity varied between 32% and 58%. Species composition in CV was the most dissimilar in comparison to the other land uses studied. PTs share about 44% of species with CC and CF, and only between 33-36% with GB and PA. Rarefaction curves and species accumulation showed more species richness in Waslala than in La Dalia, while the density of species (species per sampled area) did not differ between sites. Species richness and species density per ha differed between land use types, same pattern than Shannon and Simpson diversity indices There was interaction between agricultural land use and sites: in La Dalia, CF and CV were more diverse and equitable than in Waslala, but the pattern changed for CC, PA and GB. Patios do not differ in diversity and equity between the two sites, showing intermediate levels between studied all land uses. The richness accumulated at the landscape level was different both by sites and land uses, while the richness of species per ha and diversity per plot was only differentiated by land use, evidencing a change in the relative importance of land uses at each site.

Keywords: Taxonomic tree diversity, land use

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Functional Diversity in Agroforestry Systems of Central America

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Agroforestry systems (AFS) in Central America are characterized by a large variety of species which provide a wide range of ecosystem services. We evaluated the functional diversity of AFS related to the provision of ecosystem services such as nutrient cycling as well as carbon sequestration and stock. The research was carried out using databases from forest inventories of four AFS (coffee, cocoa, trees in pasture and living fences) in Belize, Costa Rica, Guatemala, Honduras, Nicaragua and Panama. In addition to this, the compiled information of published and unpublished sources of plant functional traits was also used, this data base allowed to idenfy a set of functional traits to obtain a data matrix as complete as possible which also contained the species of greater abundance in AFS in Central America. Then, with the selected functional traits as specific leaf area (mm2 mg^{-1}), leaf nitrogen (mg g^{-1}) and foliar phosphorus amount (mg g^{-1}); maximum height (m), density of wood (mg g^{-1}), weight thousand seeds (g), foliar phenology (deciduous and evergreen) and dispersion syndrome (anemochory, autochory, hydrochory, endozoochory and exozoochory). Six plants functional groups were identified; one of palms and five of trees species. Considering the multivariate vector of the set of traits, the functional types were denominated i) conservative, ii) conservative of high strata, iii) net acquisitive, iv) acquisitive of low size, v) intermediate acquisitive and vi) palms. After this, the presence of the plants functional types in each AFS by country was evaluated. The results indicate that groups of conservative species and palms are present in systems with cocoa in Belize, Honduras and Costa Rica, and AFS with coffee in Honduras and Nicaragua. Conservative high strata and net acquisitive species are associated with AFS with cocoa in Panama and Nicaragua and with trees in pasture in Costa Rica and Belize. Acquisitive low strata species are present in the AFS with cocoa cacao in Guatemala, in living fences in Honduras and Panama. trees in pasture are present in Honduras and Panama. The group of intermediary species are associated with living fences in Nicaragua and Costa Rica, trees in pasture in Nicaragua and coffee in Costa Rica.

Keywords: Functional types plants, ecosystem, multivariate.

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Species-area relationship for trees on farms in Nicaragua-Honduras Sentinel Landscape

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Background: The species-area relationship (SAR) is one of the most fundamental tools in ecology and nowadays it has also become a tool for sustainable management and conservation. Little has been evaluated to elucidate the best SAR models that explain and predict tree species richness (S) appropriate for productive landscapes. Trees on farms are present in almost half of the agricultural land in the world (more than 1 billion hectares) and they contribute to ecosystem functioning and people's livelihoods. Understanding patterns of SAR will help to assess the role that farming systems play in both the maintenance or degradation caused to ecosystem processes. In this study we aim to understand the tree species-area relationship for productive landscapes and the influences of land use type and scales. **Methods:** As part of the CGIAR Research Program on Forests, Trees and Agroforestry we evaluated S in 90 farms (270 farm plots) Nicaragua-Honduras Sentinel Landscape. In each plot a complete tree census and a sampling data based on transects were carried out. The full census included 781 ha of cultivated land for the most dominant land uses: cocoa, coffee, pastures, grains, and patios. Six functions were used to fit SAR, those that never reached an upper limit and those with an upper asymptote. Individual density was included as a covariable. **Results:** A total of 32 195 trees were measured, including 264 species. At plot level, SAR is better explained for exponential function, however it differed between land use types. Individual density as a covariable improved the model variance explained, 79%. Between land use type: species-area and species-density relationships were similar between coffee, cocoa and pastureland, but species-density for pastureland was different. Grains and patios differed with the other land use types and between them. At farm level, power function better explained SA. S rapidly increased in farms smaller than 40 ha, thereafter increases of S slowed down. Farms larger than 40 ha had on average, 81 tree species and less than 50 individuals per ha. On average, density of S (S/ha) was 30±10 tree species, and individual density of 79±57 tree per ha. **Conclusion:** Farm size and the composition of land uses are good predictors of S. These findings suggested that the role of family farming in the conservation of tree diversity and related ecosystem processes can be better managed and planned based on farm diversification.

Keywords: Species-area relationship, productive landscape, trees

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Gender and agroforestry: considerations for climate change

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Background: Agroforestry has been promoted as an important climate-smart agricultural practice in various parts of the world most vulnerable to the impacts of climate change; however, due to gender-based constraints, women and men can face differing obstacles to access valuable information on CSA practices related to trees on farms. Group participation can help women surmount these challenges. In particular, research on women's participation in agricultural and natural resource management groups demonstrates the benefits women can perceive in terms of improved access to trainings, knowledge development and capacity-building. The paper examines the degree to which men's and women's group participation and access to information are primary factors in implementation of agroforestry practices on farms in a territory distinguished by high climatic risk in Nicaragua. **Methods:** The study analyzes household level socioeconomic data collected in 2015 within a Climate-Smart Village of the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) in Tuma La Dalia, Nicaragua. From 271 households, a total of 493 surveys were carried out with adult men and women primary decision-makers. Households were chosen through simple random sampling. The intra-household survey collected data related to agricultural and agroforestry activities, and includes sex-disaggregated data about decision-making, group participation, and knowledge and adoption of CSA practices. **Results:** Results suggest that the average number of on-farm tree species reported is greater when women participate in agricultural or natural resource management groups, as compared to when they do not. Furthermore, while more men tend to have knowledge of agroforestry in comparison to women, when women do have agroforestry knowledge the results demonstrate that they are more prone to report implementation than men. **Discussion:** The study contributes important gender analysis of men's and women's capacities to access and implement information on agroforestry practices through their participation in groups. This developed understanding of the gender considerations of agroforestry is critical, in the context of developing climate change adaptation and mitigation strategies in the region.

Keywords: gender, agroforestry, climate change, Nicaragua

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Participatory nursery trials to conserve tropical tree species and genetic diversity

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Background: Conserving intra-specific diversity of tropical tree species populations is important to build resilient landscapes for three reasons: 1) it is a vital resource for adaptation of tree species populations and forests to climate change; 2) it is a vital resource for the domestication of food, timber, and other tree species; 3) intra-specific diversity is the basis for good quality seed material for reforestation, agroforestry, or restoration. While the conversion of forest to agriculture threatens populations of tropical tree species, the remaining trees outside forests in agricultural landscapes become increasingly important in maintaining intra-specific diversity. Several studies suggest that gene flow dynamics and intra-specific diversity can be maintained in highly fragmented landscapes with remaining trees outside forests. Some studies, however, suggest that progeny fitness decreases after fragmentation despite high levels of gene flow. But more evidence is required. We propose the establishment of participatory nursery trials to monitor progeny fitness of tropical tree species in multi-functional landscapes. **Methods:** We tested the potential of participatory germination trials with two forest communities from the multiple use zone of the Maya Biosphere. Mahogany (*Swietenia macrophylla* King) seed was collected in March 2016 from 90 adult trees from managed forest stands before and after timber extraction. Local, cheap materials were used to set up nurseries. Community members were trained in seed germination and data collection. The trials were established April and May 2016 and lasted 50 days. **Results:**The collection of germination data by community members was solid and sound. One community used the germinated seedlings to restore degraded pasture lands. No differences were observed in germination from stands before and after timber extraction. The germination results still need to be related to a gene flow analysis, which is currently carried out. **Conclusion:** This pilot shows the potential of participatory nursery trials to monitor and conserve intra-specific diversity of tropical tree species in multi-functional landscapes. These trials can provide insights about the effects of natural resources management on intra-specific diversity. The trials allow to engage local actors and can be combined with seedling production for tree planting. As a next step, the potential of these trials can be tested with other farmer and forest organizations.

Keywords: Tree Genetic Resources; Germination trials; Participatory Action Research; Genetic monitoring; Fragmentation

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Symposium
Tropical leaf phenology: field, remote sensing and modelling

The use of digital cameras to track leaf phenology and productivity in the tropics

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Background: Leaf flushing and senescence are major events in plant life cycles, exerting temporal control over the structure and function of plant communities, defining the seasonality and inter-annual variability of carbon exchange via photosynthetic processes, respiration, and litter production. However, complex and highly diverse vegetation makes simultaneous phenological observations of several sites and vegetation types very challenging in the tropics. The drivers of leaf phenology for different tropical plant communities are also poorly understood. Recently, the use of digital cameras to monitor leaf phenology and track phenological patterns across sites and vegetation types in tropical ecosystems has been successfully demonstrated. **Methods:** We used digital cameras to investigate the relationships between temporal patterns of leaf phenology and ecosystem carbon fluxes at three different Amazonian tropical vegetation types – dry forest, Atlantic rainforest and woody cerrado savanna. We installed digital cameras on carbon flux towers and collected daily photographs over three years (2013-2015). We used camera-derived leaf phenology data to investigate how well it predicts the gross primary productivity (GPP) within each site. We selected from the images a Region of Interest (ROI) representing the community and extracted the colour information by calculating the RGB chromatic coordinates index (RGBcc). **Results:** We processed around 170,000 images and high frequency data from eddy covariance measurements. Preliminary results showed a marked seasonality in both leaf phenology and GPP at sites with higher water restriction, i.e. dry forest and woody cerrado savanna. Despite leaf phenology following patterns in GPP, rainfall has likely an effect controlling GPP seasonality in these two vegetation types. **Conclusions:** This study examines how the seasonality experienced at different forest types influences vegetation phenology and their ecosystem scale energy fluxes. It improves our understanding of the different drivers of leaf phenology and how leaf development can be useful in predicting photosynthetic seasonality in tropical ecosystems.

Key words: digital repeat photography; gross primary productivity; photosynthesis, greenness indices; phenocam

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Remotely sensed seasonal canopy dynamics in the tropics: a riddle of many scales

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Background: Natural leaf aging/phenology is a fundamental driver of change in morphological, biochemical and spectral leaf traits, thereby, regulating both ecosystem processes (plant growth, energy and nutrient cycling) and remotely-sensed canopy dynamics. Leaf phenology has been proposed as a major driver of seasonal productivity in carbon-rich tropical evergreen forests yet tropical leaf phenology is poorly understood. **Methods:** We examine processes related to leaf phenology at the leaf, individual tree crown and community scale to assess the relative impact that these scale-dependent processes can have on remotely sensed NDVI and EVI time-series in a Peruvian evergreen Amazonian tropical forest. **Results:** We show that age-related phenological changes in leaf reflectance are expressed at the canopy scale but influenced by both canopy leaf area (CLA) and the leaf turnover strategies of individual trees. We also show that seasonality of greenness VIs such as NDVI and EVI2 are more strongly correlated to phenological changes in CLA then changes in leaf reflectance. At the community scale, phenological sources of reflectance and structural canopy variation such as (1) leaf phenological asynchrony within and between trees, (2) short periods of leaflessness in brevi-deciduous trees that are difficult to detect, and (3) lack of seasonality displayed by particular evergreen leaf turnover strategies can produce dampening effects on seasonal amplitudes of annual cycles observed by remote sensing VIs. **Discussion:** Our results demonstrate that complex and diverse leaf phenological processes interacting at different scales challenge our current ability to remotely sense the annual cycles of tropical canopy dynamics. Our study highlights the need to account for the interaction of these processes, and their potential covariance or unique behaviours in order to achieve significant advance in the mechanistic understanding of what creates and drives different phenological mosaics identified across Amazonian forests and in modelling their effects on water and carbon fluxes across the Amazon.

Keywords: Tropical phenology, annual cycles

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Tropical vegetation in global vegetation models: plant functional types and other simplifications

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Tropical vegetation canopies host a bewildering array of plant existence strategies ranging from grassland and savanna vegetation to wetland low forest types, upper montane krummholz and the soaring stature of lowland tropical forests. The models used to represent these ecosystems on a global scale, however, almost universally make use of a very restricted set of Plant Functional Types (PFTs) such as 'broadleaf tree' and 'C4 grass' to represent vast swathes of structurally diverse tropical ecosystems. Additionally, canopy structure is generally represented in a very basic way, usually as a green sheet of zero thickness covering the land surface. Photosynthesis is usually represented, arguably, in too much detail, whereas spatial processes such as gap formation, seed dispersal and pollination are usually not represented at all. Whether the reasons for these simplifications are practical (e.g. limited computational capacity), human (e.g. individual expertise on tropical diversity and software engineering seldom coinciding) or theoretical (e.g. legitimate interpretations of functional niche theory in the case of PFTs), their widespread use appears unlikely to change soon. Therefore, it makes sense to ask how far we can really go with current modelling structures. In 1987 Box said "all models are wrong; the practical question is how wrong do they have to be to not be useful". Borrowing from results of the Role of Biodiversity in Climate Change Mitigation project (ROBIN) and results from runs using the Joint UK land Environment Simulator (JULES), we explore whether vegetation models are still so wrong that they are not at all useful, or do we perhaps dismiss them out of hand because of their seemingly-flawed approaches?

Keywords: Tropical vegetation model simplification PFT

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Remote sensing detection of the Amazon phenology

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Background: The Amazon, Earth's largest tropical rainforest, has a critical role on the seasonality of carbon and water cycles. However, swings of both cycles depend on the phenology of Amazonian canopies. Understanding biome scale phenological cycles is not trivial, but is critical for mechanistically quantify the effects of climate change on Amazon forest functioning and its feedbacks. Therefore, the aim of this study was to understand the links between phenological cycles and remote sensing data to evaluate the drivers of phenology and connect phenology with photosynthetic capacity of Amazon canopies. **Methods:** We used multi-level remote sensing data on vegetation indices, sun induced fluorescence and climate data to evaluate the functioning of Amazon canopies. Result - We found that Amazon trees have variable phenological cycles depending on their resistance to water limitation. The enhanced vegetation index is a coherent proxy of leaf flush in Amazonia. However, does not follow the patterns of photosynthesis. The best indicator of canopy photosynthesis is the information on sun induced chlorophyll fluorescence. Our analysis indicates that leaf flushing in most of the Amazon respond to light instead of water. Interestingly, despite leaf flush occurring in the end of dry season, the maximum values of sun induced chlorophyll fluorescence are observed during the wet season. Therefore, the peak of leaf flushing and the maximum photosynthetic capacity of Amazon forest canopies occur with a lag that is related to the maturation of new leaves. **Conclusion:** We conclude that we now have a much better understanding about the representation of phenological cycles by remote sensing data. With this knowledge, the main processes driving large scale canopy phenology can be studied and process based models can be improved. Our data not only showed the main variables limiting the phenological cycles, but also the locations where light overcomes the influence of water in determining the seasonal cycles and vice-versa. The lag between leaf flush and maximum photosynthetic capacity is also a key finding for accurately model the seasonality of carbon and water cycle in Amazonia.

Keywords: modis, gome2, photosynthesis, remote sensing

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Modeling leaf phenological diversity across East Africa

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Background: Recent work has identified semi-arid and savanna-type (SAST) ecosystems as a critical component of interannual variability in the Earth system, yet our ability to model the spatial and temporal patterns that account for the variability remains limited. Patterns in leaf phenology – the location and timing of the appearance, presence, and senescence of plant leaves -- is a major contributor to this variability. Plants grow and drop their leaves in response to a variety of cues, including soil moisture, rainfall, day length, and relative humidity, and alternative phenological strategies often co-exist in the same location. **Methods:** Here we use the concept of 'phenoregions' – regions determined by their phenological similarity – across five sites in East Africa derived from Landsat data to ask what drives variation in phenoregions at the local and regional scales using a regression tree approach. This work will help inform land surface models like the Community Land Model, where uncertainty in the drought deciduous algorithm has been shown to contribute to overall model uncertainty. **Results:** We show that at the local scale, phenoregion groupings can be attributed to a suite of drivers, including topography, substrate, and land use. At the regional scale – looking from Kenya to South Africa – these drivers are similar but not identical, suggesting an interaction between local-scale drivers and regional climate patterns. **Discussion/Conclusions:** Our results suggest that applying a broad 'one size fits all' phenology algorithm for dry ecosystems does not capture the important variability at both local and regional scales across these ecosystems. Future modeling work should focus on striking a balance between model complexity and capturing the important functional diversity of SAST ecosystems. This could become increasingly feasible as new and upcoming satellite sensors like NASA's Soil Moisture Active Passive sensor and ESA's Sentinel series provide increasing amounts of data relevant to SAST phenology research.

Keywords: phenology, remote sensing, savanna, semi-arid

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Maps of the synchrony of net leaf phenology from MODIS NDVI and EVI for Meso- and South America

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Background: The leaf phenology of ecosystems can be characterised through the use of Earth observation (EO) data using a variety of approaches. The common approach is to derive time series of vegetation indices (VI) which are demonstrably related to the temporal evolution of FPAR, LAI and GPP. Another approach is to combine EO derived phenology metrics, such as start, end and, length of season and the magnitude of greening from VI time series. The latter metrics will often show high levels of uncertainty, in particular in the tropics. Here we present maps of average ranges (described as average "amplitudes") of VI for Meso- and South America, representing the synchrony of vegetation greening. They are reference phenology maps for the dynamic global vegetation modelling community, currently concerned with the development of deciduous plant functional types in the tropical and subtropical regions. **Methods:** Because of issues with noisy VI time series and the pre-processing of some of the VIs, we implemented an approach that robustly tests for the presence of genuine annual signals in VI. A Lomb-Scargle spectral analysis suitable for unevenly spaced data was applied to 2000-2013 MODIS VI. Pre-processing was used to eliminate measurement outliers and the outputs of the spectral analysis were screened for statistically significant signals to map the average "amplitude" (i.e. maximum minus minimum) of genuine annual cycles of vegetation greenness. **Results:** The maps provide an indication of net ecosystem phenology since the satellite observations integrate the greenness variations across plant individuals and species within each pixel. The average amplitude can be interpreted as indicating the degree to which the leaf life cycle of plant individuals and species are synchronised. Areas without statistically significant annual variations in greenness may still consist of individuals that show a well-defined annual leaf phenology. In such cases the timing of the phenology events will vary strongly within the year between individuals. Alternatively, these areas may mainly consist of plants with leaf turnover strategies that maintain a constant canopy of leaves of different ages. Comparison with in situ observations confirm our interpretation of the maps. **Discussion:** The maps could be used to locate evergreen and deciduous forests or could provide continental scale information for biodiversity and ecology studies that require a map of community level leaf phenology.

Keywords: VI leaf-phenology spectral-analysis average-amplitude remote-sensing

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Symposium
Advancing Bamboo Ecology, Systematics, and Conservation in the Neotropics

Bamboo diversity, systematics and evolution, with a focus on the Neotropics

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Background: Bambusoideae (bamboos), comprising 1,645+ species, is one of nine crown clade lineages within the Poaceae and represents the only one to diversify primarily in association with forests. Bamboos are classified into three tribes: Arundinarieae (temperate woody bamboos, 561 species), Bambuseae (tropical woody bamboos, 910 species) and the Olyreae (herbaceous bamboos, 122 species). The Arundinarieae has a strongly asymmetric Laurasian distribution pattern, with the vast majority of species in eastern Asia. Bambuseae consists of two major clades, the Paleotropical and the Neotropical woody bamboos (NWB), with 552 and 358 species respectively, and is distributed broadly in the tropics and subtropics with a few taxa in subtemperate regions, and extensive diversity in montane systems. With the exception of 1 genus endemic to New Guinea, and 1 species occurring in both the Neotropics and Africa, the rest of the Olyreae is restricted to the Neotropics. Olyreae typically inhabit the understory, with some adapted to gaps and edges, but the woody bamboos mostly occupy gaps and edges or open habitats. **Methods:** Recent bamboo studies are based on floristic work involving field work and herbarium specimens, and molecular phylogenomics using both plastid and nuclear DNA sequence data. In the usual absence of flowering material, complete vegetative collections are essential for discovery and identification, so targeted collecting is being undertaken in current bamboo projects (e.g., Brazil, Mexico). **Results:** The NWB clade is moderately supported, but its three subtribes are each strongly supported and in this topology: [Arthrostylidiinae + Guaduinae] + Chusqueinae. Within Olyreae, Buergersiochloinae + [Parianinae + *Olyrinae*] is strongly supported. Description of new species continues unabated in these groups and new genera also continue to be recognized. Brazil has the greatest diversity of both NWB and *Olyreae*, but the Andes, Panama/Costa Rica, Mexico and the West Indies also harbor significant diversity and endemism. **Discussion/Conclusion:** Significant species diversity remains to be described, especially in Peru and Bolivia but also in Brazil and the northern Andes. *Chusquea*, *Guadua*, *Merostachys* and *Pariana* still require significant taxonomic attention. Phylogenetic hypotheses require additional sampling of critical taxa before biogeographic patterns can be fully explored and classification stabilized.

Keywords: Bambuseae, Neotropical bamboos, Olyreae

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Exceptional dynamism in bamboo-dominated forests in the western Amazon

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Background: Bamboo dominates ~180,000 km2 of forest in southeastern Amazonia. In the southern Peruvian lowlands, two species of bamboo dominate this mixed forest, *Guadua* sarcocarpa and *G. weberbaueri*. Although there are studies about the life-cycle of bamboo and their distribution patterns, little is known about the influence of bamboo mass-mortality in forest dynamics. We asked: (1) how does bamboo affect forest structure? and (2) how does bamboo mass-mortality affect forest dynamics? **Methods:** The study site was located in terra firme forest near Cocha Cashu biological station in Manu National Park in the western Amazon. To evaluate the influence of bamboo on forest structure and dynamics we established a 7-km transect across bamboo and non-bamboo dominated forest. We also established a 1-ha permanent forest plot in a bamboo-dominated forest, monitoring tree communities ≥ 10cm in diameter over 10 years since 2000. Censuses were taken before and after the bamboo mass-mortality event in 2003. **Results:** showed low values of basal area in the bamboo-dominated forest as compared to non-bamboo across the 7-km transect. After the bamboo mass mortality event, we observed tree mortality and tree recruitment rates that greatly exceeded those recorded in Amazonian forest where bamboo was absent. In addition, above ground carbon density stocks are increasing as a consequence of the high recruitment rates and the high growth rates of the fast-growing taxa, coupled with high wood density in a dominant and fast growing species. **Discussion:** Amazonian bamboo-dominated forest is hyperdynamic, with turnover rates up to 4 times faster than non-bamboo forest. The accelerated dynamics can have important repercussions on Amazonian ecosystem function, particularly the C and water cycles, and their responses to climate change

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A fire hypothesis for the maintenance of bamboo thickets and forests as alternative ecosystem states

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Background: Despite growing recognition that tropical forests and savannas represent alternative ecosystem states determined by fire, there are relatively few examples of purely fire-determined grassy biomes in the tropics. Instead, most grassland-forest distributions, particularly in the Neotropics, appear to be determined by interactions among fire, vegetation, and soils; i.e., savannas are more likely than forests to occur on infertile soils, where tree growth is constrained by resource (i.e., water and nutrient) availability. **Methods:** To better understand the potential for vegetation-fire interactions to create tropical grassland-forest mosaics, we studied the native bamboo *Guadua paniculata* (Bambusoideae, Poaceae) in eastern lowland Bolivia. Along 150 m transects between each of six bamboo thickets (unburned for >10 yr) and adjacent forests, we sampled tree communities, bamboo populations, and soils. **Results:** Transitions between bamboo thickets and forests were abrupt, with mean bamboo density declining from 10,000 culms/ha to zero over just 10-15 m. Tree density (~5 cm diameter) in bamboo thickets (700 trees/ha) was similar to forests (900 trees/ha), but mean basal area was much lower (7.7 and 19.7 m^2/ha, respectively). This difference in basal area was due to many small diameter resprouts of trees that were top-killed in previous bamboo-fueled fires. Indeed, *Guadua* produces up to 16 Mg/ha of fine and small fuels, creating conditions for very intense fires. As evidence that such fires have a long history in these systems, we found that soils beneath bamboo thickets contained twice as much pyrogenic carbon (i.e., charcoal) as forest soils (mean 5.6 versus 2.6 g/kg, respectively). To test for the potential role of edaphic factors in determining ecosystem boundaries, we conducted multivariate analyses of soil chemical and physical variables in surface (0-20 cm) and subsoils (90-110 cm) and found no differences between bamboo thickets and forests. **Conclusion:** These results are consistent with the hypothesis that fire-vegetation feedbacks, rather than soil-vegetation interactions, maintain bamboo thickets and forests as alternative ecosystem states. Current land-use policies in Bolivia, intended to prevent forest fires, should be re-evaluated to permit the burning of fire-dependent bamboo thickets and savannas.

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Forest dynamic influenced by the dominance of native bamboo in the Atlantic Forest

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Background: Overabundant bamboos often affect negatively forest structure and ecological process. We tested the prediction that the bird community, seed rain profile, seedling and sapling establishment, and tree demography are altered in *Guadua tagoara* patches, a large-sized woody bamboo native from the Brazilian Atlantic Forest, compared to forest patches without bamboos. **Methods:** We established a seed dispersal and regeneration monitoring system in order to elucidate the forest dynamic and the demographic bottlenecks of plant regeneration cycle for both patch types. Data from soil, canopy openness and litter depth were also collected. **Results:** Bird species richness was higher in bamboo patches in all categories of diet and forest dependence. Seed rain was not greatly altered by the presence of bamboos, while bamboo patches showed higher seedling abundance, emergence, growth and mortality than patches without bamboos. However, diversity was lower in these habitats. Bamboo plots had more fertile soils, greater canopy openness, and thicker litter. Bamboo patches had lower density of adult trees and lower species density. In addition, overall tree diameter distribution was very different between habitats, with bamboo patches having greater concentration of small-sized trees. **Discussion:** The initial expansion of bamboos, forming discrete patches within mature forest, represents an intermediate-level disturbance that enhances forest heterogeneity and promotes the diversity of avian, seed and seedling communities. The presence of trees growing amidst and over the bamboos seem to play a key role in keeping the seeds falling in bamboo plots because they serve as food sources for frugivores or simply as perches for them. The loss of such trees may lead to enhanced seed limitation, contributing ultimately to the self-perpetuating bamboo disturbance cycle. Greater physical (wind and bamboo-induced damages) and physiological stress (heat and light) in bamboo patches are likely causes of bamboo-dominated patches being more dynamic, as suggested by higher emergence and death rates of seedlings. Because bamboo patches promote heterogeneity in the forest, they are important components of the landscape in tropical forests. However, in high densities, bamboos may limit recruitment for the plant community by imposing marked discordances of seed arrival and early seedling recruitment, and by arresting the later stages of recruitment in tropical forests.

Keywords: bamboo-dominated forest, Brazilian tropical forest

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Life Cycle Length and Flowering Waves of Bamboo in Southwest Amazon

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Background: Open forests dominated by semi-scandent woody bamboos of the genus *Guadua* are found in the southwest Amazon as a mosaic of patches, each being 102 to 104 km2 in size. Each patch is a single population of semelparous plants with a synchronized life cycle. At the adult stage, areas dominated by *Guadua* can be detected on images captured by orbital sensors equipped with bands in the optical portion of the spectrum. This study examined temporal and spatial patterns in the spectral behavior of *Guadua* populations over their life cycle in the southwest Amazon, using images acquired by optical orbital sensors between 1975 and 2008. **Methods:** First, repeated mortality events in the same geographic patch were observed directly, by examining over 200 Landsat images of the SW Amazon from 1975 to 2008 and annual MODIS 43B4 images from 2001 to 2008. The final question examined was whether separate bamboo populations time their flowering events independently from their neighbors. Because these populations do not share genes, no relationship is expected to be found between proximity in time and proximity in space, for the flowering of different populations. Flowering itself is not visible, so all post-reproductive dieback events were mapped using the annual wall-to-wall MODIS coverage of the SW Amazon for 2001-2008. **Results:** Life cycles of 27 and 28 years were found. Second, the life cycle was inferred for all populations within a 34,000 km2 area that had almost no man-caused deforestation. Patches with bamboo dominant in the forest canopy were mapped within this area for 21 different dates spanning 1975 - 2008. The pair of maps with highest spatial congruence was taken to be one life cycle apart in time. This method gave a life cycle of 28 years. Reproductive events of each patch (each population) occurred in a highly contagious fashion, forming super-patches of temporally clustered events. Flowering waves were also observed, i.e., contiguous patches flowering like falling dominoes. **Discussion:** A possible explanation for this may be a consequence of allochronic divergence from fewer ancestral populations and suggests a long history of widespread bamboo in the southwest Amazon. It is now possible to predict exactly where and approximately when new bamboo mortality events will occur.

Keywords: *Guadua*; Remote Sensing; Bamboo-dominated Forests.

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Endemism of the Mexican bamboos: efforts for conservation

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The Mexican bamboos are grouped in two tribes; the herbaceous (Olyreae) and the woody bamboos (Bambuseae), this last tribe has three subtribes in America; Arthrostylidiinae, Chusqueinae and Guaduinae and the three are present in Mexico. The aims of this study were: to identify the most diverse areas of Mexican woody bamboos and to detect their centers of endemism. We gathered presence records of 36 endemic Mexican woody bamboos, based on herbaria records and own collections. The richness was analyzed taking account the Mexican politic division with a cell size of 0.5º— 0.5º, using the simple and circular neighborhood methods. The endemism was analyzed following the modified area of endemism method. Mexico has 53 native woody bamboo species, 36 of them are endemic. Chiapas is the state with the richest diversity with 28, followed by Veracruz with 21 and Oaxaca with 19. The rest of the states with bamboo records have 10 or less species. The state with the highest endemism is Veracruz with 15 species, followed by Oaxaca with 11 and Chiapas with 10. The Trans-Mexican Volcanic Belt has the highest endemism with 14 species, followed by the Sierra Madre del Sur with 13 species and Sierra Madre Oriental with 10 species. Twenty six of the 36 endemic species are only known from 10 localities or less and 13 of those 26 species have less than five known localities. It is important to pay attention of those species with less than 10 records, because none of them are protected by the Mexican laws or recognized by the IUCN.

Keywords: Chiapas; Sierra-Madre-del-Sur; Sierra-Madre-Oriental; Trans-Mexican-Volcanic-Belt; woody-bamboos

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Diversity, ecophysiology and genetic variability in Venezuelan Andean woody bamboos

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Background and aims: Venezuela outstands from other neotropical countries of the region, due to the diversity of ecosystems within a relatively small territory, which have favored the diversification of woody bamboos, in terms of species richness and variety of life-forms. By 2013, a total 69 species had been described for the country, of which 22 were reported endemic. *Chusquea* is currently the most diverse genus, with 22 species, 4 of them endemic. With the aim of learning more about the ecology and diversity of the Venezuelan Andean group, we conducted studies that dealt with their ecophysiological response, species diversity and genetic variability. We originally believed that the extended vegetative phase of woody bamboos, combined with their continual clonal growth would favor the dominance of particular genotypes, particularly in cloud forest species. **Methods:** Ecophysiological studies focused on leaf-gas exchange and water relations in four Andean species: *Chusquea* multiramea L.G. Clark & F. Ely, *C. mollis* (Swallen) L.G. Clark (Ex. *Neurolepis mollis*), *C. aff. serrulata* Pilger and *C. spencei* Ernst. Species diversity studies included *C. fendleri* Munro. These were based on the analysis of morphological and anatomical data, recovered from fresh specimens, herbaria vouchers of Venezuela and Colombia and genetic studies using PCR-amplification markers (SSR, ISSR and RAPD). **Results:** Net photosynthetic rates Andean in cloud forest and paramo species of *Chusquea* range between 4-12 μmol m^{-2} s^{-1}, both groups maintain relatively high leaf-water potentials during wet and dry seasons, due a strict stomatal control, combined with low transpiration rates. Unbranched, shrub-like bamboos like *C. mollis* have lower photosynthetic rates, characteristic of understory cloud forest plants (2-4 μmol m^{-2} s^{-1}). Morphological and molecular studies revealed the existence of three new species and two subspecies. Both cloud forest and paramo bamboos present a high genetic diversity, based on the number polymorphic alleles, diversity indexes and the absence of dominant genotypes in all of the localities sampled. **Conclusion:** Venezuelan Andean cloud forest and paramo bamboos have very similar ecophysiological response across a broad range of radiation conditions. Their genetic diversity indices are comparable to those reported for non-clonal, polycarpic angiosperms.
Keywords: *Chusquea*, genetic diversity, tropical Andes

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The forest beyond the trees: woody bamboos in the spotlight of degraded subtropical forest

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An increasing number of recent publications show that bamboos have the potential to influence the diversity, productivity and dynamics of forest around the world. It is also known that its distinctive life-history traits, allow bamboo to colonize areas affected by natural and anthropogenic disturbance influencing tree community, microclimate and ecosystem processes. Here we synthesize 10 years of observational ad experimental research findings on ecology and ecophysiology of *Chusquea* ramossisima, the most abundant bamboo in Semideciduous Atlantic Forest (Argentina) to understand its role in forest dynamics. We performed field studies in forest affected by selective logging, with high bamboo abundance. We studied forest regeneration and bamboo growth rates after flowering, conducted some ecophysiological studies evaluating forest dynamic and ecosystem processes. Bamboo shows clonal reproduction allowing it to spread rapidly, and exhibits high plasticity in functional traits and leaf characteristic that enhance its growth in gaps and allow surviving under close canopy. *C. ramosissima* has similar photosynthetic from other co-occurring bamboo species. But, compared with trees, presented higher photosynthetic capacity per unit dry mass and leaves with relative low C cost. In addition, makes high root pressure and exhibits profuse guttation, at times continuing into mid-afternoon that able to colonize areas of varying water availability, that could influences forest water cycle through its potential to remove vast amounts of water from the vadose zone and affect neighbor plant saplings. Finally, the replace of trees and palms by bamboos affect structure and forest dynamics; generating changes in litterfall, litter decay rates and C cycle. Contrary our expectations the successful of tree regeneration in gaps following bamboo flowering and died, appears to be restricted to a very narrow window of increased light availability before rapid re-colonization of bamboo. Bamboos are important natural component of forest that need more attention, because they can provide refuge and food for animals, promote soil conservation and be important human resources. However, because of their impact on forest structure and positive feedback of some bamboo species with increasing disturbance resulting from forest exploitation and land-use change worldwide, they could emerge as key species, capable of influencing the dynamics of large areas of forest ecosystems
Keywords: Photosynthetic capacity, Plasticity, Regeneration

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Climatic tolerance and distribution of native bamboo along an Andes-Amazon elevation gradient

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Introduction: Vegetation across the Andes-Amazon elevation gradient is expected to be exposed to increasing drought and temperature as a result of climate change in the near future. Climatic tolerance plays a major role on species altitudinal distribution; plant ranges are shifting in order to keep track of their environmental requirements. However, we do not have much information about plant tolerance to temperature and drought along the elevation gradient. Here we use a widespread and abundant group, native bamboos, to further understand climatic tolerances across the Andes-Amazon gradient. **Methods:** I studied 12 species of woody bamboo occurring along the altitudinal gradient of Kosñipata valley in Peru, from 300 to 3000masl. For several individuals per species I measured the maximum temperature at which leaves can photosynthesize (Critical Thermal Maximum (CTMax)), and a proxy for drought tolerance (Membrane Stability). For the collection locations, I extracted temperature and precipitation data from CHELSA in order to understand the relationship between tolerances and environmental variables. **Results:** The experimental CTMax values for the bamboo species varied between 46 and 55°C and Membrane Stability ranged between 2 and 58%. CTMax was higher on the lowlands where air temperatures are higher. On the contrary, Membrane stability was higher at higher elevations where precipitation is lower and more seasonal. Drought and temperature tolerance were negatively correlated across the elevation gradient but positively correlated within individual elevation sites. **Discussion:** Bamboo species show opposite tolerances to temperature and drought according to the most pressing stress at their location; nevertheless, the within elevation relationship shows that there is no trade-off between leaf level thermal and drought tolerance at the individual level. Understanding climatic tolerance of bamboo species and how it affects distribution in the Andes-Amazon gradient will facilitate our understanding of the effect of bamboo on ecosystem structure and dynamics.

Keywords: Andes, Native bamboos, Temperature, Drought

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Multiple recurrent disturbances facilitate monodominance in a North American bamboo

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Background: Three bamboo species are native to the southeastern USA. The largest and most widespread is river cane (*Arundinaria gigantea* Walt. [Muhl.]), which occurs primarily alongside riparian forests in river floodplains. River cane was once commonly found in extensive, monodominant bamboo stands called "canebrakes," but these have declined in areal coverage by an estimated 98% over the last 200 years. During this time, humans drastically altered the disturbance regime in floodplains throughout the species' home range. Now there is considerable interest in restoring river cane to monodominant stand structure like the canebrakes described by early Europeans explorers. Like most bamboos, river cane is dependent on ecological disturbances that open gaps in the forest canopy and let in light. I studied the interacting effects of two such disturbances, windstorm and fire, on the ramet demography and stand structure of river cane in the lower Mississippi alluvial valley. In the process, I learned to age culms, a technique that could prove useful for other studies focusing on ramet demography in bamboos. **Methods:** I used multiple prescribed fires and a large tornado blowdown to examine ramet growth in river cane in Louisiana, USA. I compared burned and unburned stands of river cane growing inside and outside the blown down area to quantify the bamboo's response to sequential disturbances. I examined culms of various age cohorts to inform my findings. The study lasted 6 years, including 4 years after the prescribed fires. **Results:** Four years after burning, culm age distributions were younger in burned than in unburned stands both inside and outside the tornado blowdown. Damage rates were higher in forest than in blowdown habitats ($P < 0.001$). The two disturbances had an additive effect on culm density, as reflected by higher mean culm density in burned than in unburned stands ($P = 0.019$) and also in the blowdown versus under forest canopy ($P = 0.002$). **Discussion:** My results make clear that stands of river cane grow more densely and with younger mean culm age following both fire and windstorm disturbances. Such disturbances "reset" bamboo stands by removing older growth that is replaced by new, vigorous culms. We conclude that periodic disturbances are likely needed to produce dense, monodominant canebrake-like stand structure in river cane.

Keywords: *Arundinaria gigantea*, disturbances, fire, windstorm

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Advancing Bamboo Ecology, Systematics, and Conservation in the Neotropics: Future Steps

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Tropical America harbors 40% of the world's known bamboo species and supports extensive bamboo-dominated ecosystems, yet the vast majority of documented knowledge of bamboo emanates from Asia. A recent surge of publications has improved our understanding of neotropical bamboo ecology, taxonomy, biogeography, ethno- and economic botany, and conservation. In this symposium, researchers with a wide range of expertise in bamboo ecology and systematics will present their most recent work. These speakers, whose geographic interest extends from Argentina to the southern USA, will draw on different case studies to address several research themes, including: 1) the distribution of neotropical bamboo forests and species; 2) the role of taxonomy in bamboo's persistence in the landscape; 3) the extent of anthropogenic influences on bamboo forests and conservation status; and 4) the effect of bamboo-mediated disturbance on ecosystem dynamics. Together, these talks will illustrate the important implications of bamboo research for biodiversity conservation, ecosystem management, and tropical plant systematics, and set the stage for us to bridge major knowledge gaps among disciplines. To encourage communication and collaboration between bamboo researchers who are currently pursing complementary (albeit disparate) lines of research, we will lead a discussion that summarizes the symposium contributions. In doing so, we will highlight current research gaps and seek to develop a standardized method for conducting inventories of neotropical bamboo species, potentially providing the basis for future multidisciplinary collaborations.

Keywords: Bamboo, Bambusoideae

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Symposium
Biodiversity responses to landscape structure: Threats and conservation strategies across scales

Relative effect of forest loss and fragmentation on biodiversity in the Lacandona rainforest, Mexico

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Background: Human-modified tropical landscapes differ in the percentage of forest cover (landscape composition), and the remaining forest can show different degree of fragmentation (landscape configuration). Yet, the information on the relative impact of these two components of landscape structure on biological assemblages is scarce, but urgently needed to improve conservation strategies. Here, we assessed the relative influence of forest loss and fragmentation on the abundance of different taxa in the Lacandona rainforest, Mexico. **Methods:** We used a sample site-landscape approach. We sampled trees, rodents, dung beetles, amphibians, reptiles, phyllostomid bats, medium- and large-sized terrestrial mammals and primates in 12 to 29 forest sites, and landscape variables (i.e. percentage of forest cover and density of forest patches) were measured in 100-ha and 500-ha landscapes surrounding each forest site. We first identified the landscape size within which each landscape predictor showed stronger effects on each response variable (scale of effect), to then assess the relative effect of forest cover and fragmentation on the abundance of each taxon using generalized linear models. We separately assessed complete assemblages and forest-specialist species. **Results:** Forest cover was the main predictor of species responses, being positively related to the abundance of rodents, dung beetles, amphibians, reptiles, phyllostomid bats and medium- and large-sized terrestrial mammals, but only when considering forest-specialist species. Although more weakly, forest fragmentation tended to have a positive effect on most taxa. **Conclusion:** Our findings support the idea that forest loss shows a stronger effect on biodiversity than fragmentation per se, especially when assessing forest-specialist species. In fact, in agreement with recent evidence, fragmentation tended to have a positive (not negative) effect on most groups. The weak response of complete assemblages is probably related to compensatory dynamics, as the loss of forest species can be compensated for by the proliferation of disturbance-adapted species. Conservation strategies should be therefore focused on preventing forest loss, without assigning lower conservation value to small patches. Therefore, combining land-sharing and land-sparing approaches may be the best strategy to preserve biodiversity in this species-rich but vanishing ecosystem.

Keywords: Landscape structure; Biodiversity; Habitat loss

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Multi-scale effects on biodiversity and ecosystems services provision in coffee plantations

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Background: Crop pollination and pest control services in coffee plantations are among the most well know ecosystem services in agricultural landscapes. The provision of those services is usually related to the proximity and amount of nearby forest patches, which are usually considered as the main supplier areas of species responsible for service provisioning. However, despite this general knowledge, we still poorly understand how ecosystem services are related to native species composition, and how landscape structure modulates services at different spatial scales. Here we analyze how different landscape structural parameters and species composition are related to pest control and pollination in sun coffee plantations in the southeastern Brazil. **Methods:** We selected ten landscapes presenting a wide range of forest and coffee amount, and different landscape composition. In each landscape, we evaluated fruit set and herbivory in different coffee shrubs, using floral exclusion experiments for pollination assessment and flying vertebrates (birds and bats) exclusion for pest control evaluation. **Results:** Results suggest that pollination and pest control can considerably increase coffee fruit set, and that services are modulated by processes occurring at different spatial scales. Service provision is not necessarily higher close to forest patches, depending on a complex network of biological interactions, which is modulated by the interaction of forest cover at landscape and local scales. **Discussion:** In those systems where multiple species, which perceive the landscape differently, are providing ecosystem services, a multi-scale approach is needed. Our findings can be used in conservation and agricultural planning to maximize crop production while safeguarding native species and the services they provide.

Keywords: Pollination, pest control, landscape ecology

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Impacts of landscape urbanization on plant and animal assemblages in the Brazilian Atlantic Forest

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Background: Large-scale urbanization is becoming increasingly common in the tropics, resulting in urbanizing landscapes with unknown potential to safeguard biodiversity. Many biodiversity hotspots usually degraded and destroyed by agriculture intensification are now facing the rapid, unplanned growth of cities, villages, roads, and other urban elements that compose urbanizing landscapes. The negative impacts on plants and animals are expected to be greater than those of agricultural landscapes, as matrix becomes extremely harsh for wildlife and permeable for humans, leading to more pressure on the remaining biodiversity. **Methods:** Using a patch-landscape I assess how landscape urbanization affects plant, bird and small mammal communities in the metropolitan region of Joú Pessoa, Northeast Brazil. All groups were sampled in nine 12.6-ha circular landscapes, with 0% to 45% of urbanization, and described in terms of species richness, taxonomic composition, functional and phylogenetic terms. **Results:** All groups negatively responded to urbanization in at least one aspect of diversity. Plant communities, for instance, showed reduced species richness and mean effective number of lineages in more urbanized landscapes. Plant species benefiting from urbanization were more phylogenetically related than species declining with urbanization, suggesting loss of evolutionary diversity in the long run. Functional richness of plant communities decreased with urbanization as well. Bird and mammal communities varied more in response, but were also negatively affected in taxonomic, phylogenetic or functional terms. **Discussion:** The results indicate that landscape urbanization is a strong driver of biodiversity loss in the Atlantic forest of Northeast Brazil. As many other metropolitan regions located in the tropics, the region of Joao Pessoa has faced high urbanization rates since the 50's, suggesting that our findings could be representative to other biodiversity hotspots.

Keywords: deforestation, bird, tree, mammal

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Symposium: Biodiversity responses to landscape structure: Threats and conservation strategies across scales

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Response of plant species diversity to forest cover, water availability and chronic disturbance

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Background: Seasonally dry tropical forests (SDTFs) are one of the most threatened forests worldwide. These species-rich forests not only cope with several acute (e.g. forest loss) and chronic (e.g. overgrazing and firewood extraction) disturbances at the landscape scale, but also with climate change (e.g. longer and more severe droughts). Yet, the effects of climate and acute and chronic human disturbances on within- (alpha) and between-community (beta) components of species diversity are poorly known. **Methods:** We evaluated the effect of landscape-scale forest cover (i.e. landscape composition), several metrics of chronic human disturbance and climate (i.e. precipitation and water deficit gradients) on the composition, structure (alpha diversity, stem density, evenness, and above-ground biomass) and taxonomic and phylogenetic β-diversity of adult trees and shrubs. We assessed 5118 stems from 104 species and 31 families sampled in 19 0.1-ha plots across a 21,430-ha landscape in the Brazilian Caatinga - an important but vanishing SDTF. **Results:** Drought was the main predictor of plant composition and structure, being more important than forest loss and chronic disturbance. The effects of forest loss and disturbance on alpha diversity were actually mediated by precipitation (interacting effect). Differences in water deficit and number of cattle between plots caused an increase in taxonomic and phylogenetic beta diversities. The drier areas and those exposed to higher levels of livestock intensification were composed of similar assemblages, leading to a floristic homogenization at the taxonomic and phylogenetic level. **Conclusion:** The environmental filter imposed by drought leads to a stronger effect of annual precipitation on the composition and structure of vegetation than landscape-scale human disturbances in SDTFs. Water availability determines particularly the distribution of water-demanding plant species, and along with chronic disturbances, both variables generate a non-random distribution of species and lineages. This increases the turnover of species and lineages between environmentally different sites, but leads to floristic homogenization (loss of beta diversity) in sites with similar environmental conditions. We conclude that rapid climatic changes in the region will probably have strong negative effects on species diversity within SDTFs.

Keywords: environmental gradients, human disturbances, diversity

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Response of the seed rain to landscape structure in two fragmented rainforest regions

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Background: Assessing the patterns and predictors of the seed rain represents a fundamental step to understand the spatial structure and regeneration of plant populations. Such understanding is particularly critical for fragmented rainforests, where forest loss and isolation can limit the availability of plant diaspores and seed dispersal patterns. Unfortunately, the main predictors of the abundance and diversity of the seed rain in a given site are poorly known. Here, we assessed the effect of landscape structure on the seed rain in two rainforest regions with different intensity of land use change and defaunation levels: the Los Tuxtlas Biosphere Reserve (LTX) and the Lacandona rainforest (LAC), both in southeastern Mexico. **Methods:** We recorded the seed rain during 12 months (2015) in 40 independent forest sites, 20 sites from LTX and 20 from LAC; with 9 seed traps placed in the geographic centre of each site. Then, we measured landscape composition (i.e. percentage of forest cover and open-area matrices) and landscape configuration (i.e. fragmentation, forest edge density and mean inter-patch isolation distance) within 11 concentric buffers from the centre of each sampling site (50 to 1000 ha) to obtain the scale of landscape effect. We used a multimodel averaging approach to identify the best landscape predictors of the seed rain. **Results:** The abundance of seeds was ten times higher in LTX than in LAC. Yet, most seeds (90.4%) in LTX were anemochorous, whereas in LAC most seeds (88.4%) were zoochorous. Seed species diversity and abundance were more strongly related to landscape composition than to landscape configuration in both regions, but the relative importance of landscape configuration was higher in LTX than in LAC. In particular, species diversity and abundance increased with forest cover, but decreased with the percentage of open areas in the matrix. **Conclusion:** The seed rain can be limited in fragmented landscapes with lower forest cover and higher matrix harshness, probably because these two variables are directly related to forest connectivity, propagule availability and seed dispersal patterns. Yet, in agreement with the 'fragmentation threshold hypothesis', landscape configuration also played a key role in more strongly degraded regions, where configuration showed a higher variability. Thus, landscape structure can control seed fluxes and dispersal, potentially influencing forest successional trajectories in fragmented landscapes.

Keywords: Zoochory, defaunation, dispersal, loosers, trees

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Functional composition of tree assemblages across human-modified tropical landscapes

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Background: Functional dimension of biological diversity is crucial to understand tree species assembling in fragmented rainforests that differ in disturbance regimes and landscape structure. We still do not know whether tree species respond in the same manner to landscape metrics in regions with different disturbance histories and intensities. **Methods:** We used a large vegetation database (61405 trees from 564 species) to test the effect of landscape composition (i.e. forest cover) and configuration (i.e. forest edge density) on functional composition of tree assemblages in 98 forest sites distributed is four Mexican and two Brazilian rainforest regions with different disturbance histories. Disturbance ranged from relatively preserved rainforests (i.e. little deforested and defaunated, with a heterogeneous matrix) to strongly disturbed rainforests (i.e. highly deforested and defaunated, and dominated by a homogeneous and harsh matrix). We evaluated six functional traits related to seed dispersal and tree growth strategies, and assessed its response to both landscape metrics measured across different-sized and non-overlapping landscapes (multi-scale approach). **Results:** Different combinations of traits co-varied within each region, suggesting that different trait syndromes respond to the evaluated landscapes metrics across Neotropical rainforests. However, the general pattern for all regions suggests that landscapes with lower forest cover and higher edge density harbored tree assemblages composed of light-demanding pioneer species with softer woods and smaller seeds. **Discussion:** The functional response of Neotropical trees to landscape structure (i.e. landscape composition and configuration) depends on the regional disturbance regime, where relatively preserved forests are more affected by forest cover, whereas strong disturbed forest respond to edge effect. Our findings strengthen theoretical models on the impact of landscape structure on biodiversity, and assess how generalizable are the responses of tree communities to landscape structure.

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Symposium
Eliminating a false dichotomy: the importance of human-modified landscapes for conservation plans

Leadership and governance of landscape management for ecosystem services conservation

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An increasing number of initiatives thrive to promote landscape management at multiple scales and decision focuses (e.g. impact assessment, policy design, technology development, planning management and implementation of landscape conservation measures etc.) but concrete action is lagging. The complex problems (characterized by deep uncertainties, multiple interests and knowledge references) as well as correspondent solutions of many of these initiatives are often addressed through technical analysis (e.g. observed and foreseen impacts of climate change) and a limited consideration of the importance of adopting an adequate leadership style acknowledging the importance of behavioral and process-design issues. Increasingly, authors and practitioners consider that for moving landscape conservation agenda forward, leadership style to be adopted at a given stage of a landscape conservation initiative should be adapted to the socio-institutional context and informed by behavioral and process-design aspects. We find that different leadership styles might be needed to mobilize social action from one phase of the landscape conservation planning and implementation cycle to another.

Keywords: landscape, adaptive leadership, planning

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Is the creation of protected areas a perverse policy for social-ecological systems?

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Background: The hegemonic conservation strategy worldwide is the creation of protected areas with reduced or (presumed) absent human influence, a dichotomic tradition that artificially opposes the "society" and the "environment". However, such strategy is frequently pervasive for local communities that suffer severe restrictions in their livelihoods. To recognize the limitations of this preservationist strategy is the first step to pave the way towards a new conservation paradigm based in environmental justice. **Methods:** We aim to evaluate the prevalence of socio-environmental conflicts involving local communities and protected areas, using the Brazilian tropical dry forests (TDFs) as a case study. We separated these PAs into "integral protection" and "sustainable use" according to the Brazilian legislation. We then conducted an extensive survey in the scientific literature and official documents to determine if a given PA had (i) a management plan, which indicated the degree of governance of that PA; and (ii) the existence of a reported conflicted involving each PA. **Results:** Our survey included 34 PAs in Brazilian TDFs, of which only eight belonged to the "sustainable use" category. Only eight of these PAs (23.5%; all of them of integral protection) had a management plan, reflecting that most Brazilian PAs are "paper parks" that lack investments in land regularization, staff and infrastructure. We detected reported conflicts for 24 PAs (70.5%; 20 PAs of integral protection and four of sustainable use), mostly related to territorial claims of the local communities that were expropriated for the PA creation. Among the PAs with no reported conflicts, only one had management plan, indicating that this governance instrument was not effective for reducing socio-environmental struggles. **Discussion:** Our results indicate that the conservation strategy for Brazilian TDFs prioritizes the creation of PAs of integral protection, which reinforces the dichotomic separation of human-managed and human-free habitats. However, the prevalence of socio-environmental conflicts involving PAs is very high despite the PA category, because they are intimately related to the territorial claims generated by the eviction of local communities. Conservation plans must take local and traditional management systems into account to avoid expropriation and harmonize environmental preservation and social justice.

Keywords: Protected areas; environmental conflict; Brazil

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The agroecological matrix approach to the conservation of biodiversity at the landscape level

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Most of the world's natural ecosystems, especially in the tropics, are fragmented, with a large percentage of the terrestrial area now dedicated to managed ecosystems, pastures for livestock, forestry and agricultural systems. Consequently, managed areas must play an important role in conservation of biodiversity. Here we argue that in fragmented habitats, the matrix in which fragments of natural habitats are embedded determines whether species can be maintained in the long run or not. Agroecosystems serve both as habitat (good or bad) for biodiversity and as a matrix through which organisms need to migrate to persist as metapopulations, balancing the inevitable local extinctions. The way these agricultural systems are managed can determine if a particular population can persist in the landscape in the long term. Over the last decade, the complex interconnected issue of food production and conservation of biodiversity has been oversimplified as a binary, either land-sparing or land-sharing. We argue that while this framing is convenient for short term brute force empiricism, it is misleading if the goal is long-term conservation. With a heuristic qualitative model we show how a variety of long-term alternatives emerge from simple unavoidable biological assumptions. We also discuss the inevitable socio-political consequences of the debate and propose the concept of food sovereignty, championed by some of the largest peasant organizations in the world, as a practical way of achieving rational land management at a landscape level.

Keywords: food sovereignty, food crisis, metapopulations

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Biodiversity and ecosystems services provision in Latin American agricultural landscapes

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Conventional livestock production must shift towards more sustainable systems to face climate change challenges. Governmental policies in Latin America are investing in the development of Nationally Appropriate Mitigation Actions (NAMA) for agricultural and livestock sectors. Both scientific and local knowledge along with farmers' experiences are critical to support NAMA development and to achieve the carbon (C) neutrality goals set by these governments. However, information related to key ecological processes and dynamics taking place in tropical managed lands, such as greenhouse gas (GHG) emissions and mitigation capacity, are only available in fragmented and dispersed formats. Consolidated knowledge about the aforementioned processes are critical in understanding how the actual biodiversity inside land management schemes are able to preserve ecological functions and ecosystem services (ES). We present results on GHG emissions and mitigation actions in livestock systems (LS) and the application of life cycle analyses (LCA) to a range of CR beef farms. Our goals are (1) to identify the potential role of tree diversity conservation inside anthropogenic landscapes for the provision of ecosystems services and (2) to identify knowledge gaps related to these topics to set research priorities for tropical pasture lands. Literature review included scientific and grey sources on GHG emissions, mitigation actions, C balances and ES provisioning within LS. National survey statistics and data from field trials were used in the LCA to estimate potential productivity improvements for beef systems across the main agro-climatic zones of CR following a shift to rotational grazing with and without pasture improvement. System boundaries were expanded to consider scenarios of land sparing (reforestation) and land sharing (SPS). Progress to date includes identification and acquisition of 275 documents related to C, GHG and LCA published in the last 25 years. Ongoing data analyses showed evolution of C, GHG and LCA. Publications related to GHG emissions were dominant during 1990s. A more integrated approach in C research emerged around 2000 when studies started to focus on C cycles, soil organic C, above and below ground C and C balances. Latin-American countries have contributed with studies focusing on C biomass, GHG mitigation, emissions and balances, however European countries are leaders with recent research focusing on farm modelling and application of LCA.

Keywords: Carbon, Biodiversity, Greenhouse Gas Emissions

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Forest conservation in no man's land: protected areas and forest loss in the Catatumbo basin

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Background: The Catatumbo river basin (CRB) is located in the international frontier of Venezuela and Colombia, southwest of Lake Maracaibo, flanked by the eastern and western Andes Cordillera. The CRB contains around 14,000 km2 of montane and lowland forests which are considered among the richest in flora diversity of the humid tropical forests. Although the area has been mostly inhabited by rural indigenous and non-indigenous communities, it has already lost 53% of its extent and it maintains high widespread deforestation rates within its boundaries. Deforestation has been driven by oil exploration and the expansion of subsistence and commercial agriculture which includes illegal crops and the continuous expansion of secondary roads for colonization. **Methods:** Using remote sensing data from 1985 to 2015, we analyzed spatial and temporal patterns of deforestation within the CRB with special emphasis on the importance of local Protected Areas (IUCN categories II, III, V and VI) for avoiding deforestation during the study period. **Results:** Our data suggests that forest protection has not been guaranteed through the creation of areas of strict protection and management regimes in the CRB. Protective zones (management regimes), in the Venezuelan side of the CRB, show similar levels of deforestation within and outside its boundaries. Forest protection was only effective in the Santurban-Salazar de Las Palmas and Los Estanques protected areas (IUCN II and III) in the Colombian side. The Catatumbo-Bari National Park (Colombia, IUCN II), however, shows high levels of deforestation up to 10 km within its boundaries and although the Perija National Park (Venezuela, IUCN II) shows low levels of deforestation at its core, increase in the expansion of secondary roads and small scale agriculture in the margins are evident in the premontane valleys. **Discussion:** Results suggest that the effectiveness of deforestation avoidance in protected areas in the CRB is a function of differing biophysical, social, economic and institutional forces across the region. The persistence of continuous forest remnants in the core of the Catatumbo-Bari and Perija National Parks are likely to be the result of lack of accessibility conditions and indigenous presence, and not a result of effective institutional control. However, current trends in forest loss demonstrate that these conditions do not guarantee forest protection in the near future.
Keywords: Colombia, Venezuela, Deforestation, Protected Areas

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Ethnoecology and traditional people: contributions to biodiversity conservation and co-management

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Introduction: Ethnoecology is an interdisciplinary field that aims to investigate the knowledge of traditional peoples and communities and their ways of interacting with nature, be it in the material and economic fields or in the symbolic and spiritual ones. From a review of bibliographical and empirical studies which describe socio-ecological systems, it is possible to observe that peoples' and communities' environmental history finds itself directly related to the experiences of biodiversity conservation, sustainable use, and management. **Methodology:** The present work presents results of ethonoecological research carried out with riverside communities from Medium São Francisco River Basin, Brazil. These studies were carried out through several ethnographic ventures making use of techniques such as open interviews, direct observations, and participative diagnosis. **Results:** The riverside communities hereby taken into consideration identify themselves from specific relationships to the natural resources and the environmental characteristics of the geographic space in which they are living by the São Francisco River. Fishery communities have artisanal fishing as the reference to their way of life. Tide-water settler communities (comunidades vazanteiras), beyond artisanal fishing, occupy and cultivate on the islands and on the river banks' wetlands. Both groups face environmental conflicts related to the dispute of their territories with agribusiness and with Conservation Units established by the State. These communities organized themselves in resistance movements to ensure the resumption of their territories. They also report biodiversity loss in these areas, corroborated by scientific data, due to them being precluded from carrying out their traditional ways of resource use and management. **Final considerations:** The study of these traditional populations' environmental memory and practices demonstrate that focusing on socio-ecological systems' management and community management would be more effective with regards to conservation of biodiversity than the classic principle of untouchability established by conservation ecology.
Keywords: Riverside Communities; Community Based Management

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Symposium
The impact of the El Niño on tropical ecosystems

The impacts of the 2015/2016 El Niño on ecosystem growth and respiration across the tropics

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Background: The El Niño of 2015/2016 was among the most significant recent climate events across the tropics, with high temperatures recorded across most tropical land regions and strong droughts recorded in parts of Amazonia, Africa and Southeast Asia. Global atmospheric data suggest that during this period the terrestrial biosphere was a source of carbon to the atmosphere, with the terrestrial tropics the major contributor to this carbon source. It is unclear which mechanisms (photosynthesis, growth, plant respiration or autotrophic respiration) contributed to this tropical carbon source. **Methods:** The Global Ecosystems Monitoring (GEM) network tracked tree growth and tree and soil respiration throughout the El Niño, in sites across Amazonia, Africa and SE Asia. We recorded detailed descriptions of the full ecosystem carbon cycle, including wood, leaf and fine root production, and respiration from live wood, dead wood and fine roots. **Results and Discussion:** The results will be processed in time for the meeting. We anticipate that the results will enable insights into the relative importance of changes in tree growth and respiration in contributing to the global carbon cycle anomaly during the El Niño. By comparing drought, non-drought, and burnt sites, we may also be able to discriminate the influences of temperature, drought and fire on the carbon cycle. Ultimately, we plan to scale up these results to quantify the magnitude and mechanisms of the tropical biome carbon source during the El Niño, and explore what this means for the stability of the tropical biosphere carbon balance under climate change.

Keywords: El Nino, carbon cycle, drought

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Environmental heterogeneity drives effects of drought on tropical seedling survival

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Background: Prediction of the fate of tropical forests under a changing climate requires understanding of species responses to climatic variability together with the environmental factors that allow species to persist in the context of climatic extremes. Seedlings may be particularly vulnerable to climatic stress given low stored resources and undeveloped roots; they also provide a glimpse into the potential effects of climate change on future forest composition. **Methods:** Here we use data for ca. 55,000 tropical seedlings representing 25 woody species collected between 2007 and 2016 in tropical forest in Puerto Rico to assess (1) the effects of inter-annual variation in rainfall and solar radiation on seedling survival in this forest; and (b) how spatial heterogeneity in three environmental factors--soil moisture, understory light, and conspecific neighborhood density-- modulate these responses. **Results:** Survival was higher in years of high solar radiation and low rainfall -- including an extreme drought-- but interspecific variation in these responses was large in both magnitude and direction overwhelming the average community response. Spatial heterogeneity in soil moisture and density of conspecific seedlings were the predominant drivers of seedling survival with the majority of species exhibiting greater survival in moist sites and at low conspecific densities. At the same time, this environmental heterogeneity plays an important role in modulating impacts of rainfall and radiation on these forests. Negative conspecific effects are amplified during rainy years while the positive effects of radiation on survival are more marked for seedlings existing at low understory light levels and in dry microsites. **Conclusion.** These results demonstrate that environmental heterogeneity not only is the main driver of seedling survival in these forests but also plays a central role in buffering or exacerbating impacts of climate fluctuations on forest regeneration. Since seedlings represent a key bottleneck in the demographic cycle of plant species, efforts to predict the effects of a changing climate on long-term tropical forest composition and structure must take into account this heterogeneity and how its effects on regeneration dynamics plays out in long-term stand dynamics.

Keywords: drought, radiation, seedling, soil moisture

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The Effect of the 2015/16 El Niño on Hydraulic Characteristics of Central Amazonian Trees

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Background: extreme drought events in the Amazon forest have been more frequent in recent decades and are commonly associated with the El Niño phenomenon. Such an extreme drought occurred in 2015/16 and offered a unique opportunity to enhance our understanding of how Amazon trees respond to severe water deficit. How plants respond physiologically to such extreme short changes between water supply and demand, caused by climate anomalies, is still unknown. **Methods:** here, we present in situ observation of pressure-volume and vulnerability curves, monthly leaf water potential, leaf temperature and sap velocity from four Amazonian tree species during the 2015/16 El Niño (July/2015 to February/2016). The measurements were conducted on four trees, *Pouteria anomala*, *Pouteria erythrochrysa*, *Eschweilera cyathiformis*, *Couepia longipendula*, around the K34 tower (2°35.37'S, 60°06.92'W) at the Reserva Biologica do Cueiras (also known as ZF-2), located 90 km NNW of the city of Manaus, Brazil. **Results and discussion:** we show that three out off four species in Central Amazon crossed their hydraulic threshold (e.g. reached their 50% loss of hydraulic conductivity - P50, their leaf turgor loss point or both) during the El Niño. This is potentially due to reduced amounts of soil water available for plants, increased leaf temperatures and decreased air relative humidity. Precipitation during August-October/2015 was below 100mm and 35% lower than in 2010, the strongest drought ever recorded. In addition, leaf temperatures became higher reaching ~ 47oC. This combination of conditions resulted in the inability of these trees to cool their leaves via transpiration, leading to turgor loss (wilting point) that resulted in combined heat and water stress damage to many leaves. In addition, sap velocity in all of the trees studied decreased considerably during the driest months and leaf water potentials became more negative, even during the predawn, leading species to lose 50% or more of their hydraulic conductivity. **Conclusion:** our results corroborate the findings that frequent droughts will lead to a combination of physiological stresses that potentially increase the risk of tree mortality linked to hydraulic failure. Furthermore, our results demonstrate how vulnerable Amazonian tree species are to extreme drought events and improve our understanding of how changes in climate could affect species distribution, tree mortality, and abundance in the tropics.

Keywords: Hydraulic-threshold, pressure-volume-curve, vulnerability-curve, leaf-water-potential, plant-water-relations

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El Nino, Drones and Cocoa Farmers: How mixed methods can help us understand resilience

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Background: In 2016, one of the largest El Nino events ever recorded caused sizeable amounts of drying and an extended dry season in much of the tropical region of West Africa. Given the wide reaching impacts of this drought event on both social and ecological system components, it was important to supplement local household studies of impacts with larger landscape surveys to begin to upscale assessments of how local effects might inform resilience for potential future impacts. However, this process is often difficult due the issues associated with remote sensing in these regions, namely the clouds and Harmattan weather patterns. **Methods:** This study assessed the impact of the 2016 El Nino on three communities bordering Kakum National Park in Southern Ghana using a mixed methods approach. In order to assess the social impacts of the El Nino, the responses from the large household survey carried out in the region during 2015, 2016 and 2017 were used. This was combined with high resolution drone imagery of the region captured during late 2016 and early 2017. The images generated from the drone census are fine scale and highly detailed allowing a robust classification of land use. Further, these two datasets were meaningfully tied to one another by using the parameter of the survey respondents farms to nest the qualitative data in space. **Results:** The results of this study indicate that geographic factors contributed to the experiences of community members during the El Nino. Those farmers who had access to a greater area of land, as well as a diversity of crop types were least affected during the drought. Further, the responses between communities differed, with one community suffering more apparently due to an overspecialization on cocoa in the region, and an associated lack of subsistence crops. **Conclusion:** The outcome of this study highlight the diversity of responses to drought events, and highlight the need to undertake larger scale studies using mixed method approaches.

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El Niño drought impacts on Ghanaian cocoa livelihoods

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Backgroud: Cocoa is the primary ingredient in chocolate, and a major cash crop that supports the livelihoods of millions of smallholder farmers. 70% of the world's cocoa is grown by West African smallholders who depend on this crop to support their families. However, climate change adversely affects temperature, humidity, precipitation, soil quality, and agricultural pests - all to the detriment of the very fragile cocoa crop, undoing decades of economic development and poverty alleviation. Climate shocks, such as extended drought and erratic rainfall, are already increasing in frequency and severity in tropical West Africa. El Niño impacts are particularly pronounced across the tropics, with West Africa especially vulnerable both meteorologically and in terms of its lower economic development. **Methods:** Across cocoa-growing West Africa, 2015's powerful El Niño caused climatic conditions similar to those predicted by the IPCC: hotter temperatures, and more erratic rainfall. In this study, we assess the impacts of 2015-16's El Niño-induced drought on Ghanaian cocoa households' livelihoods, particularly to gauge how future climate change shocks could impact cocoa livelihoods. In 104 household surveys and nine focus groups - conducted in six villages around Kakum National Park, Southern Ghana - cocoa farmers detailed how they have coped with prolonged drought. **Results:** Survey respondents revealed the hardships they endured and the adaptive strategies they employed in attempt to bolster their livelihoods. Our analysis identifies farmers' personal adaptive actions, and places them on a spectrum of disruptive change. This spectrum of adaptation ranges from least disruptive to total failure: i.e., from changing planting or harvesting dates, to extending cultivation into wetter lands, to diversifying income sources, to switching to another crop, and finally to completely abandoning cocoa cultivation by migrating to an urban area. In parallel with farmers' personal adaptive resilience, we also consider resilience of the broader cocoa growing system. For instance, we find that the most personally resilient farmers employ adaptive strategies that undermine the future of cocoa cultivation. **Conclusion:** This research reconciles smallholder livelihoods from a personal resilience perspective with the continued cultivation of sustainable cocoa. Extension of our research in Cote d'Ivoire, surveying Ivorian cocoa smallholders, is currently under way.

Keywords: resilience; livelihoods; cocoa; El Niño; drought

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Strong stomatal control of canopy trees in central Amazon during the 2015 El Niño drought

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Background: Extreme droughts increase tree mortality and reduce primary productivity in tropical forests. The unusually strong 2015 El Niño was associated with a profound precipitation and temperature anomaly in central Amazonia. Stomata control is an important mechanism by which trees prevent catastrophic xylem cavitation and therefore decrease the risk of mortality, even at wet Amazonian forest ecosystems. Therefore, understanding hydraulic functioning of Amazonian trees is key to predict the vulnerability of tropical vegetation to extreme drought events. **Methods:** Seasonal variation in leaf water potential, photosynthesis and stomatal conductance (gs), dynamics of non-structural carbohydrates and vulnerability to embolism/ hydraulic safety margins were evaluated for eleven mature canopy trees during the 2015 El Niño at a central Amazonian forest site. **Results:** The average water potential at which 50% loss of xylem conductivity occurs (P50) was lower (-3.3 MPa ± 0.9) than the observed for other tropical forests (-2.08 MPa ± 1.43). The average minimum water potential in the dry season (Pmin) was -1.7 MPa ± 0.39, leading to a large hydraulic safety margin of 1.6 MPa. The maintenance of xylem water potential, despite increasing VPD and decreasing soil moisture, was related to a 43% reduction in stomatal conductance in the peak of the drought. The substantial decline in gs during the El-Nino drought led to a 40% drop in photosynthesis and 61% depletion of the non-structural carbohydrates pools. **Conclusion:** Strong stomatal regulation is a common drought-avoidance mechanism for canopy trees in central amazon, impacting negatively the carbon balance of these forests during extreme droughts.

Keywords: Safety margin; hydraulic failure; photosynthesis

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Symposium
Origins and consequences of genetic and functional variation in tropical oaks under global change

Phylogenetic diversity of the American oaks

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Oaks (*Quercus*: Fagaceae) are dominant species of temperate and subtropical forests throughout North and Central America. Ecologically, culturally, and economically, oaks are among the most important trees in the world. Yet hybridization and lineage sorting have long dogged efforts to reconstruct phylogeny in the oaks. We have in the past few years had a great deal of success inferring species-level phylogenetic relationships in oaks using restriction-site associated DNA sequencing (RADseq). In this talk, we present a PstI RADseq phylogeny of the American oaks that includes more than half of the estimated 150 species. The RADseq data support clear and strongly supported species coherence and phylogenetic signal that is structured along morphological and biogeographic lines. The red and white oaks demonstrate parallel ecological and biogeographic diversification, as both clades have filled many of the same edaphic and climatic niches. Evolving in response to moisture and temperature gradients, both clades underwent an increase in speciation rate upon dispersal into and subsequent radiation within Mexico. Red oaks and white oaks may be found growing together throughout North and Central America, rather than separating along clear ecological or biogeographic gradients. This parallel history of species divergence explains much of diversity and ecological importance of oaks in the Americas.

Keywords: convergence, phylogenomics, *Quercus*, RADseq

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Lack of negative density dependence in a Costa Rican endemic Oak

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Background: Negative density dependence (NDD) has been long posited as a possible mechanism explaining species coexistence in tropical forests. *Quercus costaricensis* is a monodominant oak species in the Costa Rican mountains. Adult trees reproduce in synchronous masting events, leading to the germination of large numbers of seedlings. Exploring the relative importance of density-dependence on seedling mortality and recruitment may provide insights into the mechanisms regulating population dynamics of this endemic and abundant species. **Methods:** In 2015 all *Q. costaricensis* individuals were mapped, tagged and measured in four 20x20m plots placed in pristine upper montane forests (3100 m asl) in Costa Rica. We used spatial statistics and generalized linear mixed models to determine (1) the effects of conspecific density, the density of *Chusquea* bamboo shoots and the amount of herbivory on the survival probability of 3799 seedlings, and (2) the effect of seedling and *Chusquea* density and distance to nearest trees in seedlings recruitment after the 2016 masting event. **Results:** Seedling height had the strongest positive effect on seedling survival, while bamboo density and herbivory both significantly decreased seedling survival after one year. We did not find evidence of NDD regulation as distance to the nearest conspecific tree or seedlings density had no significant effect on seedling survival. After masting, 1578 new seedlings recruited into the population. Only seedling density positively affected seedling recruitment. **Conclusion:** Despite significant levels of herbivory, predator satiation may explain the lack of density dependent regulation in this species. We argue that weak NDD may explain dominance of *Q. costaricensis* in the upper montane forests of Costa Rica, and that herbivory and interspecific interactions with the native bamboo *Chusquea* may be the main biotic factors regulating population growth in this endemic oak species.

Keywords: density-dependence; Janzen-Connell; herbivory; masting; seedling-recruitment

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Comparative landscape genomics of *Quercus rugosa* (Mexico) and *Q. lobata* (California)

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Background: Understanding the role of the environment in shaping genetic variation is a major goal of landscape genomics, which also provides valuable information for species management under global change. New genomic tools available for oaks (*Quercus* spp.) offer unprecedented insight into the genes that contribute to local adaptation to different environments along the landscape. One important question for comparative studies is whether the same genes are involved in environmental adaptations in different species. **Methods:** We applied a landscape genomics approach in *Quercus rugosa* in Mexico and *Q. lobata* in California to test whether the same climate variables structured overall genetic variation and whether the same genes might be involved in adaptation along similar environmental gradients. Using genotyping-by-sequencing of over 400 trees, we generated thousands of SNPs. To identify specific loci under the influence of natural selection for local adaptation and the particular climate factors shaping genome-wide variation, we analyzed these SNPs using multivariate non-linear models and latent factor mixed models. We then utilized our recently generated annotated *Q. lobata* reference genome sequence to characterize the genomic context of SNPs with significant associations and attribute potential functions to them. **Results:** We found that climate variables were significantly associated with genomic variation but they differed among species and among different spatial scales within species. A number of specific SNPs and genes were identified as candidates for local adaptation in each species, but do not generally overlap. **Discussion:** Our initial findings provide evidence of the impact of natural selection on different loci in these closely related oak species. Moreover, these results provide insight into selective forces along the natural landscape and generate a list of candidate genes associate with response to climate that warrant additional study.

Keywords: climate, genotyping-by-sequencing, landscape genomics, *Quercus*

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Adaptive differentiation in water use of a tropical oak: implications for global change

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Climate change will alter patterns of natural selection on terrestrial plants. The potential of tropical tree species to respond to these changes via plasticity or adaptive evolution is made both more complicated and more important by their longevity. We have investigated the consequences of climatic regime and dry season drought stress on the genetic distribution of ecophysiological traits in the tropical lowland oak, *Quercus oleoides*. We applied both genetic and physiological approaches to characterize patterns of natural selection and adaptive differentiation among populations from contrasting climatic regimes under natural and experimentally imposed water limitation. Several insights have emerged. First, we did not find clear evidence for local adaptation in reciprocal transplant experiments in Honduras and Costa Rica. Nevertheless, greenhouse and common garden experiments revealed strong intraspecific differences in functional traits and indicate that precipitation regime has played an important role in driving adaptive divergence in this widespread species. Populations from xeric climates with more severe dry seasons exhibited large mesophyllous leaves (with high specific leaf area - SLA), and leaf abscission in response to drought, consistent with a drought avoidance strategy. In contrast, populations from more mesic climates with less severe dry seasons had small and thick sclerophyllous leaves with low SLA and reduced water potential at the turgor loss point (πtlp), consistent with a drought tolerance strategy. Mesic populations also had showed highest plasticity in leaf turgor loss point in response to water availability, indicating that osmotic adjustment to drought is an important component of this strategy. Qst-Fst comparisons from plants in common environments showed evidence for selection in several functional traits, including SLA, leaf thickness and stomatal pore area. Variation in functional attributes was not associated with neutral population genetic structure resulting from vicariance events in Central America in Mexico but appear to be associated with relatively recent climatic variation that has occurred since the last glacial maximum. Combined, this body of work provides evidence for adaptation differentiation across climatic gradients as well as high plasticity and genetic diversity in traits that may allow resilience in response to climate change.

Keywords: climate, traits, reciprocal transplant, adaptation

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Oaks (*Quercus*: Fagaceae) diversity and Mexican protected areas: implications for conservation

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Background: Oaks are highly diverse in Mexico. Such diversity currently faces habitat destruction and climate change, among other anthropogenic pressures. Despite our comprehension of oak diversity and evolutionary history has increased in the last decades, there is still an important dearth of knowledge and consensus regarding their conservation status, as well as effective conservation strategies for their preservation. **Methods:** Mexican oak diversity was characterized using ecological niche modeling for current and future conditions (i.e., three 2080 climate change scenarios). Climatic suitability changes were estimated by describing the geographic displacement and/or contraction of oak hotspots. Species richness and risk assessment categories were compared between natural protected areas (NPA) and botanical gardens (BG) to evaluate their effectiveness in preserving ecological and/or evolutionary processes related to Mexican oaks. Result: There are 97 oak species in NPA, mostly represented by those of broad distributions (e.g., *Quercus castanea*). Most of such species have been classified of 'least concern' (35 species) and only a few are considered as endangered. Ex-situ conservation strategies (BG) showed to shelter 77 oak species, most of which are also classified of 'least concern' (40 species) and a small number of endangered ones. Thirty-nine oak species were protected in both NPA and BG, 59 were unique to NPA, and 20 to BG. Climate change scenarios suggest contractions in the climatic suitability values and habitat fragmentation for the oak forests. **Discussion:** Despite Mexican montane systems harbor impressive oak diversity, there is a worrisome scenario regarding their conservation. Climate change scenarios indicate important changes in the species climatic suitability that may enhance fragmentation and loss of connectivity, without considering current anthropogenic pressures (e.g., agricultural fringe, timber over-exploitation). Current diversity and conservation studies have focused on describing oak species richness and endemism, highlighting the need of larger NPA that could enhance their population numbers and connectivity. Yet, there is no clear diagnosis of both in situ and ex situ strategies. However, our results suggested that NPA and BG are acting as reservoirs of limited ecological and evolutionary processes.

Keywords: *Quercus*; conservation; Mexico; climate change

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Ecosystem consequences of species coexistence in highly diverse oak communities

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Background: The ecological linkages between the aboveground and belowground biotas currently are the subject of intense investigations. Particularly, the relationships between species richness and composition in plant communities and microbial soil communities are not yet clear. The genus *Quercus* is one of the most important components of temperate forest communities in the Northern Hemisphere, and Mexico is the main diversification center of the oaks in America. However, soil nutrient dynamics and microbial diversity in highly rich oak communities of Mexico has been scarcely investigated. **Methods:** We characterized the tree diversity and composition of 22 oak-dominated forests in Central Mexico along a gradient of species richness, and collected soil and litter samples. We measured the activity of three ecoenzymes produced by the microbial communities, implicated in the liberation of C (β-1, 4-glucosidase; BG), N (β-1, 4-N-acetylglucosaminidase; NAG), and P (alkaline phosphatase; AP) from organic molecules, and determined the soil nutrients concentration (total, dissolved and available C, N and P), as well as microbial C, N and P. Metabarcoding of the bacterial community was performed for each sample on amplicons of a fragment of the 16 S ribosomal ARN gene using next-generation sequencing techniques. **Results:** Total oak species richness did not have an important effect on the measured variables. However, as the proportion of white oak species increased over red oaks in the communities, we observed a higher concentration of total nitrogen, total phosphorous, dissolved organic carbon, dissolved organic nitrogen, dissolved organic phosphorous and higher activity of the betaglucosidase enzyme. However, a slight decrease in the diversity of bacterial phyla was observed along the same gradient. **Conclusions:** Our results indicate that the composition of the tree communities is more important on ecosystem functions than species diversity per se. Specifically, biogeochemical processes and the structure and composition of the bacterial community in the litter depend on the variation in the proportion of white and red oak species in each site.

Keywords: plant community, *Quercus*, biogeochemical processes

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Symposium
Socio-Ecological dimensions of changing fire regimes for tropical biodiversity conservation

Rate of spread, intensity, and heat stress decrease as tropical savanna fire approaches forest edge

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Background: In tropical landscapes, fire maintained savannas often mosaic with fire independent forests. These mosaicked landscapes have immense conservation and tourism value, however they are currently threatened by global change, specifically by changing fire regimes and increasing atmospheric carbon dioxide. In the face of such threat, fire is the most important management tool in forest-savanna mosaics. Understanding how fire behaves as it burns across such landscapes, from open canopied, grassy savannas towards closed canopied, grassless forests is therefore crucial to understand if we are to effectively protect these valuable habitats. **Methods:** This research was conducted in the forest-savanna mosaic of Lopé National Park, Gabon. Areas of the park burn annually as part of the fire management programme. We calculated the fire intensity of 18 of these burns, and measured rate of spread and temperature variables using thermocouples. From these measurements we calculated heat stress (ºC.second) that a plant experiences during the burn. All variables were measured at varying distances from the forest edge to assess how they changed as fire approached the forest from the adjacent burning savanna. **Results:** We found that the rate of spread, fire intensity, and heat stress all decrease as the fire front approached the forest edge from the burning savanna. Furthermore, how far into the forest a fire burnt was significantly correlated with fire intensity and wind speed. Char height after fire was found to correlate with fire intensity and temperature variables. **Discussion:** In order to effectively manage this process of forest encroachment using fire, it is vital to understand how fire behaves as it approaches the forest edge from the burning savanna. This is specifically important as aspects of fire behaviour can dictate how much damage woody plants may suffer during burning, and therefore fire behaviour at the forest edge is directly related to how much forest encroachment a forest-savanna transition might experience. Our results indicate that the effectiveness of fire as a tool to curb forest encroachment in the tropics is decreased closer to the forest edge, and thus extra care should be taken by managers to ensure that burning only takes place on the driest and windiest days. Post-fire char height was found to be a useful management tool as it can be employed as a quick-and-dirty method to assess fire intensity and temperature characteristics of a burn.

Keywords: fire intensity, savanna, forest encroachment

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Environmental changes and the pyroecography of the Amazon

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Background: The Amazon, Earth's largest tropical rainforest, is exposed to extensive transformations due to human activities that changes land cover and climate. One of the main consequences of human interference and climate variability on the Amazonian forests is the changes in fire spatio-temporal patterns and its impact on biogeochemical cycles and biodiversity. Therefore, the aim of this study was to quantify changes in fire patterns in Amazonia as a response to human-induce and climate change and determine the impact of these changes on the carbon cycle and biodiversity. **Methods:** We used data of long-term monitoring of permanent plots in burned forests and 13-years of monthly multi-satellite remote sensing data to depict rainfall and fire occurrence patterns and to evaluate the functioning of burned forests through time. **Results:** We found that despite a 77% reduction in deforestation rates in Amazonia, the incidence of fires have not been reduced at the same rates. Moreover, Amazonian fires tend to intensify during droughts, such as 2005, 2010 and 2015, contributing with an increase in Amazon carbon emissions. Interestingly, forests affect by fire do not recover immediately after the event. These forests stay as a carbon source for years after the event. Even after 10 years the biomass and diversity of these forests are not recovered. **Conclusion:** Because of the long-term impact of fires on forest carbon and biodiversity, policy-makers must urgently tackle fire problem in the Amazon aiming for effective environmental policies that can mitigate the problem. Alternative land management options should be also part of a sustainability plan for local populations.

Keywords: fire, Amazon, carbon, droughts, biodiversity

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Impacts of the 2015-16 El Niño mediated fires on Amazonian biodiversity and ecological functioning

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Background: Wildfires pose one of the biggest threats to tropical forests, where they are strongly linked to extreme drought events, like those caused by the El Niño. In the Amazon, due to the unusually dry conditions resulting from the 2015-16 El Niño, many fires used for farming management escaped from agricultural areas into nearby forests. As a result, the Brazilian Amazon experienced 87,024 fire events in 2015 - one of the largest records to date. Yet, our understanding of the fire impacts on biodiversity and ecosystem functioning is severely constrained by the lack of studies with pre-fire controls. Furthermore, we have little knowledge of how these fires interact with other human-driven disturbance, such as selective logging and edge effects. **Methods:** We address these knowledge gaps by using a robust Before-After-Control-Impact experimental design to investigate the impact of El Niño-mediated fires on plant communities, forest fauna (dung beetles and birds), and associated ecological processes (dung beetle-mediated soil bioturbation, dung removal and seed dispersal) sampled in 38 permanent plots in the Brazilian Amazon. Our study plots are distributed along a gradient of human disturbance, encompassing from undisturbed primary forests to secondary forests. All taxa were surveyed following exactly the same methodologies in 2010 and 2016 (six years before and six months after fires burned 15 of these plots, respectively). **Results:** Preliminary results have demonstrated the negative impacts of El Niño-mediated wildfires on distinct community metrics from all studied groups. For example, we found that fires significantly decrease the richness of all taxa, with burned plots losing up to 50% of its biodiversity. In addition, rates of all dung beetle-mediated ecological functions decreased in the plots burned during the last El Niño event. **Discussion:** This research advances our understanding of the fire impacts in human-modified Amazonian forests. Our results clearly demonstrate that wildfires are important agents of change in tropical forests that did not evolve with the presence of fire, significantly affecting biodiversity conservation and ecosystem functioning. Ultimately, as many climate models predict drier, hotter and longer dry seasons in the Amazon, we also believe that our results will be important to subsidise effective forest management strategies and fire policies to reduce the fire occurrence in the light of future severe dry seasons.

Keywords: El Niño. Wildfires. Human-modified forests.

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Post-fire resprouting and bud protection strategies in Brazilian Neotropical Savanna woody plants

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Background: Plants occurring in fire-prone environments are expected to have a set of adaptations to survive, such as resprouting ability, thicker barks, bud protection strategies and/or investing in primary growth to escape fire. Woody plants in the seasonal Brazilian savanna (cerrado) show a variety of different strategies in leaf phenology, that affects carbon and water balance, which probably reflects on fire-induced responses. We set out to test the hypotheses that distinct leaf habit would lead to different fire-related traits, and to different response strategies to fire. **Methods:** We selected the six most common woody species representing each leaf habit group (i.e. deciduous, briefly deciduous and evergreen), totalling 18 species.We measured tree mortality and topkill; type, number and volume of sprouts in an accidentally burned area of typical cerrado vegetation. In an adjacent unburned area, we measured inner and outer main stem and branch bark thickness, and characterised bud protection in selected unburned individuals of the studied species. **Results:** While only ~ 50% of evergreen individuals showed signs of fire-induced resprout, the vast majority of briefly-deciduous (> 90%) and deciduous individuals (> 70%) resprouted. Deciduous species showed thicker total bark, combined with more protected dormant buds, reflecting in a higher post-fire canopy recover. On the contrary, evergreen species showed thinner barks and more exposed buds but, unexpectedly, also showed the lowest proportion of tree topkill (~15%). The highest rates of topkill (~30%) and the highest proportion of underground post-fire resprouting were observed in briefly-deciduous species. There was no difference between the three groups regarding tree mortality. **Conclusion:** Cerrado species show different sets of fire-related traits to survive. These traits are linked to species ecological strategies, and vary according to their leaf phenological behaviour. Our findings also shed light on how fire-exclusion policies may favour different groups of species, leading to changes in plant communities over time.

Keywords: leaf phenology, bark, topkill, Cerrado

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El Niño impacts on plant community and biomass in human-modified Amazonian forests

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Background: The 2015/2016 El Niño was among the strongest that ever hit the Amazon Basin. In Brazil, the severe dry season caused by the phenomenon led to widespread understorey fires, affecting both areas of intact and human-modified Amazonian forests. Given the predictions of more frequent extreme droughts like the one caused by the last El Niño, it is crucial we better understand how the combination of drought and fire affect forest carbon stocks and plant communities alike. **Methods:** In 2014, we established 20 permanent plots in the Brazilian Amazon, distributed along a human-disturbance gradient. Both carbon stocks and plant communities have been monitored in these plots for one year before and one year after the onset of the last El Niño, when fires hit 10 of our study plots. Using detailed measurements of plant mortality, tree growth and the production of leaf litter and dead wood in all plots, we investigate the magnitude of the impact of the last El Niño on human-modified Amazonian forests. **Results:** Preliminary results show that drought increased tree mortality across all plots, including the control sites. However, fires had an over-riding impact, killing c. 50% of all plants in the affected plots, with small-stemmed trees being more affected than large-stemmed ones. Surprisingly, mortality rates were lower in secondary forests plots than in even the control sites. **Discussion:** Our results give us a glimpse into the future, when extreme droughts, and associated fires, are expected to become more frequent. They highlight the pervasive impacts of the last El Niño event in human-modified tropical forests, which could have possibly turned these forests into carbon sources rather than sinks. If we expect tropical forests to continue to provide the same set of ecosystem services that they currently do, it is vital to create efficient mechanisms to better protect them from fires, especially in years of extreme drought events.

Keywords: Degradation, fire, logging, carbon, biodiversity

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Predictors of performance: fire-free interventions in Indonesia's fire-prone peatlands

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Background: Severe peat fires are increasingly prevalent in Indonesia's oil palm frontier. Unprecedented fires in 2015 covered ~2.6million hectares, presenting severe climate, public health and economic risks. In response a number of state and private sector (PS) initiatives have been implemented to mitigate future disasters. These include a PS incentive-based scheme that offers a conditional performance-based reward. Previous pervasive short falls in policy performance suggests that improved understanding of the determinants of success is needed. This study provides timely new knowledge that identifies which conditions, and combinations of conditions, are related to high performance. These results can guide future efforts to secure equitable and sustainable outcomes in peatland landscapes. **Methods:** A random sample of households (n 240) in 8 Fire Free Villages (FFV) in Riau province, Sumatra. Questionnaires solicited responses on household economy, demography and perceptions concerning design elements of FFV. We constructed indices that measured village-level conditions that we hypothesize are related to outcomes. We apply a 2-step fuzzy qualitative comparative analysis that allows for the influence of proximate (e.g. institutional quality) and distal drivers (e.g. connectivity) of outcomes to be determined. **Results:** The dominant condition associated with high performance was the fear of sanctions. Awareness about the reward was mostly held at the elite level, with many households having little awareness of this element of the intervention. Village size and connectivity were also positively related to success, building on previous scholarship that identifies roads and community cohesiveness as important determinants of sustainable outcomes. **Discussion:** We found that while the common discourse of the fire free village program describes it as an incentive-based scheme, awareness raising over the illegality of burning was having more influence. While the fire free village model appears to be a reward based scheme, elite capture meant that households were operating under a fear of sanction rather than in response to an incentive. Important questions are raised in relation to the burden of intervention programs on an already marginalized land user group. We explore these results through an environmental justice lens and consider the policy implications with a particular focus on how to improve policy performance in an equitable manner.

Keywords: PES, behavioral-change, human-dimensions, oil-palm, fire

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Symposium
Multiple-use forests: can forest conservation and socio-economic development be combined?

Valuing and protecting multiple use forests in Brazil and Cameroon

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Background: Worldwide, and for many generations, small holder forest management systems have produced a range of goods and services while conserving forests and biological diversity. In this paper, we use examples from the Brazilian Amazon and Cameroon to illustrate the value of forests for culture, nutrition, medicine, income and ecological services, as well as how these values and management systems can withstand, or erode, in the face of widespread land use change. Currently, communities must balance not only forest conservation and socio-economic development at the local scale, but contend with increasing frequency and intensity of ecosystem transformation. **Methods:** Longitudinal studies including: forest inventories; interviews; food diaries; household surveys; marketing surveys; and community workshops were repeated at various intervals over two decades in three forest-reliant communities in Brazil and three in Cameroon. **Results:** Results illustrate how these systems integrate a wide range of species, habitats, and practices, capitalize on seasonal change, and grow from local ecological processes and biological diversity. Rather than directed primarily at quick gain, they place a premium on endurance, resilience, and well-being over time. Although these systems are dynamic and have always adapted to change, the pace of change today, and the pressures from other land uses, are greater and of a different quality than previously experienced. Frequency and intensity of land use change can result in degradation of nutritional and medicinal resources as well as an erosion of local knowledge and management systems. This paper also explores the factors that support or undermine the retention of traditional forest management systems. **Discussion/conclusion:** Multiple-use, small-holder forest management systems not only create the basis for community, health and sustainable livelihoods, but reduce risk in a complex and uncertain environment, helping local groups adapt to change, including climate change. Factors that support or undermine the retention of traditional forest management systems in the face of land use change will also be explored, including the extent of social organization, policy contexts, and the extent knowledge and practices are transferred across generations.

Keywords: Multiple-use, biodiversity, resilience, local knowledge

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Conservation and livelihood impacts of subnational REDD+ initiatives in the Brazilian Amazon

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Background: Brazil became an international showcase for forest conservation through its remarkable reduction in Amazonian deforestation from 2004 to 2013. This success seemed largely due to a series of command-and-control policies, along with a decrease in commodity prices, which primarily discouraged large-scale clearing for agriculture. Less attention has been paid to forest clearing by smallholders. In this context, implementers of subnational REDD+ initiatives in Brazil applied customized intervention packages to achieve forest conservation mostly by supporting smallholders' transition towards more sustainable land use practices. **Methods:** As part of the Center for International Forestry Research (CIFOR) Global Comparative Study on REDD+, we evaluated the impacts of different types of forest interventions on deforestation and smallholder well-being at five subnational REDD+ initiative sites in Brazil. We combined surveys in 37 villages and 1,100 households (including control groups) in 2010-2011 (pre-intervention) and 2013-2014 (post-intervention) with official deforestation data, to integrally assess changes in both income and forest cover. We also analyzed smallholders' self-perceptions of the effects of specific interventions on their land use and well-being. **Results:** Smallholders at both intervention and control sites were exposed to intervention mixes that typically contained disincentives (e.g. forest law enforcement) and enabling measures (e.g. the Rural Environmental Registry), whereas incentives (e.g. payments, alternative livelihood support) were applied mostly at intervention sites. Household incomes grew in both intervention and control villages, with no significant changes between them. In turn, deforestation was marginally reduced in intervention villages while increasing in controls, though some caveats apply. Smallholders' perceived that enabling measures and disincentives affected their forest clearing decisions most clearly, yet disincentives were also associated with reduced well-being. **Discussion:** Our study suggests that intervention packages including incentives, along with enabling measures and disincentives, may be more effective in reducing deforestation. The recent upswing in deforestation in the Amazon may highlight the limits of command-and-control measures if landholders are not provided with incentives to conserve forests, particularly when forest clearing is central to local livelihoods.

Keywords: climate change, forests, smallholders, well-being

ID:1203
Tuesday Yucatan-1
Symposium: Multiple-use forests: can forest conservation and socio-economic development be combined?

Local orchid trade and conservation in Mexico's forests: are they compatible?

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Background: Wild orchids have been heavily harvested and traded across for the globe for centuries, and many species have suffered local declines or extirpation. However, local use and trade of orchids is also widespread in many countries, including in Mexico, where some species have long traditions of cultural uses, and where many species are heavily harvested and sold in local markets for cultural celebrations and as ornamentals. Despite regulatory frameworks for limiting harvest and growing conservation concerns, there is still relatively little information on the orchid trade and its social-ecological consequences. **Methods:** We conducted a review and meta-analysis of the literature on local orchid markets, orchid demography and orchid regeneration and propagation to 1) assess the nature and scale of local harvest, 2) identify the consequences of harvest on orchid populations, and 3) assess the potential for sustainable use. **Results:** Our results show that while a very large number of species epiphytic orchids are sold in local markets, heavy trade focuses on only a few species and peaks during their flowering periods. The relative abundance of whole plants versus plant parts is highly variable across markets and species. Demographic studies of 9 species of epiphytic orchids show that populations subject to harvest of whole adult plants, decline. However, for some species, cutting flowers, harvesting only the flowering pseudobulbs, or replanting pseudobulbs offer promising strategies for sustainable use. **Discussion/Conclusion:** We draw on our findings to discuss the potential for the trade in epiphytic orchids to allow for population persistence while continuing to support local cultural traditions and local livelihoods.

Keywords: orchids, demography, harvest, Mexico, trade

ID:1192
Tuesday Yucatan-1
Symposium: Multiple-use forests: can forest conservation and socio-economic development be combined?

An Amazonian scientific network to support sustainable forest use and conservation by smallholders

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For over 10 years, a network of scientists has worked together to generate new information, support decision-making, and produce practical recommendations for sustainable management of Amazonian forests. Spearheaded by Embrapa (Brazilian Agricultural Research Organization) and focused on non-timber forest products (NTFPs), this network (known as Rede Kamukaia) enables the gathering of ecological and socioeconomic data from across the entire Amazon basin. Knowledge generation and dissemination is a primary result of Kamukaia and includes scientific articles (~35), dissertations and theses (~30), presentations in national and international conferences (~125) and technical documents (~40). The network also supports interactions with decision makers, technical courses, radio programs and field days as venues to exchange knowledge and develop sound public policies. We highlight three economically important species studied: *Bertholletia excelsa*, *Carapa guianensis* e *Copaifera* spp. For *B. excelsa* (Brazil nut), fruit production was 10 times greater in the northern versus southeastern region of the legal Brazilian Amazon due to differences in tree densities. While nut collection intensities varied greatly across the basin, natural regeneration was consistently sufficient to maintain study populations. For *C. guianensis* (andiroba), results indicated an enormous variability in seed production between years. In contrast to *B. excelsa*, most individuals did not consistently produce seeds on an annual basis, suggesting that local monitoring is critical for sound production estimates. Examination of the four *Copaifera spp*. (copaiba) distributed across the basin revealed that oleoresin production capacity varies by species, and management protocols should account for these differences. To improve extraction efficiency and reduce the manual labor typically required for oleoresin extraction, we recommend the use of a modified drill mounted to a chainsaw. Our results provide baseline information that feeds directly into the National Plan to Promote Sociobiodiverse Production Chains. The networked structure adopted not only facilitates comparative research; it also promotes data sharing, builds capacity, and strengthens professional relationships, while generating technical recommendations for on-the-ground management. We hope that outcomes generated improve producer acquisition of NTFP benefits, and enhance sustainable use and conservation of the forests on which they depend.

Keywords: Kamukaia, NTFP, forest managment

ID:1195
Tuesday Yucatan-1
Symposium: Multiple-use forests: can forest conservation and socio-economic development be combined?

Are Brazil nut populations threatened by fruit harvest?

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Background: Harvest of Brazil nuts from the large, iconic tree *Bertholletia excelsa* generates substantial income for smallholders, providing a strong incentive to conserve the mature forests where it grows. Although previous work has focused on the impact of nut harvest on new seedling recruits into *B. excelsa* populations, it is still unknown whether current harvest rates allow for sufficient regeneration. Moreover, there is additional uncertainty for Brazil nut management in terms of population response to climate change and other anthropogenic influences. **Methods:** We drew on 14 years of research in two sites in Acre, Brazil with different *B. excelsa* nut harvest intensities (39% and 81%), to produce stochastic matrix population models. **Results:** Adult (> 120 cm dbh) abundance was projected to remain close to the current observed abundance or higher through the next generation of trees. Estimates of generation times (or time to reproductive maturity) revealed medians (and 25-75 percentile intervals) of 167 (126-200) and 83 (64-112) years for each site, respectively. Elasticity analyses revealed that the asymptotic population growth rate (Î») was most sensitive to stasis parameters (the rates of survival minus the rates that trees advance to larger size classes) in sapling (>1.5 m height and <10 cm dbh), juvenile (10-40 cm dbh), and adult stages. Stochastic transition matrices calculated using variable diameter growth rates dependent on rainfall yielded average Î» values around 1.0 under extreme high, extreme low, and average annual rainfall. **Discussion:** While sustained high rates of Brazil nut harvest and climate change could potentially negatively impact *B. excelsa* populations, changes in human use of the forested landscape is a more immediate concern. To reduce the risk of population decline, smallholders and managers of *B. excelsa* rich forests should focus on conservation of pre-mature and mature individuals. Survival of these existing trees is a more pertinent risk to *B. excelsa* demography that the fate of most of the seeds it produces.

Keywords: *Bertholletia excelsa*, matrix population model

ID:1196
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Symposium: Multiple-use forests: can forest conservation and socio-economic development be combined?

Human influence on Brazil nut tree: light dependent growth and productivity in the disturbed areas.

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Background: Brazil nut tree (Bertholletia excelsa Bonpl.) is an Amazonian species. Certain ecological characteristics of this tree might have been encouraged by past or contemporary human activities. For example, the high performance of young trees (saplings, juveniles) under sunlight conditions may be favored by forest gaps and/or low intensity human disturbance (subsistente agriculture). Still, the partnership between man and tree is not always positive. The recent transformation of forests into pasture areas has led to high mortality of Brazil nut populations (in spite of legal protection) and pronounced decreased productivity of the remaining trees. **Methods:** We planted 144 saplings in experimental plantations at the Trombetas River valley, with three natural light treatments: manioc field (100% canopy removal), young secondary forest (20-80% canopy cover) and under forest (< 10% canopy opening). For nine years, plant height and stem diameter were measured, and mortality recorded. Besides, for tree years, we recorded the fruit production of Brazil nut populations in disturbed areas (closely located): pastures and secondary forests. **Results:** The Brazil nut plants at the manioc field had the greatest growth (height, diameter) than the other two treatments. The open field saplings grew in height five times more (151 ±34,2 cm year-1) and in diameter (1,8±0,5 cm year-1) eight times greater than those planted in secondary forest (height, 23,0±16,7 m year-1, diameter, 0,2±0,1 cm year-1). Under the forest, the growth of saplings was insignificant after nine years. The survival rate varied according to the treatment: 96% (manioc fields), 63% (young secondary forest) and 17% (close canopy forest). In other study, the monitoring of Brazil nut tree production in deforested area showed that the fruit production was significantly lower than in the secondary forest area. We recorded worst environmental conditions in the grazing areas compared to secondary forest: higher fire frequency, the soil significantly more compacted and with less moist content, higher daytime temperature and lower ambient humidity. **Conclusion:**: We report that the performance of Brazil nut saplings dependent on ambient light, with higher survival and growth in conditions of high light exposure. However, when the areas of occurrence of Brazil nut populations endures frequent and/or intense disturbance, the survivors trees have low productivity because of unfavorable environmental conditions.

Keywords: dendrometry, light, deforestation, production, conservation.

ID:1193
Tuesday Yucatan-1
Symposium: Multiple-use forests: can forest conservation and socio-economic development be combined?

Role of Amazon nut and timber on the viability of multiple-use forest management in Bolivia

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Background: Community families throughout tropical regions derive an important share of their income from multiple forest products, with generally positive outcomes on their livelihoods. However, the production of these forest products in a multiple-use forest management system (MFM, the production of multiple forest products within a single management unit) encompass many (yet) unknown socioeconomic and ecological feedbacks. In particular, MFM entailing timber and non-timber production may be affecting the future availability of valuable timber and non-timber tree species due to the extraction of vital plant components. We evaluated the social, economic, and ecological viability of an important MFM system widely practiced by community households in the Bolivian Amazon: Amazon or Brazil nut (Bertholletia excelsa) harvest and logging of 17 commercial timber species. **Methods:** We carried this research in 24 community households located in six communities with community forest management plans (CFMPs). We used multi-model inference and structural equation modelling techniques to determine the impact of socio-ecological factors on the income community families derived from Amazon nut and timber, and regression and matrix modelling techniques to determine the impact of harvesting intensity on Amazon nut and timber species populations. **Results:** Certain socioeconomic and ecological conditions enabled compatibility of Amazon nut and timber production in a MFM scheme. Complementarity between existing livelihood activities with forest income, and community households' increased negotiation skills and ecological knowledge allowed increasing or reducing pressure on the intervened species. Furthermore, increased logging intensity and liana-cutting counteracted the negative impact of Amazon nut harvesting intensity on the number of new recruits by enhancing the growth of small Bertholletia individuals and nut production, respectively. Commercial timber species responded differently to logging intensity. The majority responded positively, but the extent of their response varied with tree size and time since logging. **Conclusions:** Species-specific management approach and capacity building on management tasks and negotiation skills are required for a sustainable production of Amazon nut and timber in a MFM scheme. The analyses approaches used in this research should also be valid to investigate the compatible production of timber with other valuable NTFPs throughout the tropics.

Keywords: Forest products, Brazil nut, liana-cutting, logging intensity, Nut harvesting

ID:1201
Tuesday Yucatan-1
Symposium: Multiple-use forests: can forest conservation and socio-economic development be combined?

Collective titling in Peru: challenges and opportunities to secure tenure in the Amazon

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Background: Data on worldwide statutory regimes during the last thirty years show that Latin America is the developing region where the most significant changes have resulted in the recognition of collective rights to land for communal use and management. Peru has been at the forefront with many indigenous peoples' lands titled in the Amazon since 1974, when the first indigenous land titling regulation was issued. While this represents important progress, there are outstanding claims from indigenous organizations for over 20 million hectares. **Methods:** The results presented are based on research on forest tenure reforms by the Center for International Forestry Research on the implementation process for recognizing collective tenure rights in the Peruvian Amazonia. **Results:** Analyze institutional structures established to title collective indigenous lands, assessing the current constraints and opportunities to secure collective rights. Legal and historical analysis of regulations illustrate how reforms emerged. For an institutional analysis and the identification of tenure insecurity drivers, more than 50 surveys and interviews with implementation agents and non-government actors were carried out, along with 4 workshops at the sub-national level. Results. During the last 40 years important shifts have taken place in procedures and institutional structures responsible for titling. Responsibilities to recognize and title indigenous community lands have shifted between four different government institutions, involving agricultural and forestry government agencies, since forest became public domain in 1975. These changes have modified guidelines and undermined government capacities for implementation. Lack of information across different sectors, and the lack of a national cadaster, makes it difficult to determine the number of communal lands titled and areas to be titled. This has resulted in overlap of extraction rights, land invasions, conflicts and illegal extraction of resources, harming livelihoods and forest cover. **Discussion:** While Peru struggles for positive outcomes, renewed interest in collective titling has led to new goals for recognizing and titling pending communities, emerging from climate-change related funding and indigenous people's mobilization. Working with updated and official records and establishing clear coordination system among institutions present opportunities for strengthening the tenure security of Peruvian Amazonian communities.

Keywords: forest tenure reform, governance, Peru

ID:1198
Tuesday Yucatan-1
Symposium: Multiple-use forests: can forest conservation and socio-economic development be combined?

Conservation livelihood options? Agroforestry and Silvopastoral tipping points in a MAB reserve

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Background: Man and the Biosphere Reserves superposed upon peasant territories were formally conceived as spaces for idiosyncratic development policies: these spaces should allow peasant families to sustain decent livelihoods by creating agroforestry and/or silvopastoral landscapes, hence serving as high quality matrices for conservation. In reality, under a capitalistic, neoliberal society, land use dynamics in these territories tend to be driven by market transactions. This market-driven environment is unfavorable to producers - including where they adapt. It results in unsustainable land use and livelihoods and in low capacity to motivate and socially enforce conservation efforts We report on ten years of research on cooperation and conflict struggles of farmers and external actors who try to create and/or prevent the collapse of "nature-friendly" land uses in the Sepultura MAB reserve, in Chiapas, Mexico. **Methods:** We developed a multidimensional research agenda with the participation of 12 communities and many national and foreign graduate students. This agenda started off with a project promoting and monitoring farmer-based experimental fodder tree plantations to counter dry season livestock starvation and forest understory degradation. Poor adoption of fodder trees motivated us to explore more carefully the history, social identities, conditions, needs and motivations of farmers in this contended territory, and how these play out in farmers' interaction with other actors when implementing agroforestry and silvopastoral projects. **Results:** We report our analysis of three selected projects: 1) efforts to intensify and move livestock production away from forest browsing; 2) "conservation" coffee production which benefits for farmers and forests are dubious, and which might collapse under the recent rust epidemics, resulting in substantial technological and market changes; 3) *Pinus oocarpa* resin extraction in pine-grass rangelands, where cattle exclusion, fire use prohibition and unfavorable market deals could render this activity environmental and economically unsustainable. **Discussion:** We reflect on how silvopastoral and agroforestry projects constitute an unstable balancing act among actors in this MAB reserve (and probably in similar ones), and we discuss what it might take to sustain these practices for the sake of long term decent rural livelihoods and high quality landscapes

Keywords: Silvopastoral Agroforestry Livelihood Tipping points

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Tuesday Yucatan-1
Symposium: Multiple-use forests: can forest conservation and socio-economic development be combined?

Historical management practices and the conservation of domesticated Amazonian forests

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Background: Native Amazonian peoples developed multiple ways to live in forest landscapes, modifying them to improve their food production. The legacy of past land use is striking in the surroundings of archaeological sites, yet the management practices used by these societies to domesticate plants and landscapes, and the impact of these activities in Amazonian forests are still unclear. **Methods:** We used three different approaches to understand if management practices historically used by Amazonian peoples formed domesticated forests, often characterized by the presence of mono-dominated patches of useful plants. We began reviewing the scientific literature on management practices used today by indigenous and traditional Amazonian societies, and their influence on useful plant populations. Then, we developed a conceptual model about how these management practices interact with natural ecological processes to form patches of useful species. Finally, we studied 28 contemporary villages along four major Amazonian rivers to validate our conceptual model. **Results:** Our findings indicate that eight traditional management practices were used to domesticate Amazonian forests: non-useful plant removal, useful plant protection, dispersers' attraction, human transportation, phenotypic selection, fire management, cultivation, and soil improvement. Based on the scientific literature, useful plant cultivation and transportation were the most frequent practices, documented for 95 % of the species found in patches in the field. In contrast, protection was the most important practice based on field interviews, documented for 100 % of the useful species. We also found that surrounding all archaeological sites, useful tree and palm species form multiple and diverse patches, and that the dominant species are currently being managed by local people in their home-gardens, cultivated areas or managed forests. **Discussion/Conclusion:** Our findings reveal how multiple historical management practices increased the capacity for food production, while transforming pristine forests into domesticated forests that are strikingly useful today. Such practices represent an opportunity to slow deforestation and strengthen social-ecological resilience of Amazonian forests by the management of multiple useful plants left by the ancestors of the current inhabitants. **Acknowledgments:** We thank local residents for their participation, and FAPEAM and CNPq for financial support.

Keywords: cultural forests, dominance, useful plants, traditional knowledge, landscape domestication

ID:1194
Tuesday Yucatan-1
Symposium: Multiple-use forests: can forest conservation and socio-economic development be combined?

The importance of consumers of Amazon-nuts for tropical forest conservation

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Background: Most consumers on the international market have a choice about which products to consume. Many products have a negative environmental impact, but NTFPs are often associated with a strong incentive for forest conservation. Therefore, higher consumption of NTFPs could potentially contribute to the conservation of forests, but the extent of this contribution is rarely evaluated. This information could strongly influence consumers' choices if communicated. One of the most economically important NTFPs, that have the potential to strongly influence forest conservation, are Amazon nuts. In this study, we use the Peruvian-Swiss supply chain of Amazon nuts as an example to illustrate how large the impact of consumer's choice can be on forest conservation. **Methods:** Using data from different scientific, governmental and commercial sources, we analyze how much additional Peruvian Amazonian forest is conserved if Amazon-nut consumption of Swiss residents would double compared to current consumption. Limitations on Amazon nut availability are taken into account. **Results:** We will present results from initial models and discuss the implications for sustainable supply chains. **Discussion:** These results illustrate the extent to which small changes in consumers' choices can contribute to forest conservation, and emphasizes the need for consumer education about the positive contribution the consumption of some products can have on nature conservation.

Keywords: NTFP, *Bertholletia excelsa*, Brazil-nuts, consumers

ID:1200
Tuesday Yucatan-1
Symposium: Multiple-use forests: can forest conservation and socio-economic development be combined?

Exploring genetic effects of forest degradation on Brazil nut mating systems

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Background: Non-timber forest products offer a potential opportunity for the combination of social development and conservation of natural ecosystems. The amazon nut (a.k.a. Brazil nut) is an example of an arguably exceptionally successful conservation model in this context, since it is globally traded and thus economically important for a vast number of people, particularly in rural Amazon areas. Nevertheless, the rain forest where Amazon nuts occur is being affected by human-induced forest degradation due to logging of other tree species and land conversion from forest to agricultural systems through e.g. burning. **Methods:** In this project, we assess the potential effects of human impact on the reproduction systems of Brazil nut populations in Madre de Dios, Peru. We focus on the study of genetic diversity, gene flow and how these factors are associated with seedling performance in experimental plantations, both in nurseries and in the forest. **Results & Discussion:** With this component of our study we are able to detect possible events of genetic erosion in a degradation gradient in the forest, and relate this to genetic diversity and seedling performance.

Keywords: Genetics, gene-flow, degradation, Brazil nuts

ID:1199
Tuesday Yucatan-1
Symposium: Multiple-use forests: can forest conservation and socio-economic development be combined?

Symposium
Using functional diversity to understand community and ecosystem processes in tropical dry forests

Long-term shifts in trait composition and ecosystem processes in a secondary tropical dry forest

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Understanding the relative importance of land use legacies and climate in the structure and composition of plant communities remains a central goal in ecology. Increasing evidence indicate that tropical forests are experiencing changes in structure and composition, such as. increases in tree turnover rates, biomass gain, and abundance of some functional groups. It Despite this evidence, little is known about the temporal shifts in functional composition, and how these shifts relate to biotic and abiotic conditions. We assessed long-term changes in a tropical dry forest spanning 30-years to understand the relative influence of past disturbance and climate on trait composition and forest structure. The 16-ha plot is subdivided in 20 x 20 quadrats, and it encompasses stands of different ages (~80, 100, 150 years). Trees with diameter > 3 cm were measured in 1976, 1996, and 2006. Functional traits for each species were measured in 2006, and were complemented with other studies in the same region. We evaluated shifts in functional composition for 9 traits related to resource acquisition and drought tolerance. Also, we quantified absolute rates of stem density and aboveground biomass (AGB), and assessed changes in species diversity over time. If shifts in trait composition are strongly influenced by climate, then, higher turnover. rates, low AGB, and increases in drought-related traits are expected. In contrast, if the forest is recovery from past disturbance, a shift in the functional composition from conservative to acquisitive strategies is expected. We found an overall decreased on the turnover rates of stem density over time. Species diversity, AGB, community weighted means (CWM) of specific leaf area (SLA), foliar nitrogen (LNC), stable carbon and nitrogen isotope concentration increased over time, while the CWM of leaf water content, and foliar phosphorus decreased. No trends were found for the CWM of wood density, foliar carbon and leaf area. Overall, our results suggest that temporal changes in this forest may be the result of recovery from past disturbance. The significant shift of trait strategies from conservative to acquisitive (e.g., higher SLA, LNC), the decreases in stem turnover rates and increased in biomass over time are similar to those trends found in successional dry. forests across stand ages. Future analyses should include other moments of trait distribution to better estimate community responses to a changing environment.

Keywords: Functional traits, dry forests, succession

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Tuesday Yucatan-2
Symposium: Using functional diversity to understand community and ecosystem processes in tropical dry forests

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Local and landscape-scale assembly patterns of small and large trees in tropical dry forests

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Background: Plant community assembly is defined by processes occurring within and among communities. Turnover of plant strategies over environmental gradients occurs because species with particular traits are favoured under specific conditions. However, local competitive processes prevent coexisting species from becoming too similar, and consequently trait differentiation also occurs within communities. **Methods:** We used Trait Gradient Analysis in a semi-deciduous tropical forest landscape in the Yucatan Peninsula, Mexico, to investigate small and large trees community assembly patterns along successional and topographical gradients. We decomposed 45 species' functional traits (leaf area, minimum photosynthetic unit, specific leaf area, leaf dry matter content and wood specific gravity) into alpha (within-plot) and beta (among-plots) components. **Results/Discussion:** Our results suggest that very local processes, such as competition and microenvironmental conditions determine the assembly of small trees (observed as co-variation of alpha values). Large trees also showed the effect of local conditions, as well as habitat filtering associated with landscape-scale factors, such as forest stand age and topography (observed as co-variation of beta values). **Conclusion:** The different correlation structures for alpha and beta components of functional traits reflect not only community assembly processes at different scales but also how they vary with tree size in this tropical forest.

Keywords: Trait gradient analysis, succession, topography

ID:1050
Tuesday Yucatan-2
Symposium: Using functional diversity to understand community and ecosystem processes in tropical dry forests

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How Does Soil Phosphorus Affect Plant Traits and Soil Function Within and Among Dry Forests?

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Background: Soils can act as an environmental filter, favoring certain species or plant functional traits. This can feedback to affect ecosystem processes, including productivity, plant relationships with symbionts, and nutrient cycling. Phosphorus (P) availability is thought to regulate forest productivity in tropical rainforests, but the role of P in seasonally dry tropical forests (TDF) is poorly resolved. To understand relationships between soils and plant processes at regional scales in TDF, we measured total soil P and community weighted mean values of foliar P along edaphic and successional gradients in a dry forest landscape in Northwestern Costa Rica. To understand variability in soil P at coarser spatial scales, we measured soil P in four Neotropical dry forests in Colombia, Costa Rica, Mexico, and Puerto Rico. **Methods:** We measured total soil P in composite surface soil samples from 84 0.1 ha forest inventory plots in Northwestern Costa Rica. Community weighted mean values of foliar P were calculated using species-specific foliar P data weighted by the basal area of each species in each plot. We also sampled soil from replicated plots in TDF of four different countries, and measured labile P, microbial P, phosphatase enzymes, and total soil P. **Results:** In Costa Rica, total soil P varied over two orders of magnitude- from 30 to 1275 ppm in the 84 plots, which was likely driven by differences in parent material. Community weighted mean foliar P scaled directly with total soil P; forests on soil P soils were dominated by species that have low foliar P and vice versa. Labile soil P varied significantly among countries and increased from Mexico = Costa Rica < Colombia < Puerto Rico, with values ranging from 0.5 to 123 micrograms per gram. By contrast, phosphatase activity was lowest in Colombia and increased in Costa Rica = Puerto Rico, and was highest in soils from Mexico. Within countries, relationships between labile and phosphatase differed. **Conclusion:** At a regional scale in Costa Rica, our data suggest that soil P availability places strong constraints on forest composition through effects on plant functional traits such as foliar P. Thus, heterogeneous soil P within a region may promote species co-existence. Soil P was as variable at continental scales, and related to P-acquiring enzymes. Our data suggest that P may be as important in TDF as in rainforests.

Keywords: phosphorus, environmental filtering, soils

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Functional regeneration during succession in a tropical dry forest: from microorganisms to mammals

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Background: Knowledge on the regeneration of forest diversity and functioning is usually limited to the plant component, although changes in all the biota are expected due to alterations in habitat conditions. In this study, we aimed to determine the changes on soil traits, forest structure and species richness and composition of multiple groups of organisms along secondary succession in a tropical dry forest (TDF) in southeastern Brazil. **Methods:** We defined three successional stages based in forest vertical and horizontal structure and age: early (18-25 years), intermediate (50-60 years) and late (no records of clearing). Five plots of 50 x 20 m were established per stage, and the following groups were sampled using specific techniques: rhizobacteria, mycorrhiza, trees and lianas, butterflies, ants, dung beetles, mosquitoes (Culicidae), birds and bats. We also determined soil chemical and physical characteristics and forest structure (tree height, density and basal area). **Results:** Soil fertility increased along the successional gradient, and the same pattern was observed for all the forest structure variables. However, species richness and composition showed mixed results depending on the organism group. Three groups usually considered as good bioindicators of habitat quality did not differ in species richness and composition between stages: butterflies, ants and dung beetles. On the other hand, rizhobacteria and mycorrhiza differed both in species richness and composition between stages and may be more sensitive to changes in environmental conditions in TDFs. The other five groups differed either in species richness or composition between one or two pairs of successional stages. **Discussion:** Although changes in abiotic conditions and forest structure match the predictions of classical successional models, the response of each group of organism is idiosyncratic in terms of diversity and ecological function, as a consequence of specific resource requirements and life-history traits. In general, diversity increased and functional groups changed mostly from early to intermediate-late stages, strengthening the importance of secondary forests to the maintenance of ecosystem integrity of TDFs.

Keywords: Functional groups; succession; diversity; chronosequence.

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How seasonal are seasonal tropical forests?

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Background: Almost all tropical environments vary seasonally. Precipitation seasonality is a defining feature of tropical dry forests, for example, and influences carbon and nutrient cycling, species interactions, and the timing of growth and reproduction. The consequences of extensive deforestation of tropical forests lends urgency to the study of seasonality and its effects on communities and ecosystem processes. Yet there is no standardized metric of seasonality, and more precisely climatic variability, which limits large-scale comparative approaches and our ability to forecast future climate change impacts. **Methods:** I argue that decomposing time series of climate data using wavelet analyses provides a standardized metric of climatic variability comparable across spatial and temporal scales. I use this approach to test the hypothesis that seasonality is a key driver of community assembly across latitude. First, I use NOAA's National Centers for Environmental Information climate data across the world to quantify climate variability. Second I compare whether this metric predicts functional trait diversity across neotropical latitudinal and elevational gradients. **Results:** Most notably, I show that functional diversity increases with increasing climatic variability, supporting the hypothesis that increased spatio-temporal environmental variability allows for the coexistence of functionally diverse species. **Discussion:** I outline how trait variation and climatic variability can shed light on the assembly and structure of tropical biota and how these diverse systems may respond to future climate change.

Keywords: functional trait; spatio-temporal; variation; climate

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The functional spectrum of legumes in secondary tropical dry forests

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Understanding which legume species and functional traits are favored during tropical forest regeneration could provide a useful framework for active restoration of degraded areas. However, the role of legumes during secondary succession has been analyzed comprehensively in only a few wet forest sites. In this study, we evaluated legume abundance during secondary succession across the Neotropics, and examined how recovery from disturbance, large-scale environmental gradients and functional traits affect the ecological success of this prominent plant family. We extracted plot-scale legume abundance from 42 chronosequence studies in the 2ndFOR network that span a broad gradient of precipitation (from 750 to 4000 mm), and identified traits that are favored in distinct successional environments. For each species, we determined the potential to fix N_2 and quantified leaf size and type, traits that correlate with reduced water loss in arid environments. Further, we explored additional physiological and morphological traits in seedlings of a subsample of legumes of different leaf type using a series of shadehouse experiments. Legume trees dominate young (5-20 years) tropical dry forests (with annual rainfall < 1500 mm/yr). Above 1500 mm rainfall, legume relative basal area in young forests was lower. Early successional legumes in dry forests had common traits, including the potential for N fixation and bipinnately compound leaves. As seedlings, bipinnate legumes have traits related to fast acquisition of carbon, nitrogen, and water: high rates of photosynthesis and biomass accumulation and low water use efficiency (WUE). On the other hand, pinnate legumes have traits that optimize resource conservation: slower rates of growth, higher WUE, and higher biomass investment into fixation. The strong dominance of legumes in secondary dry forests of the Neotropics may be due to a suite of traits, which together may reduce the cost of flushing leaves rapidly once seasonal rains arrive. We observed contrasting whole-plant carbon, nutrient, and water economies between legume seedlings with pinnate versus bipinnate leaf type. Each group sorted along a resource acquisition-conservation gradient defined by rapid carbon assimilation (bipinnate) and high water use efficiency (pinnate). The functional variability among species and leaf types may help account for the exceptional dominance of legumes in the forests of the dry tropics.

Keywords: legumes, succession, fixation, bipinnate, Neotropical

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Resource acquisition strategies predict seedling performance in a tropical dry forest restoration

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Background: Successional trajectories of tropical dry forests (TDFs) are not well understood, but recent observational studies have found TDFs transition from tree communities with conservative traits to communities with acquisitive traits, the opposite of wet forests. Considering this successional theory when designing TDF restorations could therefore increase restoration efficacy. To determine if the presence or absence of remnant vegetation controls the performance of tree species with different resource acquisition strategies, we planted a 6 ha restoration experiment with trees that have conservative or acquisitive trait syndromes into plots with different management treatments: clearing existing vegetation (early succession), or interplanting into existing vegetation (later succession). **Methods:** Twelve native species were assigned to acquisitive or conservative groups based on hierarchical cluster analysis of multiple traits, resulting in mixes of six species for each trait syndrome. In September 2015, we cleared three 1 ha plots, and three 1 ha plots were left with scattered trees. Each 1 ha plot was divided into four 50x50 m split plots, and two replicates each of the species mixes (acquisitive/conservative) were assigned randomly to those plots. To quantify seedling performance we measured survival seasonally for one year. **Results:**and **Discussion:** We hypothesized conservative species would have higher survival than acquisitive species in the cleared plots because conservative TDF species are theoretically more adapted to early successional conditions. Our data were consistent with this hypothesis, as conservative species had 9.3% higher survival in cleared plots than acquisitive species ($p<0.05$). By contrast, we hypothesized that acquisitive species would have higher survival than conservative species when interplanted. However, we found that conservative species had higher survival than acquisitive species in the interplanted plots ($p<0.05$), but the difference was only 4.0%. Our initial results show that species with conservative traits had higher survival than species with acquisitive traits at early successional stages, which aligns with recent advances in TDF successional theory. Furthermore, while we did not find any differences in survival between the cleared (30.3%) and interplanted (30.4%) treatments, conservative species had 6.7% higher survival overall ($p<0.05$), indicating that successional theory can aid in the design of TDF restorations.

Keywords: dry forest, restoration, functional traits

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Friends or enemies?
Soil microbes show contrasting effects on dry forest seedlings facing drought

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Background: Tropical dry forests (TDF) occur in regions with a strong rainfall seasonality, which typically experience from 3 to 10 months of drought (< 100 mm). Climate models predict hotter and drier conditions across TDF regions by the end of the 21st century, but little is known about how TDF plant species will be impacted by these conditions. In particular, how drought will impact the biotic interactions of plants with other taxa such as soil microbial mutualists, and how different functional groups of these microbes (i.e., mycorrhizal fungi and nitrogen-fixing bacteria) will help plants to cope with new environmental conditions, is largely unknown. **Methods:** For this study I grew seedlings from 3 N-fixing legume species (*Pseudosamanea guachapele*, *Samanea saman*, and *Pithecellobium dulce*), 2 non-fixing legume species (*Hymenea courbaril* and *Senna spectabilis*) and 4 non-legume TDF species (*Sapindus saponaria*, *Spondias mombin*, *Guazuma ulmifolia* and *Hura crepitans*) with and without soil microorganisms from TDF under three water treatments: control (C), reduced precipitation (P), and reduced frequency of precipitation (P). N-fixing legumes associate with N-fixing bacteria and arbuscular mycorrhizal fungi (AMF), while non-fixing legumes and non-legumes associate only with AMF. Plants in the control treatment received the equivalent of precipitation in a dry forest (160 ml/week), while plants in the precipitation treatment received half the water of the controls (80 ml/week), and plants in the reduced frequency treatment received the same amount of water as the controls, but every other week (160 ml/2 weeks). **Results:** Plant mortality was higher for plants associated with AMF than for plants associated with AMF and N-fixing bacteria under both drought treatments. Furthermore, the benefits and costs of both AMF and N-fixing bacteria under different drought treatments, reflected on plant growth, varied across species. **Conclusion:** Thus, predicted changes in climate may significantly impair not just plants, but also their soil symbionts, in ways we are only beginning to understand.

Keywords: drought, soil, tropical dry forest

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The environment vs tropical dry forests: importance of intraspecific variability of traits

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Background: Climate change and fragmentation are major threats to world forests. In seasonally dry tropical forests (SDTF), changes in yearly rainfall variability, longer intervals between wet and dry years and, particularly, a decline in rainfall predicted by climate models, could influence the relative performance of species. Understanding how functional traits related to drought tolerance vary across environmental gradients in SDTF could be important to predict species' responses to these threats. We explored how the magnitude and variability of leaf and wood anatomy traits varied across temperature and rainfall gradients within and among six tree species. **Methods:** We measured functional traits in populations distributed across a rainfall gradient in SDTF in Colombia. We measured two leaf and five wood anatomy traits in at least five individuals per population. To explore variation of each functional trait across rainfall gradient we used linear mixed models and we estimated the coefficient of variation. **Results:** Trees growing in drier populations showed leaf traits associated to drought tolerance such as higher leaf mass per area and higher leaf dry matter content. In contrast, wood anatomy traits did not vary in most species except for *Astronium graveolens*. We did not find differences between coefficient of variation across population for any species. **Conclusion:** The limited plasticity showed by wood anatomy traits, could increase cavitation risk in populations where projections predict higher temperatures, lower rainfall or longer drier seasons. The synergism between climate change and fragmentation in Colombia's SDTF could aggravate this scenario with ecosystem level consequences.

Keywords: intraspecific variability, functional traits

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Using functional traits to explain drought-induced liana mortality in tropical dry forest

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Background: Lianas (woody vines) are the second most abundant woody growth form in many tropical dry forests surpassed only by trees. Despite their abundance, little is known on how lianas respond to drought. The worst drought on record for the tropical dry forest of Northwester Costa Rica occurred during the 2015 El Niño Southern Oscillation and the 2016 dry season. We are taking advantage of this drought to be able to study liana response to extreme drought events. Our first objective was to quantify liana mortality following this extreme drought event and determine if susceptibility to extreme drought is family and/or species specific. Our second objective was to use functional traits to attempt to explain levels of drought susceptibility among different liana species. **Methods:** We conducted a survey, before and after the 2015 extreme drought event, of all lianas with a diameter of ~1 cm at 130 cm from the base in 18 - 0.1ha permanent plots. These plots are located across two conservation areas in the tropical dry forest of Northwestern Costa Rica. We calculated the percent mortality for each species. For the 20 most abundant species we measured the following functional traits: predawn and midday leaf water potential during the wet season and one month after the beginning of the dry season but before leaves had senesced, leaf nitrogen content, petiole length, leaf specific area, leaf thickness, wood density, wood vessel diameter, and wood vessel density. **Results:** We measured a total of 1,915 liana stems. By the end of the dry season following the extreme drought event, 21.1% of liana stems had died. Mortality was not even across all families of lianas ($F_{18,36}$ = 4.30, P<0.001) and depending on the species the mortality rate was from 0 to 65%. There was no significant correlation between any of the functional traits that we measured and percent mortality. **Discussion:** Although we do not have data for the baseline mortality rate of lianas because we did not start the liana surveys until 2014, we assume a mortality rate of over 20% is abnormally high, and at least partially driven by the 2015 drought. Also, not all families and species of lianas are equally vulnerable to drought. Some species were much more vulnerable than others. However, we were unable to find any functional traits that could explain this difference in mortality rates between species.

Keywords: lianas, drought, tropical dry forest

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Emerging patterns of plant functional strategies along hydric gradients in tropical forests

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Background: In many scenarios, actions of ecological restoration imply the assemblage of stable plant communities that favor the recovery of biodiversity and specific ecosystem functions. Our ability to design such assemblages depends on the capacity to predict what species can be established and prosper in degraded lands, and how those species modify the environment. In this study we develop a conceptual model on the environmental barriers to the establishment of trees in anthropogenic tropical landscapes, the way they change across climatic gradients, and the changes in the main functional trade-offs guiding filtering processes of those successful species in degraded lands. **Methods:** The predictions of this model are tested by synthesizing multiple published studies on filtering processes occurring in different climatic contexts from the seasonally dry to the wet tropics. **Results:** We derive plant functional strategies successful in areas with degraded cover vegetation, and determine easy functional indicators. **Discussion:** We discuss the implications of the resulting filtering patterns for the selection of useful species in efforts of restoration and maintenance of ecological processes in tropical anthropogenic mosaics.

Keywords: Functional-traits, tropical-forests, hydric-gradients, restoration

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Effects of the potential invasive shrubs on soil hydraulic processes in a tropical dry ecosystem

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Background: In Colombia 90% of dry tropical forest has disappeared due to antropogenic disturbances. Worldwide biological invasions are considered as the second cause of biodiversity loss. In systems transformed or degraded by livestock, agriculture, logging and mining, the appearance of exotic species with invasive potential is frequent. However, the impact of biological invasions on ecosystem processes have been little studied. Based on that, we explore the impact of species with invasive potential on soil hydraulic regulation processes in a tropical dry forest and their relationships with the functional features and strategies of the species of the community. **Methods:** The study was developed in Beltran municipality at Cundinamarca department-Colombia. We defined three sites with different levels of transformation. Three plots of 100m2 were installed in each area and four soil hydraulic regulation processes. Additionally, hydraulic and leaf functional traits in invasive potential and native species were meassured. A model of mixed efects with nested blocks was introduced and comparisons of traits between types of species and zones were made. An index of functional diversity and community weighted mean of the traits. We calculated simple correlations among the process and the traits measured. **Results:** We found significant differences between hydraulic functional traits of plant species. While, native tree species showed conservative and acquisitive functional traits, related to hydraulic safety and hydraulic efficiency, exotic plant species presented conservative traits. Soil hydric processes, related to soil infiltration and soils hydraulic conductivity, did not show significant differences between sites, neither climatic periods. In contrast, soil compaction and soil moisture differed between sites and climatic periods, where dry forest showed higher soil moisture and lower soil compaction, during rain period, but exotic plant sites improvement compared with degrade sites. We found the correlation between the soil moisture with CWM of tree and functional diversity, with major diversity keep the soil moisture. **Conclusion:** Our results suggest that even sites dominated by exotic plants have not showed functional structure and diversity such as dry forest, those sites increase hydric soil processes compared to degrade soils sites. However, the best scenario for hydric processes in soils conservation in tropical dry forests is to keep the forests.

Keywords: disturbance, invade area, soils moisture

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Forest cover on landscape scales is a driver for insect guilds diversity in tropical dry forests

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Background: Insects herbivores are an important component of biodiversity with a close relationship with plant species and plant parts. The dispersal of individuals from different habitats in the surrounding landscape determines local diversity, and the vegetation texture formed by crop connectivity in forests represents niche availability for herbivorous insects to find food, shelter and breeding sites in the surrounding landscape. **Methods:** We evaluated herbivore β-diversity and the effects of forest cover availability on guild richness and abundance at five different radii scale landscapes , based on the RapidEye classification. We assessed herbivore communities at 48 sites from four dry forest regions ranging from latitudes 19° south to 19° north, three regions are located in Brazil and one in Mexico. **Results:** We collected 2,893 insects representing 438 morphospecies, including 113 folivorous, 225 sap-sucking and 100 xylophagous insects. β-diversity was higher in the region with the most unpredictable weather, and species turnover contributed most to β-diversity at all sampled dry forest regions. Forest cover on a landscape scale enhanced local species richness and abundance. Nevertheless, folivorous richness was only associated with the minor landscape scale (0.25 km radius), while the sap-sucking and xylophagous insects richness and abundance were positively affected by forest cover in all five spatial scales, with higher explanatory power which ranged from 1 to 1.5 km radius around the study field. This reflects potential dispersal distances. **Conclusion:** The higher species replacement among sites of dry forest regions, and the biologically relevance of forest cover to herbivorous insect diversity suggest that the maintenance of forests areas in the surrounding landscape contribute to dry forest ecosystem resilience. The variation in landscape scale requirements among guilds indicates that the management of landscape features is as important as the conservation of a particular forest fragment in order to preserve dry forest herbivore diversity.

Keywords: Dispersal abilities, land scales, guild structure, β-diversity

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Fluctuating asymmetry, leaf sclerophylly and herbivory: an altitudinal gradient analysis

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Environmental gradients might promote stressful conditions that can affect plant physiological and morphological traits. Past studies have shown that plants located at higher altitudes can present higher levels of both leaf sclerophylly (LS) and fluctuating asymmetry (FA). While it is expected that higher FA levels should be accompanied by higher leaf consumption by herbivores, lower herbivory would be expected for elevated LS. Aiming to investigate this contraction our objective was to determine the effect of altitude on LS and FA and evaluate the relative importance of these two morphological traits on herbivory rates of *Tibouchina granulosa* Cogn. (Melastomatecea) in Brazilian Atlantic Forest. The study was conducted in southern Brazil, along a 725m altitudinal gradient where we measure LS, FA and herbivory from leaves of 29 individuals of T. granulosa. There was a strong and positive effect of altitude on both LS and FA but only FA was related to herbivore. Our results suggest that as altitude increases plants face more stressful conditions, leading to higher developmental instability and higher FA. This instability may lead to a higher nutritional quality of leaves and herbivores may use leaf asymmetry as a cue. The lack of a relationship between LS and herbivory gives us evidence that, in the studied location, LS is not primarily used as plant defense and probably has other functions related for example to water and nutrient stresses. These results may be considered a baseline for the understanding on how altitudinal stress and potential herbivory pressure can influence plant establishment.

Keywords: elevation, abiotic stress, developmental instability

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Forest-flooded ecotones: ant species distribution in response to Canopies and natural succession

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Background: Natural Ecotones between forests and flooded or freshwater habitats has become a neglected area of study. Our group has demonstrated that canopy habitats predominated in natural edges between freshwater and forests, due to the pattern of tree branches bending towards the water or flooded nude soils, seeking for light. We tested the hypothesis that the type of ecotone open habitats, varying from all year flooded, seasonally flooded, and finally to herbaceous, wet soil only, influences the patterns of ant species distribution between forest soil and canopy in an ecotone. **Methods:** We compared the transition between ecotonal canopies in a montane, and mid altitude forests, in the Doce River basin, in the Atlantic rainforest. An ecotonal canopy- open swampy woodland was compared with an ecotonal canopy-herbaceous natural succession after lake retraction. Transects in the ecotone and 50 metres inside the forest, with 20 pairs soil-trees non attractive pitfalls were settled as the sampling design, repeated in different ecotones. **Results:** The montane forest had 1211 ants sampled in the ecotones, from 49 species, against 752 ants of 51 species inside the forest. Early rainy season and soil had more ant species than late rainy season and trees, regardless habitats. *Camponotus rufipes,* a dominant canopy species in the montane forest, was the most frequent in the ecotone, both in soil and trees. The mid-lowland forest had 3778 ants from 137 species in the ecotone and 2896 ants from 81 species inside the forest. Again, more ant species richness was found in early rainy season and in the soils, but in this forest also a greater number of species was significantly found in the ecotone than inside the forest, especially for the arboreal ones. Dominant and aggressive ant species were found in the ecotone, such as *Camponotus atriceps*, *C. cingulatus* e uma espécie de *Solenopsis* (sp3). *Sericomyrmex mayri* was very abundant in the soil of lowland forest and *C. atriceps* was very frequent in both forests. **Discussion:** Results suggest that constant, predictable flooded habitat is a filter type of environment, where few forest species can couple with, while a drying out lake is a dynamic, rich environment, capable of sustaining a distinct fauna than the forest, while also collecting forest species, attracted by resources caused by the low-to-ground canopy added to the succession itself.

Keywords: canopy ecology; Atlantic rainforest; ants

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Changes in plant-pollinator interactions deplete plant progeny fitness in fragmented landscapes

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Over the past two decades there has been much research to determine habitat fragmentation effects on the mutualistic interactions involved in sexual plant reproduction and seed dispersal, which shape the reproductive success and genetic characteristics of remnant populations. Reduced area of remaining natural habitats and hostile agricultural matrices reduce pollinator richness and abundance. As a result plant populations produce on average less quantity of progeny in fragmented habitats. An equally important but a less-well recognized feature of plant reproduction is the genetic and biological quality of progeny, which represents the complementary aspect of the reproductive event as it determines the recruitment and survival potential of plant populations. Here we show results of a systematic literature review to determine overall habitat fragmentation effects on the genetic characteristics of progeny and on progeny performance. We found strong overall negative fragmentation effects on progeny performance in 105 unique plant species across the world. Progeny performance of pioneer species were significantly less affected than late successional species. Progeny generated in fragmented landscapes were genetically less diverse and showed higher inbreeding coefficients than progeny from continuous habitats. Interestingly, we also found a significant negative relationship between progeny performance and inbreeding coefficients: individuals with higher inbreeding coefficients showed lower performance in fragmented habitats. Our results indicate that fragmentation effects on progeny performance is mostly due to changes in mating patterns elicited by pollinators, increasing self-pollination and/or mating among relatives. We discuss the implications of these findings for long-term plant population persistence in ubiquitous fragmented landscapes.

Keywords: Germination, seedling, genetic diversity, performance

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Herbivory in the face of biological invasions

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Globalization, increased traffic through trading routes, has increased the rate of new records of potential invasive species worldwide with increasing risk of cascading effects. Oceanic insular ecosystems and biodiversity hotspots are of special concern because of the unique combination of particular evolutionary lineages concerting in them as they may be challenged by invasions. Invasive animal and plants may trigger cascading effects. Here we report on two studies focused on herbivory and its drivers. First in a late Pleistocene refuge currently occupied with Seasonally Dry Tropical Forest the invasive plant *Briophyllum pinnatum* caused a significant increase in herbivory in native plants accompanied by a reduction in the top-down controls of herbivory while bottom-up controls were relaxed. Also in the Socorro Island deep in the Mexican Pacific Ocean introduced sheep disrupted the trophic networks resulting and increased herbivory the endemic flora mostly due to the reduction of bird populations or foraging activities in invaded sites. These remarkable similarities highlight the predominant role of the predation of herbivores as a determinant of damaged in plant populations and the fragility of high trophic levels to ecosystem perturbations.

Keywords: Biodiversity; trophic interactions; cascading effects

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Symposium: Insect-Plant interactions: patterns and processes in a changing world

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Thirty years of insect-plant interactions in a nutshell: a review of responses to global change

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Background: Changes in ecosystems after disturbances are of central concern in ecology. Natural areas worldwide are threatened by agricultural expansion, land-use intensification and climate change. These factors can lead to direct extinction of species, but also alter complex relationships between interacting species. In this study, I focus on global change effects on insect-plant interactions through the use of systematic reviews and meta-analyses. **Methods:** Studies were searched on meta-analyses published between 1992-2016, addressing the effects of global environmental change on plant-herbivore interactions and effects sizes (Hedge's d and lnRatio) and associated variances were computed and compared. **Results & Discussion:** Accumulated data has shown that insects are both directly affected by global change as well as indirectly by changes in host plants. Air pollution, for example, decreased soil arthropod abundance by 20%, whereas leaf damage by herbivores increased by 167%, as overcompensation for poor resource quality. Elevated atmospheric nitrogen - a direct consequence of fertilizer use in terrestrial systems - increased tree biomass by 27.3%, foliar nitrogen by 18.3%, and enhanced insect performance. The scenario of accelerated fossil fuel combustion, fertilizer use and anthropogenic nitrogen fixation increase tree palatability, raising concerns regarding the chance of global forest insect pests aggravation. Chemical-mediated plant-insect interactions have been a topic of intense investigation for over 40 years and data accumulated in more than 170 articles have shown that herbivory rates decreased when plants accumulated metals, but increased by more than 90% with high nutrient inputs. Higher CO_2 increased plant growth but decreased plant quality through unbalances in C:N ratio, increasing herbivore consumption by 80% for generalist herbivores. **Conclusion:** These global environmental changes have the potential to affect insect-plant interactions thus leading to changes at the population and community levels that may include the loss of ecological functions, ecosystem processes and services in both tropical and temperate ecosystems.

Keywords: insects, plant quality, herbivory, meta-analysis

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Symposium
The impacts of agrarian change on local communities: sharing experience from the field

Agrarian changes and rural livelihoods in an upland landscape of Bangladesh

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Background: Trajectories of land use change poses great challenges in sustaining rural livelihoods and environmental benefits. In the recent past decades, the south-eastern upland landscape of Bangladesh has experienced changes in agricultural land use accompanied with forest conversion and the establishment of monoculture plantations. However, there is a lack of understanding on the changes and associated livelihood impacts on rural households. **Methods:** This study examines how the agriculture and forest-based livelihood provisions have interacted over recent years and assess the implications of this agrarian change on food security and income. We interviewed 304 households with structured questionnaires in three sites: upland, mid- and lowland. The questionnaires covered information regarding the changes of agriculture and forest land uses and associated contributions to food production and income at household level. **Results:** In over half of the households surveyed, the respondents experienced a decrease of their overall farm land with a concomitant loss of crop variety and livestock resources. Farming area relatively increased in the upland site associated with land/forest clearing activities, with almost 90 percent decrease of the forest cover, yet food sufficiency and annual income remain low here. While farming areas decreased in mid- and low-land sites but increased monoculture fruit garden, intensive cash crops and wage activities contributed to greater food production and income. Two-thirds of the households experienced more travel time and distance required for forest product collections. While the loss of forest cover largely affected middle- and low-land communities in accessibility and availability of the forest products, fuel wood and fruit availability increased to a certain extent due to the planting of trees on farms and monoculture establishment. **Discussion & Conclusion:** Overall the study has provided insights into agrarian changes with both positive and negative social-ecological outcomes. The diverse impacts of agrarian change on food production and access to forest based benefits are significantly associated with site conditions and land uses at the landscape. We recommend that further investigation of integrated strategies for landscape management might be effective to deal with the various changes and complex problems of food production and conservation at the landscape scale.

Keywords: Forest, Land use, Food, Income

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How do ecosystem services vary in different agrarian systems? A cross-site perspective

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Background: The majority of deforestation in tropical forests has resulted from agricultural expansion. As the need to feed a burgeoning population increases, maintaining and balancing the diversity of other ecosystem services provided by forests and landscapes remains challenging. Understanding the diversity and interactions among ecosystem services across landscapes, especially in agricultural landscapes, has been a heavily researched topic in the field of the ecosystem services. Yet in tropical agrarian systems, there are very few cross-site comparisons, which allow for overarching theories about the impacts of different agrarian systems on ecosystem services. **Methods:** Here, we conducted nearly 2000 household surveys across seven tropical countries in different agrarian systems ranging from subsistence farming to intensive monocultures. We surveyed households about the use of ecosystem services from local forests as well as about household agricultural practices. We also used three decades of Landsat imagery to track forest cover and fragmentation. Synthesizing information from landscape-scale remote sensing and local household surveys to better understand the impact of different agrarian systems on the diversity of ecosystem services, we ask three main questions: (1) How do the diversity landscape services vary in different zones of agrarian change and with total forest cover and forest edge? (2) Are there any trade-offs/synergies among specific forest resources in different agrarian systems? (3) Which forest types facilitate use of forest resources? **Results:** We found the diversity of ecosystem service use was greatest in subsistence agricultural systems and lowest in monoculture systems. We also found that certain ecosystem services were more prevalent in different agrarian systems, particularly in subsistence systems and mixed agrarian systems. Communities in different countries relied on range of forest types including riparian and remnant forests as well as protected in unprotected forests to access ecosystem services. **Discussion/Conclusion:** In forest-dependent communities, understanding the balance of different ecosystem services is particularly important for maintaining livelihoods, and may contribute to a better understanding of how forest fragmentation and agricultural change impact local use of ecosystem services.

Keywords: surveys, landscape, remote sensing, fragmentation

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Beyond the land sparing vs. land sharing framework: views from agricultural scientists

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In the last decade, the land sparing and land sharing approaches have provided the main framework for policy makers to debate and act on the impact of agriculture on nature. This framework has been useful in bringing attention to this issue; but it has been driven mainly by conservation ecologists. As agricultural scientists with practical experience in developing, testing and promoting alternative forms of agriculture in some of the most biodiversity-rich areas of Latin America, Eastern and Southern Africa and South Asia, the authors of this paper argue that the framework suffers from a number of limitations when considering farming and rural livelihoods. Four of these limitations are explored in four separate sections: (1) the lack of pragmatism and flexibility when considering agriculture, (2) the lack of consideration for what happens after the farm gate and for farmers' objectives, (3) the lack of consideration for synergies between agriculture and biodiversity, and (4) the overly mechanistic way the framework links agriculture to biodiversity. In each section, approaches to overcome these limitations are proposed, and illustrated with concrete examples from Latin America, Eastern and Southern Africa and South Asia.

Keywords: biodiversity; intensification; multifunctional landscape; services

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Can mapping forest loss, fragmentation, and change help improve long-term comparative analyses of livelihoods and equity in ecosystem services?

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Agro-forest mosaic landscapes provide a suite of ecosystem services (ES) which support people as well as native biodiversity. Long-term maps of forest change and forest fragmentation can provide valuable context for understanding the challenges faced by the many forest-dependent communities who exist within and around protected areas. Using consistent replicated studies in 6 countries, we examine livelihoods and ecosystem services for households and villages along key forest gradients: high, medium and low levels of contemporary forest cover; different rates of forest loss in recent decades; and different levels of forest fragmentation. High spatial resolution satellite imagery also helped provide detailed information on forest resources (such as homegardens), which are often absent from forest inventories. The relative amounts of forest cover and agricultural land use surrounding households and villages impacted the availability of, and access to, forest and agricultural products. Our work shows that regardless of the status of contemporary forests, historical forest cover affected survey respondents' view of how ecosystem services have changed over time. We also explored role of overall forest cover versus configuration of remaining forest patches and their impact on access to ES. Our approach will enable better comparative research on conservation strategies in regions where livelihoods and ecosystem services are also of concern. Our work helps convey the strengths, weaknesses and utility of combining remote sensing and household surveys. Such mixed-methods are useful in gauging the equitable distribution (or lack thereof) of ecosystem services and can help identify situations where forest cover is most particularly germane to local livelihoods. Such spatial information can also help guide forest restoration activities designed to improve access and equity to forest-related services. Thus, livelihood comparisons that span a range of forest cover (while holding other variables constant) can provide informative contrasts regarding the potential role of forest protection, loss, and restoration in supporting livelihoods as well as nature conservation.

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Consequences of forest loss for smallholders and their response in Southern Ethiopia

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Background: Deforestation may have a number of negative effects on rural livelihoods, however rural households do not passively sustain these situation but actively respond, as shown by several examples of farmers led reforestation. Our goal is to understand the outcomes for rural livelihoods of different deforestation trends and land use patterns and to explore the households' responses. **Methods:** Three sites decreasing in their tree cover, access to forest and increasing in their cropland proportion, but otherwise with almost identical conditions were selected in Southern Ethiopia. A mix of methods were used between September 2014 and September 2015: remote sensing, tree counting, household surveys, participatory rural appraisal and focus group discussions. **Results & Discussion:** A change from forest and grassland to cropland resulted in improved food security and income but led to a reduction of construction materials, fuelwood and livestock numbers across all sites. As a household's response to the scarcity of these products, reforestation occurred in all zones at different times: first in the intermediate zone -high tree cover, no access to forest-, then in the zone most distant to the forest -most deforested-, and finally closest to the forest -highest tree cover-. Reforestation occurred through Eucalyptus establishment and natural regeneration -based on inhabitants' decisions- Homestead establishment and proximity to the homestead were found to promote reforestation and perennial land uses: tree cover, woodlots, grasslands and false banana -Enset - plantations. Currently, livestock ownership and its equality increased with decreasing cropland specialization and decreasing distance to forest; with implications observed in wealth indicators. Livestock and trees were mentioned as assets that reduce vulnerability and support poorer households. **Conclusion:** We conclude that farmer led reforestation occurred as an active response to recover diminished ecosystem services, and that although crop specialization originally improved food security and income, it later promoted inequalities, vulnerability and reduced wealth; oppositely a higher proportion of perennial land uses within the agricultural matrix and access to forest could help to reduce these problems.

Keywords: livelihoods; inequality; farmers' managed reforestation

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Drivers of dietary transitions: Deforestation and agrarian change in complex rural landscapes

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Background: Changing demands for agricultural products driven by ongoing population growth and shifting socioeconomic demographics is leading to transitions in dietary patterns throughout the developing world. Global demand for agricultural products is expected to increase by 1% per year over the period of 2007-2050â€"equivalent to a 60% increase in production over the same period. Concurrently, a global nutrition transition is manifesting itself in the increased demand for certain agricultural commodities, in particular vegetable oils, refined carbohydrates and animal source foods. Smallholder family farms still dominate global agricultural systems, comprising 98% of all farms and covering 52% of agricultural land. Yet, these farms are increasingly becoming commercialized and transitioning away from diverse subsistence systems towards specialized market orientated operations leading to dramatic shifts in the scale and nature of agricultural landscapes. **Methods:** How these agricultural transitions affect the environment, ecosystem service provisioning, and the livelihoods, well-being and health of local populations is a key focus of this project. To answer these questions, we have applied a novel methodological approach as part of the Agrarian Change Project which aims to explore the nature of forest loss and landscape-scale agricultural transitions in tropical forested areas across seven countries. We examine how commodity-driven changes in agricultural landscapes manifest themselves as dietary transitions at the local scale which represents an often overlooked social dimension of tropical conservation. **Results:** Here we present evidence to support the notion that deforestation and agrarian intensification of landscapes can drive nutritional transitions at a local scale and that agricultural commercialization may improve food security, but its effects upon dietary diversity are yet to be fully understood. **Discussion:** Understanding the roles that forests play—beyond the maintenance of biodiversity and ecosystem services—in the diversity of rural diets may provide conservationists with yet another tool to address issues surrounding land use change, rapid rural development and the associated socio-environmental impacts.

Keywords: Agriculture, Forests, Food, Livlihoods, Sustainability

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Symposium
Tropical Pollination Services in the Anthropocene

Loss of rare orchid bees in the Amazon: effects of plateau size and bauxite mining

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Background: The knowledge of spatial pattern of beta-diversity is of great importance for practical biodiversity conservation and interpreting ecological information. Tropical forests, especially the Amazon Rainforest, are well known for their high species richness and low similarity in species composition among sites. We aimed to determine the effect and relative importance of geographic distance and climatic factors on species richness and turnover in orchid bee assemblages in plateaus of the Brazilian Amazonia. We hypothesized that smaller plateaus would present lower phylogenetic diversity of orchid bees compared to larger plateaus. **Methods:** Orchid bees were collected from nine plateaus scattered throughout the FLONA Saracá-Taquera, Brazil. Data of the spatial location of bees, elevation, temperature, precipitation, and evapotranspiration potential were correlated with orchid bee community geography. The distance-decay in similarity relationship was analyzed using simple linear regressions. Phylogenetic diversity, was performed using Faith's phylogenetic diversity (PDFaith) and mean pairwise phylogenetic distance weighted by species abundance (MPD). Result- Bee richness varied from 15 to 24 species per plateau, while abundance varied from 108 to 424 individuals. The two dimensional NMDS (stress 0.14, proportion of variance 0.70) indicated the existence of a geographical/environmental gradient in orchid bee species composition among the plateaus. The level of pairwise similarity among communities ranged from 20.0 to 61.1% (Bray-Curtis index, mean = 40.7%) when considering the total abundance of the 30 most frequent bee species. Similarity in species composition among the plateaus decayed both as function of climatic (R= -0.34, p=0.03) and geographic distances (R= -0.53, p<0.001). The greatest dissimilarities in bee assemblage composition were observed among pairs of sites located 20-30 km from each other. There was a positive and statistically significant relationship between the number of trees and orchid bee species richness (R^2=0.48, p=0.036). Most of the relationships among species were highly supported by bee phylogeny. **Discussion/Conclusion:** Our results are in accordance with many other studies conducted in the Amazon Basin that show that environmental gradients strongly affect the turnover of animal and plant species in tropical forests. Rarer bee species should become threatened in the near future as bauxite mining expand in the region.

Keywords: Bees, Community, Amazonia, Biogeography, Diversity

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Symposium: Tropical Pollination Services in the Anthropocene

The diversity of flower color and the pollination modes of rupestrian grasslands plants

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Background: Flower color is a major trait for communication between plants and their pollinators. The diversity of flower color may be the result of the selective pressure exerted by pollinators, which present a wide range of visual systems, differing in the way they perceive and select colors. Flower color diversity is also related to species composition, a determinant factor in naturally heterogeneous environments, as the tropical rupestrian grasslands (campo rupestre). Rupestrian grasslands encompass a mosaic of tropical vegetation physiognomies, with high species diversity and endemism, a unique natural environment to investigate flower color diversity. In this context, we aimed to: describe the diversity of flower color patterns of the studied rupestrian grassland; and verify whether flower colors are related to their potential pollination vectors. **Methods:** In the vegetation mosaic of the Espinhaço mountain range ("Cadeia do Espinhaço"), a rupestrian grassland at Serra do Cipó (Minas Gerais State, Brazil), we measured flowers' reflectance spectrum of 300 species. For that, we used a spectrometer which includes ultraviolet light (UV), covering all pollinators visual range. All plant species were identified and had their pollination mode classified based on directly observation, bibliography information or flower morphology. Flower colors were analyzed using the models described for the visual system of each pollinators' groups. **Results:** We preliminary analyzed flower color of some species potentially pollinated by bees and by hummingbirds. The white melithophilous and red ornithophilous flowers were UV absorbers, as expected from other studies. While bee flowers reflected mainly between 300-500nm, bands of better bee's chromatic sensitivity, hummingbird flowers reflected mainly between 500-700nm, wavelengths for which bees have no chromatic sensitivity. The high reflection on longer wavelength may decrease the attractiveness of ornithophilous flowers to bees, which may be a niche separation of floral visitors based on the conspicuity of the flower colors for each pollinator group. **Conclusion:** Our results corroborate the influence of pollinators' vision system on the evolution of flower coloration, reinforcing the idea of coevolution between plants and their pollinators. As observed for those few species, we expect to find influence of the pollinators' visual systems in the general pattern of flower color diversity of the studied rupestrian grasslands.

Keywords: pollination, flower-color, plant-animal-communication, rupestrian-grassland, visual-systems

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Symposium: Tropical Pollination Services in the Anthropocene

Anthropic effects on pollinators in the southernmost limits of subtropical dry forests

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Human activities are dominant drivers of current biodiversity changes throughout the world. Land use practices such as deforestation, grazing, and agriculture affect ecosystem structure and functioning and regional climate. The southernmost limits of subtropical dry forests have experienced the highest rates of deforestation worldwide over the past decades, and such landscape changes can alter plant-pollinator interactions in different ways. Animal pollinators are responsible for the sexual reproduction of 80% of angiosperms and also play a key role in fruit/seed production of domesticated species and in the reproduction of many useful wild species. Due to the essential ecosystem services provided by animal pollinators it is particularly important to learn about their dynamics in such changing environments. Here we assess pollinator richness and abundance in different anthropic scenarios: i) a gradient of habitat fragmentation landscapes, ii) unburned, high and low fire frequency sites, and iii) a gradient of agricultural intensification. Habitat fragmentation strongly reduced richness and abundance of Lepidoptera and Diptera and small solitary bees. More mobile pollinators such as hummingbirds, *Bombus* spp. however, showed no changes. *Apis mellifera*, showed an increased in relative abundance in smaller habitat fragments. Fire frequency also elicited species-specific responses of pollinators. *Bombus* spp. were equally abundant across sites whereas other pollinators such as *Megachile* sp., *Notanthidium* sp., *Trimeria* sp. were either reduced in abundance or absent. Bee richness and abundance decrease in highly managed orchards as compared to organic management. We discuss the implications of these findings for the reproduction of native plants species in ubiquitous human-altered landscapes.

Keywords: Pollinator, habitat loss, fire, agriculture

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Reproductive plant phenology and pollination networks in a Costa Rican montane tropical forests

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Background: Reproduction in vascular plants is expected to synchronize with biotic and abiotic conditions that allow successful pollination and seed maturation. Pollinator mediated selection is believed to be a predominant selective factor shaping flowering patterns in plants. Climatic conditions may also influence phenology as they may regulate resource availability or the seasonal abundance of pollinators. The reproductive schedule of plants may also be limited by phylogenetic constraints, where flowering time is similar among related individuals. Given the forthcoming changes in climate, the relative importance of factors shaping reproductive schedules in mountainous habitats will provide information on how plant species adjust to climatic changes, and how such adjustments affect animal-plant interactions. **Methods:** Starting on 2013 we recorded flowering phenology on 70 herbaceous species and woody shrubs in an upper montane forests of Costa Rica. The number of flowering individuals per species was recorded monthly along a 1 km transect. We also collected and identified all insects visiting flowers and recorded bird visitors. We used circular statistics to describe flowering patterns and generalized linear models to relate flowering phenology to climatic conditions. Phylogenetic relationships were determined using Phylomatic and a multivariate phylogenetic eigenvector regressions analysis (PVR) was used to assess the influence of phylogeny and climatic factors on flowering phenology. Pollinator networks were created and interaction evenness and pollinator generalism were estimated for each species. **Results:** Most species (68/70) showed distinct seasonality with only 10 species flowering in the rainy season, while the flowering peak of most species (66/70) occurred during the dry season (Nov-Mar). Only two species flowered continuously. Changes in precipitation and temperature did not affect the onset of flowering, nor changes in peak flowering dates. Phylogeny influenced the flowering phenology of species in the upper montane forests of Costa Rica. Pollinator networks showed low specificity among taxa. **Conclusion:** Our results suggest that flowering phenology of the upper montane forests in Costa Rica occurs more commonly in the dry season and that phylogenetic restrictions predominately affect flowering patterns in these species. Predicted climatic changes for the Costa Rican highlands could affect the phenology and reproduction of this plant community.

Keywords: Phenology; Montane-forests; pollinator-networks; climate change; Costa Rica

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The importance of vertebrates in pollination ecosystem services

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Background: Vertebrates have been considered as pollinators of many wild plants and few crops. In all continents mainly bats and birds can be considered as important pollinators of many plant species. In America bats and birds can be considered the most important vertebrate pollinators of wild and crop plants. Aims: In this work the importance of those two vertebrate groups was evaluated by studying plant-animal networks in both wild and crop plants to estimate the importance and dependence of these pollinators. **Methods:** Data on plant-vertebrate pollinator networks were collected both from field studies done by the authors and from literatura and analised to determine importance as pollinators, dependency and risk of extintion from conservation concerns for both plants and pollinators. **Results:** Plants dependant on vertebrates as pollinators may be more prone to extintion risks due to loss of pollinator connections. Important plants were determined both for bats and birds. Using network analysis dependency and risk of extintion was determined and importance for conservation assessed.

Keywords: hummingbirds, bats, conservation, pollination

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Tuesday Merida
Symposium: Tropical Pollination Services in the Anthropocene

Pollinator crisis affects pollination services and food security in Latin American countries

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Background: Animal pollination is one of the essential services provided by ecosystems to humans. In the face of a potential worldwide pollination crisis, it is important to assess which countries may be more vulnerable in order to prioritize pollinator conservation efforts. Human population density and poverty levels; and the degree of pollinator dependence for food provisioning are key aspects to identify vulnerable countries. We reviewed the literature and evaluated these aspects to determine the level of human food provisioning dependence on pollinators in several Latin American countries. **Methods:** We evaluated the extent to which food production depends on animal pollinators in several Latin American countries by comparing cultivated area, produced volume and yield value of major food crops that are pollinator dependent with those that are pollinator non-dependent. In addition, we valued the ecosystem service of pollination based on the degree of pollinator dependence of each crop. **Results:** In Brazil, a total of 68% of the 53 major food crops depended to some degree on animals for pollination. In México, nearly 85% of 170 of fruit and/or seed consumed species depend on pollinators for productivity. In Argentina, from a total of 68 crops, animal pollination increased production directly in 37 and indirectly in 13 cultivated species. In Central America, pollinator dependent crops are also very efficient in terms of productivity per unit area but current market economies have driven these countries to increase pollinator independent crops that are less efficient and less sustainable. For example, an increase in non-pollinator dependent cultivated areas such as sugar cane, rice, bananas and pineapple and a decrease in coffee in Central America. **Conclusion:** In many Latin American countries, pollinator-dependent crops generated larger income but cover a lower cultivated area and produce less volume compared to non-pollinator-dependent crops. Native wild pollinators also play a key role in fruit or seed production of domesticated plant species and in the reproduction of many useful wild species. Pollination services are particularly important in rural areas of Latin America, as the livelihood of a large proportion of the population exclusively and directly depends on ecosystem services for subsistence.

Keywords: Pollination, reproduction, food security

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Tuesday Merida
Symposium: Tropical Pollination Services in the Anthropocene

Symposium
Primate conservation in human-disturbed habitats

Demography and population viability of spider monkeys *Ateles geoffroyi*

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Effective conservation of endangered populations depends on accurate estimations of their viability and the factors that determine their vulnerability. Population viability, in turn, depends on demographic parameters that are often hard to estimate for long-lived species. Here we take advantage of a 20-year long dataset to analyze life histories of Geoffroy's spider monkeys (*Ateles geoffroyi*). All *Ateles* spp. are endangered throughout the Neotropics, while playing important roles as seed dispersers and flagship species for conservation. We collected data on individually identified monkeys in a group inhabiting the area around the Punta Laguna lake, in the *Otoch Ma'ax yetel Kooh* protected area (5327 ha). Group size varied from 19 individuals in 1997 to 43 individuals in 2016. Data were collected by scan sampling of subgroups for 4-6 daily hours, 4-6 days per week. We built a matrix model of the demography of the group representing it as a birth-flow, stage-structured population. During the 20 years, 17 females immigrated into the group and 19 females emigrated from it. We recorded 63 births (28 females, 28 males and 7 of unknown sex), occurring in all months of the year, although concentrated around December and January. We recorded 31 disappearances (not including those of 4-9 years old females, who we assumed emigrated from the natal group). Of these, we confirmed 4 deaths, all males between 5 and 7 years old, at least 3 of which died due to attacks from their own group's males. The population growth rate was 1.089, suggesting that the population is increasing. Females have a 0.79 survivorship into the 17-21-year stage, while males have a 0.49 survivorship at that stage. Three reproductive females are at least 32 years old. An elasticity analysis revealed that female survivorship during the first 5 years and female fertility during the 17-21-year stage contribute the most to the population growth rate. While suggesting that the spider monkey population in the area is healthy, our results need to be interpreted within a larger spatial and temporal context. For this, we use survey data and an analysis of land use and cover change for the past 16 years to estimate the population density in the protected area as a whole. These estimations provide realistic starting points to project population size into the future using the matrix model described above.

Keywords: demography; matrix models; population viability

ID:1002
Tuesday Celestún
Symposium: Primate conservation in human-disturbed habitats

Evaluating extinction debt in the critically endangered Mexican howler monkey

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Background: Fragmented forests are highly dynamic, as fragments often exhibit spatial changes through time. However, the lack of longitudinal studies has limited our understanding of the impact that temporal fragment dynamics have on biodiversity. Such longitudinal studies are particularly important in taxa with slow life histories, as they may exhibit a time lag between habitat disturbance and population collapse (i.e., extinction debt), or similar delays between habitat restoration and population recovery. Recognising such situations is critical for predicting future populations and, therefore, for conservation and management. **Methods:** We examined demographic and biogeographic data for a population of critically endangered Mexican howler monkeys (*Alouatta palliata* mexicana), residing in 39 forest fragments in Los Tuxtlas, Mexico, at two discreet time points (2001 and 2013). We carried out population censuses to gather demographic data (fragment occupation, number of individuals per fragment, fragment density, mean group size and immature/female ratio) and used GIS data to characterise habitat (patch size, isolation and shape). Using a multi-model averaging approach, we related demographic attributes in 2013 to fragment metrics in 2001 and 2013 and assessed whether populations were better predicted by current or historical fragment characteristics. We also assessed whether and how changes in fragment metrics between 2001 and 2013 promoted changes in demographic attributes between years. **Results:** Over the study period, we observed an increase in patch size and a decrease in patch isolation. In response, the overall population size grew from 332 to 560 individuals, with an average increase of 6 individuals per fragment. Fragment occupancy and population size in 2013 were more strongly and positively related to fragment size in 2001 than in 2013. However, change in fragment size through time was the best predictor of change in population size. **Discussion:** Our findings suggest that there is an extinction debt in the howler monkey population in Los Tuxtlas, as demographic data is more closely predicted by past biogeography. However, surprisingly, forest recovery in a relatively short period (13 years) promoted the rapid recovery of primate populations. Therefore, howler monkeys seem to be relatively resilient to habitat disturbance, and their conservation will principally depend on preventing forest loss and reversing forest fragmentation.

Keywords: extinction debt; fragmentation; primate; conservation

ID:1006
Tuesday Celestún
Symposium: Primate conservation in human-disturbed habitats

Determinants of lar and pileated gibbon abundance in a unique contact zone

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Natural contact zones between species are vital testing grounds for ideas about speciation, species coexistence and behavioral evolution. Many gibbon contact zones in Southeast Asia have already been destroyed by deforestation and it is thus urgent that the few remaining ones are well protected for study. Lar and pileated gibbons (*Hylobates lar* and *H. pileatus*), are only found in contact in central Thailand, where hybrids are found amid a mixture of parental phenotypes. We aimed to investigate the environmental factors determining the relative density of the two species, their habitat affinities, and the extent of the area containing hybrids and backcrosses found in mixed-species groups. We employed an auditory survey by means of a grid of listening posts that covered approximately 300 square kilometers. We used N-mixture models based on multiple visits to estimate the effect of several environmental parameters on gibbon abundance. Most mixed-species groups were found in a radius of 3 kilometers constricted in the middle of the two gibbon distributions. Pileated gibbons were not as abundant as lar gibbons, perhaps due to poaching, as park headquarters lies in the lar side of the zone where poaching pressure is less. Indeed, all forms of gibbons declined with increasing distance from park headquarters. We recommend that patrolling be increased in more remote areas, especially in areas where pileated gibbons are more prevalent.

Keywords: hybrid zones,species coexistence, N-mixture models, primate abundance

ID:1003
Tuesday Celestún
Symposium: Primate conservation in human-disturbed habitats

The conservation value of matrix composition for primates in fragmented habitat

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Background: With the extent of tropical forest degradation, primates increasingly inhabit forest patches embedded in anthropogenic matrices. Such matrices are composed of different elements (e.g., agricultural lands, cattle pastures, secondary forests, live fences), but large uncertainty remains about the ability of primates to use different matrix elements. Here, we assessed the use of matrix elements by primates worldwide. **Methods:** We reviewed 300 evidences on matrix use by primates, and recorded the type of element used and their main activity (feeding, resting and/or traveling). We also gathered information on some functional traits (diet, locomotion, home range, diel activity, body mass, and habitat type) and the conservation status (based on the IUCN red list) of species. **Results:** We found 147 primate species using the anthropogenic matrix in 44 countries distributed in the Neotropics, mainland Africa, Madagascar, and Asia. Secondary vegetation and vegetation corridors were more frequently used than arboreal crops and annual crops, and although scarce, we also found records of primates using cattle pastures and human settlements. Feeding, traveling and resting records were observed in all matrix elements, but vegetation corridors were mainly used for traveling, and the rest of matrix elements were mainly used for feeding. Most primate species were forest specialists, diurnal, arboreal, with medium (10-100 ha) to large (> 100 ha) home range requirements, and with a frugivorous (34% of species), omnivorous (20%) or folivorous-frugivorous (17%) diet. Also, most primate species (60%) are not threatened with extinction. **Conclusion:** Our findings highlight the behavioral plasticity of primates, and suggest that the certain elements of the anthropogenic matrix may play a key role in primates' ecology and conservation, providing important food resources and opportunities for traveling (i.e. spatial connectivity) in fragmented landscapes, but also increasing exposure of primates to threats (e.g. diseases, hunting, predation). Thus, a combination of land management strategies (e.g. matrix enrichment with food tree species, creation of structural connectors such as linear patches, live fences and scattered trees), and environmental education is needed to increase the conservation value of the matrix for primates and favor primates' persistence in human-modified landscapes.

Keywords: Land-use change; Land sharing; Monkeys

ID:1001
Tuesday Celestún
Symposium: Primate conservation in human-disturbed habitats

The impact of anthropogenic disturbance on the viability of black howler monkeys

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Background: Population viability analysis (PVA) allows assessing extinction risk, which is of paramount importance for conservation and natural resource management practices. In addition to the modeling of the influence of deterministic demographic processes on the extinction risk of populations, PVA allows simulating the consequences of stochastic factors. The aim of the present study was to model the effects of anthropogenic disturbance events (ADE) on demographic parameters of extinction risk for 11 subpopulations of the Endangered black howler monkey (*Alouatta pigra*), in Campeche, Mexico. **Methods:** Models were built using information collected during a seven-year demographic monitoring of the subpopulations, as well as on published life history data. We used the software VORTEX to study four extinction parameters: subpopulation growth rate; final subpopulation size; probability of extinction; years to extinction. For each subpopulation we ran three models: a baseline model; one model with 5% increase in the frequency of ADE; one model with 10% increase in ADE. We ran a fourth model excluding ADE for subpopulations that were known to be exposed to ADE in baseline models. For each of these models, we also ran a sensitivity analysis in which vital rates were sequentially varied by ±10%. **Results:** As ADE increased, subpopulation growth rate, final subpopulation size, and years to extinction decreased, whereas probabilities of extinction increased. When ADE was removed, subpopulation growth decreased more slowly, subpopulations included more individuals, and extinction became less probable and was delayed. Small subpopulations that were not affected by ADE faced high extinction risk. Extinction parameters were particularly sensitive to adult female survival and fertility. **Conclusion:** ADE is predicted to be a major stochastic factor influencing the extinction risk of black howler monkeys in Campeche, although subpopulation size, female survival, and fertility are also determinant for long-term viability.

Keywords: anthropogenic disturbance, extinction, population management, primates, PVA

ID:1005
Tuesday Celestún
Symposium: Primate conservation in human-disturbed habitats

Determining the effects of habitat disturbance on Geoffroy's spider monkeys in the Yucatan Peninsula

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Background: Habitat disturbance is widely recognized to cause population declines of mammal species and changes in ecosystem functioning. Human population increase, a booming tourism industry, and climate change are modifying the landscape of the Yucatan Peninsula. The aim of our study was to determine the effect that different types of habitat disturbance have had on Geoffroy's spider monkey (*Ateles geoffroyi*) populations at the landscape scale. In particular, we tested the hypothesis that spider monkeys are vulnerable to habitat disturbance. We predicted the number of monkeys to be lower in degraded forests. **Methods:** We performed 16 line transect surveys in 4 sites in the Yucatan Peninsula where we recorded the number of individual monkeys encountered and sampled all trees with DBH>5cm (n=17075) along 500m segments (*n*=72). After removing correlated variables, habitat disturbance variables consisted of the distance to roads, distance to villages, forest loss and presence of forest fires. We calculated the density of all sampled trees, density of large trees (DBH>35cm), basal area of food trees, and canopy height. We ran generalized linear mixed models to determine the effect of these predictor variables on the number of spider monkeys sighted on 216 km of line transect walks. We calculated the importance value index (IVI) to compare tree species composition across sites. **Results:** Forest loss ($p<0.05$) and presence of forest fires ($p<0.001$) negatively affected the number of monkeys, whereas density of large trees ($p<0.001$), basal area of food trees ($p<0.05$) and canopy height ($p<0.01$) positively affected the number of monkeys. According to IVI, the 10 most important tree species varied across sites but all sites had a combination of secondary forest species, mature forest species and species important in the monkeys' diet. **Conclusion:** Our results showed that when available, spider monkeys prefer tall canopy, high density of large trees and high basal area of food trees, common characteristics of mature forests. The number of spider monkeys is more affected by forest degradation (e.g., forest loss and presence of forest fires) than human presence (e.g., distance to villages and distance to roads). Overall our results shed light on the factors affecting spider monkey populations in the Yucatan Peninsula.

Keywords: vegetation sampling, importance value index

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Symposium
Biogeography, ecology and sustainability in Caatinga: the largest dry forest in South America

The ecology and biogeography of Neotropical Seasonally Dry Tropical Forests

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Background: Woody plant species distribution suggest that Seasonally Dry Tropical Forests (SDTF) are evolutionarily and ecologically more complex, diverse and singular than previously perceived. However, a more comprehensive view about SDTF is still to emerge. **Methods:** Here we review and present syntheses about key ecological aspects and the evolutionary history of SDTF. **Results:** SDTF consist of a true biome due to the predominance of deciduous woody plant species, which confer a shared physiognomy. Briefly, SDTF can consist of 21 floristic nuclei from Mexico to Argentina, most of them as spatially well-delimited/disjunct units. These nuclei can also be grouped into 2-12 major regions based on species similarities, with a clear north-south major separation. Ecologically, SDTF cover from 250 to 1800 mm annually, supporting a collection of vegetation types from deciduous tall forests to scrub vegetation. Despite of the predominance of deciduous plants, SDTF apparently differ in many ecological aspects, including plant life-form profile, plant reproductive biology, species assembly and ecosystem functioning, particularly nutrient stocks. SDTF nuclei also differ in terms of land use and the predominant socio-ecological systems, resulting in distinct threats and biodiversity responses. Rather than suitable and prosperous agricultural lands, some nuclei or regions cover naturally unfertile soils, from which human populations hardly achieve acceptable levels of livelihood and persist as fragile societies. Biogeographically, SDTF present few plant species in common, elevated rates of endemism due to local speciation and narrow-distributed species, increased species turnover among nuclei, and plant species bearing adaptations to open/arid environments. This scenario is expected to emerge from prolonged and aging isolation, with some taxa from the Miocene. Rather than a wide-raging biota emerging in the Pleistocene, SDTF have an old and "polyphyletic" origin with local speciation and events of long-distance dispersal supported by evolutionary distinct pools of source taxa. **Conclusion:** Rather than subsamples of a broad meta-community, SDTF consist of almost evolutionarily independent units. They also support unanticipated biological singularities, with distinct socio-ecological systems, threats and biota responses to local/global human disturbances. Such a complex scenario, while reinforces SDTF as a global heritage, poses immense challenges to SDTF persistence.

Keywords: biogeography, SDTF, plants, evolutionary history

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Origin and evolution of Caatinga flora

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Background: The Caatinga Domain (CD) in northeastern Brazil covers an area of c. 849,000 km2 and harbors the largest and most continuous expanse of the Seasonally Dry Topical Forests and Woodlands biome (SDTFW) in the New World. Phytogeographical data collected over the past ten years support previous hypotheses that recognized two major biotas in Caatinga SDTFW: the Crystalline Caatinga, mostly associated with medium to highly fertile soils in the wide Sertaneja Depression; and the Sedimentary Caatinga, mostly associated with poor sandy soils derived from patchy sedimentary surfaces. A third floristic set could be represented by tall Caatinga forests. **Methods:** We revised floristic literature and herbaria databases to provide a comprehensive checklist of the CD flora. We performed phylogenetic meta-analyses of selected SDTFW lineages to estimate times of divergence, ancestral areas, and biogeographical processes resulting in the current angiosperm diversity of CD. **Results:** We recorded 3150 species in 930 genera and 152 families of flowering plants from the CD. About 23% of the species and 31 genera are endemic to the CD. The phylogenetic analyses indicated that plant diversity in the Caatinga arose mostly by in situ speciation following Mid to Late Miocene vicariance events with two major SDTFW nuclei: (1) the northwestern Caribbean dry coast of Colombia and Venezuela, and (2) the southwestern South America dry forests of southern Bolivia and northwestern Argentina. **Discussion/conclusions:** The CD is the richest SDTFW area in the New World and harbors an expressive amount of endemic taxa. Ancient (Mid to Late Miocene) vicariance followed by in situ should resulted in the current floristic patterns in CD. Phylogenetic analyses also uncovered unexpected patterns of recent radiations, with geologically new species and incomplete lineage sorting that sharply contrast with the most common phylogenetic patterns found in SDTFW clades. Recent, mostly Pleistocene, ecological speciation better explains the emergence of distinct biotas on sandy and karstic surfaces.

Keywords: SDTFW, Diversity, Endemism, Evolution

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Ants from Caatinga: diversity, biogeography and responses to climate change and human disturbance

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Despite the abundance and ecological relevance of ants in most terrestrial ecosystems, our knowledge of the ant fauna from Caatinga is very poor. Furthermore, ants (like all the biota) in the Caatinga are largely endangered due to the historical unsustainable exploitation of natural resources and climate change (mainly, increased aridity levels). In this work, we present an overview of the diversity, taxonomy, biogeography and functional composition of the Caatinga ant fauna, along with a synthesis of its response to increased chronic anthropogenic disturbance and aridity. We compiled a database consisting of 572 presence-absence ant records and 276 ant species/morphospecies from 37 localities. We found that the great majority of Caatinga has not been intensively sampled for ants, and the intensive sampling that has been conducted reveals high rates of species turnover between localities. Species accumulation analysis suggests that many Caatinga ant species remain to be discovered. The great majority of ant species recorded in Caatinga are widely distributed in other biomes, especially in Cerrado, and only a few known species are endemic to Caatinga. This very low level of endemism, combined with highly depauperate species richness in a Neotropical context, is in stark contrast to the Caatinga flora and other faunal groups. We have also validated the use in the Caatinga of a global model of ant functional groups that classifies ants according to biogeographical scale responses to environmental stress and disturbance. We revealed significant changes in ant taxonomic and functional composition with disturbance, with predictable winner-loser replacement, a pattern that widely occur throughout the world. Disturbance winners were highly generalised species with wide environmental tolerances and species favouring open habitats (e.g. Opportunists and Dominant Dolichoderinae). In contrast, highly specialised species were disturbance losers (e.g. Specialist predators). Aridity also affected both species and functional group composition. Since species and functional group composition of the ant fauna is sensitive to increasing disturbance and aridity, this has important implications for the many ecosystem services provided by ants. We claim that the preservation of Caatinga areas with high biodiversity value is priority for maintaining Caatinga biodiversity into the future. We finally conclude with some future directions of ant research in Caatinga.

Keywords: ants, biogeography, Caatinga, disturbance, diversity

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Current knowledge on the Caatinga fish fauna (species richness, endemism and conservation status)

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Background: The Caatinga biome, located in the semi-arid region of northeastern Brazil, is dominated by a seasonally dry tropical forest and encompasses a relatively modest hydrographic network, characterized by intermittent water courses. Even the major rivers which are perennial, such as the São Francisco and Parnaíba, possess mostly intermittent tributaries within the Caatinga. In spite of some early explorations dating back to XVIth century and the systematic compilation of fish species which started in the beginning of the XIXth century, until recently the fish fauna of the Caatinga biome has been considered poorly known due to the lack of adequate sampling. To ensure the preservation of aquatic biota of the Brazilian semiarid region, which faces many impacts due to water scarcity, diversity and distribution data are required. **Methods:** The present study assessed the current state of knowledge on the Caatinga fish fauna, in terms of species richness, endemism and conservation status, based on a literature review, recent field work and collection records. **Results:** As major results, we found a considerable increment of the species richness in the biome when compared to previous estimates, totaling 377 primary and secondary freshwater fish species, 209 of which are considered endemic to the hydrographic ecoregions on which the Caatinga occurs, 15 are introduced from other basins and 19 listed species have doubtful taxonomic status. Additionally, 35 species are currently recognized as undescribed. We also highlight that the 33 endangered fish species in the Caatinga possibly are not included in protected areas, and that the conservation units in the biome are not enough to ensure protection to endemic and endangered fish species. Among the challenges to the conservation of the Caatinga fishes is the São Francisco Interbasin Water Transfer, which will input water to the four main temporary rivers of the Mid-Northeastern Caatinga Ecoregion. Ecological niche modelling indicated that 11 among 49 species exclusive of the São Francisco basin have higher potential risk to invade the receptor basins. **Conclusion:** For the conservation of the Caatinga fishes, there is an urgent need for preservation of the integrity of the temporary aquatic environments, that besides representing important areas for shelter, feeding and rest for several fish species, also harbors the diverse Cynolebiidae annual fishes, mainly in the São Francisco Ecoregion.

Keywords: Anthropogenic impacts, temporary rivers, bioinvasions

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Ecology and Biogeography of terrestrial vertebrates from the Brazilian Caatinga

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Background: The Caatinga biome is the largest fragment of Seasonally Dry Tropical Forest in South America, restricted to Brazil. For many years, the region was considered species-poor and lacking character. Its fauna was thought to be mostly composed of widespread species shared with two other biomes, Chaco and Cerrado, which form a diagonal of open formations crossing South America from northern Argentina to northeastern Brazil. **Methods:** We used field surveys conducted and literature records to evaluate richness and endemicity of Caatinga terrestrial vertebrates. For amphibians and lizards, we also modeled species distributions and generated surface maps of potential distributions. We also review the literature on the ecology, biogeography, and conservation of terrestrial vertebrates in the Caatinga Biome. **Results:** In total, we identified 1002 species of terrestrial vertebrates (119 endemics) occurring in the Caatinga Biome (endemics in parenthesis): 98 amphibians (20), 79 lizards (38), 112 snakes (22), 10 amphisbenids (5), 7 turtles, 3 alligators, 183 mammals (11), and 510 birds (23). For amphibians, the eastern portion along the Atlantic Forest border and mesic enclaves in higher-altitude areas in the core of the biome are richer. For lizards, marginal areas east and west present high species richness, while most of the core of the biome has lower values of potential richness. **Discussion:** Despite the harsh semi-arid climate and the obvious constraints imposed on vertebrates in the region, few papers have been published on the ecology of Caatinga vertebrates. From natural history and population ecology to large-scale macroecology studies, the literature on terrestrial vertebrates from the Caatinga is only in its infancy. It is the less studied biome in Brazil, making it likely one of the less studied faunas in the world. The number of species tallied herein is 161 species higher than previous estimates. This increase is due to new records, new species, and to the inclusion, in the present study, of species from mesic enclaves occurring across the biome. Some groups, especially amphibians, still present high rates of species descriptions, which are now being fuelled by recent molecular appraisals and phylogeography work. As for other taxa, Caatinga terrestrial vertebrates are at risk because of the small network of protected areas, aggravated by the incomplete sampling of the biome and the lack of ecological information for the majority of the species.

Keywords: Caatinga, vertebrates, richness, ecology, Biogeography

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Plant-animal interactions in the Caatinga: patterns, response to human disturbances and perspectives

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Background: Interactions between plants and animals are extremely diverse and consist of both evolutionary and ecological forces for angiosperms, insects and many groups of vertebrates. However, human encroachment imposes a myriad of threats for biodiversity, including habitat loss and fragmentation, collection of forest products and habitat degradation by livestock production. **Methods:** Here we present an overview of plant-animal interactions in the Caatinga vegetation, the largest dry forest in South America, its response to human disturbances and future scientific agenda. **Results:** Although the Caatinga biota is exposed to a semiarid climate (240-900 mm annual rainfall), plant pollination is very specialized, involving 15 different systems and a high percentage of pollination by vertebrates. Abiotic seed dispersal prevails, but Caatinga is a global hotspot for myrmecochory, with more than 100 woody species depending on ants for seed dispersal; saurochory is also a distinctive dispersal mode in Caatinga. Extrafloral nectary-bearing plants are also very conspicuous in Caatinga, achieving 15% of woody species and 40% of individuals at local spatial scale. These plants are protected against herbivores by a diverse ant community. Leaf-cutting ants (LCA) and exotics goats represent the most voracious herbivores (LCA herbivory rate is 20% of leaf in their foraging areas). Human disturbance has been demonstrated to reduce all mutualistic interactions, while promote a proliferation of herbivores as LCA and goats. For instance, old-growth forest stands support a higher diversity of pollination systems as compared to regenerating stands following pasture and agriculture, which support a higher frequency of species pollinated by bees and an absence of species pollinated by beetles, birds and vertebrates. Moreover, ant species providing high-quality dispersal services are highly sensitive to increasing disturbance and its seed removal rates and distance decrease with increasing disturbance. On the other hand, it was observed a 7-fold increase of LCA colony density within the first 50 m along roads as compared to distances up to 300 m, along with an increasing in herbivory rate due to herbs proliferation. **Discussion/conclusion:** Disruption of plant-animal interactions in human-modified landscapes have negative effects on ecosystem services as pollination, seed dispersal, pest control, nutrient cycling and the persistence of the endemic flora of Caatinga vegetation.

Keywords: Biodiversity; winner-loser replacement; ecosystem services.

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Sociecology of natural resource use in the Caatinga: lessons for biodiversity conservation

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Background: The interaction of people with the natural environment is ancient. Humans have great power to transform the natural environment and to interfere with the food chain and the processes that enable the renewal of populations of other species. The needs and demands for subsistence and economic growth convert natural systems to social-ecological systems. Understanding the functioning of these anthropogenic systems is extremely important for the conservation of biological diversity as well as environmental management and sustainability. **Methods:** This chapter aims to highlight the findings published on the interactions of human populations with animal and plant resources in the Caatinga. **Results:** In this type of ecosystem, seasonal and interannual variations in the rainfall pattern and the unpredictability of the total annual rainfall as well as the length of each season and the occurrence of interrupting events in the duration of each season in time and space have great influences on ecosystem functioning and the life dynamics of human populations. The diversity and intensity of the use of plant and animal resources reflects the knowledge and characteristics of the social structure of local communities that interact with the environment. **Discussion/Conclusion:** The collection of forest products and the hunting of wild animals of the Caatinga generate transformations in habitat conditions and often diversify the types of forest microhabitats. This ultimately affects not only the life cycle of resource use but also the dynamics of other species and over the medium and long term, the sustainability of human practices and the dynamics of the entire social-ecological system. Thus, we will discuss the role of people in ecological processes and identify gaps that need to be filled for a change in perception and the integration of humans in ecological studies.

Keywords: human ecology, ethnobiology, ethnozoology, ethnobotany

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Cultural ecosystem services in the Caatinga: a big data approach

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Background: Cultural Ecosystem Services (CES) include all of the non-material benefits that ecosystems provide for local people and visitors. These benefits arise through the interaction of cultures and natural features (e.g. landscape conformation, iconic species, etc.). The Caatinga region of northeast Brazil is densely populated, has a rich history of human habitation and unique biophysical characteristics: these attributes have generated a wide range of CES for both the local inhabitants and national / international visitors. **Methods:** We provide a concise summary of the history of human interactions with the Caatinga and review current knowledge of CES, focusing on the role of the ecosystem as a source of: i) aesthetic value; ii) recreation; iii) religious and spiritual value; iv) cultural heritage and identity, and; iv) research and education. Our data is drawn from a variety of sources, including a novel content analysis of geo-referenced photographs from 105 State parks and 104 Federal parks within the Caatinga. **Results:** All forms of cultural ecosystem services are present in the Caatinga, but to date there have been no systematic efforts to quantify and map them. In our analysis, almost 70% of geo-referenced photographs could be classified as representing aesthetic appreciation of the landscape (frequently deep cut canyons and gorges, waterfalls, tracts of Caatinga forest and brejos). There were also a high number of photos representing social activities and sporting recreation. **Discussion/Conclusion:** Despite its clear importance for ensuring the social resilience of protected areas and natural landscapes, CES is still at a very early stage of development and academic studies are almost completely absent in the Caatinga. Our big data approach allows for large scale quantification of CES, but inevitably suffers from certain inherent biases of user-contributed content.

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The main threats to the Caatinga dry forest and their implications for conserving biodiversity

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Similar to other seasonally tropical dry forests around the world, the Brazilian Caatinga is exposed to human disturbances associated with rural populations devoted to subsistence farming (i.e. forest-dependent people) and agribusiness. Here we present an overview covering the main threats imposed to the Caatinga biota and their impacts on biodiversity persistence and provision of ecological services. Adaptive and mitigatory procedures are also provided. Irrigated fruit production, cattle raising, slash-and-burn agriculture and wood collection for energy supply respond for most of habitat loss (i.e. 35% of original cover) and converted natural landscapes into mosaics consisting mostly of vegetation regenerating patches. Remaining vegetation (i.e. regenerating and old-growth forests) are continuously exposed to chronic disturbances, including collection of firewood, timber and medicinal/ornamental plants. Native vegetation also represents the main forage source for livestock (particularly cattle and goat). Farming has also resulted into the introduction of exotic invasive plant species for multiple uses such as the *Prosopis juliflora*. This tree species has successfully invaded degraded river banks and by forming monospecific stands has precluded the regeneration of native Caatinga vegetation. Such local human disturbance operates in addition to climate change, which has been considered as a potential threat to Caatinga biota. Average annual rainfall is expected to drop a quarter while temperature may experience a 4°C-increment in this century, i.e. increasing aridity. All these threats have been documented to (1) reduce taxonomic, functional and phylogenetic diversity of woody flora; (2) promote biotic homogenization of plant and animal communities; (3) disrupt key ecological processes such as pollination, seed dispersal and pest control; and (4) reduced vegetation biomass and nutrient stocks at all ecosystem compartments. Collectively, these disturbance-related responses are proposed to impair livelihood and future economic/social development based on sustainability. To overcome this challenge we argue for: (1) research devoted to better farm practices to deal with slash-and-burn agriculture, extensive livestock production and forest extractivism; (2) large-scaled restoration initiatives, particularly in desertified spots; (3) effective control of deforestation and habitat conversion; and (4) increment in the Caatinga system of protected areas.

Keywords: tropical dry forests; biodiversity; disturbances

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Future climate change in the Brazilian Caatinga biome

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Background: This study discusses the general aspects of climate change projections in the Brazil's Northeast region, in which is located the Caatinga biome. **Methods:** It is described the main findings reported on the IPCC Fifth Assessment Report (IPCC AR5), and a brief review of the literature addressing climate change in Northeast Brazil. In addition to a thorough review of the literature, it is assessed simulations and projections of temperature and precipitation changes provided by 24 state-of-the art Earth System Models -ESMs from the CMIP5 dataset that were analyzed in the IPCC AR5. Result. The semi-arid region of Northeast Brazil is already vulnerable to the current interannual climate variability, and climate change projections indicate that the region will be deeply affected by precipitation deficit and increased aridity in the next century, with negative consequences for the Caatinga biome. Rainfall variability, land degradation and desertification are some of the factors that combined could make Northeast Brazil one of the world's most vulnerable regions to climate change, with potential adverse impacts on the rich species diversity and water resources. For scenarios of future projections, the near surface air temperature should increase by approximately 1.3 °C for the RCP2.6 (low radiative forcing scenario), and by 4.4°C for the RCP8.5 (high radiative forcing scenario) by the the end of the twenty-first century. For the Caatinga biome, there is a considerable spread among rainfall change projections of between +1.5 and -1.5 mm day^{-1}, relative to 1961-1990, making it hard to identify any tendency in projected rainfall change. However, the RCP8.5 forcing scenario shows a slight rainfall reduction of about 0.3 mm day-1 by 2100. **Conclusion:** Among the most affected regions in Brazil, the Amazon and Northeast regions appear as large hotspots. For some modeling studies, projections of the future climate drive a savannization of parts of Amazon and desertification of the Caatinga region, with potential adverse impacts on biodiversity, supply and quality of water resources, carbon storage and the provision of other ecosystem services. Therefore, despite the many uncertainties that remain in projections of climate change, the scientific knowledge available today is enough for the decision makers to implement mitigation and adaption measures to prevent dangerous climate change in the region.

Keywords: Climate Change; Caatinga Biome

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Systematic Conservation Planning in the Caatinga Drylands

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Background: Systematic conservation planning is a key tool for conservation prioritization in megadiversity countries. Here, we describe a recent participatory effort to update the Priority Areas for conservation, sustainable use and shared benefits of the Caatinga biodiversity. **Methods:** A series of participatory workshops were executed with the aim of defining (i) the adopted method, (ii) the conservation targets and goals, (iii) the cost surface, and (iv) the determination of the priority area limits and proposed actions. **Results:** The systematic conservation planning process culminated in the determination of 282 Priority Areas as defined by the Brazilian Ministry of Environment Law 223 of 21 June 2016. Such network comprehends important areas for 691 conservation targets, including 350 red-listed plant species, 65 threatened birds, 31 mammals, 30 reptiles, 22 amphibians, and 126 fishes, besides additional special habitats (e.g., caves) and endangered ecosystems. A landscape connectivity analysis indicated the potential of each area for restoration programs. The analysis clearly identified 53 Priority Areas that are the best cost-effective proactive conservation opportunities in existence today. **Discussion:** It is highlighted that an effective financial mechanism should be created if one wants to transform conservation planning in actions. **Conclusion:** Brazil has nowadays an updated systematic conservation plan for the Caatinga biome and a historically unique window of opportunity to protect its biodiversity for the centuries to come.

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Sustainable Development in the Caatinga, Brazil

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Background: The Caatinga is South America's largest tropical dry forest region. It harbors a rich and diversified biota, whose proportion of endemic species among different groups of organisms ranges from 7% to 57%. Intense land use in the last centuries has already caused serious environmental damages and accelerated desertification. Loss of ecosystems associated with chronic poverty can reduce the resilience of local societies, making them more vulnerable to climate change. **Methods:** We present an overview of the challenges to promote sustainable development within the region by analyzing changes in indicators of land cover, population, and human development from 1990 to 2010. **Results:** The human population in the Caatinga went from 5 to 8 million people from 1990 to 2010, with most of the growth restricted to urban centers. The extension of natural ecosystems has been reduced to 748.000 km2 in 2010, but this area is possible smaller as there are technical problems to identify correctly what is a natural ecosystem in a dry region that have been so severely affected by human interventions. The average Human Development Index across the 1,213 municipalities that compose the region went from 0.502 (1990) to 0.592 (2010), demonstrating a very low progress compared to other Brazilian regions. **Discussion:** Although Brazil has designed and approved several national policies that promote sustainable development in the last two decades, most of these policies failed to produce significant changes at the local level in the Caatinga. Municipalities in the region are generally poor and have not the capacity to advance progressive programs such as local Agenda 21. A sustainable development strategy for the Caatinga should be designed to (1) improve human well-being indicators, (2) avoid further habitat loss and desertification, (3) maintain key ecological services, and (4) promote the sustainable use of the region's natural resources. Implementing an effective sustainable development agenda for the Caatinga means improve local governance as well as mobilize broad support from both public and private sectors.

Keywords: dry forests, conservation, development, resilience

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Symposium
Participatory modeling and games to engage people in science based conservation ecology and planning

Strategic Socioecological board-games and ABMs: livelihoods of other people / other species.

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There are many traditional and new methods and approaches for engaging rural actors in reflections about their roles in shaping social life and ecosystem functions. Cooperative game theory, spatially explicit lab and field common-pool-resource experiments, role-playing games, interactive agent based models, companion modeling and policy simulation exercises are increasingly being used for this purpose. Each has strengths and limitations. Some are highly controlled, generic, stylized and abstract while others are open-ended, context dependent and realistic. Most have been developed to expose and understand the core social dilemmas and human behaviors involved in the collective/contested appropriation, use and management of specific resources or whole territories. Some strategic board games and agent based simulations also involve explicitly other kind of actors: networks of plants and animals- selforganized into natural and agricultural ecosystems- whose complex interactions are critical for their own survival and for human well-being. In the past few years we have engaged in designing and deploying strategic board games and agent based simulations that address complex socioecological interactions at many different scales. In this talk we will give a general overview of the different types of rural socioecological games and ABMs found in the literature; we will offer a brief showcase of the tools we have developed; we will exemplify in more detail with two of our strategic board-games: Sierra Springs and Azteca Chess. In both cases we will also present the methods we have used in dozens of workshops to evaluate players'engagement, learning and behaviors. Sierra Springs helps farmers to become aware -in a safe and engaging form- of how they might be building social preferences when confronted with current environmental and social threats and opportunities they face. It also helps those academics that influence land use policy making and/or promote and operate monetary cash transfer programs to better understand the actors and issues involved, and how their own reactions to the game differ from those of farmers. Azteca Chess is a strategic, two player board-game that captures in a stylized way the fascinating natural history and the dynamics of a complex network of direct, indirect and cascading trait-mediated interactions among five species of arthropods dwelling in shade coffee bushes. Autonomous pest control emerges as one possible outcome of the game.

Keywords: Strategic socioecological board-games and ABMs

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Ethnobotany in postmodern contexts: Linking tourism architecture and community forestry

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Background: The need to engage diverse social actors, work across disciplines and integrate various sources of evidence poses significant epistemological and methodological challenges to conservationists embedded in new ruralities. **Methods:** We engaged a variety of social actors and integrated diverse sources of evidence to disentangle the drivers and multi-scale processes underlying the linkages between tourism architecture and community forest management in Quintana Roo, Mexico. Rooted in ethnobotany, we explored forest-based materials used for thatched huts in resort architecture, asking: 1) How forest product management and use has evolved over time? 2) How species vulnerability varies across management contexts? and 3) What can other tropical regions can teach us about these forest-tourism linkages?. **Results:** In Quintana Roo tourism architecture sustains forest and agricultural livelihoods. In the last 30 years, changes in market aesthetic preferences and regulations drove innovation and influenced landscape management. Product harvest has been influenced by new developments, post-hurricane reconstruction and hut maintenance. Regional species preference pervade; at the local level, species vulnerability was associated with variations in local forest governance arrangements and local population structure. Across the tropics, thatched huts in tourism settings have diverged from traditional dwellings. Changes in supply, new architectural and institutional contexts, coupled with divergent approaches to material authenticity, often resulted in species substitution, the use of chemical treatments, and the emergence of synthetic look-alike materials. **Discussion:** The regional resource base, local ecological knowledge, and vernacular architecture formed the foundation that interacted with market preferences and trends and evolving regulations in new built environments. Thus, linkages between tourism architecture and community forest management are in constant evolution and full of complexities. Such intricacies cannot be included in forest management plans, but affect how resources are managed. While not ignoring larger-scale influences, close scrutiny of local and regional processes were key to identifying factors of change and species vulnerability.

Keywords: forestry, ethnobotany, tourism, Mexico, architecture

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Forests and Fires: A Tabletop Game for Teaching and Research on Natural Resource Management

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Background: Natural resource management involves not a little uncertainty as to the outcomes of human decisions, whether for the biophysical environment or the livelihood consequences. Games with random generation of probability-based outcomes of decisions serve not only as a useful learning platform for players to experience the consequences of decisions under conditions of uncertainty, but also as a research tool to gather data and make comparisons about player behavior under different conditions. **Methods:** We present the game mechanics of "Forests and Fires" a tabletop game where players make decisions about resource management in the Amazon, a region threatened by land use change and degradation due to coupled anthropogenic and climate change impacts. Using simplified rules for resource management options and established probabilities for outcomes, players make decisions about resource use and then roll dice to resolve uncertainties. Resource use involves a combination of harvesting non-timber forest products and timber, and clearing forest for crops and cattle. The game mechanics are based on previous games but incorporate an iterative procedure that seeks to capture sequences of decisions across growing seasons with regard to their ramifications for resource degradation, fire risk, and the consequences for livelihoods. Findings: Resource management decisions early on in the game yield non-linear trajectories of decision options later with regard to resource and livelihood outcomes. Further, randomly determined events, notably fire risk, can greatly alter the trajectories of resource degradation and livelihood prospects later. **Discussion:** This game platform permits modifications of probabilities for certain outcomes resolved by random rolls, such as increased fire risk under conditions of drought induced by climate change, modifications to product prices due to economic fluctuations, and other scenarios. Such modifications can be tailored based on scenarios of future change, in order to observe effects on player decision probabilities as well as distributions of outcomes for resources and livelihoods.

Keywords: Amazon, land-use, forest, degradation, fire

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Ganando ganado: A game to facilitate stakeholder review of tropical reforestation research

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Background: A land cover change from cattle pasture to tropical forest is occurring in many Latin American landscapes, with major implications for carbon sequestration, biodiversity conservation, and human livelihoods. Research on the social and ecological causes of these forest transitions could benefit plans for forest landscape restoration. **Methods:** We used a participatory approach with local stakeholders to review the assumptions, boundaries, and simplifications that underlie interdisciplinary research on forest cover change. We developed a conceptual model to explain tropical forest gain in Southwestern Panama. Our conceptual model explains forest cover increases as a result of insufficient farm labor to clear encroaching trees off cattle pastures. We translated our conceptual model into a board game that represents the social-ecological dynamics of this land cover change, and asked Panamanian farmers to critically review the game's structure and assumptions. **Results:** Overall, farmers agreed with the narrative that labor scarcity has led to an increase in tree cover. Our role-playing game assumed that labor was a requirement for pasture maintenance, with transient laborers within a competitive labor market. Focus groups responded favorably to these game design elements and described real examples of each. In contrast to the positive feedback from focus groups on labor dynamics, game design elements related to the game's grazing system were poorly received. We assumed that secondary forest growth and cattle grazing were mutually-exclusive land uses. However, the farmers in our study described tree cover returning to actively-grazed pastures. Because agricultural practices have the potential to alter secondary succession, an improved understanding of grazing dynamics could help explain variation in forest recovery rates. **Conclusion:** Focus group discussions highlighted gaps in our knowledge of ecological dynamics, generated new hypotheses for land use change, and enabled us to refine future questions on the consequences of labor scarcity. Interdisciplinary research to understand tropical forest gain in agricultural landscapes will play a key role in forest landscape restoration. Role-playing games could contribute by integrating social and ecological dynamics into a format that can be reviewed by stakeholders. Ultimately, stakeholder review could lead to improved strategies to promote reforestation in human landscapes.

Keywords: game, participatory, reforestation, cattle, social

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Participatory modeling to increase efficacy of environmental planning in gold mining in Peru

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Background: Gold mining is one the main causes of environmental damage in the Peruvian Amazon. In Madre de Dios (MDD), this activity forms part of livelihood of thousands people that exploit gold illegally. In an attempt to formalize gold mining, the national government created the "Formalization National Plan" to regulate artisanal and small scale gold mining (ASGM) to interdict illegal mining. Despite these actions, mining activities in MDD are in the gray area between "illegality" or "in process of formalization". One of the factors hindering formalization is the lack of participation of miners in decision and planning. So far, formalization plan has not reduced illegal mining or environmental damages. To make ASGM sustainable, new planning processes need to be developed. An informed policy representing multiple perspectives and concerns of all stakeholders may have more chances to be successful. **Methods:** This research aims to explore how participatory modeling (participation of local stakeholders) in developing best practices to prevent and mitigate environmental impact of mining, could impel the implementation of more effective planning to control negative effects of gold mining in MDD. Using participatory modeling, we aim to identify which factors have impelled or hindered formalization. We also seek this method will be useful to create more appropriate participatory institutional structures for law enforcement, planning and decision-making. **Results:** The results of this participatory method will be the construction of normative criteria aimed to increase the effectiveness of policy implementation and to reduce unintended environmental harms as a consequence of illegality. The normative criteria will address scenarios where people could be integrated into the planning process in order to generate legitimacy, and real commitment in the long-term with designed policy. **Discussion:** Participation of local actors is an opportunity to gain unique insights and levels of acceptance of formalization process that would not be achievable only by external experts and policy makers. Engaging stakeholders allows gaining a broader understanding for better collaborative problem-solving. Participatory modeling can provide more alternatives or spaces for dialogue, which permit to increase stakeholders' satisfaction in decision-making outcomes, and their support for policy implementation.

Keywords: participatory planning, mining, environmental harms

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Gaming for Landscape Planning: A Participatory Tool to Build up a Shared Conservation Agenda

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Background: People's livelihood in Amazonia depends greatly on multiple uses of forest and services, but weak legal security, illegal logging, and deforestation are putting this important resource at risk. Conservation and Development Projects (CDP) advocate to improve local participation in landscape planning and to reward good practices to address resource regeneration, people's well-being and biodiversity conservation. This is an opportunity for forest dwellers and small farmers, but ruling land use under multiple stakeholder expectations are among of the biggest challenges in environmental policy and implementation. **Methods:** We developed a board game to present varying landscape scenarios to local people. We simulated scenarios in which families should decide how to use individual and common lands under business as usual scenario, players are free to set their own management rules and also have to play with a set of simulated rules regarding deforestation, logging, and land use change. The rules can be taken from local legislation and can be adapted according to the country situation. Players may select livestock production, agroforestry, and timber and non-timber extraction, or other activities, ranging from high to low profitability. In the game, the probability to spread fire and to be caught in illegal actions is defined by the role of a dice. **Results:** A pilot experiment with local technicians and forestry students showed risky individual choices may hamper the governance, economic and climate mitigation goals of CDP and national norms. Players faced tradeoffs between maximizing economic returns and clearing forest beyond normative or potential conflicts with neighbors because of fire spread. In particular, some individuals take the risk to enhance profitability clearing forest for cattle, at the probability of spreading fire to special sites and lands of players more inclined to sustainable practices. **Discussion/Conclusion:** Gaming for landscape management led to a productive discussion on the impact of individual choices on common goods and environmental services and the importance of participatory land use planning, and forest stewardship. A shared understanding of problems, trade-offs, and uncertainty of risky behavior opened the opportunity to discuss a common agenda of land use planning and conservation and recommendations for policy and norm implementation.

Keywords: Conservation, Forest, Games, Governance, Planning

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Symposium
Modeling Tropical Forest Dynamics and Element Cycles in an Era of Global Change

Current-generation climate change projections over different tropical ecosystems

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Background: Some of the most significant uncertainties in current-generation climate and earth system models pertain to the simulation, under both present and future conditions, of tropical terrestrial climates and the two-way multiscale interactions between climate and ecosystems. This talk is intended to provide an overview of state-of-the-art climate and earth system modeling efforts to understand tropical climate-ecosystem interactions in a changing climate, focusing in particular output from the ensemble of Coupled Model Intercomparison Project Phase 5 (CMIP5) model simulations performed in support of the 5th Assessment Report of the Intergovernmental Panel on Climate Change. **Methods:** A brief survey of the features of CMIP5 models, such as their spatial resolution and representation of various atmospheric and land surface processes, their projection of future climate change over tropical land regions, and associated biases and uncertainties will be presented. Approaches for multimodel evaluation and model-observation comparison, such as climatological means and variances, root mean square error, and empirical orthogonal function analysis, will be applied. **Results:** The diagnosis of climate model simulations conditioned on ecosystem type will then be discussed, e.g., considering changes in annual-mean rainfall, seasonality, variability, and extremes over regions currently covered by tropical wet, tropical dry forests, savanna, or grassland. Both robust climate change signatures over these ecosystems across the ensemble of CMIP5 models as well as uncertainties will be highlighted. Efforts to attribute uncertainties to specific coupled climate-ecosystem processes will be described. **Conclusion:** These results emphasize the critical need for comprehensive and multivariate observations of ecophysiological processes across a range of ecosystem types for validation and refinement of climate or earth system models as well as practical challenges such as differences in scale between available measurements and models.

Keywords: climate-ecosystem interactions, climate models

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Modeling and measuring phosphorus at the root-soil interface for improved tropical forest models

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Background: The need for Earth system models (ESMs) to represent the carbon exchange of tropical forests under current and future conditions, coupled with the recognition that tropical forest productivity often is limited by phosphorus (P), has spurred the development of P-enabled ESMs. The P model that has been incorporated into the ACME Land Model (ALM-P) has been successful in improving estimates of NPP at tropical forest sites that are presumed to be P limited, but pan-topical projections are constrained by the paucity of data on soil P availability and its control. **Methods:** Guided by critical uncertainties in ALM-P, field measurements are being conducted in a subtropical wet forest in Puerto Rico. One important model uncertainty is organic P mineralization, which is affected by root and microbial activity such as the production of phosphatase enzyme. We measured phosphatase activity on first and second order roots of dominant tree species at three sites differing in P availability. To inform a new generation of trait-enabled models, we also investigated potential covariation between phosphatase and fine-root chemical and morphological traits and aboveground traits. **Results:** Resin P values in soil varied three-fold across the sites, corresponding to differences in parent material and slope position. Species inhabiting the site with the least soil P availability exhibited the greatest root phosphatase activity. On ridge and valley sites with common parent material, *Dacryodes excela* trees exhibited the greatest phosphatase activity and the greatest root [P]; *Prestoea montana* trees had the least. Second-order roots of *D. excelsa* had the smallest root diameter and the largest distribution of fine roots in the surface soil layers. In contrast, *P. montana* had the largest root diameter and a consistent distribution of biomass throughout the 30 cm soil profile. Correlations with foliar P were weak, but wood density may be promising. **Discussion:** As we assemble more data from other tropical species and sites, our challenge will be to synthesize and simplify the observed variation in a manner that permits informative representation of P availability at the scale of an ESM grid cell. Discovering correlations between root traits associated with P availability and more easily observed aboveground traits can support development of a new generation of trait-enabled models. These initial observations from Puerto Rico provide an approach toward these goals.

Keywords: Phosphorus, phosphatase, root traits,

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Tropical dry forest productivity and a changing hydrological regime: using measurements and models

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Background: Climate models forecast that neo-tropical dry forests will receive much less rainfall in the 21st century than in the 20th century. Terrestrial ecosystem models are one of our most important tools for assessing the implications of such rainfall changes for forest productivity. However, inferences drawn from models may hinge on model representation of plant functional diversity. Here, we evaluate whether trait diversity (input to models) can reasonably reproduce the observed range of plant responses to water stress in tropical dry forests. **Methods:** The Ecosystem Demography model 2 was updated with a new representation of tropical dry forest trait diversity. Correlations between traits were parameterized on the basis of meta-analysis. Our new representation of traits and trait correlations allowed us to also more mechanistically model plant hydraulics, phenology, and water stress. We carried out simulations with varying representations of trait diversity and hydraulic mechanism to understand how these factors affected our model simulations. Simulations were evaluated against five years of field data from a selection of Costa Rican tropical dry sites and from remote sensing data for Mexico and Central America. **Results:** Model performance was contingent on assumptions about trait diversity. When parameterized with observed traits, the model generated realistic diurnal simulations of leaf water potential and stem sap flow. On longer time scales, including trait diversity and hydraulic mechanism in our simulations allowed us to better predict seasonal leaf area index dynamics and inter-annual variations in tree growth. We found that our trait-based model was also able to simulate spatial variability in seasonal leaf area index when forced with spatially-varying climate and soil drivers. **Discussion/Conclusion:** Models can provide reasonably accurate simulations of seasonal and interannual vegetation dynamics in neo-tropical dry forests. However, simulations are greatly improved by including realistic representations of trait diversity and plant hydraulic mechanisms. A major challenge for the future will improving simulations of drought-related mortality.

Keywords: dry forest, models, traits, hydraulics

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Modeling tropical forest carbon dynamics and responses to nitrogen and phosphorus perturbation

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Tropical carbon (C) dynamics are commonly constrained by soil phosphorus (P) and nitrogen (N). Elevated CO_2 concentrations will likely exacerbate plant nutrient limitations due to higher plant productivity. Representing CNP interactions in large-scale earth system land models is therefore fundamentally important for predicting future tropical forest responses under a changing climate. Here we report new developments in the Accelerated Climate Modeling for Energy (ACME) Land Model (ALMv1-ECA-CNP) regarding CNP interactions. The development is based on (1) recent theoretical advances in understanding belowground multiple-consumer, multiple-nutrient competition; (2) a dynamic allocation scheme based on resource availability to balance whole system functioning; and (3) global datasets of plant physiological traits. First, we benchmarked the new model (considering CNP interactions) in pan-tropical regions (23.5 S to 23.5 N) with ILAMB (The International Land Model Benchmarking), and showed substantial improvement over the baseline model (considering only CN interactions). We further benchmarked the new model's transient responses to nutrient perturbations, leveraging N and P fertilization experiments at tropical forest sites. We found that the plant productivity response ratio ((NPPfert - NPPcontrol)/ NPPcontrol) could be captured only when the whole system nutrient functional balance is taken into account. Compared with other candidate models (e.g., fixed resource allocation), the results highlight the importance of self-regulation and adjustment of forest ecosystems in response to long-term resource supply imbalances (e.g., by CO_2, N, P) that are likely to occur over the next several decades.

Keywords: ACME land model, CNP dynamics

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Capturing the function of nitrogen fixation in the tropical forest carbon sink

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Background: Recent work suggests that a tropical carbon sink may be supported by symbiotic nitrogen fixation, yet whether and how the field-observed processes can be scaled up to predict long-term changes in the carbon cycle remains unclear. Three findings - that tropical nitrogen fixers use a facultative fixation strategy whereby they adjust their fixation rates to meet soil nitrogen deficiencies, that fixation rates are highest during periods of high net carbon accumulation but decreases as carbon accumulation rates stabilize and that species differ in their fixation function - provide particular challenges to attempts to scale up and model fixation's role in supporting the tropical carbon cycle. Here I will discuss these challenges, evaluate current approaches to scaling up fixation and provide some insights into improving the incorporation of fixation into models. **Methods:** I will draw from a series of field- and laboratory- based experiments and observations that I have made with collaborators that illuminate the function of symbiotic nitrogen fixers in tropical biogeochemical cycles. In addition, I will review the literature for current approaches to scaling up fixation. Finally, I will present our current best-practice for incorporating fixation into a forest dynamics model, ED2. **Results:** The findings indicate that fixation cannot be scaled from the abundance of nitrogen fixers trees in a tropical forest; fixation is a dynamic property that behaves as a carbon-nitrogen feedback mechanism, up-regulating when nitrogen demand is high due to rapid carbon accumulation, and down-regulating when nitrogen demand can be met by soil nutrient supply, depending on the needs of the individual tree. DGVM/climate change models generally do not portray the key process of nitrogen fixation sufficiently and often times scale fixation to an ecosystem property, such as evapotranspiration or NPP. **Conclusion:** Capturing fixation in models and efforts to scale up to ecosystems and biome-scale properties, while a challenge, can be simply and relatively accurately accomplished by allowing fixation to dynamically respond to the needs of trees/vegetation, based on a series of costs and benefits associated with the trait. Models that incorporate such a dynamic process will find that nitrogen fixation may help to alleviate nutrient limitation on the tropical carbon sink.

Keywords: nitrogen fixation, carbon sink, models

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Using tropical tree rings to validate models of tree growth and forest dynamics

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Background: Simulation models of tree growth and forest dynamics are crucial tools to assess effects of global change on tropical forests. One of the challenges in developing and using these models is the poor data availability for model calibration and validation. Tropical tree-ring analysis can deliver long-term and annually-resolved data for this purpose. Tree rings yield information on growth rates (ring width), annual growth variation (tree-ring chronology), water use efficiency and stomatal openness (13C isotopes), nitrogen cycling (15N isotopes), rainfall (18O isotopes), photorespiration (isotopomers) and drought resistance (vessel size distribution). Here we present results of several tree-ring derived variables for tropical tree species and give examples how these can be used for model validation. **Methods:** (1) We developed and used an individual tree simulation model, IBTREE. We then used a tree-ring chronology for the Thai forest tree Toona ciliata to calibrate this model and evaluate the role of rainfall, temperature and CO_2 concentration in explaining annual variation in tree growth. (2) We measured 13C signature in wood of 12 tropical tree species in Cameroon, Thailand and Bolivia to evaluate long-term changes in water use efficiency and leaf-internal vs atmospheric CO_2 concentration (ci/ca). (3) We measured 15N signature in wood of 6 species in Cameroon, Thailand and Bolivia to detect long-term changes in N cycling. **Results:** (1) Our tree growth model predicted high sensitivity of Toona tree growth to CO_2 concentration and maximum temperature. Yet, the observed variation in Toona tree growth (tree-ring width chronology) was best explained by model simulations that were forced using just maximum temperature and rainfall; thus without CO_2 concentration. (2) We found that intrinsic water use efficiency strongly increased during the past century and ci/ca ratios remained stable. (3) We found no evidence of strong changes in nitrogen cycling for the three sites. **Discussion & conclusion:** A number of tree-ring derived variables can be used to validate model output over long periods of time. Cautious interpretation of tree-ring derived variables is required due to effects of tree-size, sampling strategy and tree demography. Our results demonstrate the multiple ways in which the archive stored in tree rings can assist in improving simulation models for tropical trees and tropical forests.

Keywords: tropical forest, modelling forest dynamics

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Symposium
Working with others for carnivore conservation: interdisciplinary, participatory and action research

Interdisciplinary and participatory action research for jaguar conservation in Mexico

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Research on jaguar has exploded over the last decade in Mexico, providing a much better understanding of the species' conservation status. However, conservation issues cannot be considered in ecological isolation, especially when it comes to the conservation of a species that can kill livestock. While efforts have been made to address the social cost of the conservation of such species through a compensation scheme implemented to cover the economic losses due to predation, the region of Calakmul, host to the largest jaguar population in Mexico, continues to witness a biodiversity conflict over jaguar management. To address that conflict, we developed an interdisciplinary project using a grounded approach to understand better its different components. We used methods from the social sciences such as focus groups, interviews and workshops to carry out the project, working with ranchers' associations, ranchers, conservation NGO representatives, as well as conservation officials in the Calakmul region. A first phase of the project aimed at understanding the local environmental management context, the critical social characteristics of the conflict, the local actors involved and the relationships between them. The results, among others, indicated frustration against the compensation scheme that was seen as hardly accessible by local actors. From this first assessment, we developed a participatory action research aimed at evaluating the perception of the compensation scheme in the region. The evaluation of, and satisfaction with, the scheme was strongly related to the trust of ranchers in the fund and to the transparency of the process. The second phase involved understanding the construction of the feeling of injustice regarding environmental issues, including jaguar predation, among locals (ranchers and farmers). The unfairness of the situation was widely expressed, and understanding how these feelings emerge and vary is required to act upon in order to support better management approaches. The feeling of injustice seemed to derive from a lack of recognition of local knowledge and way of life, and from a lack of inclusion in decision making. Overall and so far, our results have been stressing the importance of social, rather than biological or economic, aspects of the biodiversity conflict. While the participatory nature of the project provided evidence for collaborative strategies, our interdisciplinary approach enables new actions in conservation.

Keywords: ground-level perception, fairness, environmental justice

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The socio-ecological approach for the conservation of large carnivores in Mexico

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The decline of large carnivores' populations is a global concern for conservation. Causes of decline include: (1) habitat loss and fragmentation caused by spreading of agricultural frontiers; and (2) conflicts with human populations triggered by the use of wild prey by humans and impact on livestock by carnivores. In Mexico, all three big carnivore species, namely black bear (*Ursus americanus*), jaguar (*Panthera onca*) and puma (*Puma concolor*), have a protected status: jaguar and black bear are considered endangered and puma is listed under special protection. This has triggered many studies of these species, by far and large from an ecological-biological perspective, which has informed strategies for their conservation. However, the social aspects of carnivore conservation have been largely overlooked, despite the need for strategies allowing coexistence between the large carnivores and people with whom they share a common space. Coexistence can only be achieved by understanding the conflict, and I use a socio-ecological perspective to do so. I will recount the socio-ecological studies I have carried out over the last 10 years on the three species of large carnivores in Mexico, showing successes and failures, but mostly learning. My work had four main lines: 1) perception toward carnivores and environmental knowledge, 2) coexistence through improvement in productive practices, 3) socio-educational research, and 4) monitoring of population and biological parameters of large carnivores. The inclusion of the social approach in the studies of the conservation of large carnivores allows to integrate the land-owners in the long term strategies for conservation. Successful efforts on biodiversity conservation must include landowners, academia and non-governmental organizations.

Keywords: Jaguar, Oso negro, Puma

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Large Carnivores Conservation in a Co-Managed Protected Area of Western Tanzania

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Background: Large carnivore conservation is challenging. It requires large areas of natural habitat, species compete with human hunters for preys and have a reputation of dangerousness as they might occasionally prey on or attack humans. In addition, for pastoral societies large carnivores represent a threat to their livelihoods. In such a context, the ability of low status protected area to contribute significantly to the conservation of such species might be questioned. We investigate the case of Mlele Beekeeping Zone (MBKZ), a co-managed protected area in Western Tanzania. **Methods:** Combining methods from applied ecology (transects counts, systematic grid camera trapping) and social sciences (semi directed interviews, focus group, participatory observation), we attempted to: confirm the presence of species and if possible produce population estimates; assess species distribution and correlate it with human infrastructures; identify natural and anthropic factors affecting species abundance and; identify and characterize the attitudes towards carnivores of a selection of local stakeholders. **Results:** MBKZ host a diverse community of carnivores (18 species). All four large carnivore species are present and resident. They have been detected yearly since 2008. Population estimate remain partial, lion and wild dog populations are low, with probably less than 20 individuals respectively. Leopard population fares better with an estimate 40 individuals. Hyena population is probably over 300 individuals. Hyenas and leopards have a widespread distribution, while lion and wild dogs are located in remote parts of the MBKZ. **Discussion:** Several ecological factors can explain observed abundances: habitat type, prey preferences, prey availability, interspecific competition. But the low levels of population of lions and wild dogs is better explained with anthropic factors such as over-hunting of male lions during past years, prey availability decrease consecutive to illegal hunting, and poisoning of cattle carcasses. Attitudes towards carnivores seems directly influenced by the ability to make a living with forest based activities. In this sense community users such as beekeepers, employees such as village game scouts, or government staff involved in management all perceive positively the presence of large carnivores. In contrast, cattle keepers perceive large carnivores as a threat to their livestock and hence have a negative attitude towards them.

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Building field capacity in conflict transformation for sustainable conservation outcomes

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Background: Protracted conflicts are making it difficult to meet conservation goals necessary to protect biodiversity. Achieving conservation objectives requires new approaches that promote change and address complex social issues causing conflict. Conflict transformation from the peacebuilding field is an underutilized process that addresses conflict complexity from a constructive perspective. Building capacity of field teams to analyze and address biodiversity conflicts through a "lens" of conflict transformation, can provide opportunities to challenge existing assumptions about social conflict, identify new problem-solving approaches, and develop interventions that build sustainable relationships and conservation outcomes. **Methods:** I developed a conflict transformation training program with train-the-trainer for the Grevy's Zebra Trust (GZT) to build field capacity in addressing conflicts impacting conservation goals in Kenya. Peacebuilding and experiential learning methodologies were developed to cultivate understanding and collaboration towards achievement of conservation objectives. The rationale for the training content and process, design, learning methodologies, delivery, and evaluation is grounded in learning and development and peacebuilding theory and practice. I evaluate the GZT conflict transformation training model from two contexts, learning and development and conservation impact, and also applicability to other conservation organizations. **Results:** Building field capacity with a conflict transformation approach, which includes critical thinking and practical peacebuilding strategies and skills, can provide a productive path to address biodiversity conflicts. Results from my evaluation of the GZT training suggest that conflict transformation training framed within a conservation context to meet specific objectives and includes custom experiential learning has positive impact on conservation goals. **Conclusion:** Investing in conflict transformation training strengthens conservation capacity to analyze and address conflict situations. Applying a proactive conflict transformation approach to conservation conflicts can offer new opportunities to build relationships between parties in conflict and facilitate the development of innovative and collaborative strategies to address social conflicts at the root of biodiversity conflicts. Conflict transformation training is applicable across multiple conservation disciplines, from management to field level.

Keywords: conflict, conservation, impact, training, biodiversity

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Global Carnivore Conservation: Now Hiring, More Actors Needed!

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Mammalian carnivores are increasingly the subject of applied ecological studies. In addition, they are frequently used as the face of broader, regional wildlife and ecosystem conservation efforts. As charismatic fauna that are immediately recognizable by the world public, the effectiveness with which carnivores can attract attention and limited resources to conservation issues is rivaled by few other taxonomic groups. Yet despite the increase in visibility, research and media attention, and conservation focus, many of the world's threatened carnivore populations continue to decline. This may in part be due to an increasing reliance on science driven by the needs of graduate students and other academic timelines, which constrain the types of studies and the complexity of applied scientific questions that can be posed. A lack of diverse, robust funding sources to pursue inductive and hypothetico-deductive inquiry frameworks further restrict the scope and scale of conservation and ecological research, and often precludes insights only gained through long-term or large-scale analytical frameworks. Of likely greater relevance to carnivore population declines however might be the limited implementation or dearth of integrative, holistic conservation programs. Our model for executing this type of approach relies on a bedrock scientific framework, but adopts broad interdisciplinary inclusiveness that also spans: conservation evidence, conservation psychology, human dimensions and sociology, economics, policy development, law enforcement, education, geographical and land use contexts, and public relations, among other practically relevant fields of study. This approach necessitates the cooperative participation of numerous actors and institutions, including scientists, activists, and storytellers; nonprofit organizations; local, regional, and national government departments; commercial businesses corporations; landowner and community associations; and potentially other stakeholder groups. Here we discuss examples of context-specific approaches that we and our partners have applied in pursuing the conservation of carnivores. Although projects vary in context, scale, scope, they necessitated the transcending of science without abandoning it, which I contend is most effectively done when scientists work effectively and efficiently with all actors, and recognize that science itself is a small part of a more complex conservation equation.

Keywords: carnivores, interdisciplinary, participatory, integrative, inclusiveness

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Beyond participation to partnership: integrated conservation and the Sustainable Development Goals

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As tropical biologists, we study ecology but are also interested in achieving biodiversity conservation. However, tropical regions can be arenas for war, human migration and population pressures, agricultural and resource speculation by small farmers or trans-national corporations and subject to impacts of climate change and invasive species. Historically, local development needs have threatened habitat and species conservation, but globalization has extended threats from international agents; for example, increasing market routes for carnivore body parts for traditional medicine. Within this context, we need to reconfigure our strategies for carnivore conservation, working beyond participation in our projects to seeking genuine partnerships with others. The UN Sustainable Development Goals (SDGs) offer new imperatives for collaborative approaches. This paper thus addresses the following questions: firstly, how might the SDGs reconfigure our working relationships with other actors? Secondly, could a shift from participation to partnership approaches benefit conservation outcomes? Thirdly, what attributes might be exhibited by successful integrated conservation and development projects? We draw on the narrative of the emergence of the SDGs, in particular of Goal 17 (Partnership), and discuss experiences to date at national and international levels. We then analyze case studies of integrated conservation and development programmes, drawn from success in the St Andrews Prize for the Environment annual awards. We find that the form and extent of partnership can differ greatly, but successful partnership projects offer long term potential; greater buy in to conservation goals; align with local, national and international objectives; and widen opportunities for further collaborative work. Projects such as the 'Lion Guardians' offer new hope for conservation, but also require that we shift from ecologist to development roles, or work with others in development, and emphasize the need for action research. Such projects have committed leaders, multiple funding sources, are framed by real world problems and are embedded within local and global networks of power and influence. These examples demonstrate some mechanisms to work with others to achieve carnivore conservation. The SDGs offer additional opportunities to pursue joint objectives for sustainability.

Keywords: sustainable development, partnership, prizes, SDG

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Symposium
Conservation challenges in the agro-forest frontier; past, present and future

Challenges in agro-forest frontiers

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Background: Throughout the tropics forested landscapes are being converted into landscapes dominated by agriculture. Locally, degraded agricultural landscapes are reverting into productive systems with a substantially larger share of trees (agroforestry systems). Agro-forest frontier landscapes consist of a mosaic of different land uses, and are highly dynamic, reflecting the continuous changes in the interactions between people and the environment. Understanding the mechanisms that underlie and drive these social-ecological systems, including the complex and shifting institutional arrangements, is a crucial step towards designing and negotiating, in close collaboration with the actors, strategies for targeted land use. Such strategies need to reconcile the maintenance of biodiversity with the supply of a wide portfolio of ecosystem services, and meet the needs of local actors. **Methods:** The landscape-transforming strategies of the various actors in these agro-forest frontier areas have direct consequences for ecosystem services that the landscape currently and in the future provides. The FOREFRONT program has three objectives: 1) to identify and understand the ecological and social drivers that shape agro-forest frontier landscapes and their ecosystem services, 2) to explain temporal changes in the social-ecological system and their consequences for landscape configurations, 3) to design adaptive strategies to balance and optimize the supply of ecosystem services in changing landscapes. **Results:** Using a comparative approach, FOREFRONT evaluates particularly dynamic agro-forest frontier areas in Mexico and Brazil, representing a diversity of important drivers shaping land use change and land use conflicts. The landscape approach entails an integrated vision of land use planning, policies and management decisions to maintain the resilience, productivity and sustainability of landscapes for the benefit of the people who depend on them. Such an integrated vision is crucially important to take into account the increasing complexity of land issues and the multiple and often competing claims on land use. **Discussion:** The challenges in the FOREFRONT agro-forest frontier areas will be addressed and compared to similar ones in other areas across the globe, using available experiences described in the literature and being evaluated in running programs elsewhere.

Keywords: Agro-forest frontier, conservation, reconciliation

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The fate of forests in agro-forest frontier landscapes, implications for conservation

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Background: Most of the world's remaining tropical forest is located inside human-modified landscapes. These forests could matter a lot for biodiversity conservation, but their actual contribution depends on their location, successional status and how they are managed. **Methods:** We study the humid tropical region of Marques the Comillas in Chiapas, Mexico. Colonization took place in '70-'80, by 38 agricultural settler communities and the region exhibits a high diversity of landscape configurations. We used a unique combination of long-term forest monitoring plots (in secondary and primary forest) and Landsat-based, multi-temporal remote sensing techniques. This allowed us to get a better understanding of changes in forest cover, their successional status and their contribution to biodiversity and ecosystem functions since colonization. **Results:** We found that currently most (55%) of the forest that remains is high-diversity mature forest, 30% is secondary forest and 15% is plantation forest. Mature forest has seen dramatic declines in the first 2 decades after colonization. Declines have slowed down and caused that mature forest patches have become increasingly fragmented and degraded. Median secondary forest ages increased in early colonization history, showing an optimum of 15 years in the early '90s and then gradually becoming younger, which may indicate land scarcity. Secondary forests today are ephemeral and rarely persist longer than 8 years, which allows restoring most of their aboveground carbon, but restricts their role for restoring soil fertility and for biodiversity conservation. The last decade has seen an increase of monoculture plantations; mainly for rubber and palmoil. These contribute little to biodiversity conservation and are mostly located on abandoned pastures, although examples where they replaced forested lands were also found. **Discussion:** We found a large variation in forest dynamics trajectories, despite the fact that initial colonization occurred in a short time-frame. This variation allows further studying the socio-cultural conditions under which forests persist in agro-forest frontiers and informing policy measures. We conclude that deforestation is still more prominent than reforestation in the study region, and that reforestation is mainly in the form of biodiversity-poor short-lived secondary forests and monoculture plantations. This warrants continued degradation and the need for improved conservation measures.

Keywords: forest dynamics, secondary forests, colonization

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Landscape Transformation History in Loma Bonita, Lacandona Jungle, Southern Mexico

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Background: The Marqués de Comillas region (Chiapas, Mexico) and the Loma Bonita community are embedded in the Selva Lacandona which has been designated as a priority area for conservation because of the important ecosystem services it provides to the region. In the past decades the region has faced an increase in human settlements caused by external factors, such as governmental programs/policies that have incentivized roads' construction, colonization and land conversion to pastures/agriculture since the 1970s. Formal studies analysing the complex relationships between localized social and ecological variables involved in the provision and degradation of ecosystem services and more particularly in the process of land change, are lacking. This case study concentrates on the landscape transformation history told by the people that physically change the landscape. Using an assemblage theory, this research explores the complex dynamic relations (affects) that have enabled the emergence of a mixed social-ecological landscape (forests, pastures and agricultural lands) during the last 45 years in Loma Bonita. **Methods:** Methods include qualitative data derived from an in-depth ethnographic approach that involves participant observation, in-depth/life-histories interviews, and document review. **Results:** The results show that the affects that have enabled the mixed social-ecological matrix landscape in Loma Bonita include elements from individual life histories (place of origin/land-use practices), culture (values/beliefs/religion), needs and desires, views on ecosystem services, economic needs/incentives, tenure rights, perceptions and values towards the land and to a lesser extent factors such as governmental programs/policies. **Conclusion:** These results add a deeper layer to the analysis of what are the main drivers of high rates of deforestation in the region and in Loma Bonita in particular. The understanding that landscape transformation is a dynamic and complex multi-factor process can provide inputs to design more desirable landscapes trajectories that are compatible with sustainable land-uses and livelihoods.

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Deforestation-reforestation in Mesoamerican Mountains as rural livelihood response to Neoliberlism

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Mountainous, humid and subhumid tropical highlands in Mesoamerica conform vast territories inhabited for many centuries by indigenous people, or colonized during the last sixty years by a more culturally mixed population of small land-holders. They include -in Mexico- the Sierra Madre Oriental, Sierra Madre del Sur, Sierra Madre de Chiapas, Altos de Chiapas and- in Central America - mainly the Pacific Mountains of Guatemala and Honduras and the archipelago of Volcanoes in El Salvador. Detailed and comprehensive reforestation-deforestation remote sensing studies for the first decade of the XXI century (e.g. Redo et al 2012; Hansen et al. 2013) as well as more localized case studies reveal a dynamic and complicated pattern in which both processes are at work, rendering an intricate mosaic of multi-sized spaces with net deforestation, net reforestation, or apparent stationary conditions. In this talk we do not describe or try to tease out the specific conformation of these patterns. Rather, based on thirty years of observation in the Highlands of Chiapas, ten years of multidisciplinary research in the Sierra Madre de Chiapas and on Mesoamerica literature review, we reflect on the diverse and dynamic livelihood strategies of people living in these territories - at the forest frontiers where deforestation/reforestation processes occur- and on how they might be related- as cause and consequence- to these intricate and changing refor/defor patterns. We identify general multi-scale drivers and actors of livelihood conformation and change in these territories from the 1960Â´s to our days, and focus on those at work since the fall of the Berlin wall (1989) to the rise of the Trump wall (2017). We describe (a) the very dynamic capacity of this generally poor population to change their livelihood strategies in response/resistance to the labor, land, water and produce market opportunities (and conflicts) created by promotors of neoliberal globalization in the region, (b) the general refor/defor effects to be expected from the main livelihood strategies deployed by different households within the same region observed, and (c) the ecological and social benefits, costs and dangers derived from these strategies for the local population and other actors.

Keywords: Reforestation Deforestation Mesoamerica Livelihoods Neoliberalism

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Tradeoffs between bundles of ecosystem services in human-modified landscapes

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Background: Tradeoffs between bundles of ecosystem services are at the very core of the transformation of agricultural landscapes to agriculture. The current mosaics with a gradient of management intensities interspersed by secondary forests lead to tradeoffs among bundles of ecosystem services supplied, among bundles of benefits to stakeholders derived from these services, and among bundles of values held by stakeholders on the services. In this talk we present a summary of the conceptual developments relative to these tradeoffs between bundles of services, benefits and values and showcase some of the most relevant corresponding results. **Methods:** We will draw from the most recent international literature with emphasis on the products derived directly or indirectly from the Partners, Forefront and associated networks to highlight the most relevant conceptual developments and the corresponding results. **Results:** Tradeoffs in the supply of bundles ecosystem services arise from different land uses associated to gradient of management intensities and along secondary forest succession. Two contrasting bundles of supporting, regulating, provisioning and cultural ecosystem services are supplied: those linked to conserved forests and older successional stages, and those linked to agricultural activities. Tradeoffs among bundles of benefits to stakeholders derived from the services arise from the scale at which the benefits flow from agro-forest frontiers to stakeholders. The most contrasting tradeoffs among bundles are those arising from private costs/benefits and public costs/benefits. Tradeoffs among values held by stakeholders on these services arise from generational shifts in context, e.g. education, markets, agricultural/conservation policies. Those with less education and with support from agricultural development policies in the 70's tend to emphasize the intrinsic, instrumental and relational values associated to agricultural activities while those with more education and more diverse livelihoods increasingly emphasize instrumental values associated to conserved forests. **Conclusions:** Important tradeoffs among bundles of services are found within agro-forest frontiers, and include those associated with their supply, their benefits to stakeholders, and the values attached to them. All these dimensions are relevant when considering the drivers underpinning the transformation of the agro-forest frontiers as well as future opportunities towards sustainability.

Keywords: secondary forests, benefits, values

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Using agroforestry approaches to promote conservation in rubber dominated landscapes

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Background: Tropical plantations occupy an increasing proportion of the world's agricultural land (Oil Palm 14 M ha, Rubber 10 M ha, Pulp &; Paper 45 M ha) and have been responsible for substantial deforestation and biodiversity loss. Impacts on ecosystem services are also often considerable, particularly with respect to increased carbon emissions, reduce dry season water flows, wet season flooding, increased soil erosion and reduced soil fertility. However, these impacts stem largely from the management of these crops in monocultures and may be alleviated through agroforestry approaches. Rubber has been cultivated in SE Asia for over 100 years but, driven by demand for natural latex from economic growth in China (70% of demand is for tyres), there has been a massive expansion of monoculture rubber throughout northern mainland SE Asia. In traditional rubber growing areas, smallholder farmers quickly adopted rubber but cultivated it in enriched fallows, aka jungle rubber. These traditional systems have been shown to support similar levels of biodiversity and ecosystem services to advanced natural regeneration, but have low productivity as a consequence of growing rubber from seeds and at low densities. However, experiments have shown that high yielding rubber clones can be grown in agroforests without loss of yield, as compared to monocultures. **Methods:** I reviewed the literature on rubber intercropping, including both journal articles and grey literature, and conducted field visits. In addition, we modelled the economic returns from a series of rubber agroforestry systems. **Results:** Rubber can be intercropped with a wide range of other plants, provided competition for light is managed. Modelled economic returns suggest the highest returns can be made from intercropping with high value timber and shade crops (e.g. Cardamom) but fruit trees are also economic provided labour opportunity costs are low. **Discussion:** Rubber agroforests can be used to diversify smallholder incomes, providing insurance against rubber price fluctuations, and improve outcomes for biodiversity and ecosystem services. We are currently implementing a series of field trials that will examine the economic and ecosystem services benefits of rubber agroforestry. Oil Palm and short rotation timber species can also be grown in mixtures or agroforests. More emphasis on such approaches would generate better outcomes from conservation.

Keywords: restoration, ecosystem services, mulituse landscapes

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The socio-ecology of tired lands: a basis for managing resilience in Amazonia

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Background: Designing sustainable land-use systems requires identifying the boundaries of resources' exploitation that govern the resilience of socio-ecological systems. Resilience can be measured as the magnitude of disturbance that a system can experience before moving into a different state or condition. Operationalizing resilience and translating it into management recommendations requires identifying thresholds of pressure associated with switches in the system. Local communities commonly identify and classify different conditions of the managed system based on factors such as resource availability, management demand, productivity, past legacies and future costs. In the Brazilian Amazon, local people call it a tired land (terra cansada in Portuguese) fields that have become unproductive, in general terms. In this study we investigate the mechanisms underlying the formation of tired lands, aiming to understand what drives the resilience of shifting cultivation systems in Central Amazonia. **Methods:** We combine traditional ecological knowledge and multivariate biophysical surveys to try and identify thresholds and feedback loops that can help drawing practical recommendations for avoiding degradation and ensuring resilience. **Results:** Our results show that farmers identify tired lands as fields with low crop yield, high weed infestation, slow fallow recovery, with specific weed and fallow species and which have had intensive land use in the past. The proximate causes of the formation of tired lands are beyond soil exhaustion and include feedbacks between management practices and natural regeneration that favors lianas and weedy species with persistent root systems. Such positive feedbacks may delay fallow regrowth and threaten the system resilience. We identified that 4 shifting cultivation cycles is a threshold above which a land becomes tired. **Discussion/conclusion:** Respecting such thresholds and breaking the feedback loops are needed to avoid the formation of tired lands. Although farmers recognize such thresholds, the combination of high crop demand, narrow market opportunities and land scarcity by accessibility are the ultimate causes of the expansion of tired lands in the riverine context. Based on biophysical data and farmers experiences we provide recommendations for avoiding and restoring tired lands and guaranteeing the resilience of shifting cultivation systems in Amazonia.

Keywords: degradation, management, thresholds, TEK, farmer

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The role of participatory monitoring in forest restoration

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Global forest restoration initiatives present an unparalleled opportunity to reverse the trend of land degradation and participatory monitoring could play a crucial role in providing accountability, generating local buy-in and catalyzing learning in monitoring systems. Our review confirms that local people can reliably collect accurate data on forest change, drivers and threats that local monitoring can cost up to one-third of professional monitoring. However, there must be sufficient local incentives and support, including orienting the restoration activities to meet local goals and priorities. Successful participatory monitoring systems can quickly generate information that is adequate to answer the questions and needs of local stakeholders — not necessarily scientifically rigorous data. A scalable, multisite forest restoration monitoring initiative should have a small number of indicators shared by all sites, with the flexibility to determine other indicators to respond to local needs. It should emphasize the creation of learning networks to facilitate the connection of stakeholders at multiple levels with the information they need for decision making and social learning.

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Keywords: participatory monitoring, restoration, reforestation

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Balancing biodiversity losses with profitability in the Atlantic Forest of Brazil

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Background: Previous studies have suggested that many of the effects of fragmentation are due to the type of matrix in which patches are embedded, with matrix habitats that are more dissimilar to the natural habitats having a stronger impact on species loss. In many areas of the Atlantic Forest, plantations of Eucalyptus are replacing low intensive cattle pastures. In principle, this trend may be beneficial for biodiversity, as Eucalyptus plantations also are forest systems, and may be more profitable than cattle ranching, thus benefiting local people. Here, I test how the bird community inside and outside forest patches is affected by matrix type and assess the economic profitability of *Eucalyptus* and pastures. **Methods:** Data were collected in the Atlantic Forest of Brazil, in the State of São Paulo, between 2016 and 2017 (still ongoing). Birds were sampled with point counts in 50 sites during this period, and in each site birds were sampled in fragment interior, fragment edge, in the matrix, and in pasture, Eucalyptus and forest controls. Economic output data was obtained from public available sources and databases of land price. **Results:** Results show that, in average, there are twice as many bird species in pastures than in *Eucalyptus*. Forest patches embedded in pastures are too more speciose than patches surrounded by Eucalyptus, however this difference was only observed in patch interior, as patch edges adjacent to pasture had similar numbers of species to those near Eucalyptus. The bird community found in patches embedded by *Eucalyptus* was more similar to pristine forest than the community within pasture-surrounded patches. Altogether, the observed changes to the bird community suggest that birds are not performing all of their functional roles in human-modified landscapes, and that these changes particularly affect pest control. Results for this region show that *Eucalyptus* plantation is many-fold more profitable than cattle ranching. **Discussion:** Although data collection is still ongoing, these findings contradict previous literature suggesting that matrices that are more similar to the natural habitat are more beneficial to biodiversity. Despite the fact that *Eucalyptus* supported fewer bird species than pastures, the effect size of this difference was small when compared to the high profitability of this land use.

Keywords: Atlantic Forest, birds, fragmentation, matrix

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Improved management towards novel agroecosystems

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Background: Worldwide, animal agriculture is the leading cause of habitat loss, species extinction, and water pollution. Animal-sourced food are linked to 51% of global greenhouse emissions, at the same time agricultural activities are the main economic activity in rural areas. As conservationists, our challenge is to create integrated landscapes that, both maintain biodiversity and the people's livelihoods. **Methods:** To tackle this challenge we set to co-design along with rural communities, production systems that decrease the negative effects of forest fragmentation favoring functional connectivity across the landscape. Currently, we are establishing AgroSilvoPastoral Systems (ASPS) as a biodiversity conservation strategy and sustainable livestock production in communities of Los Tuxtlas, Mexico. These ASPS combine restoration plots embedded in a high intensity rotation system with grasses and foraging trees. To promote knowledge and establishment of ASPS as a biodiversity conservation strategy and sustainable livestock production, we conducted 4 workshops in two local communities. At the start and end of each workshop, we applied closed-ended questions to the assistants to evaluate changes in their perception about these systems. **Results:** In average, 76% of the income per household of the evaluated communities came from livestock production as meat or milk. However, milk production and selling calf as meat averaged daily income of $14.7 US per household. **Discussion:** Comparative studies in the Neotropics have shown that silvopastoral systems (agroforestry arrangements that combine grasses with shrubs and trees for animal nutrition and complementary uses) may reach production levels equal to or higher than conventional grazing systems, but provide a longer lifespan for productive lands. On the other hand, maintaining restoration plots embebed in open pastures have proved to 1) increase landscape connectivity, 2) increase seed influx, 3) increase seedling recruitment and 4) improve soil properties. Through this project, we will test how combining silvopastoral systems as the matrix of restoration patches into ASPS may assist in improving the livelihoods of low-economy cattle ranchers as well as maintaining landscape connectivity, ecosystem services and biodiversity. Additionally, ASPS will provide landscape complexity which will result in more resilient systems in the face of climate change.

Keywords: AgroSilvopastoral systems, agricultural landscapes, restoration

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Mexican experiences in restoration. How to comply with international agreements?

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Background: The Convention on Biological Diversity (CBD) of the United Nations (1993) established a Global Strategy for Plant Conservation which is the framework for the Mexican Strategy for Plant Conservation (EMCV, in Spanish) coordinated by the National Commission for the Use and Knowledge of Biodiversity (CONABIO, in Spanish). The third objective of this strategy refers to the increase of restored areas and the recovery of degraded ecosystems. Following the CBD Strategic Plan, the "Bonn Challenge", an international agreement to restore 150 million of hectares in the entire world, was established in 2011. Further, in 2014, the 20 X 20 initiative promised to restore 20 million hectares in Latin America, of which Mexico promised to restore 8.5 million. However, only four of 13 Latin America countries that signed the restoration agreement have a restoration plan; Mexico does not have a plan. **Results and Discussion:** In 2014, CONABIO established the Coordinating Committee for the Implementation of the Strategy for Plant Conservation. To fulfill the international agreements, several activities have been carried out by this committee: the First National Restoration Symposium (2014) and a book that incorporates the experiences gathered in the meeting (2016) aimed to congregate key actors (academics, government agency workers, and restoration practitioners). The book includes a methodology for selecting priority restoration areas, the evolution of policies for ecological restoration of forest ecosystems and experiences in ecological restoration of degraded ecosystems in nine Mexican ecosystem types, occurring in 13 states. Later, a workshop called "Challenges and prospects to meet the international agreements on Ecological Restoration" supported by the Center for International Forestry Research (CIFOR) and CONABIO (2015) was carried out to establish a protocol to evaluate restoration projects in Mexico. The national evaluation is in progress; some preliminary results show that ecological restoration activities in Mexico showed a peak during 2004-10 because of several initiatives generated by CONABIO. Most projects are still active in different phases, from pilot trials to monitoring phase. The identification of key actors, the national evaluation of restoration projects and the analysis of weakness and strength of existing restoration plans of Latin American countries are the supplies to establish a successful ecological restoration plan for Mexico.

Keywords: Ecological restoration, Mexico, restoration plans

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Technological innovation for nature conservation in productive landscapes

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Nature conservation requires sustainable and integrative management of natural resources, productive lands and protected areas. This in turn demands changes in the models of putting at work knowledge and the actors that carry this knowledge. We still drag along an expert-biased model of knowledge generation, communication and transmission, without grasping the clues of constructing solutions and alternatives as one more actor with all the others involved. We first have to learn how to ask the correct questions that lead to the shared understanding of basic social-environmental processes. That questioning must be a part of a multi-actor heuristics, where scientists play a role, because alternative processes, models and frameworks need scientific input, but also that of other actors. This means finding other arrangements to conduct research than in the conventional laboratories; other funding sources than foundations and research councils; other actors to carry out projects than students, technicians and researchers; other means of communication than scientific journals; other measures than the numbers of publications, citations and impact factors. We need also technology to generate the tools, devices, models, methods, required to achieve the goal of sustainable management. Luckily, current technological means allow easier-than-ever generation of alternative models for sustainable management of our environment. Knowledge society, social and academic networks, satellite communications, computing capacities, public databases, smartphones, etc., provide an unprecedented wealth of knowledge resources and capabilities to respond to complex challenges in almost any corner of the planet, and on hand exchange of opinions on the process. We provide some examples of technologically enhanced innovation applied to social environmental processes that foster nature conservation, as in avocado plantations and agroforestry systems. These examples help us to find ways to make the qualitative change from failed expert cultures to vivid social-environmental action with multiple expert involvement, notably involving local knowledge.

Keywords: local knowledge; management; society; sustainability

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Symposium
Defaunation and Ecosystem services

Dynamics of an empty forest in Perú: 11 years later

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Background: Research on the "empty forest" syndrome has burgeoned in recent years, uncovering associated distortions in a number of forest processes, including seed dispersal, seed predation, species composition and secondary effects, notably, reduced carbon storage. Studies conducted to date have not always led to similar conclusions but many of these have been based on short-term results that may not reflect long-term trends. **Methods:** We report on conclusions reached after a multi-year effort to monitor turnover, seedfall and recruitment in two matched upper Amazonian floodplain forests 90 km apart in Perú, one with an intact fauna (Cocha Cashu) and one with a severely depleted fauna (Boca Manu). **Results:** To our surprise, we found that clear patterns present in a 2004 inventory of these plots were not strongly supported in subsequent inventories in 2009 and 2015. For example, some species known to be dispersed by large primates were recruiting at high rates as saplings in the "empty forest." The result is not a fluke because we observed it in replicate plots >100 km distant. Moreover, the seed shadows of species dispersed by large primates were not consistently contracted in the "empty" forest. The pattern of small sapling recruitment in the empty forest does suggest a marked divergence in species composition over time, but the signal is slow in working its way up the age structure. Anticipated changes in species composition will lead to altered carbon storage in the future, provided surprise developments to not upset current assumptions. **Discussion:** It has been a humbling experience to realize that we know less about the consequences of defaunation in tropical forests than, inspired by hubris, we thought we knew a decade ago.

Keywords: Amazon, Carbon, Defaunation, Seed dispersal

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A pantropical assessment of physical damage to forest seedlings and the impact of defaunation

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Background: Biotic and abiotic forces shape plant communities across ontogenetic stages, driving patterns in survival, vegetation structure, and species diversity. In tropical forests, many of these forces are facilitated by interactions with animals, which can either promote or inhibit plant reproduction. Disruptions to these interactions - such as vertebrate defaunation - can generate broad changes in tree recruitment, forest structure, and carbon storage, with demographic filtering at early recruitment stages responsible for many of the effects. Research to date has largely focused on a subset of prominent interactions, even though concurrent modifications to less-studied ecological processes can drive changes of opposite directionality for individual species or entire communities. As such, it remains difficult to predict the outcomes of defaunation for tropical forest plant communities. **Methods:** We sought to quantify non-trophic physical damage to seedlings in biogeographically distinct forests across the tropics, and to compare these effects between non-hunted, unlogged forests vs. those subjected to hunting and/or logging. A total of 1800 artificial seedlings were established across 18 sites, with three sites in each of two forest conditions (intact vs. hunted and/or logged) in the Neotropics (Peru), Afrotropics (Gabon), and Indo-Malayan tropics (Sabah, Malaysia). Seedlings were censused monthly for 12 months, recording damage generated by vertebrates, plant debris, and unknown causes. **Results:** 79% of all artificial seedlings were damaged during the 12-month study period. Across all sites, forest conditions, and regions, vertebrates predominantly drove artificial seedling damage, damaging 49% of all seedlings, compared to 16% damaged by plant debris. White-lipped peccaries (Peru), elephants and red river hogs (Gabon), and bearded pigs (Sabah) likely generated the strongest vertebrate effects. Hunting had a significant impact on rates of non-trophic damage caused by vertebrates, with 87% reduction in hunted sites in Peru and 46% in hunted and logged sites in Gabon, compared to undisturbed sites. **Discussion and conclusions**: Our results indicate that physical damage by vertebrates is likely a major filter on seedling survival that significantly regulates plant reproductive success in undisturbed tropical forests, with significant long-term changes in vegetation composition, structure and ecosystem services forecast in defaunated tropical forests.

Keywords: Regeneration, pantropical, non-trophic, defaunation, ecosystem-function.

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Revitalizing the natural phosphorus pump

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Background: Humanity is facing two pressing concerns: a potential shortage of the key ingredient of fertilizer, phosphorus and the loss of large animal biodiversity. We are approaching "peak phosphorus" where phosphorus may become more expensive as it becomes rarer, thus endangering the green agricultural revolution and our ability to feed ourselves. Animals play a key role in the recycling of phosphorus from the ocean depths to the continental interiors, but this has declined by >90% over the past 10,000 years. **Methods:** Here we propose a mechanism to help alleviate both problems at once by restoring the natural system of animal mediated phosphorus recycling. **Results:** This could be achieved with a REDD+ type-trading scenario where money could either be used to build wastewater treatment plants or to restore the animal natural capital and increase natural phosphorus recycling by an order of magnitude with a value >10 billion USD. **Discussion:** Defaunation has reduced key ecosystem services such as phosphorus distribution. Refaunation of our ecosystems could not only increase biodiversity but solve another key problem of society - peak phosphorus.

Keywords: defaunation, ecosystem services, phosphorus, megafauna

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Searching for signals of defaunation-induced carbon loss at regional scales

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The widespread loss of vertebrate frugivores from tropical forests around the world, driven by over-hunting, could be inducing changes in the composition of tree communities, reducing mean wood density or aboveground volume in ways that fundamentally alter carbon storage. Simulations based on tree demographic data suggest that hunting-induced loss of forest carbon might be occurring in the Neotropics and Afrotropics but not in Southeast Asia where, unlike in other tropical realms, most of the dominant trees do not rely on animals for regeneration. To test these predictions, we use high resolution remote sensing data, combined with empirically validated maps of hunting pressure, to assess whether forest biomass is negatively correlated with defaunation. We compare results from Peru and Malaysian Borneo to test the hypothesis that the impacts of vertebrate frugivores on forest carbon storage vary across continents. Tropical rainforests store a substantial portion of Earth's carbon. Accurately assessing changes in these carbon stocks are critical for global-scale carbon budgeting and climate change assessment. Indeed, a prominent strategy for climate change mitigation is to Reduce Emissions from Deforestation and forest Degradation (REDD), which focuses on paying countries to stop logging so as to preserve standing forest carbon. But it may be that addressing logging is not sufficient -that REDD needs to also prevent overhunting or risk insidious erosions of carbon pools.

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Continental-scale carbon savings from tropical forest bushmeat hunting

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Harvesting of wild animal populations from terrestrial ecosystems represents a key source of animal protein, providing food and income for over a billion people worldwide. This invariably leads to varying degrees of wildlife depletion in terrestrial ecosystems, a global scale phenomenon that has been difficult to map and quantify. Research on tropical forest "bushmeat" harvesting has proliferated in the last two decades, uncovering a wide variation in local per capita meat consumption, patterns of overhunting for different game species, and associated ecological consequences, including seed dispersal and seedling recruitment bottlenecks of large-seeded plants, and associated changes in forest carbon storage. Wild meat consumption can abate global greenhouse gas (GHG) emissions by sparing land from deforestation, and reducing agricultural inputs and methane emissions from enteric digestion in ruminant livestock. We calculate the carbon substitution value in human carnivore diets across the neotropics under both "empty" and faunally intact forest scenarios to estimate the GHG emission savings provided by forest wildlife. We find that, in line with national policy targets of most Amazonian countries, considerable forest land sparing and abatement of GHGs can be achieved by wild meat substitution of domesticated livestock. However, this requires that wildlife populations are sustainably managed to retain their maximum value.

Keywords: Defaunation, Hunting, Ecosystem services, Carbon

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Defaunation of seed dispersers and predators affects carbon storage in tropical forest

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Background: Defaunation of large frugivores affects carbon storage ecosystem services in tropical forest. However, previous studies relating frugivore defaunation with changes in carbon storage ignore the potential compensatory effects on plant recruitment for frugivore redundancy and the decrease of seed predation pressure in defaunated communities. **Methods:** Based on data of recruitment success of large-seeded hardwood trees *Cryptocarya mandioccana*, we investigated the contribution of the main seed disperser in three areas within a defaunation gradient of seed dispersers and predators to assess possible compensatory effects. By comparing the seed dispersal effectiveness (SDE) among the seed dispersers, we predicted the relative impact of their local extinctions on plant recruitment taking into account compensation effect and changes in seed predator community. Based on the results, we simulated the change of recruitment success of large-seeded trees consumed by our disperser community and evaluated the subsequent change in overall carbon storage, taking into account their replacement by co-occurring plant species, the level of seed predation, and compensation effects of mutualist species. Finally, we estimated the monetary contribution of the seed dispersal service provided by each frugivore species to carbon stock. Result: The loss of large seed predators increase net seed mortality in 7 to 30 % due to an overcompensation of the activity of small rodents in absence of larger seed predators. On the other hand, the loss large seed dispersers can be buffer by the compensatory effects of smaller frugivores in seed removal, but it is not sufficient to prevent a significant decrease of carbon stock. Indeed, the disruption of the seed disperser community would lead to a similar loss of carbon stock (-2.6%) as the disruption of the seed predator community (-2.5%). Besides, Areas without target disperser community (i.e. Muriquis +Howlers+ Jacutingas) will suffer an impoverishment of the carbon budget of US$13.50/ha to US$43.5/ha depending whether the community is defaunated or not in seed predators. **Discussion:** We show that defaunation of seed dispersers and seed predators affects carbon storage in tropical forest. The maintaining of the carbon storage ecosystem service, and the associated paymments, requires the conservation of intact seed disperser and predator communities and that compensation by smaller dispersers only slightly mitigate carbon loss.

Keywords: Defaunation, dispersers, predators, carbon storage

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Bird and bat predation services in tropical landscapes - spatial context and abundance relationships

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Background: Rapidly ongoing transformation of natural habitats and intensification of land use lead to persistent declines in biodiversity, but the implications for the associated delivery of ecosystem services remain surprisingly poorly understood. A better understanding of ecosystem services in relation to local and landscape context, as well as to species assemblage structure, plays a key role in improving land use and conservation programs. **Methods:** Tropical agroforestry systems such as cacao and coffee can support and benefit from high biodiversity levels - which can further facilitate substantial increases in crop yield and serve as an insurance against insect pest outbreaks, especially in smallholder plantations. Their potential to contribute to food security and sustainable land use concepts depends on local and landscape factors and requires a better understanding of functional relationships between species community structure, ecosystem service provision and human well-being from a landscape perspective. Pest suppression services provided by birds and bats have received great attention in this regard and may serve as a viable alternative to the application of intensive farming practices in tropical landscapes. But only in recent years, the effects of birds and bats on arthropod suppression, multitrophic interactions and crop yields have been evaluated experimentally and in relation to local and landscape factors to understand their relative importance. **Results:** I will present an overview of the available literature and recent findings from community wide manipulation experiments on pest-suppression services of bats and birds across the tropics, including results on their impact on ecosystem service provision in tropical forests and agroforestry systems, implications resulting from global distribution patterns of feeding guilds and habitat affiliations, and recent findings on the importance of species abundance for the magnitude of ecosystem service provision. **Discussion/Conclusion:** Despite revealing global patterns of bird and bat predation services, our results provide implications for improved agricultural management, with respect to socio-ecological challenges in smallholder agroforestry systems. Furthermore, our findings demonstrate that the shape of functional relationships, considering the importance of species abundance for ecosystem service provision, provides an indicator of the resilience to defaunation in tropical landscapes.

Keywords: ecosystem services; defaunation; functional relationships

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Context dependent effects of large wildlife loss on zoonotic disease risk

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Background: It is increasingly evident that the current wave of anthropogenically driven biodiversity loss can be a driver, as much as a symptom, of global change. Yet our ability to predict when and where defaunation events will cascade to affect community structure and ecosystem processes remains limited. This study explores the effects of defaunation and associated land-use change on prevalence and risk of infectious disease at the land scape scale. **Methods:** Conducted in East Africa savanna ecosystem, this study examines the abundance and prevalence of infected hosts and vectors in both experimentally defaunated and naturally defaunated landscapes. **Results:** We find evidence for strong and systematic increases in rodent and tick borne disease following experimental large wildlife removal due to systematic increases in rodent abundance. However, when large wildlife loss is combined with secondary land use change (e.g. agricultural or pastoral land use) the results become much noisier, and much more context dependent, with stronger effect sizes in less productive environments. The mechanisms underlying the effects of defaunation on infectious disease vary across types of disturbance, but include a combination of predictable changes in abundance and competence of hosts. These results suggest potential for synergies between defaunation and climate change impacts on infectious disease risk

Keywords: Defaunation, disease, context-dependence, multiple stressors

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Cracks in island keystones: threat interactions push island flying foxes to the brink

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Following pressure from litchi and mango growers, in late 2015 the Government of Mauritius deployed its Special Mobile Force to shoot > 30,000 individuals of the Mauritius Fruit Bat, *Pteropus niger*, a threatened island endemic and the last of three *Pteropus* species to survive on the island. Illegal hunting and a second cull at the end of 2016 resulted in a total population reduction of > 50% in less than two years. The Mauritian Fruit Bat is just one of 53 island *Pteropus* species, or flying foxes. Intensive hunting and trading of island *Pteropus* in the last century drove one species to extinction and led to the listing of all others under CITES by 1989. Although the ecological importance and vulnerability of island flying foxes was clearly elucidated in a series of publications that followed CITES listing, collectively island flying foxes remain the most vulnerable bats in the world. All four of the recent global bat extinctions were island flying foxes, and 57% of species remain threatened (assessed as Critically Endangered, Endangered, Vulnerable by the IUCN). Moreover, conservation status of threatened species, as measured by the Red List Index, continues to decline at a far more rapid rate than other bats and most vertebrate groups. Here we assemble evidence from the last 25 years in support of the keystone role that flying foxes play in island ecosystems, and describe the threat synergies and feedback loops driving many species to the brink of extinction and compromising the ecosystem services they provide. Flying foxes are effective dispersers and pollinators because of fast, long-distance flight, rapid digestion and in-flight defecation, and an ability to move large seeds. They are elevated to keystone species on islands because they are often the only vertebrate capable of connecting populations within and among islands. On some islands this derives from colonization limitations and evolutionary contingency (e.g., loss of flight, megafaunal downsizing). On others, historical defaunation of other native vertebrates has left flying foxes as the sole effective dispersal agents. Hunting and habitat loss remain the primary threats to species, but most threatened species are subject to multiple interacting threats that accelerate declines and disrupt ecosystem services. Unless bat populations are stabilized and recover, many native island plant communities are living on borrowed time.

Keywords: defaunation, bats, islands, ecosystem services

ID:1019
Wednesday Yucatan-2
Symposium: Defaunation and Ecosystem services

Estimating economic losses to tourism in Africa from the illegal killing of elephants

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Background: Recent surveys suggest tens of thousands of elephants are being poached annually across Africa, putting the two species at risk across much of their range. Although the financial motivations for ivory poaching are clear, the economic benefits of elephant conservation are. poorly understood. **Methods:** We used Bayesian statistical modelling of tourist visits to protected areas to quantify the lost economic benefits that poached elephants would have delivered to African countries via tourism. Our database included information on average annual visits to 165 protected areas (PAs) within 25 elephant range-state countries (these 25 countries collectively contain >90% of Africa's elephants), including 110 PAs that currently contain elephants. In addition, we harnessed information on the most recent (typically ca. 2009-2013) comprehensive elephant population estimates and rates of illegal killing at 216 PAs, and on the average direct and indirect spending levels of nature-based tourists visiting PAs in Africa. **Results:** Our results show these figures are substantial (an average of ~USD $25 million annually), and that the lost benefits exceed the anti-poaching costs necessary to stop elephant declines across the continent's savannah areas, although not currently in the forests. of central Africa. Furthermore, elephant conservation in savannah protected areas has net positive economic returns comparable to investments in sectors such as education and infrastructure. **Conclusion:** Elephant conservation in PAs of the savannahs of East and Southern Africa represents a wise investment with immediate and ongoing payback for tourism. Rates of return are positive, sometimes strongly, in these areas, indicating that tourists' willingness to pay to see elephants as part of a visit to a PA are sufficient to offset the increased costs necessary to safeguard elephant populations. On the other hand, elephant-based tourism cannot currently be expected to contribute substantially to the conservation of forest elephants in central Africa. In these remote, difficult-to-access areas where tourism levels are currently lower than in savannahs and where elephants, with few exceptions, are difficult to see, different funding mechanisms that capture public concern and the 'existence value' of elephants will be necessary to halt recent declines.

ID:1020
Wednesday Yucatan-2
Symposium: Defaunation and Ecosystem services

Symposium
Quantitative acoustic ecology: using sound in tropical biodiversity research and conservation

Coping with global change: shifts in anuran distribution in a tropical mountain

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Background: Global changes, such as climate change and infectious diseases, threaten animal and plant species even in natural and protected areas. To cope with these global changes, species may adapt, move or decline. Here, we test for shifts in anuran distributions in the Luquillo Mountains (LM), a tropical montane forest in Puerto Rico by contrasting occurrence probabilities from historical (1931-1989) and current data (2015-2016). **Methods:** Historical data were gathered through the Global Biodiversity Information Facility (GBIF) and published literature, while the current data were collected using acoustic recorders along three elevational transects. We used a GLM and occupancy models to compare the past and current anuran distributions. **Results:** In the recordings, we detected the 12 native frog species known to occur in LM. Historically, the elevational range (mean=791 m) of these 12 species in LM was larger than in the present (mean=486). For most species, the optimum elevation shifted upslope, with shifts >100 m for *E. portoricensis* (816-947 m), *E. brittoni* (39-318 m), *E. hedricki* (496-683 m) and *E. wightmanae* (618-1049 m). Overall, there was an upward shift in the species elevational range, and this pattern was more common for lower than upper limits. Four species presented a more prominent upward shift (>100m) in the low end of the elevational distribution: *E. portoricensis* (344-567 m), *E. gryllus* (39-669 m), *E. locustus* (268-771 m), *E. richmondi* (329-713 m). **Discussion:** We hypothesize that these dramatic shifts are due to a synergistic effect of climate change and infectious diseases, which are restricting many species to higher elevations and a much smaller area. Three evidences support our hypothesis: 1) LM is a protected reserve without any obvious land use change in the past 80 years. 2) There was an increase in the frequency of dry periods coincident with amphibian declines in LM. 3) Bd was found in the preserved skins of frog specimens coinciding with the beginning of anuran declines in LM. Our study confirms general impressions of amphibian population extirpations at certain elevations, and corroborate the level of threat by IUCN. In addition, we have shown how acoustic monitoring and occupancy models were able to detect changes in elevational range for the amphibian community. From a practical management perspective, this means much time and effort can be saved when using acoustic monitoring to understand animal response to global changes.

Keywords: Climate change, infectious diseases, ARBIMON

ID:1119
Wednesday Yucatan-3
Symposium: Quantitative acoustic ecology: using sound in tropical biodiversity research and conservation

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The effects of noise on the soundscape in an Brazilian Atlantic Forest remnant

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Background: Brazil is one of the most important pulp producers in the world, cultivating much of it in extensive eucalyptus plantations. Many activities related to eucalyptus exploitation have potential impacts on biodiversity. However, there are few studies evaluating them in tropical regions. **Methods:** Using passive acoustic monitoring, we analyzed short-term impacts of noise produced by wood chippers used for field processing of Eucalyptus in an Atlantic Forest remnant. Recordings were collected at three distances from the forest patch edge (two points per distance: 0, 50, 150 m) during three scenarios (pre-chipping, chipping, and post-chipping). We analyze (1) the variation in acoustic activity and soundscape composition; and (2) the change in acoustic activity of five forest bird species (*Xiphorhynchus fuscus*, *Pyriglena leucoptera*, *Corythopis delalandi*, *Basileuterus culicivorus* and *Myiothlypis leucoblephara*) using automated species-specific detection. **Results:** The soundscape analyses showed significant differences, among scenarios in anthropophony (0 to 2 kHz) but not in biophony (>2 kHz). However, when we analyzed different frequency bands, we found variation in the use of acoustic space among scenarios and among bands, with almost no variation in the use of acoustic space among scenarios in frequencies between 2 and 4 kHz (23%; 21%; 20%); a significant decrease in those between 4 and 6 kHz (39%; 23%; 19%); and an increase in those between 6 and 8 kHz (15%; 17%; 25%). The results obtained through the species-specific models corroborate the variations observed in frequency bands analyses, mainly between 4 and 6 kHz (where most acoustic activity of modeled species is concentrated). Post-chipping, *P. leucoptera* seemed to recover similar levels of acoustic activity observed pre-chipping. *M. leucoblephara* presented a gradual decrease in acoustic activity from pre- to post-chipping scenarios. *C. delalandi* and *B. culucivorus* exhibited the most dramatic changes, dropping acoustic activity close to zero without recovery even long after chipping. *X. fuscus* did not show significant changes across scenarios. **Discussion:** Our results strongly support a significant impact of the operation of wood chippers on the forest animal community. These results were presented to the Fibria Celulose team that are implementing control and mitigation measures in order to reduce or, even, neutralize the negative effects of noise produced by this activity.

Keywords: Soundscape, Birds, Atlantic Forest, *Eucalyptus*

ID:1121
Wednesday Yucatan-3
Symposium: Quantitative acoustic ecology: using sound in tropical biodiversity research and conservation

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Soundscapes reveal impacts of natural gas exploration in a tropical forest

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Background: Hydrocarbon exploration and extraction are increasing rapidly in tropical forests, and little is known about their impacts on biodiversity. In high diversity tropical habitats, acoustic monitoring is an excellent tool for sampling a large proportion of the fauna across spatial and temporal scales. **Methods:** We documented impacts of natural gas exploration on biodiversity in a pre-montane forest in Peru by deploying passive acoustic monitoring devices at five distances from an exploratory well. We investigated how soundscapes varied with distance from the platform and also between the construction and drilling phases of well operation. **Results:** All sites demonstrated a pattern of greatest acoustic activity below 8 kHz, with peaks of activity throughout the night (18:00-06:00) and lower activity during the day (08:00-16:00). Soundscapes showed that similarity of acoustic frequencies, including those generated by anthropogenic noise, was greater among sites closer to (≤250 m) and farther from (~500 m) the platform. Soundscapes also revealed more frequencies were used overall during construction than during drilling and showed a weak trend of increasing frequency richness with increasing distance from the disturbance. Regions of the soundscape corresponding to anthrophony (0-2 kHz), biophony (2-8 kHz) and high frequencies (8-22 kHz) displayed distinct patterns from one another. **Discussion:** Results demonstrate that soundscape analysis is a useful tool for evaluating the impact of development activity on the acoustic community, and should be used as a "best practice" in monitoring biodiversity to guide mitigation strategies. For example, in the current case, operational activities should take place during the hours 08:00-17:00 to minimize overlap with the hours in which animals are most active. Additionally, steps should be taken to muffle sounds from machinery in the platform area and reduce the distance at which they can be heard into the forest. Furthermore, not only must the area within the platform be restored after activity has ceased, but monitoring and restoration efforts should extend into the forest, at least up to 500 m where changes in soundscapes are most evident. Studying the soundscape offers the opportunity to go beyond species-specific approaches, letting us examine how the vocalizing community as a whole changes in response to anthropogenic activities.

Keywords: soundscapes; impact assessment; biodiversity monitoring

ID:1120
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Symposium: Quantitative acoustic ecology: using sound in tropical biodiversity research and conservation

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Linking soundscapes patterns to the vegetation structure in the Amazon Rainforest

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Background: The relationship between soundscapes and vegetation structure has been poorly studied despite the important ecological and conservation implications that this kind of information might uncover. Studies that have addressed this topic were limited in sample size or have not recorded the soundscape passively. In addition, no study addressing this relationship has been conducted in a speciose location like the Amazon Rainforest. Here we link soundscape patterns to vegetation structure using a large dataset of recordings and detailed vegetation structure data from eight different Amazonian habitats. **Methods:** We used autonomous audio recorders (AAR) to collect sound data in natural and anthropogenic habitats in the northern Brazilian Amazon. Twenty AAR were programed to record one minute every ten minutes over a one-week period in each habitat resulting in 12,000 recordings per habitat. Vegetation structure data (diameter at breast height, shrub cover, canopy cover, height, ground cover, litter depth) in a 10-m radius were collect in each AAR deployment site after the recording procedure was finalized. We used supervised and unsupervised machine learning algorithms to link the soundscape features (e.g. spectral centroid and acoustic complexity index) to the vegetation structure of each site. Result. The machine learning algorithms revealed significant heterogeneity of the vegetation structure among and within each habitat studied. Self-organizing map clearly show that different clusters formed between burned and forested habitats. Random forest classification yielded a low out-of-bag error and the acoustic complexity index was the most important feature in the classification. They indicated that unique sound signatures within and among habitats are driven by differences in the vegetation structure, such that larger trees and greater shrub and canopy cover supported more diverse animal communities. **Conclusion:** Using a large data set of recordings and detailed vegetation structure data we show that unique sound signatures are driven by different animal communities associated with different vegetation structure, and habitats with similar vegetation structure were similar acoustically. This data collection and analyses approach can be used to explore habitat selection theory and to monitor the impacts of environmental changes (e.g. land use change and wildfires) on animal communities.

Keywords: machine learning algorithms, soundscape patterns

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Behavioral Biogeography: The effects of forest fragment size and isolation on acoustic meme diversity in birds

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Background: Acoustic signaling is a common form of behavioral information transmission in many animal species and may be either genetically inherited or culturally learnt and transmitted between individuals, creating flows of cultural traits (memes) across the landscape. The biogeography of memetic traits in animal populations is poorly described but can have major implications for their evolution, ecology and conservation. In this study, we expand on classical Island Biogeography Theory to characterize the α (i.e. within population), β (i.e. among populations) and γ (i.e. total) acoustic meme diversity for four species of song-learning Hawaiian forest birds in a naturally fragmented landscape. We then examine the effects of species characteristics (mobility and population size), and landscape variables (isolation and habitat fragment size) on patterns of diversity of learned acoustic traits. **Methods:** Automated sound recorders were programmed to record bird vocalizations for five minutes every 20 minutes in 19 wet-forest fragments on the island of Hawaii during the 2015 breeding season. Network analysis and a modeling approach were used to study the overall meme structure and the factors affecting meme diversity. **Results:** As predicted, large fragments had richer meme diversities for all species, while the effect of isolation was species-dependent. Fragments with larger populations showed greater α-diversities for two species, while the species ability to move through the landscape had minor effects on the acoustic patterns. The structure of the acoustic traits was nested (i.e. the memes in fragments with lower meme diversities are a subset of the memes in fragments with higher meme diversities) for all the species. Moreover, the meme structure for one species ('Apapane, *Himatione sanguinea*) suggested the existence of acoustic 'dialects'. **Conclusion:** Overall, meme diversity depended on both landscape variables (fragment size and isolation), and species characteristics (population size and, to a lesser extent, mobility). The results of this study improve our understanding of the biogeography of animal information transmission in fragmented landscapes.

Keywords: Acoustic meme diversity, information transmission

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Large scale bioacoustics-based biodiversity monitoring of Mexico

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Background: Monitoring biodiversity and ecosystem health nationwide in a megadiverse country is a difficult task that often implies extensive human effort and complex data management techniques. Large scale acoustic data collection using autonomous recorders has been ongoing since 2014 in Mexico as part of the National Biodiversity Monitoring System (SNMB, acronym in Spanish) coordinated by the National Commission for the Knowledge and Use of Biodiversity (CONABIO). Manual review of such an ever-growing acoustic collection is a difficult and time consuming task without the use of content-based data mining tools. We explored Deep Learning (DL) techniques for automated bat (order Chiroptera) detection in the ultrasonic spectrum based on bioacoustic data. **Methods:** A collection of software tools were built to allow experts to remotely annotate bat calls in spectrograms produced using bat acoustic data collected from sites across America and for which the bat species was known. The resulting labeled bat calls were used as patterns for training a bat detection deep neural network. The model was validated using an independent set of labeled data. **Results:** In order to integrate human knowledge and machine learning into model training, the following elements were incorporated to the system: 1) a graphical interface for annotating spectrograms, 2) a set of processing and querying services that read and write on a database, 3) a set of tools for retraining models using new information, and 4) a group of bat experts using these tools. 13,450 precise time-frequency spectrograms were initially annotated to build a set of training examples. The model detector was 90% accurate on this training set when measured by 5-fold cross-validation and >80% accurate using an independent validation set coming from Neotropical bat expert annotations. A DL based classification model for 68% of all Mexican bat species is currently being developed. **Discussion:** Ultrasonic recordings are the largest subset of data within the SNMB, and most of this data is attributed to bat calls. Because there are fewer sounds in the ultrasonic spectrum (relative to the audible spectrum), bat species detection is somewhat easier to resolve using machine learning than calls of other taxa in the noisier audible spectrum. The bat detector network built for this purpose demonstrates the great potential of DL as a source of tools for on-going, large scale biodiversity monitoring.

Keywords: Bioacoustics, Biodiversity Monitoring, Machine Learning

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Wednesday Yucatan-3
Symposium: Quantitative acoustic ecology: using sound in tropical biodiversity research and conservation

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Symposium
A landscape perspective on biodiversity conservation and management in oil palm mosaics

Forest connectivity for seed dispersal in Borneo: before and after oil palm development

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Background: Animal-assisted seed dispersal is an important ecosystem process often imperiled by habitat loss and fragmentation through the reduction of functional landscape connectivity. The loss of seed dispersal affects natural regeneration processes (e.g. through changes in gene flow or vegetation dynamics) in remaining forested areas, and can limit the outcomes of forest restoration initiatives. In Borneo, rapid oil palm expansion has resulted in extensive forest loss and fragmentation, and thus, it has likely impacted functional connectivity and seed-dispersal processes across forested landscapes in the island. To investigate these impacts, we modeled changes in habitat availability, species distribution and functional connectivity of frugivorous forest vertebrates between 1973 and 2015. **Methods:** We mapped concentrations of frugivorous vertebrate species in the island, using refined species distributions and habitat availability maps, and modelled landscape functional connectivity for these species through graph theory approaches. Our methodology allows us to determine the contribution of a forest patch, or a forested area, to the overall functional connectivity in the landscape. **Results:** Spatially explicit models of connectivity for frugivorous birds and mammals showed a marked loss of connectivity throughout Borneo's forests over the past 40 years, in particular for forests below 1000 m. These lowland forests are highly diverse and can house concentrations of up to 60 frugivorous species in a given patch. The extirpation of these species is likely harming native plant populations, with impacts that are expected to worsen over generations. **Discussion/Conclusion:** Through our models we are able to identify areas that are critical to the conservation of functional connectivity for frugivorous species at the landscape and regional scales. As such, our approach can be used to prioritize areas for the maintenance of seed dispersal processes. These conservation priorities are especially important in the face of continued expansion of commodity plantations (such as oil palm) in Borneo.

Keywords: biodiversity, connectivity, landscape, oil palm

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Do High Conservation Value (HCV) areas improve rainforest connectivity in oil palm landscapes?

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Background: Conservation of biodiversity in oil palm-dominated landscapes requires habitat networks that connect remaining areas of rainforest. Our empirical studies reveal that oil palm plantations may act as barriers to the dispersal of some rainforest-dependent species, making it important to examine ways of improving rainforest connectivity in order to facilitate the movement of species through these agricultural landscapes. Roundtable on Sustainable Palm Oil (RSPO) voluntary certification standards require areas of rainforest with High Conservation Values (HCVs) to be conserved, and we examined whether these HCV areas make an important contribution to landscape connectivity. **Methods:** We used RSPO audit reports to create digitized maps of HCV areas in Indonesian Borneo, and remotely-sensed landcover data to assess the quality and placement of these HCVs. We also used a modelling approach that combines patch-based metapopulation dynamics and electrical circuit theory to assess the connectivity benefits of HCV areas for species with different dispersal abilities. **Results:** HCV areas provide some connectivity benefits, but these benefits are site-dependent. The extent to which HCV areas improve connectivity depends primarily on the amount of forest remaining in the landscape surrounding the plantation. **Discussion:** Our study quantifies the ecological impacts of the HCV process, and hence the impact of the RSPO's environmental sustainability standards for reducing biodiversity losses in oil palm plantations. It is important to assess the robustness of the HCV process and provide recommendations to the RPSO for managing HCV areas in order to promote connectivity and biodiversity in oil palm landscapes.

Keywords: Landscape connectivity, fragmentation, RSPO, Borneo

ID:1111
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Symposium: A landscape perspective on biodiversity conservation and management in oil palm mosaics

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Exploring biodiversity-yield trade-offs in rubber and oil palm smallholder systems

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Background: Tropical biodiversity conservation and agricultural production are commonly perceived as incompatible. How tropical biodiversity conservation can be reconciled with the need for increasing socioeconomic gains without further expansion of agricultural land is a major challenge in the current UN "Decade of Biodiversity". Tropical smallholder agriculture is a major driver of ongoing agricultural expansion; yet, it may also harbor great potential for maintaining relatively high levels of on-farm biodiversity while optimizing the income of farmers. However, multidisciplinary studies to quantify the relationship between socioeconomic and ecological functions under different land-uses and management options in tropical smallholder systems are rare. **Methods:** The Collaborative Research Centre EFForTS (Ecological and Socioeconomic Functions of Tropical Lowland Rainforest Transformation Systems (Sumatra, Indonesia)) studies smallholder land-use in the three dominant rainforest transformation systems in Jambi Province, Sumatra: agroforestry jungle rubber, rubber monoculture and oil palm monoculture. Using extensive sampling and a multidisciplinary approach, we assess the species richness of the major taxonomic groups in these land-uses, variation in agronomic practices and socioeconomic drivers, as well as the final ecosystem service to farmers, crop yield. **Results:** We find only weak evidence for biodiversity-yield trade-offs. Comparing responses in species richness of nine major taxonomic groups (e.g., bacteria, ants, trees) across the three land-uses, we find no significant correlation of biodiversity and yield in 24 comparisons, two negative correlations and 1 positive correlation. **Discussion:** We identify agronomic and socioeconomic drivers of variation in biodiversity and in yield, and give recommendations for biodiversity-friendly farm management that simultaneously allows for considerable increases in income. Despite considerable losses in biodiversity following rainforest conversion, yield gaps in smallholder land-use systems allow for increasing socioeconomic functions without further compromising ecological goods.

Keywords: socioeconomic-ecological trade-offs, habitat complexity, management

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Symposium: A landscape perspective on biodiversity conservation and management in oil palm mosaics

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Integrated landscape approaches to managing social and environmental issues in the tropics

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Poverty, food insecurity, climate change and biodiversity loss continue to persist as the primary environmental and social challenges faced by the global community. As such, there is a growing acknowledgement that conventional sectorial approaches to addressing often inter-connected social, environmental, economic and political challenges are proving insufficient. An alternative is to focus on integrated solutions at landscape scales or 'landscape approaches'. The appeal of landscape approaches has resulted in the production of a significant body of literature in recent decades, yet confusion over terminology, application and utility persists. Focusing on the tropics, we systematically reviewed the literature to: (i) disentangle the historical development and theory behind the framework of the landscape approach and how it has progressed into its current iteration, (ii) establish lessons learned from previous land management strategies, (iii) determine the barriers that currently restrict implementation of the landscape approach and (iv) provide recommendations for how the landscape approach can contribute towards the fulfilment of the goals of international policy processes. This review suggests that, despite some barriers to implementation, a landscape approach has considerable potential to meet social and environmental objectives at local scales while aiding national commitments to addressing ongoing global challenges.

Keywords: landscape approaches, review, implementation, policy

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Symposium: A landscape perspective on biodiversity conservation and management in oil palm mosaics

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Reframing the evidence base: ensuring our research makes a difference to oil palm sustainability

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Background: The oil palm industry is responsible for serious environmental damage but is vital to the economies of the countries where it is grown. Therefore, it is essential that we find more sustainable ways of producing palm oil which balance economic and environmental needs better. Scientists have an important role to play in solving this complex problem but we need to overcome barriers of communication, relevance and timeliness in order to create more impact for our research. **Methods:** We developed a process of knowledge exchange to improve the uptake of science into policy for more sustainable palm oil. We illustrate this process using a successful case study in which we synthesized data on biodiversity levels and ecosystem functioning in forest fragments to determine viable forest patch sizes for use in the design of conservation set-asides for certification standards. **Results:** Our synthesis showed that while large tracts of forest are necessary to conserve the full complement of species diversity, at the "within-plantation" scale, patches of a few hundred ha have considerable conservation value. As a result of our knowledge exchange process, this information has been successfully incorporated into industry guidelines and initiatives. **Conclusion:** Our process was successful because we have developed long term working relationships with key stakeholders. We were therefore able to understand their policy needs and reframe the scientific evidence accordingly. Continual dialogue and interaction with the policy arena is essential for enabling scientists to provide relevant and timely information for improving oil palm sustainability.

Keywords: fragmentation, policy, biodiversity, Borneo, conservation

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Symposium: A landscape perspective on biodiversity conservation and management in oil palm mosaics

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Realizing ecologically sound land-use planning in the oil-palm industry

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Oil palm agriculture has been identified as a major driver of biodiversity loss in the tropics, due to the large-scale deforestation associated with its rapid expansion. Sustainability initiatives in the industry have focused on reducing habitat loss resulting from new oil palm development. We argue, however, that these efforts have failed to address the spatial and temporal dimensions of this process, particularly by ignoring the broad range of threats to biodiversity that arise from oil palm expansion; notably habitat fragmentation and changes in ecosystem processes. We propose that land-use planning in the industry needs to actively anticipate and address the full scope of threats to biodiversity, as well as the spatial and temporal scales at which they operate, in order to preserve the ecological viability of these regions. We discuss how adequate regional planning and landscape-based approaches can contribute to address these shortcomings, what type of indicators could be used to guide such planning, and the factors that may facilitate or hinder the success of these approaches. The presentation finishes the session by summarizing and connecting the various topics addressed throughout all presentations in this symposium.

Keywords: land-use planning oil palm

ID:1112
Wednesday Yucatan-4
Symposium: A landscape perspective on biodiversity conservation and management in oil palm mosaics

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Symposium
Bridging conservation ecology and genomics in the study of species with Crassulacean Acid Metabolism

Evolution and diversification of CAM in tropical epiphytic orchid species

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Background: Crassulacean Acid Metabolism (CAM) is a water-conserving mode of photosynthesis present in about 7% of vascular plant species. Thanks to genomic technologies, our understanding of the genes that modulate the expression of Crassulacean Acid Metabolism (CAM) is rapidly expanding. To better understand the role of CAM in species radiations and the molecular mechanisms of CAM evolution, we study CAM evolution in orchids, one of the largest families of flowering plants. **Methods:** Plasticity of CAM in orchids is assessed using 24 hour gas exchange under drought stress conditions. Carbon stable isotopic composition of leaf samples from over 2,000 species were used to map the occurrence of CAM in the orchid family. To investigate patterns of functional diversification related to the expression of CAM in orchids, comparative analysis of RNA sequencing from closely related species with CAM and C3 photosynthesis are used to identify genes that follow time-dependent patterns associated with the CAM pathway. Anatomical leaf traits of 60 orchid species with C3, weak CAM and strong CAM were compared and related to photosynthesis type. **Results:**. Measurements of 24-hour gas-exchange shows that some orchid species with weakly expressed CAM can significantly increase their CAM activity when water stressed and, in some cases, revert to weak CAM upon re-watering. CAM species tend to have lower average stomatal size and lower stomatal density related to lower stomatal conductance when compared to C3 orchid species. Based on carbon isotope analysis, new genera with CAM were discovered, and CAM was shown to have evolved multiple times within the Orchidaceae. **Discussion:** The occurrence of CAM is correlated with shifts to epiphytic habits, especially within the Subfamily Epidendroideae, a clade with the majority of extant CAM species in orchids. Anatomical and physiological traits are important drivers in CAM evolution and are further discussed. Using closely related Oncidiinae orchid species, candidate CAM genes and regulators are assessed to better understand the molecular basis for the evolution of CAM. This project is part of a Dimensions of Biodiversity team effort aimed at understanding the evolution of CAM in plants.

Keywords: Crassulacean Acid Metabolism, orchids, epiphytes

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Vanilla species in the Choco Wet Forest (Colombia) distribution and functional traits

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Background: Species coexistence mechanisms include a broad range of strategies to occupy different ecological niches. In diverse tropical rain forests plant species are strongly limited in their use of biotic and abiotic resources because of competition. Plant abiotic resource partition is visible through water and nutrient uptake strategies, meanwhile biotic interactions with endophytes and pollinators may reflect biotic resource partition. We studied four coexisting native Vanilla species in the Choco Wet Forest (Western Colombia) in order to understand which are the main determinants for its coexistence. We analyzed whether ecological niches of these four species overlap and if fruit harvesting of native populations is long-term sustainable. **Methods:** Vanilla species were studied in eight sites. We recorded species distribution, reproductive monthly phenology during a year, floral morphology, breeding system, functional traits, floral visitors, pathogens and microorganisms associated with roots. **Results:** Our results showed that the four *Vanilla* species (*V. planifolia*, *V. odorata*, *V. cribbiana*, and *V. trigonocarpa*) presented different mechanisms to avoid direct competition among them for resources from top to bottom. Species occurred in the same locations with a subtle differentiation among habitats. Leaf functional traits were segregated among species and differences were maintained along a plant vertical stratification. Floral morphology, aperture, receptivity and flowering peaks were similar among species. Plant-pollinators and plant-microorganisms networks were well defined for each species. Fruit production was scarce during a year of monitoring. **Conclusion:** Niche segregation of Vanilla species through biotic and abiotic resource partition prevent competitive exclusion and hybridization, however fruit productions is very low. Species in such conditions will be very vulnerable to fruit harvesting. *Vanilla* species showed a very low fruit production and a narrow niche overlapping even when they coexist in the same locations. Our study indicates that Vanilla species will be face a population bottleneck if fruit harvesting is not controlled.

Keywords: Coexistence, leaf functional traits

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Evaluating the occurrence of CAM photosynthesis in orchids from Colombia's contrasting habitats

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CAM photosynthesis is considered a key innovation enabling orchids to occupy stressful and/or arid habitats, but only about 5 % of all orchid species have been surveyed for photosynthetic pathway. Likewise, the relationship between photosynthetic pathway and climatic variables has been poorly understood. Here we expand the survey of photosynthetic pathways among tropical orchids by analyzing the carbon isotopic signatures (Î´13C) of herbarium material of 1,143 Colombian species belonging to 189 genera. The occurrence of CAM was then analyzed in a biogeographical context using the geographic coordinates from the herbarium specimens and climatic variables extracted from the WorldClim Data Base. With the Î´13C values and climatic data from each sample we run a generalized linear model to determine the relationships between climatic variables, epiphytism and taxa with the photosynthetic pathway. CAM was present in 10.3% of species surveyed. We report for the first time CAM on orchids at very high altitudes (> 3,000 masl). The variables that had a significant effect over photosynthetic pathway were taxa (genera), precipitation of driest quarter, mean annual temperature and growth habit. CAM was more frequent on epiphytes, and on drier and warmer sites in the lowlands. We also find a very unique elevation distribution pattern of orchid diversity. While most previous work report one peak of high diversity at mid altitude (i.e. about 1,500 m along the belt of cloud mountain forest), we found one additionally peak of high orchid diversity in the lowlands, at 0-500 m elevation. This work represents the first screening of photosynthetic pathway in Colombian orchids and establishes interesting insights on climatic-photosynthetic relationships.

Keywords: Carbon isotopes-Climatic data-epiphytism-Orchidaceae-photosynthetic pathway

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Seasonal expression of CAM photosynthesis in three species of *Clusia* in Panama

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Background: *Clusia* is a neotropical genus of approximately 300 species of arborescent plants. It is the only known genus that contains trees exhibiting the water-conserving CAM (crassulacean acid metabolism) pathway of photosynthesis. *Clusia rosea* is considered to be a species with constitutive CAM, whereas *Clusia pratensis* and *Clusia* minor are considered species with facultative CAM. Information on photosynthetic-pathway characteristics is largely derived from experiments with potted plants under controlled conditions. C3-CAM relationships have never been examined over a complete annual cycle in the field. In the 18-month study presented here, CAM activity was assessed in situ at narrow, weekly intervals in plants of *C. rosea*, *C. pratensis* and *C. minor* undergoing seasonal wet-dry season changes in Panama. **Methods:** Plants, up to 6 m tall, grew in natural soil at the forest edge at the Smithsonian Tropical Research Institute facilities in Gamboa, Republic of Panama. Plants were studied from November 2015 to April 2017, covering a complete wet season and two dry seasons. At weekly intervals, mature sun leaves were excised at dusk and dawn and 2 leaf discs (diameter 2 cm each) per leaf (= one sample) were frozen in liquid nitrogen. For determination of titratable acidity, samples were boiled sequentially in 50 % ethanol and water, and titrated with 25 mM NaOH to pH 6.5. Carbon isotopic signatures of leaves collected during the wet and dry seasons were determined with a ratio mass spectrometer. Photon flux density (PFD), rainfall, temperature and relative humidity were continuously monitored at the study site. **Results:** *C. rosea* showed pronounced nocturnal acidification on almost all days throughout the year, whereas in *C. pratensis* and *C. minor*, nocturnal acidification was confined to the dry season. During the wet season, *C. pratensis* and *C. minor* maintained high levels of leaf acidity throughout day-night cycles, with acidity levels at dusk occasionally even exceeding those at dawn. Nocturnal acidification was strongly influenced by PFD during the preceding light period, particularly in *C. rosea*. **Conclusion:** While CAM photosynthesis occurs year-round in *C. rosea*, it is a dry-season-only phenomenon in *C. pratensis* and *C. minor*.

Keywords: Clusia, facultative CAM, drought, photosynthesis

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Under what conditions *Clusia* expresses CAM photosynthesis, C3 or any of its intermediate forms?

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Background: *Clusia* is a Neotropical widely distributed genus with around 300 worldwide species, and about 143 species reported for Colombia. This group is diverse and versatile; it has a great diversity of life forms even within the same species. The group seems to have a high degree of metabolic plasticity where species can move from C3 to CAM in response to water scarcity or growth form. The aim of this research was to assess the importance of growth form and environmental variables in determining the metabolic pathway on Clusias from Colombia. **Methods:** We sampled leaf carbon isotopic composition of 574 herbaria specimens of 117 Clusia species from 12 different Herbaria in Colombia. We selected the following environmental variables: Altitude, annual mean temperature, maximum temperature of warmest month, minimum temperature of coldest mont, temperature annual range, mean temperature of wettest quarter, mean temperature of driest quarter, mean temperature of warmest quarter, mean temperature of coldest quarter, annual precipitation, precipitation of warmest quarter, precipitation of coldest quarter, cloud cover and habit. **Results:** Our study covered 81.1% of all the *Clusia* species from Colombia. Our finding indicates that altitude and annual precipitation were the key environmental variables influencing the expression of CAM. CAM was most prevalent at low altitudes and was presented in regions with low precipitation. No CAM species appeared above 500 m.a.s.l and C3 species had a wide altitudinal range. *Clusia* reported in greater number C3 photosynthetic (95.72%) followed by C3_CAM (11.11%) and CAM (5.12%) photosynthesis. Additionally, both *C. fructiangusta* and *C. minor* each with 12 collected specimens, presented two types photosynthesis, C3 and the intermediate pathway C3-CAM, within the same species. For *C. minor* this behavior had already been reported. Also, *C. nigrolineata* with only 3 specimens showed two types of photosynthesis C3 and CAM. **Discussion/Conclusion:** With this, it was found that 17 *Clusia* species reported variation among their population since they showed two types of metabolism for each species. This variability in CO2 uptake patterns with these three metabolic pathways (C3, C3-CAM and CAM) may have contributed to the successful invasion of *Clusia* into a wide range of ecosystems and altitudes in the tropics.

Keywords: Photosynthesis, C3, CAM, C3_CAM, Climatic-variables.

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Engineering Tissue Succulence and CAM to Improve Plant Water-use Efficiency

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Background: To overcome the negative effects of global warming and drying trends, an increased reliance upon crassulacean acid metabolism (CAM) crops or the introduction of CAM, a water-wise form of photosynthesis, into C3 food and bioenergy crops might serve as a useful strategy to improve the water-use efficiency (WUE) of sustainable food and biomass production in the future. **Methods:** Tissue succulence was engineered via overexpression of a basic helix-loop-helix (bHLH) transcription factor from wine grape. RNA-seq-based transcriptome profiling was performed on the common ice plant, a facultative CAM model in which CAM can be induced by water-deficit or high salinity stress, to identify specific gene family members with CAM-related functions. Arabidopsis promoter regions were identified that provided circadian, drought-inducible, and mesophyll-specific gene expression patterns. Selected promoters were matched to the expression patterns of target CAM enzymes and were used to construct custom transcription units using Multisite Gateway® Pro recombinational cloning. Gene circuits consisting of combinations of TUs were then assembled using Gibson isothermal assembly using a series of custom position, adapter, and carrier vectors. **Results:** Tissue succulence, which is thought to be an anatomical requirement of nocturnal C4 acid storage of CAM species, was achieved through the overexpression of a bHLH transcription factor from wine grape. Arabidopsis plants with engineered tissue succulence displayed increased cell and organ size, increased biomass and seed yield, and improved salinity and drought tolerance, compared with controls. A facile gene stacking strategy was also developed that enables the assembly of multiple TUs with appropriate circadian and drought-inducible expression patterns necessary for the genetic reconstitution of facultative CAM into host C3 photosynthesis species. **Discussion:** Increased cell size is expected to increase malate storage capacity, and reduced intercellular air space is expected to limit internal CO_2 diffusion out of the leaf during the day to increase the capacity to perform CAM. The plant-specific position/adaptor/carrier vector system developed has enabled the rapid, reliable, and scalable creation of complex CAM gene circuits using the Gibson isothermal assembly process, which are in the process of being introduced into Arabidopsis and Poplar.

Keywords: CAM, WUE, drought, salinity, biodesign

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Being CAM in the Yucatan: Strategies for survival in key species

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Background: We explore the morphology and lifecycle strategies of two groups of species in the Yucatan Peninsula, the epiphytic species of Bromeliaceae and the terrestrial species *Beaucarnea pliabilis* (Despeinada or Pata de elefante, family Asparagaceae, subfamily Nolinoidae), which had not been previously described as CAM. Both these groups are successful in drought prone, stressful environments within the Peninsula. And both of them show plasticity, from being in more exposed sites of a dry forest in the Northern Yucatan, to the shaded understory of the Southern, more mesic forests. **Methods:** We present field data of both bromeliads and *Beaucarnea* generated in field sites across the Peninsula, sampled in 10 x 10 m plots that describe their abundance and morphological traits. This data is related to local environmental variables. We also present germination and growth experiments in the greenhouse, which characterize their ability to withstand drought and excess light. Result. Both the Bromeliaceae species and the *Beaucarnea* show morphological and physiological plasticity that explains their ability to inhabit a range of habitats of varying precipitation and light incidence. For the Bromeliaceae, we found seeds and leaf traits differentiated between those species inhabiting either the wetter or dryer extreme of the Peninsula. In the case of the *Beaucarnea*, only one of the three species studied, the one native of Yucatan, *B. pliabilis* showed weak diurnal acid fluctuations. This species showed high storage of osmolytes, and a significant relationship between the acidity and water potential, signaling that it may use CAM to lower its water potential and increase water transport towards the leaves. These acid fluctuations were higher when under drought. In the field, significant changes in height and in diameter of the stem were found between dry and wet habitats. **Discussion and/or Conclusion:** The CAM species of the Yucatan Peninsula show great plasticity to deal with the changing environmental conditions, allowing them to remain active year round, even when most other species may be deciduous or short lived. This plasticity necessary to survive within site variation may also enable their distribution in contrasting environments of the Peninsula.

Keywords: Crassulacean acid metabolism, *Beaucarnea*, Bromeliaceae,

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Elevational ranges of tropical montane epiphytes point to high sensitivity to climate change.

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Background: Tropical montane forests are the most biodiverse regions on the planet, but may be at high risk under climate change. In order to test standing hypotheses that tropical species are sensitive to small changes in climate, we need detailed data on these species' climatic niches, which is currently lacking. Here we provide novel estimates of climate sensitivity from the field for epiphytic plants, which are highly sensitive to microclimate and may be early indicator species for the biological effects of climate change. **Methods:** We measured the precise elevational ranges of 72 species in two genera (*Elaphoglossum* and *Peperomia*) through detailed surveys across large elevational gradients on three mountains: Monteverde and Volcan Barva in Costa Rica, and Volcan Baru in Panama. We also carried out a large reciprocal transplant experiment with 17 species across six climatically distinct sites in Monteverde, which has been monitored for 2.5 years. Species were transplanted both outside of and within their native ranges, testing whether these epiphytes can survive in climates outside those where they are currently found, and whether any sign of local adaptation exists between populations in different climatic zones of the native range. **Results:** Many species occupy different elevational ranges on the three nearby mountains. Additionally, the local elevational ranges of each species are much smaller than their global elevational ranges. Finally, transplant experiments indicate that most species suffer when moved outside their native climatic niche in the field, even when they were moved to elevations at which they were observed on other nearby mountains. Specifically, precipitation and moisture exert much stronger control over epiphyte fitness than does temperature; the largest changes in precipitation caused near total mortality within 6 months. **Conclusion:** This study combined local, regional and global scale distribution information to gain an accurate picture of species' climatic niches. Species' elevational ranges measured in situ on three mountains show that individual populations, even within the same region, occupy much smaller realized climatic niches than what we would measure for the species as a whole. The results from our transplant experiment indicate that a drying trend, as predicted in some parts of the neotropics (including Central America), could be devastating for epiphyte communities, which are highly sensitive to moisture availability.

Keywords: climate change, epiphytes, biogeography, elevation

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Can the use of CAM plants contribute to climate change adaptation in Mexico?

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Anthropic global climate change is anticipated to drive down agricultural yields during the present century owing to a combination of increasing air temperatures and decreasing precipitation. In this scenario, the development of alternative, climate-ready crops may provide a pertinent adaptation measure, such as the utilization of crops with Crassulacean Acid Metabolism that have been selected to maximize productivity under potentially stressful environmental conditions. Indeed, the cultivation of *Agave*s, for example, to obtain fiber, sugars, or ethanol has been suggested as an adaptation to increasingly dry environments, given their ability to remain physiologically active throughout the year, including in sites with marked seasonality. Potential productivities for *Agave* species from Mexico were modeled under current climate and the IPCC Ar5 RCPs to determine potential regions for cultivation in Mexico over the course of the present century. A special consideration was made for *Agave tequilana*, utilized to produce tequila, and A. *angustifolia*, whose potential productivity may decrease by up to 40% by mid-century and 60% by 2090 in the territory considered in their respective Geographic Designations. However, alternative optimal regions for their cultivation are likely to emerge during the present century for the CAM crops considered in this work, which appear to be better suited than other crops to fare environmental change during the present century.

Keywords: climate-change, food-security, bio-fuels, aridity

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Mapping nitrogen pollution in a megalopolis: the case for an atmospheric CAM bromeliad

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An increase of nitrogen deposition resulting from human activities is not only a major threat for global biodiversity, but also for human health, especially in highly populated regions. It is thus important and in some instances legally mandated to monitor reactive nitrogen species in the atmosphere. However, deployment of automated networks can be excessively costly for most cities so the utilization of widely distributed biological species suitable for biomonitoring may be a good alternative. The aim of this work was thus to assess the suitability of the atmospheric CAM bromeliad *Tillandsia recurvata* as biomonitor of nitrogen deposition by means of an extensive sampling of this plant throughout the Valley of Mexico, the basin where the megalopolis of Mexico City (population 20 million) is located, and subsequent measurements of nitrogen metabolism parameters. Nitrogen content of *T. recurvata* was significantly higher in the city than in the countryside, the rates of wet deposition showed no effect on the nitrogen content of this plant. In contrast, a linear relationship between the nitrogen content and the atmospheric concentration of NOx was observed (R2=0.75). Also, the isotopic composition showed a linear relationship with the NOx concentration, plants tissues were 15N enriched, in sites with high concentration of NOx and was depleted in less polluted sites (R^2=0.5). However, in sites where the NOx concentrations were above 212 ppm, this plant was not found, which suggest that NOx in high concentrations is toxic for this plant. *T. recurvata* is not as good biomonitor for nitrogen wet deposition as other biomonitors, but it is excellent for nitrogenous gases in the atmosphere. In addition, its CAM photosynthesis enables it to be physiologically active year round to record pollution. These plants can be utilized to determine the status of the NOx emissions in regions without monitoring networks.

Keywords: Biomonitoring; Megacities; Urban ecology

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Leaf physiology and the distribution of CAM tank-epiphyte bromeliads at multiple spatial scales

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Background: Trait-mediated divergences in bioclimatic relations could represent an important pathway to the evolution and maintenance of genus-level diversity, but there are few comprehensive studies of this effect in regional florae. To investigate this topic, we mapped the distributions of epiphytic, tank-forming CAM bromeliads of the genus *Aechmea* across the Northern Range of Trinidad, a topographically and climatically heterogeneous continental island in the southern Caribbean. **Methods:** Multi-season field surveys were carried out to map species distributions. Structural-functional characterisation of representative plants was undertaken, and species distribution modelling (SDM) was performed to determine which environmental factors and species traits are involved in niche segregation. Modelled projections of species distributions on the island of Tobago were ground-truthed, and projections of distributions under an aggressive 2070 climate scenario were performed. **Results:** Distribution mapping highlighted distinct elevational and latitudinal effects on species presence and abundance, with some evidence for vegetational effects on bromeliad distributions. Bioclimatic differentiation captured by SDM was associated with contrasting water-use strategies, stomatal sensitivity, temperature relations, and drought responses. Many divergences in function were connected with differences in leaf structure. Projected distributions under the 2070 climate scenario suggested extreme vulnerability to upslope shifting of bioclimate envelopes in the montane species. **Discussion:** At a regional scale, the distributions of CAM tank-epiphyte bromeliads across the Northern Range of Trinidad are strongly influenced by broad environmental gradients acting on species structural and functional traits. Topography generates a complex climatic mosaic that modulates these general patterns. At the landscape scale, vegetational composition, controlled by climatic and edaphic factors, can be important. At the scale of individual canopies, bromeliad phenotypic plasticity leads to only weak differentiation in microhabitat preferences. This investigation highlights how interspecific variation in vegetative trait complexes related to abiotic tolerances is an important and underexplored contributor to the ecological diversity of the Bromeliaceae. Climate change could lead to rapid loss of suitable habitat for more environmentally-specialised species, potentially leading to extinctions.

Keywords: Epiphytes; Bromeliaceae; Ecophysiology; Climate change

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Symposium
Exploring the fate of tropical forests under drier climates: linking mechanisms to models

Seasonal and El Niño changes in LiDAR-derived LAI and leaf area profiles in an Amazonian forest

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Background: The ecophysiological dynamics of Amazon forests influence climate through carbon and energy cycling. With drought frequency projected to increase, improving simulations of forest drought responses in Earth System Models (ESMs) is a current priority. Insights may be gained from observations of seasonal dry periods. Previous studies have characterised the seasonality of total leaf area index (LAI) in evergreen tropical forests but few have investigated whether seasonal patterns of LAI differ between canopy strata. We hypothesize that the variability of plant traits with height and microenvironment gives rise to vertically structured LAI seasonality and drought responses. **Methods:** We assessed seasonal patterns of LAI and vertical canopy structure across three years, including the 2015-2016 El Niño-induced drought, in the Tapajós National Forest, Brazil using monthly ground-based LiDAR measurements. **Results:** Large and opposing seasonal swings in LAI at different canopy levels aggregated to small variations in total LAI. In all years, leaf area increased in the upper canopy during the dry season, and decreased in the lower canopy. The trends reversed at the onset of the wet season. Seasonal changes in satellite-derived enhanced vegetation index (EVI) agreed best with LIDAR-derived upper canopy LAI, not total LAI or the lower canopy. During the El Niño year, the seasonality of LAI and vertical canopy structure were similar to other years, but amplified. Total LAI declined dramatically at the height of the El Niño. Initially, the lower canopy was most strongly affected, but towards the end of the drought, the upper canopy lost considerable leaf area. **Conclusion:** Our results show that small seasonal changes in total LAI can mask more dynamic phenologies at different levels in the canopy. Satellite-derived EVI appears to primarily capture seasonality of the canopy surface. Seasonal structural responses are indicative of stronger drought effects. Lower canopy responses are consistent with water limitation of small trees, and the upper canopy with changes in light availability. Significant deep soil water depletion may explain the delayed negative response of the upper canopy to drought. The dynamic nature of within-canopy structural changes implies differences in the carbon balance of canopy strata, as aspect which could help to improve ESM predictions of seasonal patterns of productivity and drought responses at evergreen tropical forest sites.

Keywords: tropical forests, drought, forest structure

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Mortality of tropical dry forest tree species following an extreme drought

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Background: During the past El Niño Southern Oscillation event, Central American region experienced the most severe drought on record. Precipitation deficits varied regionally, but the most severe decline occurred in areas with tropical dry forests (TDF). As TDF trees species cope with recurrent seasonal drought, it is possible that they are resistant to unusual drought. By contrast, it is possible that dry forest trees are vulnerable to drought, as their dynamics are closely linked to rainfall. Thus, our goal was to understand the effects of an abnormal drought event on TDF tree communities, linking species responses to drought with their physiological traits. **Methods:** We conducted our study in the tropical dry forest of the northwestern region of Costa Rica. We recorded tree growth, mortality and recruitment along a period of eight years in 18 plots that span edaphic and successional gradients. Additionally, during 2015 we surveyed eight 200 m transects in order to incorporate landscape patterns of tree mortality. Furthermore, in order to provide insight into the underpinning mechanisms determining tree mortality patterns we collected functional traits data on the most common species (27) in our surveys. **Results:** We found an overall increase of mortality during the drought from a yearly average of 3.1 to 6.2% yr^{-1}, which correlated with the decrease in precipitation. Interestingly, 2015 mortality rates varied from 60 to 0 % yr^{-1} depending upon species. Some species showed a decrease in growth rates prior to mortality, consistent with the hypothesis of carbon starvation. While there was no preferential mortality by size class, older forests were more affected than early successional stages. Surprisingly, plant functional traits were not strong predictors of interspecific variation in mortality rates. **Discussion:** A significant reduction in precipitation for two years led to a large increase in mortality, suggesting that tropical dry forest tree species are sensitive to drought. At the same time, we found that responses are highly variable among species and possibly depend on several physiological mechanisms working together. From our data, we propose that both mechanisms, hydraulic failure and carbon starvation, take place when species undergo severe drought stress for long periods.

Keywords: Ecophysiology, growth rates, rainfall deficit.

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Impact of the El Nino-Southern Oscillation on transpiration of tropical forests

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Background: There is a current lack of knowledge regarding responses of tropical forests to climate change, especially in context of extreme drought or precipitation events. Since pan-tropical forests are among the most highly productive biomes on earth, uncertainty in climate-driven controls on their carbon and water exchange with the atmosphere limit accurate projections of future ecosystem functioning and subsequent feedback to global climate. Large collaborative research programs have started in recent years to address this problem, including the Next-Generation Ecosystem Experiments-Tropics project (NGEE-Tropics), whose efforts are focused on improving knowledge of tropical forests and their response to climate in order to improve Earth System Models Here we provide a comprehensible analysis of tree transpiration responses during the 2015-2016 El Niño-Southern Oscillation event (ENSO) using data collected from multiple tropical research sites with a wide gradient in annual precipitation. **Methods:** Sap flow data were collected during and after the ENSO event from trees representing more than 40 species and 10 plant families across multiple sites and tropical regions. Heat pulse and Granier-style sap flow probes were installed near the base of the tree in outer sapwood and provided an index of the ENSO impact on tree water use. We restricted our analysis to trees containing continuous measurements before, during and after the ENSO event enabling us to determine a range of tree responses to decreasing water resources and subsequent recovery from drought stress **Result/Discussion:** We found a large heterogeneity of sap flow responses during the ENSO within and among study regions. The diversity of strategies to deal with drought stress was partially explained by species functional traits (e.g., wood density, hydraulic strategy and growth rate), background climate conditions, and intensity of soil water depletion during the ENSO. This analysis demonstrated that the regulation of water use by trees under adverse conditions is highly variable across regions and species in the tropics, and that more long-term experimental and modeling studies of tropical forest hydrodynamics is needed to understand their feedback to climate.

Keywords: ENSO, sapflow, drought, diversity

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Importance of individual level and fine scale traits for predicting ecosystem functioning

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Background: Functional traits hold the promise to be used as scaling tool, by connecting plant characteristics with plant performance and ecosystem functioning. Most trait-studies take species as units, and detect strong trait trade-offs that are linked to growth and survival. However, communities are in fact composed of individuals and the question then, is whether individual level traits are good predictors of performance attributes relevant to ecosystem scaling, such as individual growth. Another relevant question for scaling is how much variance there is in hydraulic traits across local hydrological environments, that are usually not included in large-scale ecosystem models. **Methods:** To address the first question we measured 25 traits for ~1000 individual saplings distributed across a range of hydrological environments (from dry plateaus to waterlogged valleys) in a central Amazonian forest, and related these traits to individual sapling growth. For the second question we measured anatomical and physiological hydraulic traits on 15 congeneric species pairs, of which one was restricted to dry plateaus and the other to wet valleys. **Results:** Individual tree growth was weakly predicted by key individual traits such as specific leaf area (SLA) and wood density (WD), and was much more related to local light conditions and the height position of the individual in the forest canopy. Species in plateaus and valleys showed consistent differences in hydraulic traits. Plateau species had higher resistance to cavitation (P50) and WD, but lower mean total vessel area, mean vessel hydraulic diameter, sapwood area and SLA than in valleys. **Conclusion:** Our results suggest that functional traits may not be a panacea for improving ecosystem models at all scales. At the mesoscale (~ 100 km2), trait representation in the community should have converged to average optimal values for the predominant conditions, so the variation between species is diluted by the dominance of individuals with a small set of traits. Small variation in traits at this scale imply low contribution to predictions of growth. At the same time, recognition of contrasting traits between hydrological environments at small scales (<1 km2) may be critical for a correct scaling up of mortality responses to drought. Therefore, the importance of traits for upscaling depends critically on the spatial scale over which models are set.

Keywords: growth; survival; scaling-up; tropical-forest; Amazon

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What happens when the soil-plant-atmosphere continuum breaks down in tropical trees?

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Background: During droughts, trees must allow their water potential (WP) to decline in sync with soil WP in order to maintain the pressure gradient that drives transpiration. Since soil-to-leaf hydraulic conductance declines with WP, at some point of soil dryness trees are unable to extract and transport water for transpiration. Drought mortality through hydraulic failure is commonly assumed to occur when soil water is unavailable. I tested this assumption. Specifically, I predicted that variation among species in leaf shedding, root responses, and vapor conductance through bark leads to variation in plant WP maintenance and drought survival. **Methods:** In two seasonally dry forests in Panama, I tracked cohorts of saplings for diffusive conductance, leaf area, and WP for 20 months. These data were combined with trait data to parameterize a hydraulic transport model that predicted maximum transpiration rates. I also subjected potted saplings to extreme drought conditions (soil WP < -10 MPa) and measured plant WP, leaf area, and lateral root surface area. In the lab, I gravimetrically measured water-loss rates of stem segments to calculate bark vapor conductance. **Results:** Among a diverse set of species, the hydraulic transport model, which assumes that trees adjust diffusive conductance to prevent hydraulic failure, predicted actual diffusive conductance well. When droughts drove maximum transpiration rates near to zero, trees shed their leaves. Some leafless trees continued to decline in WP, suggesting water loss from stems and/or roots. In the potted saplings, all species had reduced leaf area during the drought, but only the species that had reduced lateral root surface area maintained high plant WP (~-1 MPa) and had high survival. Bark vapor conductance varied among species and was similar in range to leaf cuticular conductance. **Discussion/Conclusion:** In seasonally dry tropical forests, low soil WP often limits transpiration in saplings to zero. At this point, hydraulic models predict failure of the soil-canopy continuum, which is associated with plant mortality. However, some species maintain homeostasis in WP by minimizing water loss through reduced leaf and root surface area and by relying on stored water to buffer against inevitable water loss through bark. Incorporating these processes will be necessary to distinguish between drought dormancy and mortality in hydraulic transport models.

Keywords: drought, phenology, hydraulics, roots, mortality

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Modeling tropical forest responses to severe drought using a constrained terrestrial biosphere model

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Background: The seasonally dry tropical forest (SDTF) biome is widespread in Mexico and Central America. Here, we explore whether these seasonally dry forests are resistant to drought on timescales other than seasonal, or whether seasonal drought makes them particularly vulnerable to drought on other time scales. This question is urgent in light of both the recent, severe El Niño-associated drought and the fact that climate models are predicting that seasonal areas of the neo-tropics to be drier in the 21st century than in the 20th century. **Methods:** We carry out our analysis with a mechanistic ecosystem model that links climate (model input) to variations in ecosystem structure, composition, and functioning (model outputs). The model has previously been validated against observations of phenology, litterfall, and tree growth. Here, we focus on the impact of the 2015 drought on the tropical dry forests of Guancaste, Costa Rica. This year was the driest in the 30+ year meteorological record. We analyzed tree mortality at several levels: the ecosystem, in terms of size classes, and in terms of functional groups. Model results were compared to field observations. Finally, we evaluated model sensitivity to several mortality-relevant processes. **Results:** For the 2015 drought, the model simulations were broadly consistent with the observations: plot-level mortality rates were 2-3 times higher during the drought than before the drought. Neither the simulations nor observations show a strong dependence on size class or plant functional group. Instead, mortality rates were highest for trees with the lowest relative growth rates prior to drought. Simulated responses were sensitivity to parameterizations of phenology, carbon storage, and mortality due to hydraulic failure. **Discussion:Conclusion:** Elevated mortality rates during the drought suggest vulnerability of this system to long-term drought. This vulnerability is of great concern, considering the predicted drying of this region. The closeness of model predictions to observations is encouraging, but further model-data comparison is warranted. In particular, model parameterizations of hydraulic failure need improvement.

Keywords: drought; models; Costa Rica; hydraulics

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Symposium
Partners in science: Collaborating with communities, policy-makers and institutions

Assessing the impact of research in tropical landscapes by scientists and local actors

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Background: Current debates in the conservation sciences argue for better integration between research and practice, often citing the importance of the dissemination and implementation of scientific knowledge for environmental management and policy. This talk focuses on a relatively well-researched protected area (Madidi National Park) in Bolivia, presenting different interpretations and understandings of the local relevance and availability of research findings. We base our analysis around the following questions: 1) In what ways was the research conducted in the region relevant for management, and to what extent was it made accessible to local actors who could use the information? 2) How do people living and working in the region perceive different forms of research dissemination? 3) What additional spaces exist for knowledge-exchange during the process of scientific research? **Methods:** We carried out a systematic analysis of all scientific research conducted between 2004-2013 in Madidi NP, identifying 88 research projects whose principal investigators were then contacted for more information regarding dissemination and implementation. In addition, we carried out interviews (n=137) and workshops (n=12) with local actors to better understand to understand implications for how local actors perceive the value of research and conservation. **Results:** Of a total of 88 scientific research projects identified during the systematic analysis, we were able to gather complete information on 40 projects directly from the principal investigators. 38 of the 40 projects (95%) were directly related to conservation, ecology and/or natural resources management. We found that a majority of researchers (83%) stated in the affirmative that their project had definite or potential implications for management of natural resources. However, we also found evidence of mismatch in terms of where and how findings were disseminated. Interviews and workshops shed light on a high degree of misinterpretation of the objectives and outputs of scientific research, and provided alternate interpretations of research impact. **Discussion/conclusion:** We discuss the critical consequences of these findings for the future of conservation science and practice in biologically and culturally diverse landscapes, with a call to action for academic institutions to support researchers in prioritizing local dissemination practices.

Keywords: impact, dissemination, stakeholders, knowledge-exchange

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From rural development to community organization of the territory: A four decades experience

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The Environmental Studies Group (Grupo de Estudios Ambientales, GEA) is a multidisciplinary Mexican non-profit association formed in 1977 with the purpose to improve relationship between humans and nature, especially focused on social - environmental problems and alternatives in rural areas. Since the beginning we have learnt from indigenous and peasant people, continuously engaged in a dialogue with traditional agriculture and knowledge, as part of the peasant science. Another trait has been the constant linkage with academic world, thus consolidating participatory action-research capabilities for a better understanding of social - ecological dynamics and restraints in agricultural and forestry systems. Our first experiences in the 70's and 80's were mainly linked to sustainable community forestry. After decades of concessions to private business, forest control was taken by communities with collective ownership over them. GEA and other groups helped in this process. In the 90's we contributed to systematization and exchange of rural participatory experiences in Mexico and Latin America, and organized our work around two concepts: a) Peasant Management of Natural Resources and b) Sustainable Agro-food Systems, which became two programs of GEA. Both have been implemented for two decades in the mountains of Guerrero. The first one has undertaken actions adapted to local realities and decided by the communities. We have seen that the stronger community institutions are (assembly, authorities, committees, norms and agreements), the better conserved are their natural resources and the commons (forests, watersheds, etc.). The second one has contributed to better linkages between production and consumption in rural and urban areas, and to healthy alimentary practices and traditional gastronomy, in an effort to counter the invasion of junk food in the country. Both approaches are complementary and imply that the community and the peasant families are in the center, as the main actors who need to rescue their deep knowledge and memories, often hidden or undervalued by decades of contempt, abandon and exclusion. At the same time, we have promoted innovation, based on the intertwining between different knowledge and technical systems, in order to face new problems. As a result of these experiences, our theoretical approaches have migrated. Former rural development concepts are being formulated as community organization of the territory.

Keywords: Community Participation Food Agroecology Territory

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Who owns the question? Community directed research addressing conservation issues in Guyana

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Background: Habitat loss and species declines driven by human activity have increased rapidly across the tropics, compelling scientists working in the world's most biodiverse regions to delve into conservation. Meanwhile, society has become increasingly globalized and democratic, ecology moved to include humans in a systems view of the world, and conservation has shifted towards more participatory and decentralized approaches - factors which make the integration of research and conservation intuitive in theory, but more complicated in practice. **Methods:** We believe that opening up the research process to a high level of participation is key to moving from data collection to conservation action. Encouraging participation marks an important shift from completing a research project to facilitating a research process that may take place over multiple projects/years. We built trust early on by providing fair compensation and ample training, incorporating local knowledge, creating opportunities for leadership development, allowing proven leaders to work independently, sharing results locally, and recognizing the unique contributions of collaborators. As collaborators grew in their understanding and confidence, we created an environment where feedback and research ideas we shared freely through friendly conversations about local issues and potential solutions. Once ideas were shared, support and follow through proved critical. Turning over question generation transitioned us into the role of consultants, teachers, and facilitators in support of the development of community leaders seeking to address important issues using a rigorous scientific approach. **Results:** We will discuss the process and outcomes of our partnerships with indigenous communities and private landowners in the Rupununi Region of Guyana, highlighting efforts to explore practical aspects of local folklore, synergies between tourism, conservation and land tenure issues, and impacts of development related to road construction and improvement, commercial hunting, conflict between livestock owners and large carnivores, and trade in wildlife products. **Conclusion:** Partnerships with resource users that address conservation issues can be successfully forged through research, but the onus for facilitating of this process falls on the researchers who must be willing to concede control over the direction of their research program to qualified and motivated local collaborators.

Keywords: community, conservation, Guyana, participation, research

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From the conservationist approach to biocultural territories: Changing the paradigm?

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Background: One of the phenomena that currently drives environmental research is the process of environmental degradation. There is a long history of research from which the particular experiences of human societies in interaction with their surrounding ecosystems are re-valued and re-signified and from which it is considered viable to create alternative solutions to environmental degradation. A key reference is that of biocultural diversity, which explains the complex expressions of cultural and biological diversity as mutually dependent and geographically coexisting. In this sense, biodiversity conservation can not be separated from its use and nature and culture are an inseparable binomial which becomes the axis of sustainability. Some authors propose that biological conservation must be tackled from a social and ecological perspective acquiring relevance the biocultural dimension of the territory. The present work aims to present three case studies to analyze the conditions threatening biocultural diversity and the elements that articulate actions for their protection. **Methods:** The case studies were carried out in the State of Michoacan, Mexico, in three contrasting regions: the Alto Balsas, Tierra Caliente and the Purepecha region. The research process enrolls in the Participatory Action Research approach which in this case includes the reconstruction of environmental history, documentation of local environmental knowledge, and the perspectives for the protection of the territory and its biocultural heritage. **Results:** There is a recognition that the biological diversity of the communities included in the study is the result of the historical interaction of local societies and nature. This has a deep local value. These historical interactions also incorporates local inertia defined by global contexts. It is recognized that biocultural diversity is threatened mainly by power relations and inequality as well as locally decontextualized production schemes with high socio - ecological costs. In the three regions of study permanent research processes are demanded according with local needs that consolidate local institutions, local knowledge, technological processes and evaluation and monitoring schemes. **Conclusion:** Biocultural diversity is framed in multiple territorial contexts and its protection is first and foremost a process of sustainable practices and local governance schemes that is concretized through agreements between specific social actors.

Keywords: Biocultural territories, Conservation, Michoacán, México

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Strategically creating spaces to integrate scientific findings into policy: A Brazilian example

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Science only irregularly reaches public spaces and legislative debates. The value of the classically focused scientist who seeks new discoveries and a better understanding of scientific processes is undisputed. Increasingly, however, many researchers seek to generate knowledge that is more directly useful in addressing societal and environmental problems. What strategies might be adopted that could better translate ecological research into conservation policy? In my 18 years as a professional forest geneticist and ecologist, I continue to be very passionate about research, curious in knowing the "whys" of biological processes. However, I have also purposefully cultivated personal connections in the spaces where science meets public policy development and giving value to communication. From the beginning of my research career, I have actively pursued potential partners in government agencies, universities and non-government organizations, not just at the end of the research process, but throughout, as suggested by Jansen (2008). Early on, I was perplexed by colleague behavior at public events. Some only attended when they received a speaking invitation. Many would give their talk and leave. I have tried to do things differently. I consider that a big part of my job as a researcher is being physically present and mentally committed in programs, initiatives, fora, associations, consortia, work groups. I try to be present for the entire scheduled event, and actively participate in and contribute to discussions. A key factor for moving research into policy is personal contact between researchers and policymakers (Brownson et al. 2006), purposefully creating spaces for interactions, often, and with enthusiasm. Another key strategy in creating these spaces is to keep an open active mind, thinking in terms of solutions, and engaging oneself in the interests of others. This active engagement generates positive energy that connects people and connects ideas. It creates a huge network of relationships reflecting a bit of you to the world. I would say that "love" is the basis of the network. References. Brownson, RC, C Royer, R Ewing & TD McBride. 2006. Researchers and policymakers: Travelers in parallel universes. American Journal of Preventative Medicine 30:164-172. Janse, G. 2008. Communication between forest scientists and forest policy-makers in Europe - A survey on both sides of the science/policy interface. Forest Policy and Economics 10:183-194.

Keywords: network, communication, interaction spaces

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Creating academic environments that value and support on-the-ground transdisciplinary partnerships

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Background: It is widely recognized that academic graduate programs related to conservation must adapt to novel and increasingly complex socio-environmental conditions. We present two teaching experiences, both of which aim to promote and enhance collaboration between communities, policy makers and institutions carried out in Mexico: a) "Democratization of conservation leadership" carried out by University of Florida in collaboration Universidad Veracruzana (UV) was part of the UV Graduate Program in Tropical Ecology, and b) UV Diploma Program "Organizational and technical basis for forestry and agroforestry management" created and implemented by UV faculty from different disciplines, a local ONG, and local forest experts in the nahua region of Sierra de Zongolica. **Methods:** We used a wide range of participatory methods in these two teaching experiences: group dialogue and reflection, historical memory-construction of collective time lines, participatory observation, focus groups, and field-based applied activities. These programs were based on the concepts of "situated knowledge" and "democratization of leadership". The former is a pedagogical approach that incorporates the collective construction of knowledge and the recognition that everyone possesses experiences and knowledge to share and to learn from. Democratization of leadership is conceived as the ongoing process of enhancing and enabling the engagement of different voices and views. **Results:** We identified both individual and collective outcomes. Individual participants recognized the value of their own experiences and knowledge and appropriated new skills, knowledge and capacities. We also identified that the two teaching experiences constituted the basis of long-term collaborations, beyond the institutional frames and projects duration. **Discussion:** Through the collective reflection carried out among teachers, students, practitioners, community teachers and leaders, we identify some of the most salient outcomes of both teaching cases: a) the importance of bridging different forms of knowledge, b) the need for solid interdisciplinary formation of students, but also of encouraging skills and values, such as empathy and listening, and c) the importance of field-based activities, as well as learning by doing, which involves a wider and close collaboration with diverse stakeholders.

Keywords: collaborative teaching, transdisciplinary, situated knowledge

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Symposium
New Views of Structural Complexity and Tropical Ecosystem Function

Tree architecture influences stem respiration: 3D models to better understand forest productivity

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Understanding ecosystem productivity is a grand challenge in ecology. Great strides have been made in recent years, but uncertainty limits our understanding. Bottom-up measurements of forest productivity can lend insight into mechanisms that top-down methods such as eddy flux cannot. A downside of bottom-up methods are the uncertainties involved in scaling up sample measurements to the stand scale. Stem respiration is particularly vulnerable to these uncertainties of scaling, as a measurement of few square centimeters is scaled across hundreds of square meters of a tree's surface using allometries built from a small sample of trees in central Amazonia. Furthermore, these estimates rely on strong assumptions about the depth and distribution of metabolically active tissue (i.e. sapwood, cambium, and phloem). Here we use 3D models of hundreds of trees derived from terrestrial LiDAR scans of a stand in Cauxiana, Brazil coupled with stem respiration and sapwood depth measurements to improve our estimates of stem respiration. We find that tree architecture has large and predictable implications for stem respiration, leading not only to improved stand-level estimates, but also insight into the role of architecture in life history strategy and resilience to climate change induced temperature rise.

Keywords: productivity, respiration

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Ancient Amazonian populations left lasting impacts on forest structure

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Background: Amazonia contains a vast expanse of contiguous tropical forest and is influential in global carbon and hydrological cycles. Whether ancient Amazonia was highly disturbed or modestly impacted, and how ancient disturbances have shaped current forest ecosystem processes, is still under debate. Amazonian Dark Earths (ADEs), which are anthropic soil types with enriched nutrient levels, are one of the primary lines of evidence for ancient human presence and landscape modifications in settings that mostly lack stone structures and which are today covered by vegetation. **Methods:** We assessed the potential of using moderate spatial resolution optical satellite imagery (MODIS) to predict ADEs across the Amazon basin. We used four indices derived from the MODIS nadir-BRDF adjusted reflectances (MCD44A4) product, and four dry season months for the years 2004, 2005, 2009, and 2010. Maximum entropy modeling was used to develop a predictive model using presence locations of ADEs across the basin and only satellite derived remotely sensed indices. **Results:** ADE sites were predicted to be primarily along the main rivers and in eastern Amazonia. ADE sites, when compared with randomly selected forested sites located within 50 km of ADE sites were less green and had lower canopy water content. This difference was accentuated in the two drought years, 2005 and 2010. This is contrary to our expectation that ADE sites would have nutrient rich soils that support trees with greener canopies, with the forests on ADE soils being more resilient to drought. Biomass and tree height were lower on ADE sites in comparison to randomly selected adjacent sites. **Discussion:** Our results suggested that ADE-related ancient human impact on the forest is measureable across the entirety of the 6 million km2 of Amazonian basin using remotely sensed data. The high spatial heterogeneity in ADE sites across the Amazon suggests that pre-Columbian occupation by indigenous people was complex, varying substantially across this ecologically diverse region.

Keywords: terra preta, MaxEnt, remote sensing

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Measuring forest structural diversity across a degradation gradient in an Ethiopian cloud forest.

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Background: Tropical forest degradation is a subtle process that introduces changes to forest structure and puts pressure on biodiversity. Even though satellite remote sensing is capable of detecting forest cover changes due to deforestation, and fragmentation, it is a challenging task to capture processes such as forest degradation (usually small scale changes under the forest canopy). Thus, mapping of vertical forest structure is required to characterize and quantify the structural differentiation between degradation gradients. The specific objectives are: (i) assess forest structural diversity over a degradation gradient, and (ii) explore the potential of satellite data for upscaling. **Methods:** The study was performed in the montane cloud forests in Kafa (Ethiopia). Plots were randomly chosen over a degradation gradient, ranging from intact core to heavily degraded forest, including Participatory Forest Management (PFM) sites. To map the vertical structure, we made use of a Terrestrial Laser Scanner (TLS) which has the capability of quantifying forest structure (1). The following parameters were obtained: canopy openness, tree heights and density, Plant Area Volume Density (PAVD). Parameters from the ground based measurements are then linked to high resolution satellite images (i.e. SPOT5 and Planet data) for upscaling purposes. **Results:** There is a clear difference in all TLS derived parameters over the carbon gradient, with e.g. PAVD ranging from an average of 5.1 for intact core forest to 1.9 in heavily degraded forest. The variation in PAVD in PFM sites was high, indicting different management (i.e. degradation) intensities. SPOT5 derived NDMI and SWIR data showed a high correlation with respect to the TLS derived PAVD, while the Planet data was able to capture the canopy openness as measured by the TLS data. **Conclusion:** The results of this study were able to capture the carbon gradient, showing larger canopy openness fractions and lower PAVD in degraded plots, while the understory vegetation complexity in intact core forests were captured by higher PAVD and PAI. The results from the satellite derived parameters show the potential of upscaling and mapping structural forest biodiversity over the Kafa Biosphere Reserve. Reference. (1) Palace, M., et al. (2016) Estimating Tropical Forest Structure Using a Terrestrial Lidar. PlosOne 1-19 (2016).

Keywords: Forest degradation, Terrestrial Laser Scanner

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Studying lianas in the tropical forests with multiple return terrestrial lidar measurements

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Background: Lianas are an important component of tropical forests, commonly constituting up to 40% of the woody stems and about 35% of the woody species. Lianas compete strongly with trees for both above- and belowground resources. Tropical forests are currently experiencing large-scale structural changes, including an increase in liana abundance and biomass. Despite the large amount of data currently available on lianas, there are few quantitative studies on the influence of lianas on the vertical structure of the forest. **Methods:** Terrestrial laser scanner (TLS) is an active remote sensing technique and measures forest structure parameters with high spatial accuracy. We collected data between February 2015 and April 2015 from a large-scale liana removal experiment in a secondary forest in Gigante Peninsula, Panama, to study the impact of lianas on the forest structure. We derived Plant Area Index (PAI) and vertical plant profiles from the TLS data of three 80 by 80 m removal plots and three 80 by 80 m control plots. We then calculated Plant area per unit volume (PAVD) as a function of height, which we used to describe the vertical structure of the forest. Result. The average PAI of the removal plots and the control plots did not differ - they were 3.45 and 3.47 respectively. However, the peak PAVD height of the average vertical profiles between the treatment plots were significantly different. Peak PAVD of the removal plots was 6.5 m, whereas the peak PAVD height of the control plots was 10 m. **Discussion:** After four years of liana removal, there was no significant difference between PAI from the plots with and without lianas. Though the trees had compensated for the loss of lianas, there was a significant difference in the vertical distribution of the canopy constituents. The substantially greater peak PAVD height in the vertical profiles of the control plots indicates that lianas attenuate light in the mid-canopy of the forest. However, the lower maximum canopy heights in the control plots could be explained by the occlusion caused by the liana leaves in the top of the canopy. This study demonstrates the potential of TLS to study the contribution of lianas to the forest canopy structure.

Keywords: TLS, lianas, tropical forests, PAI, vertical plant profiles

ID:1139
Wednesday Kabah
Symposium: New Views of Structural Complexity and Tropical Ecosystem Function

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Characterization of tropical forest structural change with multi-temporal Terrestrial Lidar

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Background: Quantitative characterization of tropical forests tree-dimensional (3D) structure and its changes along the time are challenging due to their large complexity. Yet they can contribute to a better understanding of the light distribution and competition, ecosystem response, and ultimately the 3D distribution of primary production. Logging changes the vertical and horizontal forest structure, altering at different intensity the sub-layers along the vertical profile and across the area. In order to understand the impacts of logging it is crucial to assess which parts of the canopy get more intensively affected and which remain unaffected. However, up to now, studies described forest structure change by parameters defining either the vertical (e.g. canopy height) or horizontal structure (e.g. DBH distribution or gap fraction) but their integration into the 3D space remained largely untackled due to limits in data acquisition across the vertical profile. In contrast, 3D point cloud data provided by Terrestrial Laser Scanners (TLS) enables to describe the 3D distribution of vegetation and to quantify 2D canopy structural parameters along the vertical profile. **Methods:** We collected data from 29 plots in 3 tropical forest sites (9 plots of 50x30m in Peru, 20 plots of 40x30m in Indonesia and Guyana). Plots were scanned with a TLS Riegl VZ-400 before and after one large tree was logged per plot. Trees larger than 10cm DBH were inventoried and georeferenced, and after logging damaged trees were assessed. We coregistered pre-post-harvest TLS data and classified them in voxels of 1x1x1m as vegetated or empty. We computed the vegetated voxel difference in the 3D space between pre-post-harvest determining regions with biomass loss. Loss and remaining vegetation were mapped in 3D plots, 2D plots of canopy damage along the vertical profile in height bins of 5m, and changes in vertical distribution of vegetated voxels per zones of 5x5m. **Results:** Preliminary results from 2 plots in Indonesia and Guyana demonstrated that repeated TLS data acquisition enabled to characterize the 3D forest structural changes, showing the 3D distribution of biomass loss by the tree harvested and collateral damage. **Conclusion:** This method allows to typify logging areas with substantial changes in either the upper or lower part of the canopy or all along the vertical profile. These latter outcomes have implications for the detectability of selective logging with satellite images

Keywords: 3D forest structure, Lidar, logging

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Wednesday Kabah
Symposium: New Views of Structural Complexity and Tropical Ecosystem Function

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The sensitivity of simulated tropical forest productivity to different canopy architecture models

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Background: The canopy structure of tropical forests can have profound effects on the distribution of energy within stands and thus control the dynamics of individual trees and their communities. The representation of canopy structure within dynamic vegetation models varies from single layer approximations to detailed 3D calculations of light profiles. Understanding the potential effect of different canopy architecture models can thus prove particularly valuable for reducing the uncertainties in simulations of forest productivity. **Methods:** We implemented different canopy architecture models within an individual-based and trait-spectra vegetation simulator (TFS), and explored the sensitivity of the simulated primary productivity at the individual and stand level following different canopy architectures. The canopy architecture models included the perfect plasticity approximation (PPA) as well as an empirical stochastic model of individual light availability based on tree height. Simulations at the individual and stand level were evaluated against measurements from ten intensively measured plots of the GEM network along a 3300 m Amazon-Andes elevation gradient. **Results:** Although at the stand level the different canopy architecture models did not have a significant effect on the estimation of primary productivity, at the individual tree level the PPA approximation yielded in general higher growth rates compared to the empirical light availability model. These differences were more pronounced at bigger size classes. **Discussion:** The PPA canopy architecture model can be adequately used to approximate light availability for individual trees in relatively undisturbed forest stands. However potential differences in growth estimates of bigger trees, arising from the deterministic estimation of light availability with PPA, may have important direct and indirect effects upon the simulated dynamics of tropical forests.

Keywords: Canopy Architecture, Tree growth, TFS

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Wednesday Kabah
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Distance decay of tree species composition in lowland Amazonia using airborne imaging spectroscopy

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Background: The forests of Amazonia are among the most biodiverse ecosystems on earth, yet accurately quantifying how and why this diversity varies through space (i.e. beta diversity) remains a significant challenge. Here we use high-fidelity, airborne, imaging spectroscopy provided by the Carnegie Airborne Observatory to quantify a key component of beta diversity, the distance decay in species similarity through space, across three landscapes in Northern Peru. **Methods:** We used an unsupervised approach to estimate turnover in species composition through space from imaging spectroscopy data. We first validated this approach at one landscape (Allpahuayo Mishana) using an independent dataset of 50 forest census plots (0.1-1 ha). We then applied this approach to two further landscapes, which together represented three key forest types, terra firme forest, seasonally flooded forest and white-sand forest. Forest types were then isolated using Lidar derived digital elevation models and tree canopy height maps. Finally, we modelled distance decay relationships within forest types. **Results:** Our validation data demonstrate that beta diversity within and among forest types can be accurately estimated from airborne spectroscopic data using our unsupervised approach. Distance decay relationships were found to vary among forest types, with seasonally flooded forests showing stronger distance decay than white sand and terra firme forests. **Discussion:** Consistent with previous work, our data confirm that high fidelity spectroscopic data can be used to accurately estimate beta-diversity in tropical forests. Using this spectral data we are able to demonstrate differential distance decay relationships among forest types. This represents a significant advancement, as unlike previous studies, we are able to sample continuously across landscapes, rather than interpolating between a limited number of forest census plots.

Keywords: beta-diversity Amazon imaging-spectroscopy

ID:1144
Wednesday Kabah
Symposium: New Views of Structural Complexity and Tropical Ecosystem Function

Symposium
Leaf cutter ants and forest ecosystem processes

Leaf-cutting ant effects on soil fertility and plant performance: a review

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Background: Leaf-cutting ants (LCA) are considered as one of the most important agents of soil disturbances that affect vegetation patterns, but these asseverations are based on isolated studies or anecdotic data. Here, we use meta-analysis techniques to quantitatively analyze the generality of these effects and determine some of their sources of variation. **Methods:** We identified relevant studies by conducting key-word searches and performed separate meta-analyses to assess the effect of LCA on three soil fertility traits and three plant performance traits. For soil fertility we evaluated the effect of LCA on: 1) nutrients, 2) cations, and 3) pH. For plant performance we analyzed separately: 1) plant growth, 2) plant density (e. g., plant cover, and 3) plant species richness to include effects at individual, population and community levels. **Results:** Our results reveal that (a) LCA nest sites showed higher level of soil fertility than control sites, but the key source of these nutrients is the refuse material rather than the nest-soil itself, (b) refuse material from external piles tended to be richer in nutrient content than those from internal chambers, (c) nest sites from temperate habitats showed higher cation content than those located in tropical/subtropical habitats and (d) nest sites showed higher plant growth but similar plant density and plant richness than adjacent non-nest sites. **Discussion:** LCA improves nutrient content in nest sites through the accumulation of refuse material. Thus, the location of the refuse will have a relevant role affecting vegetation. LCA species with external refuse dumps may benefit herbs and early vegetation stages, whereas those with internal refuse chambers may benefit long-living, large trees. However, the positive effect on individual plants does not extend to population and community levels. On the other hand, refuse material from external piles and nest sites in temperate habitats tend to show higher fertility than refuse material from internal nest chambers and nest sites in tropical/subtropical habitats. Therefore, LCA species with external refuse dumps in temperate regions could be of particular relevance for nutrient cycling and vegetation patterns.

Keywords: Ant nests, bioturbation, ecosystem engineers

ID:1130
Wednesday Maya
Symposium: Leaf cutter ants and forest ecosystem processes

Tropical rainforest methane consumption by leaf cutter ant nests and soils under variable moisture

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Background: Tropical forests sequester up to 40% of the anthropogenic and natural carbon exchanged with the atmosphere. Even though soils are the largest pool of terrestrial carbon, relatively little is known about the methane flux capacity of tropical forest soils. Under high moisture conditions, decomposed carbon is likely released as methane by methanogens. Much of that methane is consumed by methanotrophs in dryer conditions. During dry seasons, surface rainforest soils become dryer at the surface. Leaf-cutter ant nests are known to have different soil moisture profiles and responses to precipitation events than the surrounding soil, and may impact the carbon gas dynamics of this ecosystem. The relative production of carbon dioxide and methane, two important greenhouse gases, in tropical rainforests may greatly impact global climate trends. **Methods:** In 2015-16, the globe experienced an unusually strong ENSO event, which caused dryer conditions in tropical forests of Central America. Methane flux was measured during and after the El Niño event in bimonthly campaigns from March 2016 through March 2017, at the La Selva Biological Station, Costa Rica. Fluxes were measured in replicate chambers in four sets of paired leaf cutter ant nests and non-nest controls. **Results:** We found an average CH_4 sink of -0.018 mg m^{-2} h^{-1}. This flux is roughly four times lower than the average forest consumption rate, however most forest methane flux data is from temperate and boreal forests. While differences in flux magnitude between months were not significant, CH_4 consumption was greatest in May 2016, and lowest in March 2016. There was an inverse correlation in control plots between soil moisture and methane consumption. However, in nest plots there was no relationship between methane and soil moisture at low to medium moisture levels, but the inverse correlation increased dramatically at higher soil moisture levels. **Conclusion:** We observed relatively constant methane consumption in all soils during the El Niño event, which suggests that dry conditions of this tropical rainy season stimulated methanotrophy. This confirms our hypothesis that ENSO controls much of the year-to-year variability in the tropical forest methane cycle, primarily by turning the tropical forest from a strong annual source for CH_4 during the La Niña or normal rainy season, to a year-round sink for CH_4 during El Niño events. These data help to fill the gap in knowledge of tropical forest methane flux.

Keywords: Soil; ants; methane; methanotrophy; carbon

ID:1129
Wednesday Maya
Symposium: Leaf cutter ants and forest ecosystem processes

Soil structure and CO_2 gas dynamics are affected by leaf cutter ants in a neotropical wet forest

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Background: Leaf cutter ants (LCA) are ecosystem engineers in tropical forest ecosystems. We studied the effect of LCA on soil CO_2 gas dynamics in primary and secondary tropical wet forest soils at La Selva Biological Station, Costa Rica. Our goals were (1) to assess the effect of LCA Atta cephalotes nests on soil CO_2 concentrations (sCO_2) and soil respiration (efflux) rates, and (2) to connect temporal variation in sCO_2 and efflux rates to environmental conditions. We hypothesize that LCA soil structure manipulation in the form of nest vents and soil tortuosity impacts sCO2 dynamics. **Methods:** We installed gas wells and collected sCO_2 monthly over 2 years. Some nests were abandoned during the study period, but we continued to sample them to assess LCA legacy effects. Our operating assumption was that soil moisture is a main driver of sCO_2; as a result, we hypothesized that sCO_2 changes followed a logistic function based on cumulative rainfall. We conducted a soil efflux and vent flux measurement campaign to assess the correlation between the sCO_2 and the CO_2 emissions to the atmosphere. **Results:** We found that sCO2 from gas wells were similar between nest (N) and control (C) plots during the drier periods, but sCO_2 increased more markedly in C than in N during wetter periods. The legacy nest effect varied among abandoned nests, and revealed no consistent pattern across sites. Soil efflux was lower for N than C, since the CO_2 diffusive gradient from the soil to the atmosphere in C was greater. Simple flux calculations suggested that reduced soil tortuosity in N plays a role in maintaining lower sCO_2. Nest vent effluxes were substantially greater than soil effluxes. **Conclusion:** The changes in soils associated with LCA nests have large impacts on soil CO_2 dynamics. N tend to maintain relatively constant, lower sCO_2, while sCO_2 ranges to greater values in C. The logistic function described sCO_2 variation with seasonal rainfall. Overall, nests were better ventilated, both as a result of vent construction and reduced soil tortuosity. Vent diffusion (and/or convection) likely removes CO_2 from the nest and from the adjacent soil matrix. Understanding the legacy effect of abandoned nests requires further investigation. The magnitude and duration of that effect may depend on age and size of the colony.

Keywords: carbon, leafcutter ants, moisture, tortuosity

ID:1131
Wednesday Maya
Symposium: Leaf cutter ants and forest ecosystem processes

Dynamics of root and mycorrhizal fungi in leaf cutter ant nests in a lowland tropical forest

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Tropical forests have the highest productivity per area of any biome, yet we have less understanding of belowground carbon (C) balance of tropical ecosystems. Leaf cutter ants (LCA) are ecosystem engineers that alter soil structure, soil nutrient pools, and gas fluxes, which may create spatial heterogeneity in dynamics of roots and mycorrhizal fungi and C cycling. We examined how soil conditions and root and hyphal dynamics differ between LCA nest and non-nest areas in a lowland tropical forest at the La Selva Biological Station, Costa Rica, hypothesizing there would be greater root and hyphal growth and turnover in LCA nests relating to differences in abiotic soil conditions. Sensor arrays were installed in February 2015 and March 2016 at nest and non-nest sites, each consisting of one automated minirhizotron (AMR) and a series of soil moisture, CO_2, O_2, and temperature sensors placed at four depths. Images were collected daily and sensors collected data every fifteen minutes to generate daily averages. AMR images were analyzed using Rootfly to measure roots and hyphae for lifespan, biomass C, and turnover rate calculations. These data were regressed with sensor data to determine differences between nest and non-nest sites. Soil moisture, CO_2, and O_2 concentrations differed between nest and non-nest soils. Nest soils generally had lower soil moisture and CO_2 along with higher O_2 when compared with non-nest soils. Soil moisture dropped significantly in nest soils during dryer periods while remaining more stable and consistent in non-nest soils. There was no difference in temperature between nest and non-nest soils. Soil moisture had a significant relationship with root and hyphal growth such that drying of soils yielded greater root and hyphal activity and soil saturation increased die-off. The sensor data suggest that LCA alter their soil environment to reduce CO_2 concentrations and soil moisture while raising O_2 concentrations above surrounding non-nest soils. In turn, the changes in soil physical properties influence root and hyphal dynamics such that growth occurs at different rates between nest and non-nest soils. Differences in soil structure and root and hyphal dynamics lead to greater CO_2 release from LCA nests than non-nest soils. As LCA contribute to spatial heterogeneity in CO_2 release, their distribution may be important when scaling up and generating C balance estimates across lowland tropical forest landscapes.

Keywords: leaf cutter ants, mycorrhizae, roots

ID:1126
Wednesday Maya
Symposium: Leaf cutter ants and forest ecosystem processes

Amount and composition of dissolved organic matter in leaf cutter ant nests

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Background: Neotropical forests are significantly influenced by leaf cutter ants (LCA). Dissolved organic matter (DOM) plays an important role in the movement of organic matter within ecosystems and the presence of LCA likely affects the amount and chemical composition of DOM leached from the nests. The aim of our study was to quantify the seasonal variation in total dissolved carbon (TDC) and total dissolved nitrogen (TDN) fluxes in LCA nest and control sites. We hypothesized (1) that TDC and TDN fluxes will be higher inside LCA nests due to continual input of fresh organic matter and fungal activity and (2) that TDC in nests will be characterized by low molecular weight compounds. **Methods:** Suction lysimeters were installed at 20, 60 and 100 cm depths in July 2014 at three nest and two control sites on three differing soil (residual and alluvial) / forest (primary and secondary) combinations, La Selva Biological Station, Costa Rica. Samples from 45 lysimeters (9 nest and 6 control sites) are collected monthly since March 2015. TDC and TDN concentrations were measured using a Total Carbon Analyzer with a Total Nitrogen Unit. The TDC quality was determined using absorbance measurements at 254 nm (UV254nm). **Results:** During the wet season 2015, TDC (1.3 to 7.4 mg/L) and TDN (0.1-1.5 mg/L) concentrations were highly variable across sites. TDC concentrations in nest sites tended to be higher (and more variable) than control sites but differences were not significant. In contrast, we found a significant effect of soil depth on TDN and C:N ratio. Across soil and forest types, UV254nm values tended to be higher in nest sites (although not significant) than control sites suggesting that nest TDC is characterized by higher molecular weight compounds (i.e., greater aromatic content). **Discussion:** The absence of significant differences in TDC and TDN concentrations between nest and control sites might be partly explained by the high variability in nest activities. Further, high rainfall during the wet season 2015 may have resulted in large vertical C and N fluxes masking the effect of LCAs on dissolved organic matter. Higher molecular weight compounds in nests suggests preferential removal of low molecular weight TDC due to enhanced biodegradation. Overall, our results showed greater heterogeneity among nests and across soil depths than previously expected.

Keywords: biogeochemistry, ecosystem processes, herbivory, heterogeneity

ID:1127
Wednesday Maya
Symposium: Leaf cutter ants and forest ecosystem processes

Microbial Symbionts of Leaf-cutting Ants

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Leaf-cutting ants harvest substantial amounts of leaf material, foraging on nearly 15% of the annual production of plant biomass, to cultivate a specialized fungus for food (*Leucoagaricus*). This complex symbiosis includes at least four coevolved organisms: the farming ants, their fungal crop, a specialized mycoparasite of the ant's fungal gardens (*Escovopsis*), and actinomycete bacteria (*Pseudonocardia*) that the ants culture on their bodies to obtain antibiotics against the parasites. We described an additional symbiosis with Nitrogen-fixing bacteria that colonize the fungus gardens and contribute to supplement the ants' nutrition. We are currently collaborating with a group of experts from different fields to tackle the contribution of these Atta microbial symbionts to the biogeochemical cycles in tropical ecosystems and also our efforts in Costa Rica focus on potential biotechnological applications of the ants' microbial symbionts. Control strategies to manage this pest have been difficult due to their eusocial behavior and ability to avoid foraging hazardous particles; causing economic losses in the agricultural sector, this situation motivates the development of research on microbial-based biocontrol strategies. Another promising investigation area is the bio prospecting for new antibiotics, as the recently discovered antifungal selvamicin.

Keywords: leaf cutting ants, microbial symbionts.

ID:1128
Wednesday Maya
Symposium: Leaf cutter ants and forest ecosystem processes

Symposium
The dry tropics: vulnerability and resilience

The dry tropics: state of the art

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The typical perception of many ecologists and of the general public that the term "tropical" refers to evergreen tropical rain forests is inaccurate. This perception is influenced by the fact that, by far rain forest is the most studied vegetation type among tropical landscapes worldwide. The myriad of vegetation types conforming the dry tropics (e.g., dry forests, cerrado, caatinga, savanna), in contrast, has been seriously neglected. Such a scientific bias has determined that our understanding on the mechanisms and processes involved in their regeneration remains incomplete and therefore our capacity to conserve and restore ecosystems in the dry tropics is limited. The aim of the symposium is to provide solid empirical information to fulfill at least part of this gap of knowledge by bringing together studies on the ecology of the dry tropics, including examples from North, Central and South America. These studies consider local, regional and global perspectives on how several ecosystems in the dry tropics are vulnerable and/or resilient to natural (hurricanes and fires) and anthropogenic disturbances (deforestation and habitat degradation). Furthermore, the contributions consider several aspects of ecosystem functioning including the physical environment, the fauna and flora and biotic interactions. Finally, several restoration techniques are discussed for the recovery and conservation of ecosystem function in the dry tropics of the Americas.

Keywords: Disturbance, dry tropics, ecosystem functioning

ID:1232
D-Thrusday Yucatan-1
Symposium: The dry tropics: vulnerability and resilience

Tropical Dry Forests and Global Environmental Change

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Background: Through land-use change and agricultural and industrial activities, humans are reshaping the land, oceans, atmosphere, and climate. How changes in nitrogen deposition and the timing and magnitude of rainfall will affect seasonally dry tropical forests is highly uncertain. Here I review what is currently known about 1) whether tropical dry forest (TDF) species composition and ecosystem processes will be vulnerable or resistant to increased frequency and/or severity of drought, and 2) how nutrient availability modulates these responses, paying attention to which nutrient(s) most affect plant and microbial processes. **Methods:** We conducted two literature reviews by identifying and synthesizing all relevant papers. We searched for papers that used observational or experimental approaches to understand how global environmental changes are affecting TDF communities, from microbial to ecosystem scales, with a focus on Neotropical dry forests. **Results:** A wide range of scenarios could result in drought conditions for TDF tree species, including decreased rainfall or changes in the variability and timing of rainfall. These changes may result in increased tree mortality, decreased productivity and fecundity, and ultimately shifts in community composition. Shadehouse experiments often reveal idiosyncratic responses among species to water and/or nutrient addition, highlighting a need for studies to identify mechanisms underlying specific responses. Last, because Neotropical dry forests are so heterogeneous in terms of soil parent materials, prior land-use history, and climatic regime, is it difficult to identify a single nutrient that most limits productivity or to generalize about interactions between soil fertility and climatic variability. **Conclusion:** Neotropical dry forests appear vulnerable and not resistant to changes in rainfall. It is likely that nutrient availability will mediate these responses, but we currently lack the data necessary to understand how soil fertility affects plants and their symbionts or pathogens under changing climate regimes. Moreover, the large heterogeneity that characterizes Neotropical dry forests precludes simple generalizations. recommend experiments along distributed plot networks that are arrayed along environmental gradients to understand how simultaneous changes in rainfall and nutrients affect dry forest communities.

Keywords: drought, nutrients, global change, mortality

ID:1230
D-Thrusday Yucatan-1
Symposium: The dry tropics: vulnerability and resilience

Vulnerability of the Tropical Dry Forest Vegetation to High Intensity Hurricanes

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Background: Tropical Dry Forests (TDF) are facing hurricanes with greater frequency and/or intensity in some neotropical regions, probably as a consequence of climatic change. These highly diverse ecosystems are endangered by anthropogenic activities that have transformed most of this original area to agricultural fields, pastures and secondary forests. The effect of anthropogenic disturbance can determine the degree of vulnerability of TDF to natural disturbances, especially when they occur with unusual intensity. **Methods:** In this study we compared the impact of a category 5 hurricane in a Mexican TDF (Chamela) between preserved forest sites and anthropogenically disturbed sites. In ten plots, five with preserved forest and five anthropogenically disturbed, we evaluated the impact of the hurricane in terms of plant species composition, structural and functional vegetation traits and soil biogeochemistry. We also looked for functional and phylogenetic signals in the vulnerability of taxa and functional groups to high intensity hurricanes. **Results:** We found that almost 40% of the individuals evaluated were severely damaged or killed by the hurricane. Preserved forests presented a higher proportion of damaged individuals than disturbed forests, showing greater vulnerability to this kind of disturbance. Surviving species showed specific phylogenetic, functional and structural traits related to wood density, resprouting capacity and maximum height, among other traits. Soil biogeochemistry changed drastically as nutrients concentration in the soil increased with sound consequences for the enzymatic activity and nutrient cycling. **Discussion:**The magnitude of the changes registered in this study suggests that this TDF is highly vulnerable to high intensity hurricanes. Remnants of preserved forests could be more vulnerable than disturbed forests and plant species mainly associated to such remnants could drastically reduce their abundance and face local extinction. This abundance reduction could be differential among functional and phylogenetic groups suggesting the possibility of a functional and phylogenetic homogenization under scenarios of frequent and/or high intensity hurricanes. This data can help us to predict plant group's fate under different scenarios of climatic change.

Keywords: Hurricanes, tropical dry forest

ID:1239
D-Thrusday Yucatan-1
Symposium: The dry tropics: vulnerability and resilience

Ecological studies on grazing exclusion and secondary succession of a Mexican tropical dry forest

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Background: Tropical dry forests are cleared for agriculture and livestock production and after some years these lands area abandoned leading to their secondary succession. Cattle raising exert strong effects on tropical dry forest vegetation and can critically influence the structural and functional integrity of the ecosystem. In this paper, we present results on different ecological studies related to changes in attributes of vegetation (abundance, species richness, biomass), functional and morphologic attributes and germination experiments for restoration purposes along secondary succession of TDF. **Methods:** Using a chronosequence-based approach, we investigate the effect on the recovery of vegetation attributes of recent exclusion of livestock from sites in succession, compared to sites with management of cattle. Also, we looked at changes in functional attributes of the most abundant trees and evaluate different tree species for restoration purposes. **Results:** Exclusion of cattle had a very important effect on density of individuals and species richness. Recovery of these attributes was more evident from the intermediate stages to the mature forest sites. Species accumulation rates, as well as equitativity, were found to be greater in sites with cattle exclusion. Presence of livestock in early stages of development substantially affected the equitativity, establishment and/or recruitment of new species throughout the succession. Exclusion of livestock from sites undergoing succession can permit a progressive and non-linear recovery of vegetation attributes, favoring more rapid succession. Functional attributes Se encontró que estos atributos cambian a lo largo de la sucesión, y también por el manejo **Discussion/Conclusion:** Extensive livestock production acts as a chronic disturbance factor that compromises the resilience and structural and functional integrity of ecosystems. Changes in functional atrtrbutes may influence ecosystem processes that may help to understand the function and dynamics of the ílamos TDF and how these are altered by cattle activity. Recognition of the impact of these activities on tropical dry forests as a mechanism that interferes with the trajectories of recovery is crucial in order to contribute to the conservation of these ecosystems. The results of this study are of value to the conservation, management and restoration of TDF in Mexico.

Keywords: Cattle exclusion; comumunity ecology; Sonora

ID:1236
D-Thrusday Yucatan-1
Symposium: The dry tropics: vulnerability and resilience

Potential drivers influencing neotropical vertebrate communities in anthropogenic landscapes

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To what extent anthropogenic landscapes are able to preserve vertebrates' communities, which play critical roles on the ecosystem functioning, remains today an open question of great relevance. In this study we evaluated potential drivers determining vertebrate occurrence in a tropical dry forest (TDF) anthropogenic landscape. The tropical dry forest is one of the most diverse and threatened ecosystems in the world. In twelve sites of secondary TDFs within an anthropogenic landscape (Chamela, Mexico), we evaluated how the habitat attributes at local scale (vegetation traits) and landscape scale (composition and configuration regarding dry and riparian forest) influence the occurrence and assemblages' attributes of amphibian, reptiles, birds, rodents and bats. In general, we found a highly idiosyncratic and epiphenomenal vertebrates' response to variation in vegetation composition and structure as well as to variation in landscape composition and configuration. Nevertheless, we identified the following general patterns: first, the variation in vegetation and landscape attributes affected the occurrence and assemblage's structure of all vertebrates evaluated. Second, the quantity and configuration of both vegetation types, dry and riparian forest, were always relevant for the vertebrates response. Third, the effect of these habitat attributes is strongly modulated by seasonality - we found a low seasonal consistency on the response to such attributes - and differs largely among different spatial scales. Our results point toward the tremendous importance of preserving remnants of the original vegetation in anthropogenic landscapes. On one hand, the remnants of preserved dry forest could favor the species colonization toward sites under regeneration. On the other hand, the strips of preserved riparian forest could act as stepping-stones, allowing species to exploit the resources available across the landscapes and offering refuge and trophic resources when they are in short supply during the dry season. To consider the multiscalar nature of the vertebrates' response to habitat attributes would allow us to design anthropogenic landscapes suitable for the occurrence of these groups, and consequently to ensure the forest regeneration and ecosystem functioning. This kind of studies also allows identification of vertebrate species that can be used as indicators of habitat quality at the landscape level.

Keywords: vertebrates, secondary forest, landscape structure

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Recovery of the species composition in a tropical dry forest: are species coming back?

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Background: The study of tropical forest recovery has gained much importance lately, given the alarmingly high deforestation rates worldwide. While successional studies have most often examined the recovery of community structure, they have paid less attention to community diversity recovery. In particular, we still know little about the resilience of (ability to recover) community composition, i.e. the return to the community of those species that are common mature forest components. Here we analyze the compositional resilience of a tropical dry forest (TDF) in Nizanda, southern Mexico. **Methods:** In a successional chronosequence that encompasses a broad spectrum of developmental stages (recently abandoned to > 70 yr), we recorded all species occurring in 17 successional plots along with their abundances, and we performed a comparable sampling for 14 mature forest plots. Additionally, for the whole study region (ca. 80 km2) we prepared a checklist of the regional pool of TDF tree-species, based on a 15 yr-long floristic survey. With this information, we performed a comparative analysis based on the identities and abundances of species occurring in both forest types. **Results:** We documented the existence of ca. 240 typical TDF canopy woody species. Of these, the 14 mature forest plots host 125 species, representing 52 % of the regional TDF flora. In turn, successional stands host together 99 species. Mature and secondary forest plots share 62 species. When considering species abundances, the two forest types differ greatly, as many mature forest species are rare in successional stands. The number of typical mature forest species increases significantly along succession, and in the oldest successional plot (72 yr) the number of species (33) is undistinguishable from the mean number of species in mature forest plots (33.9 species). **Discussion:** Our results suggest that the homecoming of species to newly formed forests is not less successful than the recovery of other community attributes, such as basal area or canopy height. The compositional resilience observed in Nizanda is apparently related to the presence of a significant forest cover (both mature and secondary) remaining in the region, and to a low intensity use of the land that has allowed the recovery process to last longer than in other areas. However, this situation may change as land use is rapidly intensifying in this part of the country.

Keywords: Chronosequence; Floristics; Resilience; Succession; Resilience.

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Savanna post-fire trophic resource supply to pollinators and seed-dispersing frugivores

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Background: Fire has an important role in tropical savannas, such as some physiognomies of cerrado in Brazil, as it can modify savanna communities' structure. Considering this, we expected that it might influence the supply of food resource to mutualists via changes in the communities' investment in sexual reproduction. Fire, be it man- or lightning-caused, has been of common occurrence in savannas for thousands of years. The complex effects of fire on ecological processes may influence vegetation structure, distribution and dynamics, which can, consequently, affect plant-animal interactions. We hypothesized that fire would alter resource availability to pollinators (pollen, nectar and oil exploiters) and seed-dispersing frugivores (fleshy fruits eaters) by altering the seasonality of reproductive phenophases in a savanna community. **Methods:** We carried out an experimental study in a cerrado area, in which we established ten 25m² plots, five were used in the 'experimental fire' treatment and five were kept intact as 'control'. To test our hypothesis, we sampled every individual from the 60 species common to both treatments. During a year, we recorded the number of individuals flowering and fruiting each month to test if fire affected the seasonality of the resource offered by the whole plant assemblage, and by specific plant sets supporting groups of pollinator and seed-dispersing frugivores. We applied Rayleigh and Watson-Williams to test, respectively, if the phenophase seasonality and the main periods of resource supply were altered by fire. **Results:** Fire lead to the early supply of nectar, pollen and fleshy fruits by the assemblage as a whole. Also, fire changed the temporal pattern of nectar and pollen availability to several groups of pollinators, and of fleshy fruit availability to every seed-dispersing frugivore, causing resource to be available earlier for many groups in the post-fire scenario. **Discussion and conclusion:** Overall, fire apparently had a neutral or even a positive outcome on food availability to mutualists in the studied savanna ecosystem. Though, the resource available to each guild of mutualists showed particular fluctuations, emphasizing the complexity of community responses in fire-prone seasonally dry ecosystems.

Keywords: Fire, Flowering, Fruiting, Mutualism, Phenology

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Restoring biotic interactions after anthropogenic disturbances in a tropical dry forest

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Background: Tropical dry forests have been widely transformed by human activities worldwide and the ecosystem services they provide are diminishing. There has been an urgent call for conservation and restoration of the degraded lands previously occupied by TDFs. Restoration experiences aim to recover species diversity and ecological functions. Different restoration strategies have been used to maximize plant performance including weeding, planting or using artificial mulching. However few of them have evaluated the reestablishment of biotic interactions. **Methods:** In this investigation we evaluated weather different restoration practices influence animal arrival and the reestablishment of biotic interactions. We particularly evaluated lepidopteran larvae diversity and caterpillar predation on plants established under different restoration treatments in Chamela region, at the Pacific West Coast of México. The restoration experiment consisted in managing 10 has of abandoned pastures introducing 12 plant species, under the following restoration treatments: mulching, weeding and control with a total of 9,000 individual plants. Two years after planting we evaluated the diversity of lepidopteran larvae associated with planted species and caterpillar predation rates using clay models. **Results:** This study corroborated the importance of plant host identity for lepidopteran presence in a particular area. Lepidopteran diveristy and herbivory rates were not affected by the restoration treatment but they were related with tree species. In contrast, caterpillar predation rates were affected by restoration treatment, with higher predation rates in control plots, while caterpillar predation rates between plant species were not significantly different. **Conclusion:** This study highlights the feasibility of tropical dry forest restoration and since lepidopteran communities were significantly different between tree species we emphasize the importance of considering the introduction of a high plant species diversity to maximize restoration diversity and ecosystem functioning.

Keywords: herbivory, predation, lepidopteran, restoration, tropicaldryforest

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Assessing the Effects of a Dry Forest Restoration Project Using Dung Beetles as a Focal Taxon

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Background: Dry forests are believed to be one of the most endangered terrestrial ecosystems in the tropics. Given this situation, conservation efforts based solely on natural regeneration will probably not suffice for the long-term preservation of this ecosystem. Thus, there is an increasing need to apply active restoration initiatives in degraded areas. The results of restoration projects are often assessed through monitoring vegetation recovery, and it is assumed that other biotic components, as well as ecosystems processes will follow a similar trend. Yet, this may not be the case. We used dung beetles as a focal taxon to assess the effects of dry forest restoration project. **Methods:** In 2014 we quantified dung beetle communities (composition, number of species, and beetle abundance at both the habitat and the trap level) and their ecological functions (dung removal and secondary seed dispersal at the trap level) in three habitats in the Mexican region of Chamela: conserved forest (F), abandoned cattle pasture with restoration (RP), and abandoned cattle pasture without restoration (P). Both RP and P were areas from which cattle had been excluded in 2010 to allow natural regeneration. In 2011 saplings (aprox. 1 m tall) of eleven native tree species were planted in RP, as part of a restoration initiative. **Results:** Sample coverage was very high and species richness was the same in the three habitats (14 species), but overall abundance was highest in F (2974 individuals), followed by RP (1566) and was lowest in P (1318). Beetle species present in the three habitats were, in general, the same. However, taking into account species' abundances revealed a different community structure in F, compared to the other two habitats, but similar structure between RP and P. At the trap-level, number of species, number of individuals and ecological functions, all showed higher values in F than in RP and P; no differences were observed between RP and P for these variables. **Conclusion:** Our results suggest that after three years the restoration effort has had no significant effect on the recovery of dung beetle abundances and on ecological functions derived from their dung-burying behavior, when compared to the effects of natural regeneration. Active restoration projects are expensive, and monitoring programs should be used to inform decision-taking on the implementation of such projects vs. less-expensive approaches based on natural regeneration.

Keywords: dry forest, restoration, Scarabaeinae

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Ecological restoration of arid lands: new methods from Caatinga vegetation

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Background: Restoration in drylands is a challenge due to the harsh conditions that impair plant survival. Restoration programs in Caatinga, (Brazilian semiarid tropical forest) frequently face as much as 70% plant mortality because of drought. This study investigates novel methods for dryland restoration to improve plant survival and overcome such low restoration success. **Methods:** Experiments were conducted in a 5 ha degraded area at the National Forest of Açu, northeast Brazil. Soil and plant shape treatments were applied in a split-plot design with five replicated blocks. In each block, soil treatments were randomly assigned in five 12 x 12 m plots: control; litter addition; irrigation; litter+irrigation; agroforesty (irrigation+crops). Inside each soil treatment, six native tree species were planted with the following plant shapes: small root +small shoot; small root + large shoot; large root + small shoot; large root + large shoot and seeds. Measures of survival and growth were taken every year during three years. The best technique for improving survival at lower cost was then applied at a large scale restoration program covering 3,3 ha of plantations, using 16 native tree species, 4800 trees in total. Tree survival was measured after the first dry season, eight months from planting. **Results:** As expected survival and growth were higher in treatments that received water, however, plants with large roots and large shoots had significantly higher growth and survival even in treatments where water was not applied. The seed sowing treatment was not successful, due to the harsh conditions that impair germination. Plant growth and survival were very successful when restoration was joined with agroforestry techniques. Plants achieve 80% survival after the first dry season in the large scale restoration intervention that applied the large shoot and root technique. **Discussion:** This work shows an unprecedented survival rate for restoration programs in Caatinga. Large plants with large roots have the advantage to reach deeper water sources in the soil during dry periods, while their large body size allows for high water storage in plant tissue. This work indicates that restoration programs in dry lands should avoid expensive irrigation methods by transplanting large plants with large roots in degraded areas.

Keywords: restoration, drought, long roots, desertification

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Soil-plowing and liana removal as restoration tools for old-fields

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Background: Soil compaction and liana growth following forest disturbance are threatening the tropical carbon sink by delaying or preventing vegetation recovery. The abandonment of unproductive lands is common in the tropical dry forest of Mexico, promoting the establishment of old fields characterized by thorny plant communities and lianas that can persist for decades, which inhibits forest succession. For example, at the Chamela region (Jalisco State, Mexico), old fields are frequently dominated by the nonnative tree *Mimosa arenosa* (Fabaceae), and lianas of the genus *Ipomea* (Convolvulaceae). Lianas proliferate in young old fields (ca. 10 years of abandonment), and these degraded sites also present a greater tree canopy openness than preserved tropical dry forests. **Methods:** On the Pacific Coast of Mexico, we selected three old fields that were abandoned ca. 10 years before our study. In each old-field, six, 25-m2 (5 X 5 m) plots were randomly established. In three of the plots the soil was plowed and lianas removed from tree stems and canopy, whereas the rest of the plots were not manipulated (control). Liana removal was done at the beginning of the experiment and 7, 17, 25, 30 and 37 mo later while the soil was plowed twice. Before and after plot manipulation all woody stems (i.e., tree species dbh > 1cm) and canopy cover were recorded. After manipulation we calculated the rate of increase in standing biomass and stem growth and survival. **Results:** The results show a significant effect of site, treatment and time on all variables with a positive effect of plot manipulation on overall biomass gain and on stem survival. **Discussion/conclusions:** Our results showed that soil plowing and liana removal concurrently facilitate forest recovery in tropical dry forest old fields through increased growth in biomass and survival of tree species. Further ecological restoration research in the long-term and its effect on tropical dry forest succession in the Chamela region is needed for developing successful restoration plans

Keywords: biomass, canopy cover, ecological restoration

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Resilience of Soil Properties to Land-use Change in a Tropical Dry Forest Ecosystem

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Background: Land-use change in tropical dry forests can dramatically alter all kind of ecosystem properties, but little is known about their resilience, with most studies focused on vegetation recovery. Here we assessed soil resilience by examining resistance to, as well as recovery from, pasture use by smallholder farmers in western Mexico, and whether soil recovery could be inferred from vegetation recovery. **Methods:** We measured 25 soil physical, chemical and biological properties, and vegetation properties in pastures, secondary forests, and old-growth forests (OGF). We evaluated resistance to pasture use by comparing OGF sites and pastures. We assessed whether those properties recovered to OGF reference values after pasture abandonment by analyzing the trajectories of properties along the chronosequence of secondary vegetation. Finally, we tested if vegetation properties (basal area, individual density, species richness) could improve prediction of recovering soil properties. **Results:** Nine out of 25 properties differed significantly between the OGF sites and pastures. From these nine nonresistant properties, six (i.e., penetration resistance, soil C concentration, soil C/N, basal area, individual density, rarefied species richness of woody vegetation) showed recovery as a significant positive relationship with forest age. In contrast, surface litter C, litter C/N, and soil available P showed no resistance and no recovery within the successional period examined, (up to 35). The best vegetation indicator for the recovery of some soil properties was woody species richness. **Discussion:** Our findings indicate that soil was overall resilient to pasture use but some properties did not recover synchronously with vegetation properties during succession, and suggest that functional differences of colonizing plants matter for recovery after pasture use. More attention should be paid to soil function, because full ecosystem recovery is often inferred only from the recovery of vegetation properties.

Keywords: Chronosequence, Pasture, Resistance, Recovery, Succession

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Symposium
Ecological drivers of succession in human-modified landscapes, from local to meta-communities

Climate as a driver of large-scale community composition

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Background: Most theories of community composition (which includes succession) are based either on neutral or "niche" models, with some consensus that which mechanism dominates is an issue of spatial scale (Garzón-Lopez et al, 2014; Chase, 2014). At larger (biogeographic scales: extents of > 10^4 km^2) climate plays an important role, not always included in theories of community composition. **Methods:** I will present a theoretical scheme of community composition based on three assumptions: (i) climate drives the distributions of individual species via the geographic distribution of their fundamental niches; (ii) at large scales, species interactions can be disregarded; (iii) fundamental niches evolve very slowly, and (iv) dispersal is a critical factor in understanding community structure. **Results:** I present the equations of the above scheme, and illustrate it with an example using tropical mammals. In the example I show how to estimate the Presence-Absence Matrix for a suite of organisms, how to extract biodiversity-pattern statistics, like alpha and beta diversity, mean covariance and dispersal fields (Soberon & Cavner, 2016), and how these are driven by climatic factors. **Discussion/conclusions**: Both conventional neutral and "niche" models of community composition ignore the many complications of realistic climate change taking place over heterogeneous landscapes. By resorting to data-intensive niche modeling and three explicit simplifying assumptions I propose a novel scheme to explain community composition at biogeographic scales.

Keywords: Grinnellian niches, climate change, community

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The role of dispersal limitation and species differences in local and landscape scale succession

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Background: Successional dynamics of tropical forests are extensively studied at the local, but not at the landscape scale. Alpha diversity generally increases during succession, but what about beta diversity? Most theories relate local species turnover to changes in local environmental conditions and differences in the life histories of species - specifically, the response of species to the successional gradient in terms of establishment and survival. Few models incorporate dispersal limitation, even while it may be an important driver of succession on local and landscape-scale. Here we use a simple simulation model to explore how dispersal limitation and life histories may affect succession. **Methods:** We run a series of alternative models to simulate succession on local and landscape scale, based on a limited number of simple rules, and to explore how succession patterns differ along two major axes of variation. First, we varied the size of and dissimilarity among local species pools. Second, we varied the degree to which species differed. This started with a neutral model and subsequently included an increasing number of functional groups, each defined by different recruitment and mortality probabilities as function of forest age. We qualitatively compared the predicted patterns with field data. **Results:** In the neutral and many of the alternative models, alpha diversity increased and beta diversity decreased during succession. We found qualitatively similar patterns in our field data. Changes in alpha diversity depended on the size of the local species pool, number and characteristics of functional groups and the relative abundance of each group. Changes in beta diversity also depended on how the functional groups were defined, but the size of and dissimilarity among the local species pools had a stronger effect. **Discussion:** Our results show that different mechanisms may lead to quantitatively different but qualitatively similar shifts in species composition and diversity, both on local and landscape scale. Perhaps the most surprising result is that a neutral model with dispersal limitation can generate patterns that are qualitatively similar to observed patterns in the field. This underscores that data on successional patterns alone tell us little about the underlying processes. Our models are simple and not very realistic. Yet, they produce potentially testable hypotheses and indicate the data we need to test them.

Keywords: Landscape-Scale Succession; Dispersion Limitation; Simulation

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Opposing mechanisms limit taxonomic convergence in Neotropical secondary forests

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Background: Understanding whether the species composition of successional forests follow deterministic trajectories towards a stable equilibrium state, or unpredictable trajectories towards multiple basins of attraction remains an elusive question. Trends of taxonomic similarity between pairs of communities over succession may depend upon on the relative abundances of species exhibiting different responses to the successional gradient. Here, we assess which species are driving patterns of taxonomic similarity over time among pairs of second-growth (SG) and old-growth (OG) stands and among pairs of SG stands in northeastern Costa Rica. **Methods:** We evaluated temporal trends of taxonomic similarity between plot-pairs using metrics based on Hill numbers. Then, we performed a sensitivity analysis to assess the contribution of different groups of species (second-growth specialists, old-growth specialists, generalists and rare) to the overall patterns in similarity between plot-pairs. **Results:** Taxonomic similarity between SG and OG increased over time, although the trend was weak, indicating that convergence between secondary and mature forests in the study area is likely to occur over long time scales. In contrast, temporal changes in taxonomic similarity between pairs of SG stands of similar age showed idiosyncratic patterns depending upon similarity metric and tree size class. Overall, limited or lack of convergence between pairwise forest stands was the result of opposing trends in changes of taxonomic similarity among different subsets of species. Forest generalists were the major driver of floristic convergence between SG and OG forests, whereas rare species and old-growth specialists were an important source of divergence. Second-growth specialists mostly contributed to convergence between pairs of SG stands, while rare species contributed to divergence. **Conclusion:** For rare species and old-growth specialists, stochastic processes may be important drivers of successional trajectories, as these species tend to show low abundances across plots and thus are more prone to demographic drift and dispersal limitation. In contrast, the patterns among second-growth specialists and generalists provided support for the traditional model of succession, built upon niche differentiation theory. Overall, our findings provide deeper insights into the process of forest resilience in the tropics.

Keywords: secondary succession, convergence, taxonomic similarity

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The role of land use in driving successional pathways in Amazonia

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Background: Secondary succession in the tropics can follow alternative pathways. Land use is known to be an important driver of divergent successional pathways, but the mechanisms underlying land use effects are still to be revealed. Land use changes actually comprise modifications in several ecosystem processes such as dispersal limitation, nutrients availability in the soil, environmental conditions, inter-specific competition, and ecological filtering. We investigate how land use determines successional pathways by analyzing the relative importance of landscape configuration, management intensity and soil quality in vegetation structure and species composition of secondary forests in Amazonia. **Methods:** We sampled 38 same-aged secondary forests (5 yrs old) across gradients of landscape configuration, management intensity and soil quality. Additionally, we analyzed longitudinal data over >20 years of succession on fields subjected to different land-use intensities to evaluate how species composition change over time. **Results:** We found that biomass recovery was mainly driven by management intensity while diversity levels were determined by a combination of management intensity and landscape configuration. Local filters imposed by management and soil quality determined species composition and reduced species a- and b-diversity leading to early successional communities more similar to each other. Longitudinal data confirmed that successional communities regrowing on areas with a history of low-land-use intensity tend to diverge over time in terms of floristic composition, i.e. each plot may end up with a different species composition. On the other hand, areas subjected to high land-use intensity hold plant communities that remain similar to each other over time. **Discussion/conclusion:** This study suggests that the foundations of alternative pathways occur at the onset of succession. When a diverse community is lacking at the onset, increasing diversity over time will depend on new incomers dispersed from surrounding sources. Given the low contribution of late successional species to seed rain, the fact that intensively used sites tend to be located in fragmented and deforested landscapes and the homogenization of plant communities in intensively used landscapes, species build-up is bound to be slow in these areas. Intensive land use may, therefore, transform landscapes into impoverished, homogeneous and more predictable successional communities.

Keywords: species composition, landscape, soil, diversity

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Understanding the reestablishment of plant-herbivore networks in secondary tropical dry forests

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Background: Tropical dry forests have been extensively transformed by anthropogenic activities. In present times TDFs are a mosaic of primary and secondary forests within an agricultural and cattle pasture matrix. Forest succession can influence herbivore communities through changes in host availability, plant quality, microclimate, structure complexity, niche availability and predator abundance. However little information is available about how lepidopterans colonize secondary forests and if plant-lepidopteran interaction networks are reestablished. **Methods:** In this investigation we evaluated changes in plant-lepidopteran interactions across a TDF chronosequence during 9 consecutive years in Chamela, the Pacific coast of Mexico. This chronosequence is formed by four stages of secondary succession: recent abandoned fields, early succession (6-9 years of abandonment), late succession (13-16 years of abandonment) and mature forest with three replicates per stage. Each replicate consisted in 20x50 m plots, with four transects of 2x20 m. All woody plants >1 cm in diameter and >50 cm within these transects were labeled and sampled for lepidopterans during the rainy season. Caterpillars were reared to adulthood and identified in the lab. We evaluated changes in lepidopteran diversity across the chronosequence and across years, and compared plant-lepidopteran networks along secondary succession. **Results:** Lepidopteran diversity is high along the chronosequence, we have found 480 species associated with 146 plant species. Lepidopteran diversity per plot remains similar across years independent of successional stage. Plant-lepidopteran networks increase in size and complexity along succession, they form two groups: recently abandoned pastures separate from successional and mature forests. Interestingly these differences hold after 9 years of study. **Conclusion:** Plant-lepidopteran networks are reestablished during succession, once the trees are established lepidopterans are able to colonize. However, land-use history appears to be very important for determining the particular trajectory each plot takes in terms of lepidopteran diversity.

Keywords: caterpillar, biotic interactions, plant-herbivore networks

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Tree species replacement during old-field succession in a Neotropical agro-forest landscape

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Introduction. In tropical rainforests, a set of tree species is specialized in the colonization of open forest sites caused by natural disturbances. Frequently these pioneer species colonize recently abandoned agricultural fields, conforming the first stage of old-field succession. In landscapes where forest conversion to agriculture and forest regeneration conform dynamic patchworks, it can be found many pioneer species. At the local (plot) scale, however, it can be expected that pioneer species with similar ecologies will tend to compete and that few or only one species would tend to dominate. Due to this expected process, changes in environmental factors affecting the immigration and performance of species at each site may determine different arrays of colonizing species during succession, producing important levels of beta diversity of pioneer species in the landscape. Here, we aimed to assess the dynamics of species replacement during the first three decades of succession and explore to what extent pioneer species with similar ecologies may interfere themselves in the colonization of recently abandoned fields. **Methods.** In southeastern Mexico, we used a chronosequence system, composed of 17 secondary forests with 0 to 31 years old, which has been annually monitored for 3-16 years recording survivorship, growth and recruitment of all trees with a minimum height of 1 m in permanent plots (0.05 ha each). Crossing chronosequence and dynamical data, we reconstructed potential successional trajectories of change in above ground biomass for (dominant) species representing 80% or more of total assemblage biomass over the first 10 years of succession. In order to assess segregation/overlap in the potential successional trajectories of these species, we did run a Principal Component Analysis using a matrix of years since abandonment (rows) x species (columns), which cells contained values of biomass per species per year. Then, for the pioneer species with higher incidence across the studied plots and higher overlap in their successional trajectories, we tested whether at the plot level these species interfere themselves. **Results and conclusions:** In total we recorded 19 colonizing species, from which 6 (*Cecropia obtusifolia, Luehea speciosa, Ochroma pyramidale, Schizolobium parahyba, Trema micrantha* and *Trichospermum mexicanum*) were dominant along the first 10 years of succession. Incidence probability for these dominant species varied between 0.82 and 0.94; Trema was consistently the first colonizer, reaching biomass maximum before 5 years of succession, while *Ochroma*, *Cecropia* and *Trichospermum* overlapped in some degree their potential successional trajectories reaching biomass maximums during 7-10 years of succession; *Luehea* and *Schizolobium* reach biomass pecks after 15 years of succession. At the plot scale, few (1-3) pioneer species did dominate, encompassing 50% or more of the assemblage biomass. We find evidence that some species (e.g. Ochroma) were consistently superior in their biomass gain performance, suggesting a strong interference/competition process among colonizing species. We conclude discussing possible hypothesis about the role played by environmental factors and life history/functional traits explaining this purported process.

ID:1243
D-Thrusday Yucatan-2
Symposium: Ecological drivers of succession in human-modified landscapes, from local to meta-communities

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Symposium
Lightning talks and networking in tropical science: ATBC-SECSCI Chapter Symposium

Plant population and community ecology in tropical forests

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I am broadly interested in the factors that affect patterns of genetic variation, habitat distributions, and community composition of plants across broad geographic scales. My primary projects involving tropical ecology currently include studying invasive plants in their native and introduced ranges; secondary succession in Panama; global liana ecology; and forest dynamics on the island of Dominica in the Caribbean. Most of my work examines patterns in species diversity and distributions and seeks to determine the processes that give rise to them. I have conducted research in many countries in the Neotropics and a few in the Paleotropics and Oceania. I am interested in working with graduate students who have had experience working or studying in the tropics previously and have their own questions in tropical plant ecology that they are interested in pursuing. I see graduate students as "colleagues in training" and am looking for students who see a graduate degree not as an end point but as a stepping stone to a career in plant ecology or conservation.

ID:1164
D-Thrusday Yucatan-2
Symposium: Lightning talks and networking in tropical science: ATBC-SECSCI Chapter Symposium

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Plant Demography in a rapidly changing world

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A colleague once described demography as the subject having ecology's most boring fieldwork but biggest impact. We can argue about whether the former is true, but I agree about the latter - demographic analyses are used to do everything from identifying strategies for managing invasive species to studying the evolution of life-history strategies. I especially like that it allows me to study not only fascinating ecological interactions like seed dispersal, ant-plant mutualisms, and herbivory, but also how the outcome of these interactions influences the population dynamics of the participating species. Finally, it allows me both test fundamental hypotheses central to ecology and do research related to conservation and management. In short, it's a great subdiscipline for generalists. I'll illustrate these points -- and prove that our fieldwork is not as boring as my friend said it was - with examples of the diversity of research projects my students and I carry out. I'll also describe the ideal background a student interesting in joining my lab should have (spoiler alert: there isn't one) and some of the future projects for which we want to recruit new lab members.

Keywords: demography, population dynamics, conservation, climate

ID:1163
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Symposium: Lightning talks and networking in tropical science: ATBC-SECSCI Chapter Symposium

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The Interactions and Global Change Laboratory

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At the laboratory of Interactions and Global Change - University of Connecticut, we study the ecological and evolutionary consequences of global change on plant-arthropod interactions. To address this fascinating topic, we combine field and laboratory experiments with biodemography, quantitative genetics, molecular biology and insect physiology to understand how interacting species and populations adapt to novel environments, for example, novel host plants or projected global warming. Please join this symposium to know more about research opportunities in my laboratory.

Keywords: Student, Oportunities, Ph.D., M.Sc.

ID:1165
D-Thrusday Yucatan-2
Symposium: Lightning talks and networking in tropical science: ATBC-SECSCI Chapter Symposium

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Ecology and evolution of plant chemical diversity

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My research centers on the mechanisms that forge and maintain tropical plant diversity. Specifically, I study the role that plant chemistry and herbivore interactions play in the distribution, coexistence, and diversification of plants. To this date, my work integrates experimental ecology, metabolomics, statistical learning, and applied systematics, all built on the cornerstone of natural history. I have been particularly engaged in the study of species chemical diversity, a deeply overlook component of our world's biodiversity. Independently of one's field of study, chemistry is the interface by which species interact. From pheromones to colors, from allures to venoms and poisons, every species has to either use, overcome, or circumvent chemical compounds in order to complete their life cycle. Nevertheless, in spite of the vast knowledge we have today on the diversity of species, their distributions, and ecological roles, we know very little of the diversity, distribution, and function of the natural compounds produced by said species. Which ecosystems are more chemically diverse? Which taxa produce a wider diversity of chemical compounds? What are the ecological and evolutionary implications of chemical diversity both at the species, clade, and community level? Answering these questions will allow, not only a better understanding of the processes that forge and maintain the vast diversity of the natural world, but also to create better strategies for the discovery and development of novel medicines, pesticides, and the improvement of staple crops. Currently, I am looking for brave young scientists that will be interested in undertaking this questions as we move forward in this new and uncharted territory.

Keywords: plant-herbivore interactions, chemistry, ecology, evolution

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Symposium: Lightning talks and networking in tropical science: ATBC-SECSCI Chapter Symposium

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Evolutionary ecology of plants and species interactions

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My research seeks to understand interactions between plants and other organisms, including herbivores, seed dispersers, seed predators, and microbes. I am particularly fascinated by the role of plant chemistry in mediating interactions and structuring broader ecological and evolutionary processes. I conduct both basic and applied research in tropical and temperate systems, and I use a combination of approaches including observational field studies, experiments, analytical chemistry, and bioassays. I began as an Assistant Professor in the Department of Biological Sciences at Virginia Tech in Jan 2017, and I am looking for motivated graduate students to join the lab. I may also have opportunities for a post-doc and a technician this year. Most importantly, I am seeking mentees that are genuinely passionate about understanding the natural world and specifically interested in the area of research that is the focus of my lab. I am also looking for: 1) strong written and oral communication skills, 2) independent thinkers that have the drive and motivation to take on new challenges, and 3) skill sets and personalities that complement those of our existing group. Students can be supported at Virginia Tech with a combination of research and teaching assistantships, and I also encourage applications for external support.

Keywords: plant-animal interactions, chemical ecology, fruit

ID:1162
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Tropical plant-animal interactions in a changing world

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Background: Many tropical plants rely on seed dispersers to colonize new environments they may face under climate change. In a warming world, tropical biota will rely on elevational migrations to locate habitats that fit their ecological and physical requirements. The objectives of my lab are to investigate complex vertebrate and invertebrate interactions with seeds and seedlings in tropical forests. **Methods:** We work in southern Mexico and Costa Rica to address fundamental questions of how plant and animal communities will change under a warming climate. We employ manipulative experiments in the field and lab to determine biotic (vertebrate and invertebrate) and abiotic barriers to plant elevational migrations. **Results:** So far, my lab has discovered that some woody plant species do not face post-dispersal barriers to upslope migration and may be able to colonize this habitat to outpace global warming. However other species do face pre-existing biotic barriers to survival at high elevations (intense predation by terrestrial mammals). If plants are unable to colonize novel highland habitats as biomes shift upward, these barriers will prevent successful elevational migration, resulting in lowland biotic attrition. **Discussion:** Altered plant-animal interactions, especially seed dispersal and predation, will play major roles in redefining tropical plant communities as the world warms.

Keywords: plant elevational migrations, mammals

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D-Thrusday Yucatan-2
Symposium: Lightning talks and networking in tropical science: ATBC-SECSCI Chapter Symposium

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Conservation of frugivore-plant interactions

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Background:. Frugivores act as important seed-dispersal agents in tropical ecosystems, given that a large proportion of tree species in the tropics have traits adapted for animal-mediated seed dispersal. Unfortunately, frugivores are facing high risks of extinction as a result of anthropogenic and natural pressures. My objectives are to gain a better understanding of how frugivore decline and/or loss might impact ecological and human communities, and how we might limit the long-term impacts of ecological changes resulting from the disruption of such interactions. **Methods:** I have been working in Madagascar's rainforests, with lemur-plant interactions as a model system, to address multifaceted aspects of frugivore-mediated seed dispersal. I use an integrative approach combining empirical work, such as field surveys and experiments, with simulation-based modeling and phylogenetic tools to address my research questions. **Results:** So far, my results have shown that there is an important link between lemur frugivore foraging behavior and the spatial, temporal and phylogenetic patterns of seed dispersal. **Discussion:** By demonstrating the important role of lemur frugivores in enhancing plant fitness and in structuring plant-plant interactions, my work has important conceptual implications for understanding the dynamics and functioning of biodiverse plant communities. Thus, the loss of these seed-dispersing lemurs could be critical for the plant communities in this system.

Keywords: seed-dispersal, tropical forests, lemurs, Madagascar

ID:1170
D-Thrusday Yucatan-2
Symposium: Lightning talks and networking in tropical science: ATBC-SECSCI Chapter Symposium

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Effects of cattle foraging on tropical deciduous forest plant communities

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Background: My dissertation focuses on two related topics: tropical deciduous forest (TDF) tree community structure, and the foraging and ranging habits of cattle in TDF. Though domestic cattle (Bos taurus) may negatively impact tree diversity in the Mexican TDF, few researchers have quantified cattle foraging preferences for woody plant species or tested hypotheses explaining potential impact patterns. In this study, I describe dietary preferences and movement of free-ranging cattle in TDF, within a foraging and community ecology theoretical framework. I ask: (1) are woody plant abundances different in TDF with cattle, compared to protected areas with no cattle? (2) Are cattle selective browsers of woody plants? If so, what variables can explain cattle preferences? (3) Are differences in TDF with and without cattle attributable to cattle foraging preferences?. **Methods:** To answer these questions, I designed and deployed custom-made animal- mounted time-lapse video, GPS and data logging equipment to record cattle feeding behavior and movements. I also quantified tree community structure in TDF with arrays of 5m x 5m plant census plots at multiple scales: on known cow foraging paths, across all available cattle habitat within ranches in the TDF, and in adjacent, unranched cattle exclusion areas on a large biological reserve. **Results:** Analyses of foraging and plant census data show cattle exclusion areas are as diverse as areas with cattle; however, differences in community structure suggest cows may negatively impact rare tree species. The best predictor of cow preference for woody plant species is the prevalence of that species in cow foraging habitat, but cattle may select preferred habitat for foraging, rather than preferentially seek individual tree species to browse. **Discussion/conclusion:** As global human populations grow, so does the need for nuanced research at the interface of natural areas and human food systems. I have conducted my research in close collaboration with regional conservation organizations and ranchers, with the aim of improving conservation and sustainable ranch management.

Keywords: Tropical deciduous forest, cattle, conservation

ID:1166
D-Thrusday Yucatan-2
Symposium: Lightning talks and networking in tropical science: ATBC-SECSCI Chapter Symposium

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Linking economic globalization to changing traditional social-ecological landscapes

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I work closely with numerous and indigenous (Maya) communities in rural Yucatan Mexico to effect bio-cultural conservation through 1) participatory conservation research across landscapes, 2) community conservation planning, 3) conservation education and training of Maya people, and 4) coordinating a suite of diverse community-based conservation projects. All of my efforts focus on indigenous communities and their landscapes better adapting to global political-economic drivers of change. I work with a multidisciplinary team across the social and natural sciences, and aim to create a broad coalition and network of professionals, NGOs, and agencies working throughout Mesoamerica to coordinate and align our efforts with protected areas. Ultimately, I aim to extend my efforts across the Mesoamerican Biological Corridor and reshape it into a "Bio-Cultural" diversity corridor where protected areas are better connected under the auspices of "Indigenous Peoples' and Community Conserved Areas", as promoted by the IUCN. I seek a mentor with a similar passion and level of engagement with local communities and myself.

ID:1169
D-Thrusday Yucatan-2
Symposium: Lightning talks and networking in tropical science: ATBC-SECSCI Chapter Symposium

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Tropical Herpetology and Natural History

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I am a recent graduate at South Dakota State University with a degree in Ecology and Environmental Science. I have completed several undergraduate research projects including establishing a natural history collection of reptiles and amphibians for our recently added herpetology course and an Research Experience for Undergraduates (REU) project with Duke University's Organization for Tropical Studies at La Selva Biological Station in Costa Rica. My research interests lay mostly in the areas of tropical herpetology, natural history, animal behavior, and toxicology. I am looking for an advisor who has a strong passion for conservation and natural history who is interested in tropical environments and species. The toxicology project that I completed in Costa Rica has left me with many questions that I would like to explore, but I am also very open to many different types of research projects in the fields listed above. I consider myself a self-starter, and work best independently and under minimal supervision, but am also happy to work as a team. I enjoy teaching, and have experience creating college-level course work. Including our herpetology lab section, herpetology lecture, animal behavior, animal diversity, biology, and environmental toxicology and contaminants. I also greatly enjoy positions where there are elements of conservation outreach.

Keywords: tropical conservation, herpetology, natural history

ID:1168
D-Thrusday Yucatan-2
Symposium: Lightning talks and networking in tropical science: ATBC-SECSCI Chapter Symposium

ORAL SESSIONS

Oral Session
Biotic interactions in tropical ecosystems I

Coastal plant-symbiont communities respond to petroleum pollution of the past, present and future

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Background: Drilling for oil near shorelines is becoming prevalent in tropical areas, and pollution from petroleum spills or leaks can have negative impacts on ecosystems. The importance of bacteria for biodegradation of petroleum is well described for contaminated seawater and coastal soils, but very little is known about the role of plant symbionts in degrading petroleum. Endophytes are bacteria and fungi that live as symbionts within plant roots, stems and leaves. These symbionts are closely associated with the plant and some endophyte species may serve the dual purpose of promoting plant growth and degrading petroleum inside of plant tissues. In an extreme environment such as a coastal salt marsh, where oxygen is limited in soils, plants may be especially dependent on endophytes for resilience to stress and to respond to petroleum contamination. Our research addresses the questions: (1) do endophyte communities inside of coastal plants shift to incorporate and amplify endophytes that are tolerant to petroleum and can biodegrade it? And (2) do plants deliver oxygen and endophytes to polluted soils, thereby hastening the chemical evolution of petroleum? **Methods:** We compare plant-symbiont interactions observed in the field with mesocosm studies in which oil is applied to coastal plants. We use culturing and next-generation sequencing methods to profile the symbiont communities. **Results:** With respect to past oil spills, our work since the Deepwater Horizon (DWH) oil spill has shown that when coastal grasses are contaminated with petroleum, fungal endophyte abundances are generally low. Bacterial endophyte abundances remain high, but the communities shift to incorporate more taxa with known roles in biodegradation. Regarding petroleum pollution in the present, we use greenhouse studies to profile the symbiont communities and plant growth parameters in the presence and absence of petroleum. We further compare the breakdown of petroleum in the presence and absence of plant/symbiont combinations. **Discussion:** Very little information exists on the symbionts of coastal plants. Looking toward the future, our goal is to develop a mechanistic understanding of how coastal plants, symbionts and polluted soil interact. This knowledge will hasten the development of remediation tools that use plant-delivered, naturally occurring symbionts to clean up polluted soils and protect shorelines.

Keywords: endophytes, pollution, Gulf of Mexico

ID:110
Monday, July 10th, 2017, Yucatán 1
Oral session: Biotic interactions in tropical ecosystems I

Tropical seed dispersal networks: emerging patterns, biases and keystone species

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Background: Seed dispersal mediated by animals is a pivotal ecological interaction in the tropics. Despite a long tradition of tropical seed dispersal studies, only recently the drivers of the structure of seed dispersal networks are beginning to be uncovered at macroecological scales. The knowledge on tropical seed dispersal comes mainly from avian dispersal studies in the Neotropics while other frugivores and tropical regions are strongly understudied. Our aim was to perform a review to characterize the state of the art, to detect potential biases affecting current understanding of tropical seed dispersal networks and to identify emerging patterns related to the identity and functional traits of the keystone dispersers and plants and discuss their implications for conservation. **Methods:** We compiled, by means of a literature search, all available information on seed dispersal or frugivory networks at the community level and extracted data on location, habitat type, level of disturbance, number of plants, animals, and links in the network, class of animal, sampling method, and recorded whether extinction simulations were performed. When the studies highlighted the role of particular species owing to their contribution to network structure, this information was also extracted and the main traits of these species were compiled. **Results and Discussion:** The networks sampled with a combination of visitation census and seed recovery from feces seem more reliable of the number of detected links and web asymmetry than networks based on a single method. Our review reveals that keystone species in most networks share a set of functional traits likely influenced by species phylogeny. Woody plants bearing small berries (in the Melastomataceae, Myrtaceae, Moraceae and Urticaceae families) were the most frequent keystone plants whereas two groups of keystone animals could be identified, namely: small obligate frugivores (Pipridae and Thraupidae) and large animals including a variety of taxonomic groups such as cracids, rodents, monkeys and megafauna. Large keystone species tend to face a higher extinction risk leading to a concern on the sustainability of the dispersal services they provide, mainly to large-seeded plant species that are essential to ecosystem functioning.

Keywords: ecological-networks, animal-seed-dispersal, functional traits, keystone-dispersers

ID:137
Monday, July 10th, 2017, Yucatán 1
Oral session: Biotic interactions in tropical ecosystems I

Seed-associated fungi in neotropical pioneers influence seed persistence, germination, and survival

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Background: Interspecific variation in susceptibility to pathogens at early life-history stages strongly influence species abundance and distribution in tropical trees. Seed-fungal interactions are especially important for determining the fate of quiescent seeds (i.e., seeds that are ready to germinate but only do so when conditions are favorable). We examined seed-associated fungi in quiescent seeds of three species of the pioneer genus *Cecropia*, and coupled this information with germination and survival of seeds that were buried for up to 18 months in a lowland tropical forest in Panama. **Methods:** Seeds were buried in five common gardens in the understory of lowland moist tropical forest at Barro Colorado Island, Panama. Prior to burial, fresh seeds from at least five different maternal sources of a single species were pooled, and then separated into different seed bags. Four replicates consisting of four bags per species, per garden were then retrieved at 1, 3, 6, 12, and 18 months after burial. Retrieved seeds were allocated to germination experiments or used to investigate the effects of burial duration, seed viability status, host species, and spatial distributions in the structure of seed-associated fungal communities. **Results:** Seed survival greatly declined for all species over time: only 40%, 30% and 20% of initial seeds remained viable after 18 months of burial for *C. longipes*, *C. peltata* and *C. insignis*, respectively. However, strong intraspecific variation was evident among replicates in our common gardens (e.g., after 18 months, 0% to 100% of C. peltata seeds survived in different replicates). Few fungal infections were found in fresh seeds, suggesting that most seeds were infected by soil-borne fungi. Seed-associated fungal communities were shaped primarily by the identity of the host species, even among congeners with similar life histories. To a lesser extent, fungal assemblages associated with live seeds were distinct from those that were dead at the time of retrieval. This suggests that fungal communities for replicates with high seed viability have greater similarity among them than replicates selected at random. **Discussion/Conclusion:** Seed-fungal interactions strongly influence germination and survival of seeds of tropical trees. Interspecific variation in seed-associated fungal communities and in susceptibility to infection by pathogenic or beneficial fungi may play an important role in the persistence of species with quiescent seeds.

Keywords: *Cecropia*, pathogens, seed defenses

ID:355
Monday, July 10th, 2017, Yucatán 1
Oral session: Biotic interactions in tropical ecosystems I

Floral specialization: an important reproductive isolation mechanism among sympatric Achimenes

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Background: Reproductive isolation through both prezygotic and postzygotic mechanisms is central to evolutionary processes of population divergence and speciation; however the relative contribution of different reproductive barriers to reproductive isolation is not well understood in most plant genera. The Mesoamerican genus *Achimenes* has been widely cultivated and hybridized in USA and Europe; however, hybrid phenotypes are infrequent in nature. This study evaluated different prezygotic and postzygotic mechanisms of reproductive isolation among three sympatric Achimenes species. **Methods:** The study was conducted at a field site in México where *A. antirrhina, A. flava*, *A. patens* co-occur. Reproductive phenology was evaluated through biweekly surveys during two growing seasons. Floral traits that might prevent intraspecific pollen transfer, either mechanically or by influencing pollinator behaviour, were measured in the field and pollinator visitation was quantified for two years. The ability to set seed in the absence of pollinators was assessed through crossing experiments in the greenhouse. We also conducted interspecific crosses to evaluate production of hybrids among all species. **Results:** Flowering phenology overlapped among the three species; however, morphological and reward traits differed among species, as did pollination systems. *Achimenes flava* was bee-pollinated, *A. patens* was butterfly-pollinated and *A. antirrhina* was hummingbird-pollinated; interspecific visits were rare. All species are self-compatible but they have a low capacity to self-pollinate autonomously. Interspecific crosses were successful among most species pairs producing more than 60% hybrid fruit set, except for *A. antirrhina-A. flava* cross, that yielded no hybrid progeny. **Discussion:** Reproductive isolation in *Achimenes* is mainly due the mechanical fit between pollinators and flower morphology, as well as ethological isolation through reward traits that mediate particular pollinator behaviors. Autonomous pollination and phenology (prezygotic), and hybrid unviability (postzygotic), apparently played a minor role as reproductive barriers. These results suggest that sympatry and overlapped phenology have promoted specialization on particular pollinators and floral diversity in *Achimenes* genus.

Keywords: reproductive isolation, specialized pollination, sympatry

ID:361
Monday, July 10th, 2017, Yucatán 1
Oral session: Biotic interactions in tropical ecosystems I

Discovering to the true pollinators, pollination networks and evolution of floral traits in *Ipomoea*

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Background: The interactions between plants and pollinators have been important drivers of Angiosperm evolution. Studies using network analysis have provided a comprehensive tool to understand plant-pollinator interactions at the community level; however, most of these studies have analyzed this relationship in terms of floral visitation and at specific times of the year. To understand how community-level interactions and phenology may influence floral evolution, it is important to assess how pollinators influence plant fitness on particular plant lineages throught the year. This is the first study that evaluates plant-pollinator networks, phenology and plant reproductive success in a group of coexisting congeners that exhibit different pollination syndromes including ornithophily, melithophily, sphingophily and chiropterophily. **Methods:** To evaluate the role of floral visitors on plant fitness, we conducted different network analyses of an Ipomoea community in the Pacific coast of Mexico, including: (1) flower visitors, (2) visitors that contact the reproductive organs, (3) visitors that deposit pollen on stigmas, and (4) visitors that effect fruit and seed production. We conducted a series of pollination exclusion experiments to test the effectiveness of pollinators and also determined the anthesis and flowering phenology of the Ipomoea species studied. **Results:** Floral visitors of most Ipomoea species included the pollinator functional group that corresponded to the floral syndrome as well as other visitors. Effective pollinators, in terms of pollen deposition on stigmas and fruit and seed production, corresponded to the floral syndromes and were the most frequent visitors in all cases. Secondary pollinators were also present in most syndromes. Coexisting Ipomoea species sharing the same floral syndrome have staggered flowering phenology or different patterns of anthesis. **Conclusion:** The fitness network of plant-pollinators of Ipomoea is determined by the floral syndrome, providing strong support for Stebbins Principle in which the most frequent and effective floral visitors are the primary drivers of the evolution of floral traits. Additionally, the pollinators registered have different levels of effectiveness on the pollination networks. Furthermore, flowering phenology determines pollination network dynamics suggesting avoidance for competition in plants with the same pollination syndrome.

Keywords: Pollination networks, Phenology, Effective pollinators

ID:441
Monday, July 10th, 2017, Yucatán 1
Oral session: Biotic interactions in tropical ecosystems I

Plant-pollinator interactions and floral biology of three Mesoamerican alpine endemic species

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Background: Alpine communities in the tropics have insular characteristics, as they occur in isolated mountain tops, with a lower diversity of plants and animal pollinators than other tropical habitats. Furthermore, harsh and fluctuating climatic conditions affect animal activity posing a challenge for sexual reproduction in alpine plants. Under such conditions, adaptations to ensure fruit and seed production, such as generalized pollination systems, autonomous pollination or apomixis should be common reproductive strategies in these high mountain habitats. We assessed the level of pollination specialization and capacity to reproduce autonomously of two Mexican and one Mesoamerican alpine endemic species. **Methods:** We documented plant-pollinator interactions and breeding systems of *Castilleja tolucensis*, *Draba nivicola* and *Arenaria bryoides* at two volcanos of the Transmexican Volcanic Belt during two consecutive years. We conducted video-camera and direct pollinator observations at the highest, most exposed vegetation belt of the alpine zone. To determine the capacity to set seed in the absence of pollinators we conducted crossing experiments in the field, and assessed pollen deposition, pollen tube growth and fruit and seed set. We also quantified female reproductive success at 3-4 populations of each species. **Results:** The pollination systems of all three species were highly specialized: pollinators were hummingbirds (two species) for *C. tolucensis*, flies (three species) for *D. nivicola*, and flies (two species) for *A. bryoides*. The latter two plant species have a high capacity to set seed autonomously, but not *C. tolucensis*. Natural pollination success varied among populations and species. **Conclusions:** The results of this study indicate that alpine plants may have highly specialized pollination systems but reproductive assurance mechanisms are common. Interestingly, hummingbird-pollinated *C. tolucensis* is highly dependent on pollinators for reproduction, suggesting hummingbirds are probably reliable floral visitors in these habitats. Since these plant endemic habitat specialists occur at mountain tops, their long-term viability is highly threatened by climate change. Thus, understanding the reproductive ecology of these plant species is fundamental to making well-informed conservation and management decisions.

Keywords: alpine, endemic, pollination, reproductive success

ID:522
Monday, July 10th, 2017, Yucatán 1
Oral session: Biotic interactions in tropical ecosystems I

Oral Session
Seedling and sapling ecology

Combined Effects of Seed and Soil Quality Drive Seedling Performance in a Tropical Fragmented Forest

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Habitat loss and fragmentation affect the structure and functioning of forested ecosystems worldwide, yet we lack an understanding of how species respond to environmental changes. Here we examined reproductive success and seedling performance of Poulsenia armata (Moraceae) in continuous and fragmented forests of Los Tuxtlas, southern Mexico. We determined seed quality and seedling performance by combining isotopic analyses in seed quality with field observations on P. armata fruit production and a common garden experiment. If resources are less available for reproduction to relic parental trees of P. armata in fragments, we predicted: 1) small fruit crops, 2) low seed quantity and quality as reflected by seed mass, seed N and C content, and germination, and 3) low seedling performance (reduced survival and growth). We expected seedlings with low parental investment growing in forest fragments to allocate greater belowground biomass to compensate for the low seed N content. We further investigated how maternal source and soil conditions manifested in the seedling stage. Soil conditions in forest fragments negatively impacted P. armata reproductive success. Trees of P. armata in forest fragments were smaller in size, produced fewer fruits and smaller seeds with lower quality compared to trees from the continuous forest. The combined effects of parental investment and soil conditions determined seedling survival and growth of this tropical tree. Notably, seedlings of this tree species had restricted plasticity for biomass allocation to roots, limiting the capacity of fragmented populations to compensate for the initial low N content in seeds. The observed seed quantity-quality trade-off to cope with poor soil conditions does not appear to be enough for successful recruitment of this species in forest fragments. Trees in forest fragments at Los Tuxtlas produced offspring competitively inferior and potentially less resilient than counterparts in continuous forest, jeopardizing the future persistence of P. armata in light of future global change.

Keywords: Stable isotopes, reproductive success

ID:70
Monday, July 10th, 2017, Yucatán 3
Oral session: Seedling and sapling ecology

Demographic drivers of local seedling distributions: growth and mortality responses to soil moisture

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Background: Climate change is expected to increase rainfall variability in the tropics, leading to longer and more intense periods of drought. Tree species distributions in tropical moist forests respond strongly to regional rainfall gradients and local variation in soil moisture related to topography. Despite accumulating evidence that seedling responses to soil moisture play a major role in shaping species distributions on both local and regional scales, the relative importance of the two main demographic drivers in this process (growth and mortality) is still unclear. **Methods:** We used two decades of annual seedling census data at 200 sites in the 50-ha Forest Dynamics Plot on Barro Colorado Island, Panama, and measured soil water potential at the seedling sites during two consecutive dry seasons, one before and one during a strong El Niño drought. We quantified the response of seedling growth and first year mortality to soil water potential for 53 tropical shrub and tree species. We used a hierarchical Bayesian approach to evaluate relationships between these demographic responses and species distributions along a continuous soil water potential gradient associated with microtopography. **Results:** We found both significant positive and negative growth responses for different species to variation in soil water potential. Growth responses to soil water potential were strongly related to species distributions. Species that grew faster where soil water potential was higher were also more abundant at those sites. In contrast, only species with higher mortality rates at drier sites were found to respond significantly to soil water potential, and there was no significant relationship between mortality responses to soil water potential and species distributions. **Discussion:** Our results show that the effect of soil moisture on growth shapes species distributions more strongly compared to mortality than previously thought. Overall, our study shows that woody species differ in seedling performance on a relatively small soil moisture gradient and that these responses shape local distributional patterns of woody species. Consequently, even slight changes in soil moisture may alter composition and diversity of tropical moist forests.

Keywords: seedlings; demography; distributions; soil moisture

ID:134
Monday, July 10th, 2017, Yucatán 3
Oral session: Seedling and sapling ecology

Effects of nutrient addition on tree seedling dynamics in montane forests of southern Ecuador

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Background: Nutrient deposition on soils due to contamination and intensive land use are modifying ecological processes in tropical forests. Using the long-term Nutrient Manipulation Experiment (NUMEX), we investigate how nutrient deposition affected tree species regeneration dynamics in tropical montane forests in the south of Ecuador, to answer the following question: does nutrient addition affect seedling community dynamics, biomass patterns, or leaf morphology and nutrient contents?. **Methods:** NUMEX started in 2008 and was set up in an altitudinal range (1000, 2000 and 3000 masl). At every altitude, 4 blocks containing 4 experimental plots were established (control, N, P, N+P). Nutrients addition on experimental plots was moderate (50kg ha-1yr-1 N, 10kg ha-1yr-1 P). Natural-occurring seedlings have been monitored annually since 2011. Complementary specific experiments were performed in the six most common species. We determined dry biomass fractions, foliar morphology as LAR and SLA and nutrient contents after fertilization in seedlings exposed or not to treatments. **Results:** The seedling community as a whole showed little response to nutrient addition, with no significant differences in mortality or growth. Seedlings density, however, decreased due to lower recruitment in treatments plots and seedling herbivory was greater under N addition. At the individual level- and leaf level, foliar N:P ratios showed P is more limiting than N along the gradient, effects in foliar morphology was different in every species and biomass showed more responsiveness to nutrients at the highest altitude. Specific species effects showed opposite increased herbivory in species at 2000m: Grafferieda emarginata to N and N+P, and Palicourea angustifolia to P. Other specific responses were observed in *Pouteria torta* at 1000m which exhibited good adaptability to growing conditions by maintaining stable foliar nutrient concentrations after nutrient addition. **Discussion:** Higher foliar P concentration compared with N among all species suggests higher P consumption in the altitudinal gradient. Complementary studies demonstrated that a growing limitation for N while altitude increases seems not to be a rule in these forests although nutrient addition did alter specific pattern of growth and survival in this study. Nutrient accumulation on soils might affect strongly survival mechanisms and dynamics of plant communities, the balance of which will only play out over long term scales.

Keywords: seedling dyamics, NUMEX, nitrogen, phosphorus

ID:371
Monday, July 10th, 2017, Yucatán 3
Oral session: Seedling and sapling ecology

Effects of the 2015-2016 El Nino on seedling dynamics across a rainfall gradient in central Panama

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Background: Water availability plays a critical role in shaping species distributions, diversity, and ecosystem function in tropical forests. Specifically, there is mounting evidence that drought is a key driver of tropical forest dynamics. Given that the severity and frequency of drought events are predicted to increase due to climate change, there is an urgent need to understand how tropical forests respond to severe drought events. In particular, a better understanding of drought impacts on the regeneration of tree seedlings is critical for determining future tropical forest composition, diversity, and function. The strong 2015-16 El Niño-Southern Oscillation (ENSO) event provided a rare opportunity to study the impact of severe drought on tropical forests. **Methods:** Across a strong rainfall gradient spanning ~65 km in central Panama, we censused seedlings at eight lowland seasonal forest sites. At each site, we established 400 1x1 m seedling plots in which all free-standing, woody seedlings >=20cm tall and <1cm DBH were tagged, measured, and identified to species. Smaller seedlings (0 - 30 cm tall) were censused in an additional 25 seedling plots per site. The first census was conducted Sept-Dec 2013, with recensuses in Oct-Nov 2014, Jan 2016, May-June 2016, and Jan-Feb 2017. With these data, we compare seedling survival across the El Nino year with survival in the two previous years, as well as between the dry and wet season. **Results:** We found wide variation in seedling mortality among years, with elevated seedling mortality during the El Nino year compared to the two previous years. Mortality was significantly higher in the dry season compared to the wet season during El Nino year, suggesting that drought played a key role in driving patterns of mortality. In addition, species varied widely in their mortality rates and differed in their sensitivity to drought. Seedling dynamics also varied substantially among sites spanning the rainfall gradient. **Discussion/Conclusions:** Our results shed light on the fundamental role of water availability in driving tropical forest dynamics, particularly seedling regeneration. Our data on differential effects of drought on species and across forest sites will inform efforts to model responses of tropical forests to extreme drought events, allowing for better predictions of the consequences of global change and improved strategies for forest management in a changing world.

Keywords: ENSO, regeneration, drought, forest dynamics

ID:481
Monday, July 10th, 2017, Yucatán 3
Oral session: Seedling and sapling ecology

Seedling fate across an elevation gradient: results from a reciprocal transplant in the Andes

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Background: Understanding species responses to climate change is fundamentally a question of species performance and distribution across environmental gradients. In the face of climate change, one option species have is to shift their geographic ranges to respond to changing temperatures, precipitation, and other climatic variables. Early life history stages will form the edges of tree geographic ranges and frequently experience high mortality rates that can impact population growth. **Methods:** We transplanted seedlings of representative tropical lowland and tropical montane cloud forest species across a 2.5 km elevation gradient in the Peruvian Andes. Seedlings were planted in three cohorts based on shared midpoints of each species' elevational range: lowland species (~ 400 - 800 m), mid-elevation species (~1300 - 1500 m), and upper elevation species (~2000 - 2500 m). At each elevation species were planted under three different treatments: mesh tents, mesh roofs, and nothing, and in gaps and in sites with closed canopies. In total, we transplanted 5610 seedlings from 13 species at 7 elevations. Here we present results from one and a half years after seedlings were transplanted. **Results:** Within their cohorts, species generally showed the same patterns of survival across elevation. With one exception, a high percentage of lowland species survived at the two lowest elevations, but the same species did not survive well at 1550 m, outside of their elevational range. Species in the mid-elevation cohort survived significantly less at the elevation closest to their midpoint than they did in either direction from the midpoint. From 1500 m to 2150 m survival of seedlings from the high elevation cohort increased and then varied greatly at the highest two elevations. Overall, there was little difference between seedling survival in different treatments and in gap and closed canopy sites. **Discussion:** The seedling survival of lowland species follows an expected pattern: high survival in a species range, low survival outside a species range. However, this is not quite the case for seedling survival in the other two cohorts. We hope that these results, combined with results from ecophysiological measurements taken concurrently with this study, we can begin to have a mechanistic understanding of what sets species ranges, and thus, better insight into how these species may respond to climate change.

Keywords: seedling, transplant, elevation, ranges, Andes

ID:612
Monday, July 10th, 2017, Yucatán 3
Oral session: Seedling and sapling ecology

Tropical sapling leaf trait and leaf productivity responses to fertilization and light

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Background: Nutrient limitation in tropical rainforests may be complex and driven by individual tree-scale properties and interactions such as functional group or taxonomic identity, size class, microsite conditions, and competitive interactions. Most research focuses on stem growth responses to fertilization as a metric of whole tree performance, but examining finer-scale responses may further elucidate the mechanisms of nutrient limitation for individual trees and ecosystems. Since leaves play essential roles in tree competitive strategies and success, as well as ecosystem productivity, we examined leaf trait and leaf productivity responses to fertilization and light availability in three functional groups (light-demanding, shade-tolerant, and N2-fixing) and nine species of saplings. **Methods:** We measured leaf mass per area (LMA), leaf lifespan, leaf productivity, and foliar nutrient concentrations in 231 saplings from a fertilization and light gradient experiment at La Selva Biological Station in Costa Rica. **Results:** We found variability at the functional group and species level for all the traits we measured, but also general patterns of responses for most traits. LMA increased in response to greater light availability for all functional groups and most species, but did not respond to fertilization. Leaf lifespan decreased in response to greater light availability for approximately half the functional groups and species, and also decreased in response to fertilization in a few cases. Leaf productivity mostly increased with greater light availability and also increased in response to fertilization in a few cases. In contrast, foliar N, P, and K had much greater variability in responses to fertilization and light. **Conclusion:** These results indicate that saplings may not be nutrient limited to build leaves with the desired photosynthetic layers for the light levels they experience, since LMA increased with light availability but not fertilization. However, leaf productivity did increase and leaf lifespan did decrease in response to fertilization for some functional groups and species, demonstrating that leaf productivity can be nutrient limited, and fertilization can increase shading mortality for leaves due to increased productivity. Finally, trees may have higher plasticity for strategies of foliar nutrient use and storage than for the other traits measured.

Keywords: nutrient limitation, fertilization, leaf traits

ID:395
Monday, July 10th, 2017, Yucatán 3
Oral session: Seedling and sapling ecology

Oral Session
Ecology, genetics, and evolution of tropical systems I

Phylogenetic position of the disjunct species *Musa ornata* (Musaceae): understand its distribution

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Background: Among the species of the banana group (*Musa* L.), *Musa ornata* shows a disjunct distribution between Asia and North America (Mexico). The wild occurrence of this species in Mexico has led to speculation about the evolutionary relationships with its Asian relatives. This study examined the phylogenetic relationships between intercontinental specimens of this species and, explored the more likely hypothesis about the origins of its distribution. **Methods:** The phylogeny of intercontinental specimens, along with other representatives of the same genus, was carried out using nuclear (ITS) and chloroplast (trnL-F, atpB-rbcL) molecular markers. The data were analyzed individually and combined using three phylogenetic reconstruction methods: maximum parsimony, maximum likelihood, and Bayesian inference. **Results:** Relationships inferred between *M. ornata* specimens were similar with the three different phylogenetic reconstruction methods used. The genetic analysis of the combined dataset grouped together all Mexican and most Asian specimens, but the monophyly of the species was not supported. **Discussion and conclusions:** The relationships suggest that Mexican populations may have originated from an Asian invasion. However, several studies and historical documents suggest the presence of *Musa* in America long before the arrival of Europeans. Based on its current distribution, phylogenetic evidence, and fossil record, this species' disjunct distribution could be explained in terms of an ancestral distribution range encompassing America and Asia, followed by its subsequent restriction to the Old World and a secondary dispersal by humans.

ID:10
Monday, July 10th, 2017, Yucatán 4
Oral session: Ecology, genetics, and evolution of tropical systems I

Taxonomic, functional, and phylogenetic thresholds are modulated by matrix composition

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Background: The biodiversity extinction threshold is an abrupt decline in species richness with habitat loss. It arises as declining landscape connectivity reduces dispersal and increases local species extinction across remaining native habitat patches. Matrix composition should influence threshold dynamics through its effects on landscape connectivity. **Methods:** Using 23 1,254 ha independent landscapes in the Brazilian Atlantic Rainforest, we evaluated how tropical avian biodiversity respond to native forest loss within habitat patches embedded either in low-quality matrix context (n= 13) or high-quality matrix context (n= 10). We defined biodiversity in three ways, as taxonomic (TD), functional (FD), and phylogenetic diversity (PD). We tested two hypotheses: i) that lower-quality matrix is associated with abrupt species loss at higher levels of native habitat, and ii) that thresholds using TD, FD, and PD occur in distinct amounts of remaining native habitat. **Results:** We found that both matrix composition and choice of diversity metric strongly influenced the location of this threshold along the forest cover gradient. First, higher-quality matrices are able to maintain higher TD in lower amounts of remaining forest cover compared to lower-quality matrices. The extinction threshold for TD occurred at 35% remaining habitat in lower-quality matrices, and 19% remaining habitat in higher-quality matrices. Second, PD was lost almost at same time as TD (at 28% and 22% in lower- and higher-quality matrices respectively) and a strong phylogenetic clustering was found in higher-quality matrices, indicating environmental filter driving phylogenetic structure of assemblages. Finally, we found no clear predictor for FD - although there is a substantial reduction in FD below 20% remaining habitat regardless matrix quality. **Conclusion:** These results highlight the importance of investigating different biodiversity indices when evaluating impacts of land use change on ecosystems, as well as the importance of matrix quality in facilitating species movement among patches, maintaining higher biodiversity levels, and providing avian-mediated ecosystem services in agricultural landscapes.

Keywords: Habitat loss, Matrix quality

ID:276
Monday, July 10th, 2017, Yucatán 4
Oral session: Ecology, genetics, and evolution of tropical systems I

Thermal niche conservatism as driver of tree community composition in tropical mountain forests

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Background: The change of tree diversity along altitudinal gradients is one of the most studied patterns by tropical ecologists. However, the mechanisms underlying this pattern are poorly understood. In this study, we evaluate the role played by the thermal niche conservatism on tree community composition along an altitudinal gradient in the Andean Amazon forests. **Methods:** Integrating phylogenetic information and species presence-absence data, we analyzed: i) the degree of phylogenetic dispersion and species diversity within a plant community along the altitudinal gradient, using the net relatedness index, the nearest taxon index and species richness (α-diversity); and ii) the replacement of lineages along the AG using the PhyloSorensen metric (β-diversity).We set 20 0.25-ha permanent plots distributed between 750 to 2,802 masl, where all individuals with DAP ≥ 10 cm were recorded. We set to explain changes in α and β diversity across the AG using soils, temperature, longitude and distance as predictive variables in a series of linear models. **Results:** The net relatedness index and nearest taxon index did not show significant relationship with temperature. However, there was a greater phylogenetic over-dispersion at intermediate elevations, which likely reflects the immigration of lineages with contrasting origins from tropical and temperate clades. β-diversity was negatively related to the difference in temperature where closely related lineages occupy similar ranges of temperature. The thermal niche conservatism hypothesis is supported for the non-random sorting of lineages along the altitudinal gradient. **Discussion:** We conclude that the thermal niche conservatism and the immigration of lineages from extra-tropical areas must have a significant effect on determining the current species assemblages in the tropical Andean Amazon.

Keywords: Andean-Amazon; temperature; niche-conservatism; phylogenetic-beta-diversity; dispersal-limitation.

ID:73
Monday, July 10th, 2017, Yucatán 4
Oral session: Ecology, genetics, and evolution of tropical systems I

Impacts of forest modification on the phylogenetic structure of spider communities in Borneo

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Background: Deforestation in south-east Asia has largely been driven by logging and the expansion of oil palm plantations. The SAFE (Stability of Altered Forest Ecosystems) Project, based in Malaysian Borneo, is a large-scale fragmentation experiment that was established in response to the challenge of understanding the ecological consequences of landscape conversion. Forest modification has the potential to alter phylogenetic structure and functional roles within ecological communities. Spiders are top predators in invertebrate food webs and therefore impact lower trophic levels. Despite this, little is known about how spiders respond to land use change in diverse tropical ecosystems. **Methods:** As part of the wider SAFE Project, we investigated how the phylogenetic diversity of spiders is impacted by land use change and how this relates to the distribution of feeding guilds (hunters vs. web builders) among habitat types. We sampled spiders from foliage at 46 points across old growth forest, logged forest, logged and fragmented forest and oil palm plantation. Spiders were identified using a combination of traditional taxonomic methods and DNA barcoding using the CO1 gene region. CO1 sequences were subsequently used to create a gene tree which included all spider species sampled. Each species was assigned to one of two feeding guilds: web builder or hunter. We sampled over 700 individual adult spiders which belonged to 184 different species. **Results:** We found that the phylogenetic structure of spider communities varied across the SAFE Project habitat gradient and that communities occurring in oil palm plantations were distinct from those occurring forested sites and most different from old-growth forest. Web-building species were more common than hunting species in oil palm planation. **Conclusions:** Our results enhance our understanding of the effects of one of the most pervasive environmental modifications currently affecting the ecological function of forests in south-east Asia. Web builders and hunters are likely to have variable top-down impacts on arthropod communities, with web builders more likely to feed on flying insects than hunters. Our findings indicate that habitat conversion in Borneo is likely to impact both the role of spiders in arthropod food webs and the genetic diversity of spider communities.

Keywords: spiders, phylogeny, logging, oilpalm, predators

ID:462
Monday, July 10th, 2017, Yucatán 4
Oral session: Ecology, genetics, and evolution of tropical systems I

Dominant trees in the Neotropics: Are they single plant lineages?

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Background: Although studies based on the Amazon Tree Diversity Network (ATDN) have enhanced our understanding of the floristic and community structure of the Amazon forest, very few have committed to face the systematic challenges and improve the taxonomic treatment of tropical plant lineages, especially those with high morphological incongruence. This is the case for *Protium heptaphyllum* (Aubl.) Marchand, a species complex classified as one of most hyperdominant trees across the Amazon Basin. My study aims to disentangle the evolutionary history of this dominant and widespread tree and check if what have been recently classified as a single hyperdominant species represents more than a single plant lineage. **Method:** We used an integrative approach based on morphology, Next Generation Sequencing, and functional ecology to test this assumption and to understand the role of habitat heterogeneity in promoting adaptive divergence in Neotropical plant lineages. *P. heptaphyllum* populations have been sampled across many different tropical habitats and biomes. DNA libraries for approximately 500 samples were designed using the double-digest RAD-seq protocol and sequenced with Illumina Highseq 4000. Morphological and functional traits were obtained on the same specimens included in the phylogenetic analysis. **Results:** This group exhibits a remarkable leaf shape, flower and fruit trait variation. However, reproductive characters were very informative to resolve its taxonomic delimitation. Preliminary phylogenetic analysis based on approximately 2000 loci showed that *P. heptaphyllum* populations should not be classified as a single hyperdominant species. According to the phylogenetic species concept, this clade could be divided into multiple diverged plant lineages. In the Amazonian white-sand vegetation (campinaranas) and lowland terra-firme forests (baixios), where this lineage was considered as a hyperdominant species, there is a high support to distinguish at least four independent monophyletic lineages with consistent morphological discrepancies. **Conclusion**: Our results suggest that conclusions made upon the hyperdominance phenomenon in the Amazon should be more cautious and conservative because there is a high chance of hyperdominant species representing multiple incipient diverged lineages. We firmly encourage tropical systematists to perform a consistent taxonomic and phylogenetic review of hyperdominant trees sampled by the ATDN.

Keywords: Hyperdominant, phylogenomics, ddRAD-seq, tropical systematics

ID:460
Monday, July 10th, 2017, Yucatán 4
Oral session: Ecology, genetics, and evolution of tropical systems I

Distribution and genetic structure of the dry tropical forest tree *Quercus oleoides* in Costa Rica.

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Background: The study of factors that determine the geographical distribution and abundance of plants and animals is a central question in population ecology and biogeography. Plant distribution is influenced by abiotic and biotic components of the environment, but how these components influence distribution at local scale is not well understood. We studied how edaphic differences my affect the distribution and genetic structure *Quercus oleoides* in three different formations within the ignimbrite plateau in NW Costa Rica at the southernmost limit of its range. **Method:** We identified the different pedons in the areas where *Q. oleoides* is found and determined their chemical and morphological characteristics. Principal Component Analysis (PCA) was performed to assess similarities of the "A" horizon of all modal soil pits according to their characteristics and the presence or absence of *Q. oleoides*. Genetic analysis was also conducted to determine the genetic structure of the three populations. **Results:** We found a total of 8 different soil subgroups belonging to two orders in the three transects. *Q. oleoides* trees were found on six soil subgroups. These findings show that *Q. oleoides* is not restricted to volcanic tuffs as proposed by other authors, and no single physical or chemical characteristics can be singled out for explaining its distribution. PCA revealed differences in chemical and physical characteristics of the A Horizon. PC1 explained 27.3 % of the variation and was mainly determined by chemical characteristics of the soils. PC2 explained 20.8 % of the variation and was predominantly determined by physical characteristics of the soils. In general, our findings show that soils from Bagaces have characteristics that are different from those of Santa Rosa and La Cruz. We found low level of genetic differentiation among *Q. oleoides* populations, but that from Bagaces was the most distant population. The genetic structure of these three populations of *Q. oleoides* is best described by two clusters (K = 2) and the likelihood of belonging to each cluster is not equally distributed across the study area. **Discussion:** Our findings are discussed in light of geology of the area, suggesting that differences in soil characteristics result from the geological history and do not determine the distribution of *Q. oleoides* at a local scale. Genetic differences among population may result from different colonization events rather than local adaptation to soil conditions.

Keywords: Genetic Structure, Phytogeography, Edaphic Association

ID:114
Monday, July 10th, 2017, Yucatán 4
Oral session: Ecology, genetics, and evolution of tropical systems I

Oral Session
Soil ecology in tropical systems

Shifts in forest functioning in response to soils explain spatial variation in CUE across the Amazon

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Background: The capacity of forests to convert photosynthate to terrestrial biomass, carbon use efficiency (CUE), is an integral part of the terrestrial carbon cycle. CUE varies globally and is markedly low in tropical rainforests, yet the processes driving variance in CUE remain poorly understood. Across the Amazon basin an interaction exists between CUE and soil physical and chemical properties. **Methods:** We will use the ecosystem model ACONITE, to identify key drivers of spatial variation in CUE, for plots with detailed measurements of carbon cycling and plant traits, along an Amazonian soil nutrient gradient. By alternating plant traits associated with respiration rate, wood and canopy dynamics, reflecting the observed range across forest plots, we are able to quantify their relative impact on carbon dynamics and CUE. **Results:** We hypothesise that CUE variance across Amazon forests is driven by the impact of wood dynamics on total respiring wood biomass. We expect model analyses to show that wood turnover rates cause a shift in wood biomass underlying CUE variance. Wood turnover rates are inherently linked to wood density, varying with soil nutrient status as a result of shifts in above-belowground competition, explaining observed spatial trends. We hypothesise a conjoint effect of canopy dynamics on CUE, exacted through the coupling of leaf photosynthetic capacitance with soil nutrient status, driving an increase in total photosynthesis relative to autotrophic respiration. We will account for the effects of wastage respiration by assessing the contribution of measured respiration rate on estimated CUE. **Conclusion**: This research will improves our understanding of the impact of plant traits on forest carbon dynamics. The interaction between soils, plant traits and CUE is expected to have a substantial impact on the carbon sequestration of Amazon forests.

Keywords: carbon cycle, wood dynamics, soils

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Oral session: Soil ecology in tropical systems

Effects of nutrient input on the decomposer community in tropical montane rainforests in Ecuador

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Background: Due to increasing anthropogenic activities deposition of atmospheric nitrogen (N) and phosphorus (P) is expected to rise in tropical forests likely affecting the structure and functioning of these highly complex and diverse ecosystems. Especially in tropical montane rainforests N and/or P are assumed to be the major limiting factors for many ecosystem processes. With 80-90% of the net primary production entering the decomposer system as dead organic material decomposition is one of the key processes in virtually any terrestrial ecosystem. However, little is known on the influence of nutrient addition on the decomposer community in tropical montane ecosystems. **Methods:** We investigated the effects of moderate N and P addition on microbial biomass, soil arthropod community composition as well as species richness and body mass of abundant and diverse decomposer arthropods (oribatid mites) along an altitudinal gradient (1000, 2000 and 3000 m) in a field experiment in tropical montane rainforests in southern Ecuador. Plots were fertilized at low dosage with N, P and a combination of both. Nutrients were applied homogenously twice a year at a rate of 50 kg N/ha as urea, 10 kg P/ha as monosodium phosphate. Samples were taken 12 and 36 months after the first fertilization treatment. **Results**: At both sampling dates microorganisms benefited from nutrient addition in particular at higher altitudes where resource quality is low. Effects on the soil arthropod community where overall only moderate, but tended to increase at higher altitude. Densities of certain decomposer taxa were strongly affected, however, the effect did not propagate to higher trophic levels suggesting that bottom-up forces are of little importance for structuring arthropod communities in the investigated tropical montane rainforests and therefore can be considered as trophic trickles rather than cascades. **Discussion/Conclusion**: Overall, the results suggest that anthropogenic activities and increased nutrient deposition are likely to result in changes in the decomposer community structure influencing decomposition processes and nutrient cycling in montane rainforests in southern Ecuador.

Keywords: fertilization, Nitrogen, Phosphorus, decomposers, microorganisms

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Oral session: Soil ecology in tropical systems

Root trait response to fertilization and interspecific interactions in an agroforest

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Background: Tree roots are increasingly recognized for their multidimensional resource acquisition strategies that can vary across and within species. In managed tree-based agroecosystems, intentional alterations of abiotic and biotic factors induce root trait variation with consequences for overall ecosystem performance and function. In general, however, we lack data on both the directionality and magnitude of intraspecific root trait response to nutrient gradients and the interactive effects with tree species mixture. We used a functional trait approach to quantify fine root construction and growth for cocoa (*Theobroma cacao* L.) in an agroforestry system in a moist semi-deciduous forest zone of Ghana. Specifically, we tested for coordinated root trait syndromes following fertilization of cocoa that were spatially integrated with shade trees or in monoculture. **Methods:** A field experiment was established with inorganic fertilizer applied at three levels to productive 15-year-old cocoa trees in three different tree species mixtures. Root-free in-growth cores were deployed at the time of fertilizer application and were collected after four months. Cocoa fine roots were extracted from cores and analyzed for a suite of architectural, morphological, and chemical traits. **Results:** There was a differential response of cocoa fine root biomass to fertilization and shade tree species, whereas fine root length density differed only among species combinations and not fertilization. Our analysis of root trait syndromes (i.e. root economics spectrum) indicate significant management effects. Traits associated with resource acquisition (e.g. specific root length and tip frequency) decreased in fertilized treatments, but these traits were poorly correlated with root growth. **Conclusions:** This study provides some of the first insights into root functional trait variation, spectra, and response to fertilizer additions and species mixture of an economically important tree crop. Our results suggest that neighbouring tree species can exhibit strong control over resource acquisition traits of cocoa roots following soil nutrient additions. This is important for understanding plant and community dynamics in managed tropical systems, specifically nutrient cycling efficiencies in tropical agroecosystems following input of mineral nutrients.

Keywords: agroecosystem; functional traits; *Theobroma cacao*

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Oral session: Soil ecology in tropical systems

Tropical forest age influences the response of soil respiration to experimental root exudate inputs

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Background: Root exudation is a key component of nutrient and carbon dynamics in terrestrial ecosystems. Exudation rates vary widely by plant species and environmental conditions but our understanding of how root exudates affect soil functioning is incomplete, especially in tropical forests. Our study aimed to determine the impact of increased root exudation on tropical forest soil carbon dynamics. **Methods:** We used the Automated Root Exudate System (ARES) to apply a root exudate (RE) solution or a procedural control solution (CW) directly into the rooting zone in a lowland tropical forest in Panama, Central America. A gravity-fed drip irrigation system applied small amounts of exudate solution daily for >1 year to 1 m-2 plots in old-growth tropical forest. We also applied RE solution weekly to mesocosms along a forest age gradient (40, 60 and >100 year-old). The amount of carbon added with RE solution corresponded to c. 5% net primary production. We assessed the effects of RE application with monthly measurements of soil respiration and we estimated soil microbial biomass at the end of the study. **Results:** In RE plots, soil respiration increased by c. 18% compared to the procedural controls over the study period, whereas the response to RE application in mesocosms varied with forest age. There was no effect of RE application in mesocosms at the >100-year old site but soil respiration increased by 11% in mesocosms at the 60-year old site and by 9% in the 40-year old site. Surprisingly, RE application had no effect on microbial biomass carbon or nitrogen. **Conclusions:** The ARES is an efficient, low-cost method to apply solutions directly to the rooting zone in tropical forests. Using the ARES, we demonstrate that increased root exudation could have a greater influence on soil respiration in tropical forests than enhanced litterfall, and the magnitude of the response is likely to vary with forest age.

Keywords: carbon; root exudates; soil respiration

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Oral session: Soil ecology in tropical systems

Tropical dry forests exhibit increasing disturbance pressure with decreasing soil moisture

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Background: Determining the causes of the tropical forest deforestation and degradation is a prerequisite for understanding how to manage them better. A wide range of disturbances of variable frequency, intensity and duration impact tropical forests and impacts differ according to tree size. Disturbances are often selective and therefore can cause shifts in species composition of forests while excessive disturbance may lead to loss of forest cover. In this study we evaluated how the severity of four disturbance types (harvesting, browsing, fire and drought) change in tropical dry forest (TDF) fragments in central India arrayed across a soil moisture gradient. We asked the following questions: (1) Which disturbances (harvesting, browsing, drought and fire) are important for tree mortality in a TDF? And do these change with size class (juvenile, sapling, adult)? (2) How is mortality and recruitment in a TDF related to soil moisture content (SMC) and does the relationship change for different size classes? (3) Is disturbance-related mortality selective? **Methods:** We analysed the structure of a TDF in central India in terms of the tree composition of juveniles, saplings and adults at five distinct sites located along a gradient of SMC, and recorded the numbers of individuals in each size class killed by the four disturbance types over two years. We also recorded total stem density and recruitment at each site. We compared annual mortality index (AMI) and its four disturbance components (harvesting, browsing, drought, fire) and annual recruitment index (ARI), against the mean SMC of each site using simple linear regression. **Results:** The impact of all disturbances and total AMI decreased as SMC increased whereas ARI increased as SMC increased. Mortality due to harvesting was substantially greater than other disturbances for adult and sapling trees whereas both harvesting and browsing were important drivers of mortality for juveniles. There was little evidence that particular species were being deliberately selected for harvesting across sites. **Conclusion:** Tree saplings and adults in this TDF were mainly killed by harvesting, indicating that anthropogenic impacts on tree mortality are more important than non-anthropogenic impacts in the TDF, and impacts of all disturbances are more severe with increasing water stress. Thus changes in TDF structure due to harvesting are likely to be more rapid in more arid environments.

Keywords: Tropical dry forest; Recruitment; Mortality

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Oral session: Soil ecology in tropical systems

Soil-mediated filtering organizes tree assemblages in regenerating tropical forests

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Background: Secondary forests are increasingly dominant in human-modified tropical landscapes, but the main drivers of forest recovery are poorly known. Soil conditions influence plant community composition, and are expected to change over a gradient of succession. However the role of soil conditions as a driver of community assembly during succession has rarely been assessed. We assessed the role of stand basal area (i.e. forest age) and soil conditions on tree community functional properties along a chronosequence of Atlantic forest regeneration following sugar-cane plantation. Our expectations were that, as nutrients are gradually allocated to biomass, edaphic environmental filters play an increasingly important role along succession by increasing functional trait convergence towards more conservative attributes. **Methods:** We sampled soil and woody vegetation features across 15 second-growth (3-30 years) and 11 old-growth forest plots (300m² each). We recorded tree functional traits related to resource-use strategies (specific leaf area, SLA; leaf dry matter content, LDMC; leaf area, LA; leaf thickness, LT; and leaf succulence, LS) and calculated community functional properties using the community-weighted mean (CWM) and the functional dispersion (FDis) of each trait separately and all traits together. **Results:** With exception of LA, all leaf traits were strongly associated with stand basal area; LDMC ($R^2 = 0.39$, $p<0.001$) and SLA ($R^2 = 0.66$, $p<0.01$) increased, while LT ($R^2 = 0.37$, $p<0.001$) and LS ($R^2 = 0.48$, $p<0.001$) decreased with forest development. Such changes in LDMC ($R^2 = 0.61$, $p<0.001$), LT ($R^2 = 0.63$, $p<0.01$) and LS (0.51, $p<0.05$) were also related to the decrease in soil nutrient availability and pH along succession, while soil moisture was weakly related to community functional properties. Considering all traits, FDis strongly decreased with increasing biomass ($R^2 = 0.46$, $p<0.001$) and decreasing soil fertility ($R^2 = 0.54$, $p<0.05$) along succession, presenting the lowest values in old-growth forests. This same pattern occurred for each trait separately, but was significant only for leaf thickness and succulence. **Synthesis:** Our findings suggest that tropical forest regeneration can be a deterministic process strongly shaped by soil fertility, which operates as a key environmental filter that leads to a convergence towards more conservative resource-use strategies, such as thinner leaves with higher leaf dry mass and lower succulence.

Keywords: Atlantic forest, Brazil, Environmental filtering, secondary succession, soil fertility

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Oral Session
Human influences on tropical ecosystems and landscapes

Conservation and Cattle Production: Improving the Matrix through Silvopasture

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Background: Agriculture shapes landscapes with important ecological and social implications. Globally, Tropical Dry Forests (TDFs) have historically been disproportionately subject to agricultural conversion. Much of conservation research focuses on forest fragments while our study aims to understand how a high quality matrix can benefit both biodiversity and farmer livelihoods through connectivity and provision of ecosystem services. The objective of this study is to assess how silvopasture can enhance the conservation value of disturbed TDF habitat while also benefiting local ranchers. **Methods:** We collected data during the summer of 2016 throughout 17 cattle ranches in Nicaragua's Rivas Isthmus where ranching is the dominant agricultural land use. We studied the ways in which isolated trees influence bird use, pasture quality, and cattle health, as well as rancher perceptions. **Results:** We documented 130 trees of various species and sizes, 7 main behaviors of 29 bird species in these trees, and the temperature and weight of 116 cattle. Trees with wide canopies, mature fruits, and lower leaf densities experienced significantly higher bird visitation rates. Preliminary results indicate that while pasture growth is lower under trees, measured nutrient quality is higher. The effects of tree cover on cattle health will also be discussed. **Discussion:** This study supports the argument that improved tree cover in pastoral systems can enhance their conservation value for resident birds without detriment to agricultural productivity. Today's agricultural practices will likely predict the future of tropical biodiversity. Sustainable land management techniques are therefore crucial to maintaining rich biodiversity, as well as thriving local populations.

Keywords: Birds, agroecology, conservation, livestock, land-sharing

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Oral session: Human influences on tropical ecosystems and landscapes

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Indigenous knowledge and spatial pattern of recruitment of Synsepalum dulcificum in Africa

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Background: *Synsepalum dulcificum*, a wild fruit plant species of Sapotacae family plays a significant role in Benin's rural communities' diet but becomes nowadays scarce in the country. To yield the mechanism underline the survival of regeneration in natural habitats and how harvesting knowledge is distributed among communities' members for its sustainable conservation, this study has assessed its recruitment spatial pattern and knowledge of local people in south-west of Benin. **Methods:** A total of 53 interviewees owners or not of *S. dulcificum* trees species were surveyed through ethnoecological and ethnobotanical knowledge. Floristic inventories following Sigmatist method of Braun-Blanquet and spatial pattern analysis of regeneration were also carried out in the habitats. A total of 28 plots of 50 m x 50 m were established around *S. dulcificum* individuals in their habitats for vegetation surveys. Nonmetric Multidimensional Scaling analysis and Monte Carlo test were performed to determine the vegetation groups which shelter *S. dulcificum* and their indicator species with R.3.3.1 software. Spatial pattern of recruitment was assessed using method of neighborhood density in relation to a focal point. Ethnobotanical index and descriptive statistics were computed and analyzed with principal component and negative binomial regression. **Results:** Results showed two vegetation groups sheltering *S. dulcificum*. Home gardens and the block fallows, farms, natural and sacred forests. S. dulcificum was well protected in home gardens than in the other vegetation groups. Spatial distribution of recruitment surrounding mother trees is aggregative for 0 m to 4 m of radius. Above 4 m a hyperdispersion of regeneration is observed. Local communities indicated that one individual tree species produces on average 14.87 kg of fruits per year with 22.15$ as income. *S. dulcificum* was used by local communities for food, vegetable toothbrush, energy wood, medicine and socio-cultural purposes. Analysis of diversity knowledge of interviewees showed an unequal repartition of knowledge. Young people detained more knowledge than old people. **Conclusions:** *S. dulcificum*'s regeneration is clump till 4 m surrounding mother trees. Due to dry seasons, all of recruitments often die. More studies are needed on genetic inbreeding of the species to develop hybrids species with fast growth rate and more resistant to drought.

Keywords: *Synsepalum dulcificum*, indigenous knowledge, regeneration

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Climate change & Bolivian Amazonian Indigenous communities: Adaptation & biocultural keystone species

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Background: Climate change adaptation across tropical forest socio-ecological systems is an increasingly important study area. Tropical regions are experiencing the earliest emergence of historically unprecedented climates (Mora et al. 2013), and local and Indigenous peoples are amongst the most vulnerable to climate change (Kronik & Verner 2010; Thomas & Twyman 2005). Already being forced to respond, the relationship of Amazonian peoples with the rainforest ecosystem is changing, with implications for livelihoods and ecosystem ecosystems. These dynamics and their future implications are poorly understood; yet responses to climate change may have an equal or greater effect than direct impacts of climate change on natural systems (Turner et al. 2010). This research presents a case study from the Tacana II Indigenous communities of the Bolivian Amazon, and investigates the impacts of climate change, local responses, and factors relevant in supporting positive adaptation across tropical forest socio-ecological systems. **Methods:** Where complex problems transcend disciplines, an interdisciplinary approach is required. This research uses a mixed-method approach to address the issue of climate change adaptation across socio-ecological systems. Data was collected through ethnographic methods (participant observation, unstructured interviews, plant walks), social science methods (structured interviews, workshops and focus groups) and natural science methods (climate data analysis). **Results:** Local-scale impacts of climate change on Indigenous peoples in the Bolivian Amazon are highlighted. Results indicate the changes already occurring, and their impacts on livelihoods. These include increasing temperatures and more severe extreme events, and implications for farming practices and health. Common responses to these changes are documented, and include diversification of livelihoods and intensified reliance on key forest products and key resources. The key human-ecosystem interactions, and important species species for successful adaptation, are highlighted. **Discussion:** The wider implications of observed responses to climate change on the future functioning of the socio-ecological system are discussed. Certain key species emerge as crucial for supporting the resilience of the socio-ecological system. Future changes given climate change scenarios are considered, along with options available for supporting positive adaptation of the socio-ecological system.

Keywords: climate change; adaptation; indigenous peoples; amazon; socio-ecological systems

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The restoration potential of indigenous agroecosystems for biocultural resilience in Hawai'i

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Growing global population highlights competition between agricultural lands for food production, urban development, and the protection of the natural environment, all under growing climate changes. These issues are especially pressing in Hawai'i, where development pressure, rates of food importation and threats to native species are among the highest in the world. The restoration of indigenous agroecosystems has been proposed as a management alternative to reconcile agricultural production with the maintenance of biodiversity, yet, indigenous agroecosystems are overlooked in academia and policy, and empirical assessments of their combined social and environmental viability are lacking. In this study, I develop spatial distribution models of three main Kānaka Maoli (indigenous Hawaiian) agroecosystems under current and three future downscaled climate change scenarios to determine their past extent, production, carrying capacity, and future potential given land-use and climate changes. Then, I evaluate the ecological, economic, and cultural outcomes of potential indigenous agroecosystem (Hawaiian agroforestry) restoration in relation to two major land uses (coffee plantation and a largely non-native secondary forest). Results indicate that Hawai'i could have sustained >250,000 acres of traditional agricultural systems, potentially producing more than 1 million mt/yr of food, levels comparable to food consumption in Hawai'i today. Carrying capacity estimations support hypotheses of large pre-colonial Kānaka Maoli populations (>800,000). Model projections show that urban development and future climate shifts are expected to have small effects on future production, however, results indicate that warmer climate scenarios will increase the proportion of agroecosystems in conservation zoned land. In terms of ecosystem services, Hawaiian agroforestry could potentially provide the highest diversity benefits, supporting 91 % higher native species richness and 10 % more groundwater recharge than the secondary forest, and revealed critical cultural services related to the interconnection of ecological restoration and cultural well-being. This study demonstrates the food producing potential of indigenous agroecosystems even under land use and climate changes and suggests the need to consider their restoration, potentially targeting low-priority conservation areas as a way to address native biodiversity, social, and cultural needs.

Keywords: indigenous agriculture, agroecology, climate change

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Oral session: Human influences on tropical ecosystems and landscapes

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Gradients of diversity of tree species in agricultural landscapes of a neotropical region

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Forest conversion for agriculture in tropical regions has led to human-modified landscapes, where remnant forest fragments intermingle with agricultural fields. These forest remnants are critical for the conservation of native biodiversity. In this context, we made the following questions: How big is the loss of native tree species in human-modified landscapes? Is this loss proportional to reduction of old-growth forest cover? To what extend secondary forests can buffer the loss of tree diversity within human-modified landscapes? Are there changes in phylogenetic diversity? We predicted that non-pioneer tree species decline in a faster rate more so than pioneer species, as the proportion of remnant old-growth forest reduce. In the Marqués de Comillas region, southeastern México, we evaluated changes in tree species diversity and phylogenetic diversity through a gradient of twelve human-modified landscapes (3x3 km2 each), where old-growth forest remnants varied between 5% and 100% old-growth forests. We established randomly 30 sampling points; where all trees with DBH ≥ 10cm were recorded. A total of 5572 individuals, 49 families, 138 genera and 203 species were recorded in a total area of 25.4 ha. We analyzed diversity from different perspectives and we found significant results that indicate that the diversity of tropical trees decrease as the coverage of primary and secondary forests disappear. Species loss thresholds were identified, where diversity declined significantly. We found that more heterogeneous landscapes contain a greater diversity of tree species. This study discusses the importance of life history attributes of the species, diversity of the landscape and the importance of primary and secondary forests for the conservation of species in tropical landscapes modified by humans.

Keywords: Diversity, pioneer, no pioneer, thresholds

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Forest biomass, productivity and carbon cycling along a rainfall gradient in West Africa.

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Background: Net primary productivity (NPP) is one of the most important parameters in describing the functioning of any ecosystem and yet it arguably remains the least quantified and understood component of carbon cycling in tropical forests. **Methods:** We provide the first comprehensive analysis of NPP and its carbon allocation to woody, canopy and root growth components at contrasting lowland West African forests spanning a rainfall gradient. Using a standardised methodology to study evergreen (EF), semi-deciduous (SDF), dry forests (DF) and woody savanna (WS), we find that **Results:** (i) climate is more closely related with above and below-ground C stocks than with NPP (ii) total NPP is highest in the SDF site, then the EF followed by the DF and WS and that (iii) different forest types have distinct carbon allocation patterns whereby the SDF allocates ~50% to canopy production and the DF and WS sites allocate ~50% to woody production. Furthermore, we find that (iv) compared with canopy and root growth rates the woody growth rate of these forests is a poor proxy for their overall productivity and that (v) residence time is the primary factor in the productivity-allocation-turnover chain for the observed spatial differences in woody, leaf and root biomass across the rainfall gradient. **Conclusion:** Through a systematic assessment of forest productivity we demonstrate the importance of directly measuring the main components of above and below-ground NPP and encourage the establishment of more permanent carbon intensive monitoring plots across the tropics.

Keywords: NPP, Biomass, Tropical forest, Africa

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Monday, July 10th, 2017, Tulum
Oral session: Structure, function, and diversity of tropical ecosystems

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Oral Session
Structure, function, and diversity of tropical ecosystems

Litter manipulation induces delayed long-term changes in litter production

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Background: Tropical forest responses to climate change are of particular interest due to large carbon stores in tropical forests and soils. Free air carbon enrichment experiments in young temperate forests show an increase in net primary production, one component of which is litterfall production. **Methods:** A long-term litter manipulation experiment in Panama, Gigante Litter Manipulation Project (GLiMP) examines tropical lowland semi-deciduous forest responses to altered litter inputs. Fourteen years of litterfall trap data from GLiMP were modeled in R using linear mixed-effects models. The full dataset was modeled to determine lag time until treatment effects reached significance, then pre- and post-lag data were modeled separately. **Results:** We confirmed that there were no significant pretreatment differences among treatment groups and no significant background trend in the controls. An initial large pulse of litter augmentation produced a short-term significant increase only in wet season litterfall. Long-term litter production increased significantly with augmented litter inputs and decreased significantly with decreased litter inputs; however, the response was delayed and did not reach significance until after several years of treatment. These long-term responses gradually strengthened over a 5- to 6-year lag period before reaching significance and then stabilized over the next 8-9 years. **Discussion:** This and a related experiment in Costa Rica showed a short-term increase in litter production when litter inputs were augmented beyond the range of natural variation of inputs for the forest, but no short-term response was reported for another study in Puerto Rico in which litter input augmentation fell within the range of natural inputs. Significant long-term litter production responses in this experiment were not observed in any other litter manipulation experiments. We hypothesize that litter manipulation in other studies was not continued long enough to overcome the delay in effects reaching significance. These results highlight the need for long-term ecosystem-scale experiments to determine how tropical forests will respond to climate change.

Keywords: litterfall manipulation, litter production

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Variation of beta diversity across an elevational gradient in the Tropical Andes

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Background: The variation of species composition along environmental gradients has been widely studied. However, sampling artifacts may be misled conclusions. Most studies of diversity patterns have implicitly assumed that patterns and mechanisms governing β-diversity are scale invariant. In this study, we aim to test the role of grain size and diameter categories on β-diversity patterns in woody community plants along a complex elevational gradient located in the Antioquia mountain ranges (Colombia). **Method:** We used 15 1-ha plots to analyse β-diversity within each plot. We partitioned each plot at different grain sizes: 10x10m, 20x20m, 50x50m and transform abundances using Hellinger`s distance. We estimated β-diversity as the variance of the entire matrix as purpose Legendre & de Caceres (2013). Then, we run a randomization procedure to determine the expected β-diversity keeping the regional species abundance and abundance by quadrant on each iteration. We calculated the β-deviation as the difference between observed and expected β-diversity. We employed linear mixed models to assess the effect of the grain size and elevation on β -diversity. Analyses were performed for two diameter categories: large trees (DHB≥10cm) and all trees (DHB1≥ cm). **Result:** β-diversity decreases which increases grain size in both diameter categories. However, grain size does not affect β-deviation. We found a negative relationship between β-diveristy and elevation and it is inverse to β-deviation. Conversely, β-deviation of all trees is not significantly related to elevation. **Discussion and conclusion**: We concluded that grain size and tree size influence our results and interpretation of β-diversity analyses along elevation gradients, and it doubts comparisons and to evaluate assembly mechanisms. Finally, β-deviation changes with elevation in large trees reflecting the role of species clumping and their effect on elevation gradients.

Keywords: Beta diversity, grain size, pattern.

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Oral session: Structure, function, and diversity of tropical ecosystems

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Climatic harshness and land-cover drive diversity and structure of Colombian tropical dry forests

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Background: Niche-based theory predicts that plant species diversity and composition, as well as forest structure, are shaped by climatic constraints and soils physical and chemical characteristics. Although this prediction has found support in many tropical forests, very few studies have addressed this issue in tropical dry forests (TDF), the most endangered ecosystem in the Neotropics. Many TDF occur in small fragments as the result of historical anthropogenic disturbance, therefore land-use cover changes are also expected to affect forest attributes. Here, we evaluated the effects of climatic and edaphic gradients, as well as land-cover metrics on TDF structure, diversity, and species composition. **Methods:** We used taxonomic and structural (basal area, stem density and canopy height) data from 15 1-ha permanent plots installed across four TDF regions of Colombia. Overall, we censused 31.738 stems of DBH≥2.5 cm belonging to 542 species. We evaluated the effects of climatic, edaphic variables and land-cover metrics on plot species diversity and forest structure by means of linear mixed models. Then, we evaluated the effect of these predictors on species composition using ordination analyses. **Results:** Our results showed that, as expected, increased climatic harshness and decreased soil nutrient availability was related with a decrease in species richness (R^2=0.62) and diversity (R^2=0.46). Surprisingly, land-cover metrics had a stronger predictive power than climatic and soil variables on TDF structure attributes such as basal area and canopy height. Also, we found that several tree species were associated with either climatic, edaphic variables or land-cover metrics. For instance, plant species in the Caribbean region were associated with the presence of sand in soils, high mature forest cover and high levels of annual insolation. Several tree species occurring in other regions, in contrast, were associated with low aridity levels and high land roughness. **Conclusions:** In spite of there being a general need to better understand how TDF are going to respond to climate change, our results show that these ecosystems strongly respond to climatic and edaphic variables. Also, we highlight the importance of evaluating land-cover changes and their consequences on the loss of diversity and structure of TDF. These transformations have been poorly studied, but should be a strong criterion for the conservation in one of the most threatened biomes in the tropics

Keywords: permanent plots, soils nutrients availability

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Precipitation partition in an avocado (*Persea americana* var. Mendez) orchard in central Mexico

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Background: Land use change from forest to agriculture can affect water cycle processes inducing major changes in precipitation water intercepted by vegetation, water infiltration into soil, runoff, evaporation and transpiration. Mexico possesses one third of global avocado orchard surface and is the world largest exporter, 74 % of avocado plantations in Mexico are located in Michoacan. Avocado plantations surface in Michoacán reached 148,000 ha in 2016, and a large proportion of this correspond to rainfed orchards that had replaced native forests. Due to the hydrological relevance of forests and the major land use changes occurring in Michoacan, we consider that an adequate description of the precipitation partition occurring in the avocado orchards is necessary. **Methods:** In this work we focused on precipitation partitioning in throughfall (TF), stemflow (SF) and interception loss (Ei) which were measured on a daily basis in a tropical avocado orchard at 2253 m elevation near Zirahuen village in central Mexico for 80 days. **Results:** The recorded precipitation of 460.5 mm included 73 events. 61.6 % of rainfall events were < 5 mm and only 13.7 % exceeded 15 mm. TF at the orchard corresponded to 81.6 %, SF to 0.17 % and Ei to 18.2 % of gross precipitation (Pg). Free TF component at the orchard (p) was 0.82 mm mm-1 and canopy storage capacity (S) 0.281 mm. Mean SF proportion (pt) value was 0.00385 mm mm^{-1}, while mean trunk storage capacity (St) was 0.00422 mm. SF index averaged 0.109 L mm^{-1} and mean trunk capacity volume (Vt) was 0.119 L. Funneling ratio (FR) averaged 2.5 and threshold precipitation (Pth) averaged 2.55 mm. **Conclusions:** The interception proportion found in the present study falls within the value range reported earlier for mixed forests in Mexico while the SF proportion in this study is under reported values in other tropical commercial fruit plantations and 14 times smaller than SF reported (2.4 %) for a native pine-oak forest in the area. The low SF proportion was attributed to low density of trees at the orchard 156.2 trees ha-1 and tree morphology. The latter is severely affected by branch pruning which creates near 90 ° angles in the lower branches avoiding that intercepted water could flow into the main stem and drips off as TF. Trunk storage volume (Vt) and stemflow index (SFI) were explained up to 89 and 87 % by trunk diameter and basal area. These variables may be suitable as predictors of Vt and SFI.

Keywords: Michoacan, water, cycle, crop, Zirahuen

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Soil fungal communities driven by nitrate across secondary forests in Costa Rica

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Background: Land use change from forest to agriculture can affect water cycle processes inducing major changes in precipitation water intercepted by vegetation, water infiltration into soil, runoff, evaporation and transpiration. Mexico possesses one third of global avocado orchard surface and is the world largest exporter, 74 % of avocado plantations in Mexico are located in Michoacan. Avocado plantations surface in Michoacán reached 148,000 ha in 2016, and a large proportion of this correspond to rainfed orchards that had replaced native forests. Due to the hydrological relevance of forests and the major land use changes occurring in Michoacan, we consider that an adequate description of the precipitation partition occurring in the avocado orchards is necessary. **Methods:** In this work we focused on precipitation partitioning in throughfall (TF), stemflow (SF) and interception loss (Ei) which were measured on a daily basis in a tropical avocado orchard at 2253 m elevation near Zirahuen village in central Mexico for 80 days. **Results:** The recorded precipitation of 460.5 mm included 73 events. 61.6 % of rainfall events were < 5 mm and only 13.7 % exceeded 15 mm. TF at the orchard corresponded to 81.6 %, SF to 0.17 % and Ei to 18.2 % of gross precipitation (Pg). Free TF component at the orchard (p) was 0.82 mm mm-1 and canopy storage capacity (S) 0.281 mm. Mean SF proportion (pt) value was 0.00385 mm mm^{-1}, while mean trunk storage capacity (St) was 0.00422 mm. SF index averaged 0.109 L mm^{-1} and mean trunk capacity volume (Vt) was 0.119 L. Funneling ratio (FR) averaged 2.5 and threshold precipitation (Pth) averaged 2.55 mm. **Conclusions:** The interception proportion found in the present study falls within the value range reported earlier for mixed forests in Mexico while the SF proportion in this study is under reported values in other tropical commercial fruit plantations and 14 times smaller than SF reported (2.4 %) for a native pine-oak forest in the area. The low SF proportion was attributed to low density of trees at the orchard 156.2 trees ha-1 and tree morphology. The latter is severely affected by branch pruning which creates near 90 ° angles in the lower branches avoiding that intercepted water could flow into the main stem and drips off as TF. Trunk storage volume (Vt) and stemflow index (SFI) were explained up to 89 and 87 % by trunk diameter and basal area. These variables may be suitable as predictors of Vt and SFI.

Keywords: Michoacan, water, cycle, crop, Zirahuen

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Oral session: Structure, function, and diversity of tropical ecosystems

Oral Session
Plant-soil-fungi interactions

Effect of coffee management regime on guilds of belowground fungi

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Background: In coffee (*Coffea arabica*), a tropical crop that is consumed globally, organic agriculture can be employed as a method for preserving biodiversity. Many aboveground taxa are known to benefit from this strategy, but the effects of organic versus conventional coffee farming on belowground communities of soil fungi are poorly understood. Soil fungi can be divided into guilds based on their microhabitat and mode of nutrition, and many of these guilds represent important plant-fungal interactions. By examining fungal guilds in coffee under different management regimes we can better understand factors affecting fungal community structure. **Methods:** We assessed the effects of management regime on soil fungal communities in twenty-five coffee fields in two regions of Costa Rica, Santa Elena de Monteverde and San Vito de Coto Brus. We interviewed farmers to classify each field as having conventional or organic management, and then recorded environmental characteristics of the site. Soil and root samples from each field were used for DNA extraction and nutrient analyses. We examined fungal community composition using high-throughput sequencing of the internal transcribed spacer region of the fungal DNA, assigned operational taxonomic units (OTUs) to each sequence, and then matched each OTU to its probable guild, if known. **Results:** Most fungal taxa could not be assigned to a guild, either because their sequences did not match those of known species in publicly available databases or their functions are not currently described. Arbuscular mycorrhizal fungi, mycoparasites, fungi known to form lichens and fungi of unknown function were more diverse in organic fields. Plant pathogens showed greater diversity in conventional fields. No difference was seen between management types for saprotrophic fungi. Nitrogen (NO_3-N) was higher in conventional fields while leaf litter depth, canopy cover, and shade tree species diversity were all greater under organic management. **Discussion:** Diversity within a guild is important for functional redundancy since it makes a community more resilient to extinctions and allows niches to be partitioned for more effective resource exploitation. Our results suggest that coffee field management affects diversity within guilds of soil fungi including mutualists, pathogens and unidentified fungi. These findings are significant for the conservation of soil and fungi, and for coffee farmers, whose crop is affected by belowground communities.

Keywords: guilds, soil fungi, organic agriculture

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Oral session: Plant-soil-fungi interactions

Mycorrhizal type mediates effects of nitrogen addition on the productivity of montane forest

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Background: Anthropogenic nitrogen (N) deposition is predicted to increase in the tropics in coming decades. Impacts on species composition, diversity and primary productivity may be especially pronounced in montane forests that are often N limited or co-limited. Furthermore, increased N availability may alter the competitive balance between ectomycorrhizal (EM) trees, often associated with N limited montane forests, and arbuscular mycorrhizal (AM) trees, often associated with P limited lowland forests in the neotropics. **Methods:** Starting in 2007, 125 kg/ha/yr of Urea-N was applied four times a year to 40 x 40 m forest plots at Fortuna, Panama in continually wet forest at 1100m asl dominated by the EM tree *Oreomunnea mexicana*. Total litterfall was recorded every two weeks and sorted into EM and non-EM fractions, and growth of a sub-set of trees in fertilized and control plots measured monthly using dendrometer bands. **Results:** N addition was associated with significantly higher nitrate availability whereas pH and other soil nutrients did not differ between treatment and control. Total litterfall was also consistently higher in the N addition plots over the study period. In contrast, N addition effects only increased growth rates for AM trees, with the largest effects for mid-sized trees (20-40 cm DBH). For EM trees, growth rates were reduced to nearly half initial rates over the decade in both treatment and control plots and did not differ between treatments. **Discussion:**These results highlight a substantial decadal shift in growth and productivity in a lower montane forest. Differential responses of EM fagales versus AM species to N addition highlight the potential for nitrogen deposition to restructure montane forests, favoring lower elevational species in ways that may be synergistic with climate warming.

Keywords: Ectomycorrhiza, litterfall, productivity, nitrogen fertilization

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Seedling ectomycorrhization of the Neotropical monodominant *Dicymbe corymbosa* (Fabaceae)

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Background: While tropical forests are known for high tree species diversity, low diversity tropical forests do occur, in which a single tree species dominates 60% or more of the canopy (i.e. are "monodominant"). Such forests are usually dominated by trees that form ectomycorrhizal (ECM) symbioses. The Neotropical, ECM canopy tree *Dicymbe corymbosa* is one such species. Following *D. corymbosa* mast seeding events, dense cohorts of shade tolerant seedlings are established and contribute to long-term monodominance. These *D. corymbosa* seedlings show diminished density-dependent mortality, unlike seedlings of most tropical rainforest trees. Ectomycorrhizal associations likely facilitate these effects through improved nutrient acquisition and root pathogen defense. **Methods.** We investigated the development of ECM associations and their relation to seedling survival in *D. corymbosa* monodominant forests in Guyana. Following the 2016 mast seeding event, 210 seedlings were collected at ages of two weeks, six, and twelve months. Seedling survival in seven long-term survivorship plots was recorded at each time interval. Seedlings at the periphery of these plots were harvested and percent ECM infection of their root systems was calculated. The number of morphologically distinct ECM root tips ("morphotypes") per seedling was recorded, and samples across the range of morphotypes were pooled for molecular analysis. **Results:** Ectomycorrhization of *D. corymbosa* seedlings occurred rapidly, with ECM colonization apparent as early as 1-2 weeks following germination. By six months, all seedlings were colonized by ECM fungi. Six-month-old seedlings averaged 3.1 ± 1.7 ECM morphotypes/seedling, increasing from just two regularly encountered morphotypes in two-week-old seedlings. Seedling survivorship remained high throughout time. The mean percent colonization of ECM roots increased with seedling age. **Discussion:** The shifts in species composition of seedling ECM fungi over time will be discussed in the context of high seedling survivorship. We aim to reveal the diversity of seedling-infecting ECM fungi, and compare these ECM communities to those of nearby adult D. corymbosa. This study will elucidate the importance of early colonization and community assembly by seedling ECM fungi in promoting their survival and, ultimately, the persistence of monodominant stands.

Keywords: Dicymbe, ectomycorrhiza, Guyana, monodominance, seedlings

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Oral session: Plant-soil-fungi interactions

Living life up high: How fungi differ between canopy and terrestrial soils

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Background: Tropical montane cloud forests (TMCF) are high-elevation forests covered with a dense cloud layer. Clouds add moisture to these forests allowing high levels of biodiversity to reside there, especially within the canopy. The biodiversity of epiphytes in the canopy is another defining characteristic of TMCF. Organic material gets trapped in these epiphytes, and it decomposes forming canopy soil. We know that tropical ecosystems contribute greatly to global C cycling, but there is a large amount of C within the canopy that is not accounted for. Moreover, we do not know how soil fungi differ between canopy and terrestrial soils. Methods Here, we compare soil fungal communities and extracellular enzyme activity (EEA) in these two soils types. This work was conducted along two elevation gradients in the Monteverde Cloud Forest Reserve (10°18´N, 84°47´W) in Monteverde, Costa Rica. Fungal diversity was measured using high-throughput sequencing and a primer set targeting the fungal ITS region. We measured EEA of C-degrading enzymes, including α-glucosidase (AG; starch degrading), β-glucosidase (BG; cellulose degrading), cellobiohydrolase (CBH; cellulose degrading), and β-xylosidase (BX; hemicellulose degrading). Results Soil temperature was higher in canopy soils during the dry season ($P = 0.01$). Soil moisture differed between the two soil types during both seasons, but the pattern varied seasonally. Canopy soils were drier than terrestrial soils during dry season ($P = 0.005$), but wetter than terrestrial soils during the wet season ($P < 0.001$). Moreover, canopy soils had higher C:N ratios during both seasons ($P < 0.001$). During the wet season, EEA of AG, BG, CBH, and BX was higher in canopy soils (P (AG, CBH, BX) < 0.001; P (BG) $= 0.002$). This pattern continued during the dry season as AG, BG, CBH, and BX activities were higher in canopy soils ($P < 0.001$). Fungal communities differed between canopy and terrestrial soils during the wet ($P = 0.012$) and dry ($P = 0.014$) seasons. Discussion/Conclusion Climate change is exposing TMCF to drier and warmer conditions. Elevation gradients are important tools in understanding how soil fungi may respond to climate change in their natural environment. Canopy soils are especially vulnerable due to the greater environmental stress that occurs up in the canopy. It is important that we determine what functional roles fungi are fulfilling, and what their roles may be in C-cycling.

Keywords: TMCF, canopy soil, fungi, decomposition

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Oral session: Plant-soil-fungi interactions

Soil microbial nutrient limitations in tropical forests - a meta-analysis

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Background: Nutrient limitations exert control on ecosystem processes, which is mainly discussed for primary productivity, but it also affects microbial activity. Soil microbial processes represent crucial factors in ecosystems, mediating the cycling of carbon and nutrients in soils, but also affecting responses to environmental change. However, especially in tropical forests, which represent an important global system in the context of carbon storage, the role of soil microorganisms is poorly understood. The growing amount of literature on responses of soil microorganisms to nutrient additions provide a valuable source to address this "hidden part" of the ecosystem at this point. Hence, we aimed to elucidate general patterns specific to this biome reviewing and interpreting these studies by meta-analytical methods. **Methods:** We conducted an in-depth literature review of responses of microbial abundance as well as various microbial process rates in soil to the additions of differing nutrients in tropical forest systems. In case of nitrogen (N) and phosphorus (P) a meta-analysis was conducted in order to evaluate overall patterns of microbial nutrient limitations, but also the impact of different moderators like elevation, soil substrate or experimental type on the observed outcomes. **Results:** The results provide clear evidence for a primary role of P in controlling soil microbial activity, especially in tropical lowland soils, whereas in montane sites N and N/P co-limitations also gain importance. Differing microbial response variables responded consistently positive to P additions, whereas N exerted divergent effects. By contrast, the impact of soil substrate and differential experimental approaches was insignificant. Interestingly, few studies evaluating the impact of further rock-derived elements point towards a non-Liebig system with several elements affecting the high diversity of microbial activities in soil, though more studies are needed to understand the respective significance in detail. **Conclusions:** In summary, we provide clear evidence for the important role of microbial nutrient limitations in tropical forests, especially by rock-derived elements, which is a fundamental basis for our understanding of ecosystem processes in this important biome, as well as of responses to future environmental change.

Keywords: soil, microbes, nutrients, forest, meta-analysis

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Oral Session
Biodiversity inventories in tropical ecosystems I

A small-scale lichen inventory yields high biodiversity during an OTS course at La Selva, Costa Rica

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Background: Lichens play an important role in tropical forest ecosystems, yet they remain largely understudied. In tropical forests, new lichen species are continuously being discovered and described. Even with a recent increase in tropical lichenology, many parts of the tropics remain unexplored. During an independent project of the Graduate Field Ecology course run by the Organization for Tropical Studies in 2015, at La Selva biological station in Costa Rica, I surveyed seven recently fallen trees for lichen diversity. **Methods:** Recently fallen trees were used so that transects could be run from the base of the tree to the canopy, providing a rare opportunity to make comparisons of lichen community composition along this light and moisture gradient. Tree trunks were surveyed in three-meter partitions, so that lichen communities could be categorized as base, lower, middle, upper, or canopy. Small fragments of lichens were collected for morphological and chemical identification in the lab. **Results**: Preliminary results have revealed that these seven trees host hundreds of lichen species, with as many as six species new to science. Results from this study showed that surveyed trees close to one another did not have lichen communities any more similar than surveyed trees far from one another. Finally, we found distinct communities of lichens along the tree trunks, with the most unique communities found in the canopy, supporting microclimate effects, such as aridity and light availability, in shaping tropical epiphytic lichen communities. **Discussion**: Our results demonstrate that microclimate and host tree effects are stronger than proximity/dispersal effects in shaping lichen communities in a tropical forest. The number of lichen species found on seven recently fallen trees imply that La Selva is a biodiversity hotspot for epiphytic lichens, and could be harboring many more undescribed species.

Keywords: lichen, epiphyte, microclimate, biodiversity, La Selva

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Monday, July 10th, 2017, Maya
Oral session: Biodiversity inventories in tropical ecosystems I

Organizing large-scale biodiversity inventories in the tropics: lessons from IBISCA projects

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Background: IBISCA is an international and informal network of biodiversity experts conducting large-scale biotic inventories in various regions of the World (www.ibisca.net). Each IBISCA project is a collective effort addressing a global ecological question. IBISCA-Panama (2003-2004) aimed at estimating the overall arthropod diversity of a lowland rainforest while the Papua New Guinea survey (2012-2014), conducted in the framework of the "Our Planet Reviewed" programme, aimed at assessing the diversity generated by the elevational factor, from sea level up to the tree line. **Methods:** All projects are multi-taxa (with an emphasis on plants and arthropods), multi-strata and multi-methods. A central database is at the heart of each project. **Results:** The data flow follows a 10 step standard process: (1) sampling design which is often a trade-off between sampling effort and representativeness; (2) pre-printing of permanent labels with unique codes for samples and specimens; (3) collection of specimens with standardized mass collection methods; (4) on-site pre-sorting of material by helpers (para-taxonomists, students) to Order level; (5) further sorting to Family level by Taxonomic Working Group (TWIG) leaders and dispatching of specimens to experts; (6) identification of the material to (morpho-)species level by taxonomic experts who send afterwards the results to their TWIG leader; (7) control of the quality of data by TWIG leaders who fill a data entry template and send it to the database administrator; (8) import and cleaning of the data by the database administrator; (9) analysis and publication of the data by participants, either collectively or individually; (10) export of the DB to a public repository of data. Assisted data entry with high tech equipment (barcode scanner, PDA) reduces the risk of errors. **Discussion/conclusion:** Our experience shows that the main bottleneck in the data flow is the processing of the huge quantity of specimens collected. Solutions include securing enough funds for this critical step, training research technicians (para-taxonomists/ecologists) to assist main investigators and focusing on a limited number of informative yet tractable taxa. An additional benefit is that providing employment to local research assistants supports initiatives of local communities to conserve their forests.

Keywords: taxonomic impediment, specimen tracking, parataxonomists

ID:167
Monday, July 10th, 2017, Maya
Oral session: Biodiversity inventories in tropical ecosystems I

Arboreal camera traps as an emerging methodology for inventorying elusive rainforest mammals

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Traditionally, medium-large arboreal rainforest mammals have been inventoried using ground based survey techniques. However, attempting to see through dense understory into the upper rainforest canopy is challenging, especially for spotting inconspicuous, cryptic and nocturnal species. Additionally, using human observers to address questions relating to hunting pressure can introduce unknown biases. Given the success of camera traps in detecting secretive terrestrial rainforest mammals, camera trapping could also be a valuable tool for inventorying arboreal species. For the first time we assess the effectiveness of arboreal camera traps for inventorying arboreal rainforest mammals and compare the results with those from other methodologies. This study was carried out at two sites within the Manu Biosphere Reserve in south-eastern Peru, the Manu Learning Centre (MLC) research station, a regenerating lowland tropical forest and the Native community of Shipetiari which was subject to ongoing human disturbance in the form of hunting. Thirty camera traps were deployed across 15 arboreal sampling locations: nine at the MLC and six at Shipetiari. Overall we detected 24 arboreal mammals species, based on 1201 records. Eighteen species were detected by arboreal camera traps, seven by diurnal line transects, six by nocturnal transects and 18 species incidentally. Six species were identified only by camera traps. Comparing arboreal camera traps with traditional ground-based techniques suggests that camera traps are an effective tool for inventorying arboreal rainforest mammal communities. They also detected more cryptic species compared with other methodologies. Daily detection frequency patterns were found to differ between ground-based techniques and arboreal cameras. A cost-effort analysis indicated that despite greater upfront costs in equipment and training for arboreal camera trapping, when accounting for the additional survey hours required to provide similar numbers of records using ground-based methods, overall costs were similar. The method has considerable potential for the study of charismatic and threatened arboreal mammal species that may otherwise remain largely unknown and could quietly disappear from the world's tropical forests.

Keywords: canopy, hunting, threatened species, disturbance

ID:283
Monday, July 10th, 2017, Maya
Oral session: Biodiversity inventories in tropical ecosystems I

A basin-wide Landsat mosaic and field inventories reveal compositional patterns across Amazonia

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Background: Amazonia is a vast area of uniform-looking tropical rainforest, but field studies have shown that considerable floristic variation is hidden under the green canopy. Ferns and Melastomataceae have proved to be good predictors of both general floristic patterns and of soil properties in these forests. Because field inventories can only provide small point samples of the biota, remote sensing is an indispensable tool when the aim is to understand and map Amazonian biodiversity across the entire basin. Our earlier research has shown that spectral patterns within individual Landsat scenes reflect patterns in plant species composition very well. However, radiometric artefacts in Landsat imagery have hampered their use over larger extents. **Methods:** We have accumulated a dataset of more than 1000 line transects to document floristic and edaphic patterns across Amazonia. We have also developed a workflow that takes advantage of recent advances in atmospheric correction, directional normalization and image compositing to produce seamless Landsat image mosaics. **Results:** We have compiled a radiometrically consistent, cloud-free Landsat TM/ETM+ image composite that covers the entire Amazon basin at 30-m resolution. Correction of the artifactual east-west brightness gradient has succeeded very well, as the seams between adjacent Landsat paths are hardly visible in the mosaic. This is also reflected in preliminary numerical results, which suggest good correspondence between spectral differences in the Landsat mosaic and species turnover as documented in the field data, even when comparisons are made over large distances in the east-west direction. **Discussion:** Our new approach to Landsat image mosaicking has produced a composite image that combines semi-continental extent with fine spatial and spectral resolution. This will give a much more accurate overview of the across-basin variation in Amazonian forests than has been available before.

Keywords: Amazonia, remote sensing, ferns

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Oral session: Biodiversity inventories in tropical ecosystems I

Phytosociological floristic inventory in the Brazilian Cerrado

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Background: The Cerrado biome has originaly 2 milhÃµes of square kilometers about 23% of the whole brasilian territory but had a big amount of his natural areas deforested by a intense anthropic action on the last decades. The formation of planted pastures and comercial soybeans plantations are still the principal economyc activities of the region and the cattle production with higer extention at about 25% of the Cerrado area (KLINK; MOREIRA, 2002). The Cerrado biome and the Atlantic forest - Rainforest are considered a biodiversity hotspot, with high rates of endemism and that undergo strong pressures by the antropic actions (BEGON et al. 2006). **Methods:** The study was conduced on the Central plateou in the Minas Gerais state, especificy around the Buenópolis County, with an 740 meters altitude and about 800 kilometers of the atlantic ocean, with the geographic position of south 17º 52' 11" latitude and the meridian of west 44º 10' 22" longitude. The smapling area was made by eight random plots with 500 square meters(10m x 50m) in na Cerrado area wiith about 28,84hectars. All the trees that has higher or equal circunference at the chest height 15 centimeters (mesuread at 1,30 height from the ground) had theirs total girth and height mesuread and also were botanically identified. Then was conduced an phytosociological analyzes (Horizontal structure) and parametic analyzes, witch means an distribuction of the number of trees and basal area by hectare and by species and by diametryc class to select sampling trees to be used to constructo alometric equations. The diversity indexes that were used was Shannon-Weaver (H') (Shannon & Weaver, 1949), mixture quotient from Jentsch (Q) (Hosokawa, 1981) and Pielou Equability (J) (Pielou, 1975). **Result:** The total volume founded on the study area was 35,4998 $m^3.ha^{-1}$. The phytosociological analyzes from the fragmente of Cerrado showed the following results: Shannon-Weaver diversity index of (H') was 2,53, the H'max was 3,14, the Pielou Equability (J) was 0,81 and the Jentsch mixture quotient (Q) was 1:22. **Conclusion:** The diametric distribution with the inverted -j is an indicative that this studied comunity showed a big amount of regenarting individuals, wich is very importante for the sustentability of that cerrado fragment.

Keywords: Cerrado; Hotspot; Brazilian; Savannah

ID:535
Monday, July 10th, 2017, Maya
Oral session: Biodiversity inventories in tropical ecosystems I

Large-scale Evaluation of Multimedia Analysis Techniques for Biodiversity inventories

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Background: LifeCLEF (www.lifeclef.org) is a worldscale research forum dedicated to the evaluation of multimedia-oriented identification systems. Its principle is to measure and boost the performance of the state-of-the-art by sharing large-scale experimental data covering thousands of species. **Methods:** Each year, hundreds of research groups register to the proposed challenges. Results are then synthesized and further analysed in joint research papers. The LifeCLEF research platform is globally organized around 4 tasks. Each task is based on large and collaboratively revised data and the measured challenges are defined in collaboration with biologists and environmental stakeholders in order to reflect realistic usage scenarios. **Results:**The first task, PlantCLEF, deals with image-based plant identification and is organized since 2011. It is based on a growing collaborative data collection produced by Pl@ntNet (http://identify.plantnet-project.org/) initiative with tens of thousands of botanists. In 2017, this dataset contained several thousands of plant pictures belonging to 10,000 species. Each image is associated with an xml file containing the taxonomic groundtruth as well as other meta-data such as the type of view, the author name, the date and the geo-loc. The second task, BirdCLEF, deals with audio-based bird identification and is based on the audio recordings collected by a very active nature watchers network called Xeno-canto. Dataset used for this task is focused on more than more than 20,000 audio recordings belonging to the more than 1000 bird species represented in the South-American region. The third task deals with the identification of sea organisms. The SeaCLEF 2017 dataset contains both 2D and 3D visual data (videos, images, and stereo camera data) and thermal images of marine organisms (mainly fish, e.g., coral fish, salmons, whales and dolphins). The last task, GeoLifeCLEF, is dedicated to automatically predict the list of species that are the most likely to be observed at a given location. This pilot task, based on GIBIF data and environmental data, is designed in the aim to facilitate biodiversity inventories through the development of location-based recommendation services. **Discussion / Conclusion:**This international challenge has the ambition to become one of the first place of exchange between ecologist and computer scientists, to solve problems related to large scale automated living organism identification.

Keywords: automated species identification, benchmark

ID:583
Monday, July 10th, 2017, Maya
Oral session: Biodiversity inventories in tropical ecosystems I

Oral Session
Functional aspects of tropical ecosystems

Getting milk: The evolution of latex as a multidimensional functional trait in tropical plants

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Background: Understanding how traits contribute to speciation and adaptation, shape species distributions, and mediate community assembly are major goals of evolutionary biology and community ecology. Plant exudates represent a unique system in which to examine the role of trait diversification on adaptive radiation because they have arisen independently in at least 40 families across six orders and occur in ca. 20,000 plant species, including more than 15% of tropical taxa representing the largest and most abundant families. and genera. Nevertheless, the biology of tropical plant exudates remains understudied; the role of exudates in lineage diversification is still unknown; and exhaustive studies of their chemical diversity and phenotypic plasticity have not been reported. **Methods:** We sampled latex physical and chemical properties within and among six tropical tree families, both within Amazonian forests and living collections of tropical botanical gardens. We then developed and tested protocols for analytical chemistry of latexes, using NMR spectroscopy and GC/MS spectrometry that ensure the exhaustive chemical analysis of the latex metabolome. **Results:** Our preliminary results show for the first time that (i) latex chemical composition seems to be uncorrelated with the type of laticifer cells (unbranched non-articulated, unbranched articulated, branched non-anastomosing, branched anastomosing); (ii) although latexes of Apocynaceae, Sapotaceae, Moraceae and Euphorbiaceae are mostly composed by triterpenoids and poly-isoprene, they occur primarily in the first two families, and (iii) latexes from Clusiaceae family have extremely low terpene contents but are composed instead by polycyclic polyprenyl acethylphloroglycinols. Results of NMR data indicate a significant positive correlation exists between chemical similarity and phylogenetic distance across these taxa, but observational evidence from species-rich genera such as *Pouteria* (Sapotaceae), *Aspidosperma* (Apocynaceae), and *Ficus* (Moraceae) suggest that substantial variation exists within genera. **Discussion:** Given the broad diversity of latexes within and among important Angiosperm families in the tropics, we examine the evidence for several functional roles of latex, including: (i) chemical defense (against pathogens, fungi and herbivores), (ii) physical defense (against herbivores, pathogens and wounds), and (iii) storage of water, metabolic wastes or nutrients.

Keywords: defense, diversification, exudates, plant chemistry

ID:323
Tuesday, July 11th, 2017, Yucatán 3
Oral session: Functional aspects of tropical ecosystems

Can we use functional traits to predict species responses to logging disturbance?

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Background: Tropical forests have a long history of timber extraction, which continues as demand for timber-related ecosystem services increases with a growing global population. Maximizing timber yield and decreasing the impact of logging increases sustainability of production forests and helps conserve undisturbed areas of tropical forest. Nevertheless, we still understand surprisingly little of how population demographic responses of many tropical tree species behave over the long-term in relation to logging disturbances. We investigated the extent to which we can predict species responses to logging disturbances based on their functional traits. **Methods:** We analyzed thirty years of data from the Paracou experimental station in French Guiana, where permanent plots were established to examine a gradient of logging disturbance since 1986, making it one of the oldest experiments of its kind. We used seven inventories from 768 circular subplots measuring saplings 1m in height to 10 cm in diameter at 1.3m height, within 12 larger plots where basal area was maintained or reduced by up to 88%. In each plot we examined abundance response ratios and vital rates of 23 common tree species representing a range of ecological life-history strategies and integrated data for 12 functional traits that were summarized by seed mass, specific leaf area (leaf economics), and twig wood density (stem economics). **Results:** We observed highly variable regeneration responses to logging disturbance among the 23 species, with 4 species decreasing in abundance with increasing basal area reduction, 10 species showing negligible response, and 9 species increasing in abundance with disturbance. An index of sapling recruitment response to disturbance showed only weak correlations with functional traits with notable exceptions to the pioneer-shade tolerance paradigm. Increases in recruitment response ratios across the logging disturbance gradient were greater for species with, both, higher specific leaf area and lower twig density. **Conclusions:** Despite species exhibiting patterns of recruitment along known ecological axes of trait variation in response to logging disturbance intensity, our results also underline the complex responses of tropical forest communities to disturbances accompanying selective logging. We caution against simplifying predictions of species responses to logging based on functional traits.

Keywords: logging, recruitment, functional traits, Paracou

ID:410
Tuesday, July 11th, 2017, Yucatán 3
Oral session: Functional aspects of tropical ecosystems

Stem photosynthesis and water transport responses to drought in southern Baja California peninsula

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Background: Photosynthetic stems are found in species from dry and hot vegetation types, including tropical woodlands and subtropical deserts. Photosynthetic stems usually have higher photosynthetic water-use efficiency than leaves but little is known about the relationships between photosynthetic traits and hydraulics, compared to the well-known relationships found in leaves. We hypothesized that plants with photosynthetic stems coordinate photosynthetic and hydraulic traits in such a way that water and carbon resources are optimized during drought. **Methods:** We measured soil water status, leaf and stem chlorophyll fluorescence traits, stem water transport efficiency traits including stem, sapwood-specific and leaf-specific hydraulic conductivity, leaf and stem bark carbon isotopes, leaf-to-sapwood area ratio, as well as functional traits including wood density, specific leaf area, and specific stem area, in twelve species from a sarcocaulescent woodland in southern Baja California, Mexico, in both wet and dry seasons. The species were categorized in two groups: 1) retamoid/having green photosynthetic stems and 2) sarcocaul/having fleshy photosynthetic stems. **Results:** Soil water potential was significantly lower in the dry season than in the wet season, and it was positively related to stem quantum yield in the dry season, but not in the wet season. We found that sarcocauls had higher hydraulic conductivity than retamoids but relatively low wood density and stem photosynthetic quantum yield and electron transport rate. There was no relationship between stem hydraulic conductivity and stem quantum yield in either season. Plants with high stem hydraulic conductivity also had high specific leaf area and enriched leaf carbon isotopic composition in the dry season, suggesting high water-use-efficiency. **Conclusions:** Our hypothesis on the coordination between photosynthetic and hydraulic traits in photosynthetic stems was not supported by the data. Sarcocauls had greater hydraulic conductivity probably because of wider xylem vessels, but also because of lower wood density than retamoid plants. However, retamoid plants were mostly evergreen and had higher stem quantum yield and electron transport rate than sarcocauls, indicating that they might have greater annual carbon balance. Overall, it appears that plants from the two groups use resources differently, but both are still able to respond positively to water shortage and survive the seven-month long dry season.

Keywords: fluorescence, functional traits, sarcocaulescent woodland

ID:174
Tuesday, July 11th, 2017, Yucatán 3
Oral session: Functional aspects of tropical ecosystems

How co-ordinated are traits of tropical trees at different scales?

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Background: Coordinated variation between and among plant traits is often used to define ecological strategies across species. This 'leaf economics spectrum' (LES) has been found globally and categorizes plants based on fast-slow strategies of leaf, stem, and root trait coordination. Despite strong correlations between species-level functional traits at a global-scale, patterns in variation have been found to be weak and/or absent across smaller scales. To understand constraints on evolution, to quantify species and ecosystem function, and to improve models that predict future vegetation based on trait coordination and trade-offs, it is crucial to examine the scale-dependency of trait co-variation. **Methods:** We investigate the magnitude of trait integration, or overall degree of correlation across traits in tropical trees across multiple scales. We focus on functional leaf and wood traits related to the LES, chemistry, and structure and defense across spatial (leaf, tree, plots), phylogenetic (species), and environmental (light) scales. We use data from over 3000 leaves (over 200 dominant species) along a 3300 m elevation gradient in Peru. For each sub-scale within each scale, we conducted a principal components analysis (PCA) using groups of leaf traits. Then, using the Eigenvalue matrix from each PCA, we calculated an integration metric (Eigenvalue dispersion) based on the correlation matrix of eigenvalues. **Results:** In general, and consistent with global studies, more integration was observed for all traits at larger spatial scales. The greatest integration overall was observed for LES traits (compared to structural and chemical traits). Elevation was significant for trait integration. Chemical traits were more integrated at larger scales. Differences in sun and shade were more important for structural and chemical traits at plot and species levels, compared to other scales. **Discussion:** Our results suggest that different selection processes operate across scales. At small scales, local factors may lead to large intra-specific variation. Hopefully, this approach can be applied to other datasets to begin to determine whether some of the major hypotheses for trait integration (e.g. metacommunity effects, disturbance) are relevant. This would help build a more synthetic understanding traits covariation as well as provide a new metric that models of community assembly or trait variation can predict across scales.

Keywords: Peru, traits, LES, trees, elevation

ID:556
Tuesday, July 11th, 2017, Yucatán 3
Oral session: Functional aspects of tropical ecosystems

Large-scale shifts in community composition and biomass loss in a forest fragment after 40

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Background: Habitat loss and forest fragmentation are among the biggest threats to biodiversity and associated ecosystem services in tropical landscapes. We document seven decades of land-use change in the vicinity of the Las Cruces Biological Station in southern Costa Rica, and examine forest dynamics in a 2.25 ha permanent plot in the ~365 ha reserve. **Methods:** Land-use change was assessed from historical aerial images. The plot was established in the primary forest and all woody plants >5 cm DBH were censused, mapped, and identified to species in two surveys taken ~5-6 years apart. **Results:** Approximately 27.9% of the region is forested currently, of which ~30% is secondary. The region has shifted from a single contiguous forest to progressively smaller forest fragments with a strong reduction in the amount of core habitat remaining, paralleled by an increase in edge habitat. Structural connectivity, however, remains high. The reserve maintains high species richness (>200 spp.), as reflected in the two censes. Many species were rare and >50 were represented by only one individual. However, the second survey showed a strong shift in species composition for both abundant and rare species, and a two-fold increase in the number of soft-wooded pioneer individuals. The dominant late-successional species in the first survey, *Chrysochlamys glauca* [Clusiaceae], as well as several members of the Lauraceae, declined dramatically and were replaced largely by early successional disturbance-adapted species. A concomitant 10% decrease in overall biomass also occurred, largely driven by the loss of larger late-successional trees. **Discussion:** Although such change is documented for fragments, it is typically noted for smaller fragments and within ~100 m of an edge, which is not the case here as the perimeter of this plot is >400 m from a present-day boundary. Further penetration was perhaps driven by a progressive invasion of disturbance-adapted species into the fragment's core over time; the loss of once-dominant late successional species could be a contributing factor. Few studies have chronicled the impacts of fragmentation on tropical forest dynamics >40 years after isolation where results indicate that even the core of a medium-sized fragment is vulnerable to dramatic alteration. This deterioration is of particular concern given that such fragments represent a substantial portion of remaining habitat in the tropics today.

Keywords: community composition, diversity, forest dynamics

ID:51
Tuesday, July 11th, 2017, Yucatán 3
Oral session: Functional aspects of tropical ecosystems

The role of soil fertility and moisture in explaining local scale floristic composition in Amazonia

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Background: Soil conditions like nutrient concentration and moisture have long been known to affect floristic composition in Amazonian forests. Nutrient-poor soils harbor different species than nutrient-rich soils. Similarly, species differences are known from the areas with moisture soils, such as shores of creek and areas with shallow water table, in comparison with drier microsites. While nutrient concentration can be readily measured from soil samples, soil moisture is more complex to determine as it usually varies through time. For that reason, soil moisture has often been overlooked as an explanatory variable in models explaining floristic composition in Amazonian terra-firme forests. However, relative topographical position of a point should work as a proxy of its soil moisture. Here, we evaluate the usefulness of a new topography-based high-resolution mapping of local hydrological conditions at landscape level in explaining floristic composition. **Methods:** Soil moisture conditions were estimated with the vertical distance between a pixel of the digital elevation model of the Shuttle Radar Topography Mission (SRTM) and the nearest drainage network. SRTM measurements of relative elevation were validated using measurements obtained with a clinometer in seventy-one 500-m-long transects along the Jurua River in Brazilian Amazonia. In the same transects soil samples were taken to measure soil cation concentration. Plant abundance data (Pteridophytes and Melastomataceae) was collected in 25 x 5 m subunits along the transects. We ran ordinations to reduce species dimensionality and regression models to evaluate both separate and joint contribution of soil cation concentration and soil moisture. **Results:** We found a high correspondence between the altimetry from SRTM-DEM and the topographic field measurements. Floristic composition was highly associated with soil cation concentration but the addition of soil moisture improved the models, mostly where relative elevation differences were higher than 10 m. **Conclusion:** Mapping of Amazonian species distributions are still challenged by scanty field data. Our results indicate that soil moisture gradients derive from remote sensing data can help in predicting floristic variability at the local scale, adding a welcome data source to the complex task of mapping Amazonian diversity.

Keywords: Pteridophytes, Melastomataceae, soils, topography, Amazonia

ID:284
Tuesday, July 11th, 2017, Yucatán 3
Oral session: Functional aspects of tropical ecosystems

Oral Session
Ecology, genetics, and evolution of tropical systems II

Movement ecology of the giant forest hog of Kibale Uganda

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Background: African wild suids living in forest environments have been poorly studied and some species as the giant forest hog (*Hylochoerus meinertzhageni)* -the largest species of wild pigs of the world- are disappearing at alarming rates, especially the eastern Africa populations due to habitat encroachment and hunting pressure. Here we present results of the first ecological study on this species in Kibale National Park, a mountain- tropical forest of southwestern Uganda. The goal of this research was to determine group size, group's movement patterns, habitat use, and foraging patterns. **Methods:** We tracked for two years two groups of this species and estimated home range, foraging patterns, and habitat use. With the help of automated camera traps deployed in salt licks and bathing points we also obtained the first account of group size and group structure for the population of Kibale National Park. **Results**: Home range of groups of giant forest hog was estimated at 10.7 km2 (Fixed kernel at 95%) with a core area of 2.7 km2 (Fixed kernel at 50% of observations). Areas with dense bushes and sparse trees surrounded by mature forests seem to be the favorite habitat for the giant forest hog where they feed on the herbaceous plants and rest in shady areas of 5 x 5 m approximately called "sleeping sites" located under the densest thickets. Giant forest hogs were captured on camera traps 50 different times and the more than 1000 photos obtained showed that group size is highly variable and ranges from 3 to 11 individuals with occasional sightings of solitary individuals. Large groups are conformed by a dominant male, one or two additional males, several adult females, and up to four juveniles. **Discussion:** Conservation of the largest pig of the world in eastern Africa will require the protection of forest ecosystems and the mosaic of habitats associated to them as the dense bushes and open gaps surrounded by mature forest. Kibale National Park is one of the last strongholds in Uganda of the population of this endangered species.

Keywords: *Hylochoerus meinertzhageni*, Fixed kernel

ID:151
Tuesday, July 11th, 2017, Yucatán 4
Oral session: Ecology, genetics, and evolution of tropical systems II

Variation in trait plasticity among Bornean tree species with contrasting ecological strategies

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Background: Phenotypic plasticity allows organisms to respond optimally to their environment, which is important for sessile organisms like plants. Because variable environments select for phenotypic plasticity, generalist species that occupy multiple habitats should have greater within-species variation in their responses to environmental variation, compared to habitat specialists. Less well examined is the idea that habitats with plentiful resources, in which species with fast-growth strategies are favored, may also select for greater plasticity. **Methods:** We tested these ideas in a Bornean tropical rain forest with three year-old seedlings of 13 tree species representing three soil specialization groups (clay specialists, sandy loam specialists, and generalists) reciprocally grown from locally collected seed in two soil types (clay versus sandy loam) and light environments (high versus low insolation). We quantified within-species variation (plasticity) in 17 functional traits and six measures of growth rate across these four treatment combinations for each species. While their genotypes were unknown, seedlings were half-siblings from several mothers, distributed roughly evenly across treatment combinations, allowing us to partition phenotypic variation into what is explained by environmental treatment, species' soil specialization, and their interaction. **Results:** We found that specialists of the more fertile clay soil type and generalists, which are found on both soils, were more plastic than specialists of the less fertile sandy loam. On average, trait plasticity due to light was greater than plasticity due to soil. While growth rates were generally more plastic than traits, greater trait plasticity was associated with greater variation in growth rates. **Discussion:** The magnitude of plasticity not only differed among traits and species with contrasting ecological strategies, but also in response to the type of environmental variation. Moreover, within species variation in traits across contrasting soil and light environments translated into far greater variation in growth rates, suggesting a non-additive effect of plasticity on whole-plant phenotypic integration. Thus, within species trait variation in response to a heterogeneous environment is not only complex, but has effects on demography that would ultimately have implications for how tree species are distributed along environmental gradients.

Keywords: Dipterocarpaceae, growth, soil, phenotypic plasticity

ID:397
Tuesday, July 11th, 2017, Yucatán 4
Oral session: Ecology, genetics, and evolution of tropical systems II

Acorn size, seed germination seedling morphology and leaf traits among oaks in Talamanca-Costa Rica

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Background: Variation in fruits size, seed germination and seedling morphology can impact the recruitment of new individuals in plant populations. This is important for high elevation plants, as they may encounter more stressful conditions with increasing elevations. We compared the acorns, seed germination, seedling morphology and leaf characteristic of the three oak species that dominate mature forests in Talamanca mountain range, Costa Rica. We examined whether oaks from higher elevations have larger acorns and seed germination, more sclerophyllous traits and higher leaf mass per area than oaks from lower elevation. **Method:** Acorns of *Quercus salicifolia*, *Q. bumelioides* and *Q. costaricensis*, were collected from along an altitudinal gradient in Talamanca. We measured acorn volume, fresh and dry weight, examined seed viability and germination and classified seedling development according to morpho-functional syndromes. Leaves characteristics from seedllings growing in a common garden were sampled to measure greeness as a proxy for chlorophyl content, thickness, leaf area and dry weight of each leaf. **Results:** There were differences in the characteristics of acorns, seed viability and germination, and seedling morphology among the three species that dominate the high elevation forests of the Talamanca mountain range in Costa Rica. *Qc* acorns were larger and heavier and showed higher viability and germination of their seeds than acorns and seeds of *Qs* and *Qb*. In *Qs*, viability was high for all acorn size classes, but this trend did not extend to germination; seeds in larger acorns, with a higher water content, showed high germination. There were differences in leaf area, leaf color, thickness and dry weight among species. Leaves of *Qs* had larger area and dry weight than leaves of *Qc* and *Qb*. Leaves of *Qc* were thicker than leaves of *Qb* and *Qs*. Overall, leaves from higher elevations were smaller, thicker and were greener than leaves from lower elevations. **Conclusions:** Acorn size, seed germination and leaf traits varied among the species that dominate the high elevation forests in Talamanca. Acorns from higher elevations are larger and have higher seed germination than acorns at intermediate and lower elevations. Leaf area declined and leaf greenness increased in seedling leaves along the elevation gradient. Consequences of these differences for the recruitment of seedling along the elevation gradient are discussed.

Keywords: *Quercus*, Recruitment, Viability, Seedling Morphology

ID:425
Tuesday, July 11th, 2017, Yucatán 4
Oral session: Ecology, genetics, and evolution of tropical systems II

Genetic structure of the CITES-listed rosewood species *Dalbergia oliveri* from Indochina

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Background: High rate of deforestation and logging leads to local extinctions and have left a high number of tropical tree species threatened, among these the CITES listed timber species *Dalbergia oliveri*. The aim of this study was to investigate genetic diversity in natural populations of *D. oliveri* in order to guide management plans for effective conservation of both natural populations and genetic resources for future breeding programs of the species. **Methods:** We collected seeds, leaf or cambium samples from 16 populations of *D. oliveri* across entire of distribution of area of Laos, Thailand, Cambodia and Vietnam and genotyped them with 28 microsatellite markers (in 8 Multiplex-sets). **Results:** We found evidence that the species reproduces clonally by root suckers, and is capable of self-pollination at rate around 20-30%. The level of genetic diversity was moderate (He=0.53) with high levels of diversity found in Chu Mom Ray National Park/mountain area (adjacent to the two countries of Laos and Cambodia), and low diversity in the peripheral populations in Laos and Vietnam. Genetic differentiation among populations was high (Gst=0.34), and strongly correlated to geographic distance between populations. **Discussion and conclusion:** Genetic clustering analysis showed a clear division of populations into five geographically defined groups. We recommended that conservation plans should aim at conserving many different populations in order to maintain as much as the current genetic variation as possible and that populations should be sufficiently large to minimize inbreeding and take into account the possible existence of clones.

Keywords: conservation genetics, *Dalbergia* species, threatened species, tropical trees, CITES, timber species

ID:633
Tuesday, July 11th, 2017 Yucatán 4
Oral session: Ecology, genetics, and evolution of tropical systems II

Genetic diversity of two tropical trees following enrichment-plating strategy in Borneo

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Tropical rainforests are well known for being the most species-rich of all the terrestrial ecosystems on earth. However, biodiversity in these forests is under threat due to logging and land-use conversion. Many restoration efforts focus on recovering species diversity and forest structure post-logging, but fewer have emphasized genetic diversity within species, which plays an important role in species adaptation to and persistence under novel climates and biological interactions. Therefore, we aimed to provide a detailed assessment of genetic diversity among seedlings used for enrichment planting for the restoration of selectively logged forests in Sabah, Malaysia, and to compare it with the levels in naturally regenerating seedlings. We sampled enrichment-planted seedlings from two dipterocarp species (*Shorea leprosula* and *Parashorea malaanonan*) within the Sabah Biodiversity Experiment (SBE) restoration project and compared their levels of genetic diversity with those natural seedlings from the surrounding forests. Our results showed that the genetic diversity estimates (heterozygosity and rarefied allelic richness) varied significantly between natural and enrichment-planted seedlings, particularly in *S. leprosula*. Interestingly, a reduction of genetic diversity was consistently observed in monocultures relative to the mixed-species plots in both species from the enrichment-planting site. This reduction of genetic diversity was likely caused by selective mortality of genotypes in monocultures over the last 13 years post-planting mortality, relative to that of the 16-species mixtures. The selective loss in monocultures may be the result of increased-density-dependent mortality, which would likely to remove genotypes that are poor competitors. Therefore, in the future, forest restoration of tropical tree species should adopt more species-rich planting schemes to prevent the loss of within-species genetic diversity associated with low species diversity.

Keywords: planting, genetic diversity, species diversity

ID:632
Tuesday, July 11th, 2017 Yucatán 4
Oral session: Ecology, genetics, and evolution of tropical systems II

Oral Session
Biotic interactions in tropical ecosystems II

Tropical plants and fungal symbionts: leaf traits as drivers of plant-fungal endophyte interactions

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Background: A central goal in community ecology has been to understand the factors that influence community composition and assembly. Species pools, interspecific interactions, and habitat effects often are invoked in structuring plant and animal communities, but we lack a similar understanding in microbial communities. Plants harbor diverse communities of fungi within their leaf tissues (i.e., endophytic fungi), which may influence plant population and community dynamics through effects on host fitness and function. In the humid tropics, where endophyte abundance and diversity are predicted to be at their highest, researchers have investigated the role of host phylogeny, habitat characteristics, and environmental conditions in mediating community composition. Although much insight has been gained from these studies, the role of host attributes, particularly leaf functional traits, is not well understood. To address this knowledge gap, our study combines molecular analyses of fungal communities and leaf functional trait data to (i) quantify endophyte abundance and diversity in a diverse community of lowland tropical trees and (ii) identify leaf traits that influence endophyte community structure. **Methods:** Our study was conducted at Barro Colorado Island (BCI) in Panama. We sampled leaves from 30 phylogenetically diverse plant species in the forest understory. For each species, we measured leaf mass per area, leaf thickness, leaf dry matter content, and leaf fracture toughness. Additionally, we isolated endophytes from each host using culture-based methods, and used Sanger sequencing to characterize endophyte diversity and community composition. **Results:** Initial results indicate no phylogenetic signal of host on endophyte communities, but host family explained a small but significant variation in fungal community composition across trees. Endophyte diversity was associated with leaf thickness, and endophyte community composition among trees reflected leaf mass per area and leaf fracture toughness. **Conclusion:** Our study suggests that host functional leaf traits play a role in shaping endophyte community composition in tropical trees. Given the ubiquity of fungal endophytes, ongoing research is focused on relating endophyte community structure to foliar chemical traits and using high-throughput sequencing for a more complete understanding of the factors influencing endophyte community composition in tropical forests.

Keywords: Endophytes, traits, woody plants fungi

ID:278
Tuesday, July 11th, 2017 Merida
Oral session: Biotic interactions in tropical ecosystems II

Hints at the structure of the arbuscular mycorrhizal fungal community from a coffee agroecosytem

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Background: Based on morphology, functional roles of arbuscular mycorrhizal (AM) fungi are thought to be conserved at the family level. If AM fungi play similar ecological roles, then competition within AM fungi may be important in structuring communities and result in negative correlations in abundance between closely-related taxa. In contrast, if AM fungi play complementary roles, then positive associations would be expected between taxa, perhaps particularly at the family level. Functions of AM fungi likely include pathogen protection as well as nutrient uptake. Consequently, abundances of some taxa should be correlated with soil nutrient availability while others may be negatively or positively correlated with either abundance of pathogens overall or of specific pathogenic taxa. **Methods:** We used high throughput sequencing of the fungal internal transcribed spacer (ITS2) and the FUNGuild database to characterize the rhizosphere communities of 25 coffee fields from two regions of Costa Rica, for which we also collected data on environmental characteristics. We then tested for associations between AM fungi, between AM fungi and fungal pathogens, and between fungi and environmental parameters using partial correlations and multivariate regression trees. **Results:** About one-third of pairwise associations between AM fungal families were strongly positive; none were negative. There were negative or positive correlations between total AM fungal abundance and plant pathogen abundance for 10% of pathogen families. However, very few correlations were observed between AM fungal and plant pathogen abundance at lower taxonomic levels. Abundances of most AM fungal taxa were uncorrelated or negatively correlated with nutrient availability and positively correlated with shade. **Discussion:** Our results suggest that AM families may play complementary roles and that AM fungal communities are not strongly structured by competition at the site level. The absence of associations between plant pathogens and AM fungi suggests that protection against pathogens is either difficult to detect at the field level or is not an emergent property of AM fungal families. AM fungal taxa with abundances negatively correlated with soil nutrients may be important for nutrient uptake Detecting associations between fungal groups is an important first step in refining our understanding of fungal community structure belowground; the experimental determination of functional roles is urgently needed.

Keywords: arbuscular-mycorrhizal fungi coffee shade nitrogen

ID:613
Tuesday, July 11th, 2017 Merida
Oral session: Biotic interactions in tropical ecosystems II

Escaping unharmed from the host ant nest: the case of the parasitoid fly *Hypselosyrphus trigonus*

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Background: Larvae of the Neotropical ponerine ant *Neoponera villosa* are parasitized by the syrphid fly *Hypselosyrphus trigonus*. Parasitoid immature stages develop well protected within the host cocoon; however, coexistence with these aggressive ants involves two challenges: finding a suitable host to oviposit and escaping from the natal nest. Our goal here was to understand how adult flies escape unharmed from the host cocoons and nest, which is particularly intriguing because syrphid flies have sponging mouthparts and cannot cut open an exit hole through the host cocoon. **Method:** From January 2016 to January 2017, 18 N. villosa colonies nesting in tank bromeliads (*Aechmea bracteata*) were collected in Campeche (Zoh-Laguna, Nuevo Becal, H, Galeana), and in Quintana Roo (Kohunlich), Mexico. Ants and their brood were counted and inspected for signs of parasitism. Cocoons were isolated for a week and then used in laboratory bioassays: five *N. villosa* workers confined with one parasitized and one unparasitized cocoon originating from the same colony (eleven replications performed). Ant behavior was recorded every 5 min for the first two hours and cocoon state was evaluated 24 h later. **Results:** Eighteen cocoons in four colonies (out of a total of 826 cocoons and 18 colonies) were parasitized by *H. trigonus*. In all the bioassays (n = 11), *N. villosa* workers opened the parasitized cocoon and dumped the fly puparia into refuse piles; by contrast, all the unparasitized cocoons remained intact after 24h of confinement with workers. In 91% of the cases, adult flies emerged without damage (5 males, 5 females). In only one case, a female emerged while being exposed to the ants and was killed. Additionally, four empty puparia were found in the refuse pile between the external leafs of the host plant of a colony, corroborating rejection by the host under natural conditions. **Conclusions:** Parasitism rate *by H. trigonus* was low (2.2% parasitized cocoons). Observational and experimental data suggest that *N. villosa* workers open only parasitized cocoons and reject puparia from the nest. The puparium rigid cuticle may represent a successful defense during manipulation by ants. Puparium rejection allows the parasitoid fly to complete its development and to emerge in a safe place, evading deadly interactions with ants. Ant nest-hygiene behavior might have driven the evolution of ant-syrphid interactions, allowing adult parasitoid flies to leave the natal nest unharmed.

Keywords: behavior, syrphid flies, ants, myrmecophile

ID:299
Tuesday, July 11th, 2017 Merida
Oral session: Biotic interactions in tropical ecosystems II

Effect of predation risk on microhabitat use by African giant pouched rats (*Cricetomys* sp.)

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Background: Seed foraging behaviour of rodents can potentially alter recruitment of tree species in tropical forests and this behaviour is influenced by predation risk. **Method:** In an experiment to determine the effect of predation risk on microhabitat use by African giant pouched rats (*Cricetomys* sp. nov) in Ngel Nyaki forest Nigeria, the 'giving up density' (GUD, which is an index of perceived risk of predation at an artificial food patch) and a spool-and-line methods were used. Three characteristic microhabitats were used in the GUD experiment: dense understory, open understory and near-burrows. **Results:** Our results showed that lower GUDs (corresponding to safe sites) were observed close to the rat burrows and in dense understory while higher GUDs (risky sites) were observed in the open. Tracking of rat movements using the spool-and-line method also revealed their more frequent use of dense understory within the forest sites. **Discussion:** Our results suggest that predation risk may be important in determining seed survival and hence tree recruitment patterns in a regenerating montane forest.

Keywords: Predation risk, GUDs, *Cricetomys*

ID:253
Tuesday, July 11th, 2017 Merida
Oral session: Biotic interactions in tropical ecosystems II

Counting the costs of mercenaries: measuring the impacts of guardian ants on ant-plants pollination

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Background: Many ant-plants (myrmecophytes) benefit from guarding by aggressive ants, at the risk of guards deterring other beneficial insects like pollinators or seed dispersers. Since 87.5% of angiosperms are animal-pollinated and 99% of ant-plants are angiosperms, ants and pollinators are likely to interact. Studies of ant-pollinator interactions show varying impacts of such interactions: ants can either increase or reduce fitness. Due to ant threats, pollinators may spend less time per flower and visit more flowers, increasing efficient pollen transfer and fitness. However, ants may also deter pollinators, causing pollen limitation and reducing fitness. Yet none of these have been expressly observed or experimentally tested. **Aim:** We studied the ecological costs of myrmecophily on the pollination ecology of a Mexican endemic ant-plant, *Turnera velutina* (Passifloraceae) in two populations (Guerrero and Veracruz) and experimentally tested the effects of ants on pollinator visitation, and its consequences on the host plant mating system and fitness. **Methods:** Ants were excluded from entire plants or branches to compare pollinator visitation patterns between control and experimental (ants excluded) units. The anthers of focal flowers in focal plants with or without ants were dyed and dyed pollen grains were counted on stigmas collected from those plants to estimate outcrossing/selfing rates. Ant corpses of the most aggressive and common ant species were placed inside the corolla to assess pollinator response to ants intruding flowers. **Results & discussion:** Pollination ecology differed greatly between sites: insect visitors at Veracruz were mainly introduced honeybees, while at Guerrero there was a richer community of native pollinators. The three most aggressive ant species patrolled plants at both sites, but native pollinators are less aggressive than honeybees and may be more susceptible to ants. Ant patrolling reduced selfing and increased geitonogamy, but did not affect pollen load on stigmas. The increase of geitonogamy in the presence of ants might be caused by partial deterrence of pollinators, inducing increased rates of pollinator movement within flowers of a plant. The presence of aggressive ants affected pollinator behaviour, increasing the amount of time they spent flying over the flowers. We suggest that this reflects time spent by pollinators in deciding whether or not to land on a potentially risky flower and increases flower handling time.

Keywords: ant-pollinator, Mexico, *Turnera*, ecological costs

ID:311
Tuesday, July 11th, 2017 Merida
Oral session: Biotic interactions in tropical ecosystems II

Non-consumptive effects of ants on coffee pest facilitate ground ant predators to enhance biocontrol

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Background: Understanding complex interactions between natural enemies and pests is essential for promoting biological control in agroecosystems. In diverse communities, facilitative interactions between predator species can have positive impacts on biocontrol. This may occur through trait-mediated effects of predators on pests. Ants that tend hemipterans on plants often exhibit non-consumptive effects on other herbivores by throwing prey from plants. While this can reduce host plant damage, it is not always clear what effect this has on nearby plants. Additionally, prey that are thrown may increase resources for ground foraging predators. Here we explore these interactions with two ant species and the coffee berry borer (CBB), a major pest of coffee worldwide. **Methods:** We performed a mesocosm experiment in an open-air, enclosed laboratory on a coffee farm in Mexico to test the interaction of two ant species on the suppression of CBB. Coffee saplings were arranged in plastic washtubs, with branches of 20 coffee berries fixed to saplings, and 20 individual berries placed on the washtub floor. A fully factorial additive study was performed with two ant species collected from the field - an arboreal hemipteran tender, *Azteca sericeasur* (on plant) and a ground-nesting generalist, *Wasmannia auropunctata* (on floor). CBB individuals were placed on plants and infestation (# CBB bored into berries) was assessed 24hrs later. Differences in infestation were analyzed with GLMMs. **Results:** On plants, *A. sericeasur* reduced infestation by 46% compared to controls ($p<.01$). This was unaffected by the presence of *W. auropunctata* on the ground. However, *A. sericeasur* exhibited a non-consumptive effect on CBB, resulting in a 52% increase in infestation in berries on the ground compared to controls without ants ($p<.01$). When both ants were present ground infestation was reduced to control levels ($p<.01$), negating the increased infestation from *A. sericeasur*. **Discussion:** These results demonstrate the importance of interaction complexity in biocontrol functioning. While *A. sericeasur* significantly reduces infestation on its host plant, this positive impact may be negated if prey survive non-consumptive attacks and damage other nearby plants. However, when the ground foraging ant *W. auropunctata* is present, this effect may be counteracted. This demonstrates that positive predator interactions, in this case mediated by indirect trait-mediated effects, can benefit pest control.

Keywords: Biocontrol, Ants, Predators, Coffee

ID:402
Tuesday, July 11th, 2017 Merida
Oral session: Biotic interactions in tropical ecosystems II

Oral Session
Seed and seedling ecology

Seed and establishment limitation at small spatial scale: Implications for savanna plant diversity

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Background: Dispersal and establishment limitations often constrain plant regeneration. At community levels, such constraints would decrease the chance of dominance by superior competitors (e.g. large-seeded plants) and allow the coexistence of large numbers of plant species even if they have similar resource requirements. The role of dispersal and establishment limitations for plant recruitment is poorly known for tropical vegetation other than forests. We evaluated seed and establishment limitations to plant recruitment in a Cerrado savanna in southeast Brazil. **Methods**: We spread 49 seed traps systematically and mapped adult woody plants in a 0.64 ha plot haphazardly established in a 127 ha cerrado fragment, recording the seed rain for one year. We also conducted seed addition experiments for four species. **Results:** In spite high seed numbers (300,000 seeds) we found strong seed limitation. Only 34% of the 73 adult shrub and tree species in the plot had at least one seed trapped and most species presented seed limitation values higher than 0.65. Fire susceptible species such as Miconia albicans and M. rubiginosa dominated the seed rain. Seed and source limitation was negative related to adult numbers within the plot and there was no relation between seed, source and dispersal limitation with plant growth form, dispersal syndrome and seed mass. Seed addition was unable to increase seedling regeneration in the species tested. **Discussion/conclusions:** There is a common belief that bottom-up effects such as precipitation and soil nutrients regulate savanna plant communities. This study indicates that seed and establishment limitations may also be important. We suggest that top-down effects such as fire can play a role in decreasing community dominance in our savanna, since the most abundant species in the seed rain are susceptible to fire. Thus, occasional disturbances by fire, pervasive seed and establishment limitation may interact and allow the maintenance of this high species rich savanna.

Keywords: dispersal limitation, Cerrado, Miconia

ID:108
Tuesday, July 11th, 2017 Celestún
Oral session: Seed and seedling ecology

Habitat filtering, dispersal limitation and local tree species coexistence: a matter of scale

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Background: Understanding the ecological processes structuring living communities is a central issue of community ecology and conservation biology. Accurate insights of community functioning rely on a relevant characterisation of the abiotic environment, an explicit consideration of space, and the integration of dispersal limitation, a central process of species coexistence in tropical forests. The variation partitioning (VP), based on multiple regression analyses with a spatially explicit component (Moran's eigenvector maps), allows assessing the pure and joined effects of the environment and spatial variables on the community composition variability, and hence potentially highlights the contributions of habitat filtering and neutral processes to species' coexistence. However, the method still lacks a solid background for interpreting the fraction exclusively related to the spatial component, generally interpreted as resulting from dispersal limitation or unmeasured abiotic parameters. **Methods:** In this study, we used tree community data of a 10-ha miombo forest (DRC) characterised by 32 soil parameters. We used an original approach by combining a spatial point pattern approach to the variation partitioning in order to get an accurate insight of the importance of habitat filtering and dispersal limitation for local tree species coexistence**. Results:** The VP revealed that soil heterogeneity related significantly to 57% of the species and explained up to 50% of their variability at scales of a few hundred meters. Combining complementary spatial approaches allowed highlighting that dispersal limitation produced patchy structures at very fine scales (few meters) for 66% of the species, explaining up to 40% of their total variability. **Conclusions:** The study highlights 1) that habitat filtering and dispersal limitation together influence local tree species coexistence, 2) that more accurate insights of community structures can be achieved by combining complementary spatial methods focusing on contrasted scales, and 3) indicates that local connectivity and habitat heterogeneity must be considered in conservation programs of miombo woodlands.

Keywords: Species coexistence, Habitat filtering, Miombo

ID:33
Tuesday, July 11th, 2017 Celestún
Oral session: Seed and seedling ecology

Return of the seed: a fourteen-year mast seeding interval in a Neotropical monodominant tree

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Background: Since the documented mast fruiting event in 2003, we have investigated annual seed output, seedling establishment, and survival, of the caesalpinioid monodominant rainforest canopy tree *Dicymbe corymbosa* in Guyana. *Dicymbe corymbosa* exhibited intermittently high, regionally synchronous seed production ("mast seeding") during 2003-2017. Combined with the ectomycorrhizal habit and reiterative shoot production, periodic establishment and maintenance of shade-tolerant seedling pools via mast seeding may be a contributing factor in persistent monodominance of D. corymbosa. **Methods:** Seed output, predation, carbon and mineral investment, and masting synchrony were quantified across ten 0.25 ha plots annually from 2003-2017 in primary *D. corymbosa* forests. Establishment and survival of distinct seedling cohorts was monitored across all years, and climatic conditions associated with mast, low seed, and no seed years were assessed. **Results:** During the 2003 and 2016 mast years, *D. corymbosa* exhibited significantly higher, regionally synchronous seed production with proportionally lower predation relative to three minor seeding events during the intermast period. Reproductive biomass and mineral investment was large relative to that in other tropical forests. The 2003 and 2016 *D. corymbosa* mast reproductive events followed El Niño-induced intensified dry season conditions. The three intermast low seed years may be independent of near-term weather conditions and had reduced seedling recruitment and survival. During low seed years, pre- and post-dispersal seed predations were higher than in mast years. **Discussion.** Our results provide unique Neotropical evidence that *D. corymbosa* has a strongly bimodal seeding pattern that leads to the establishment of extensive seedling cohorts capable of persisting for decadal time scales, facilitating persistent monodominance. During mast years, high establishment and survival rates may depend on both seed predator escape and satiation. Resource investment in large seed crops, as well as seedling persistence in shade, likely depend on ectomycorrhizal mineral nutrient uptake and carbon sharing. The impact of extended intermast periods monodominance of *D. corymbosa* will be discussed.

Keywords: *Dicymbe*, ectomycorrhiza, Guiana Shield, monodominance

ID:188
Tuesday, July 11th, 2017 Celestún
Oral session: Seed and seedling ecology

Contrasting seed rain patterns generated by functionally dissimilar frugivores using a novel modelling technique

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Background: Spatial patterns of seed dispersal has a crucial influence on plant regeneration. For a majority of plants in the tropics and sub-tropics, which are dispersed by animals, disperser behaviour is a key driver of seed rain. Wide variation in disperser traits and their behaviour results in differential contribution to spatial patterns of seed dispersal, even for the same species of plants. Our knowledge of what drives spatial patterns however, is very rudimentary for some species of dispersers. We contrast the spatio-temporal patterns of seed rain for two tree species, generated by understudied but potentially key dispersers such as Chital (deer, *Axis axis*) and pigs (*Sus scrofa*) with birds (several species), from a tropical dry forest of India. Further, we identify the potential factors likely driving these differences in seed rain patterns using a novel modelling technique. **Method:** We collected seed rain data for two species of trees (*Terminalia bellerica* and *Ziziphus mauritiana*) from 100 systematically laid grids (50x50m) covering 25 Ha, each sampled four times. Using dynamic occupancy models, we modelled observed seed rain as a function of predictors including quantity of fruit, distance to fruiting tree, availability of grass and structural cover, in a GLM framework. Crucially, we also explicitly modeled the issue of not detecting seeds even if present in a plot. **Results:** Chital and pigs dispersed similar quantities of seeds, but much more than birds. Chital dispersed seeds to nearly thrice the number of locations compared to pigs and birds, both of which dispersed seeds to similar number of locations. Seed rain by Chital varied less across time than by pigs and birds. While availability of grass and structural cover best explained seed rain generated by chital, the quantity of fruit or distance to fruiting trees predicted patterns generated by pigs and birds. **Discussion:** We found that opportunistic frugivores such as large herbivores can play a crucial roles in seed dispersal. We also found evidence that predators may influence seed dispersal by mediating habitat-use of disperser. While all species generated dissimilar seed rain patterns, Chital transported the most number of seeds to the most number of locations. Our study illustrates the utility of using occupancy models in seed dispersal studies, underscores the importance of accounting for observation errors when drawing inferences, while providing novel insights on seed dispersal.

Keywords: seed dispersal large herbivores occupancy

ID:198
Tuesday, July 11th, 2017 Celestún
Oral session: Seed and seedling ecology

Oral Session
Tropical biodiversity and conservation in human modified landscapes

Land use legacy effects on woody vegetation in agricultural landscapes of southwestern Ethiopia

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Background: Past land use legacy effects - both extinction debts and immigration credits - might be particularly pronounced in regions characterized by a long history of gradual landscape change. We evaluated how current woody plant species richness and composition patterns relate to present and historical land use in agricultural landscapes of southwestern Ethiopia, an internationally recognized biodiversity hotspot. **Methods:** We surveyed woody plant species in 72 randomly selected 1 ha sites in farmland, and grouped them into forest specialist, generalist, pioneer and planted species. First, we investigated woody plant composition and distribution using non-metric multidimensional scaling. Second, we modelled species richness in response to historical and current distance from the forest edge. Third, we examined diameter class distributions of trees in recently converted versus long-term permanent farmlands. **Results:** Historical distance to the forest edge was a primary driver of woody plant composition and distribution. Total species richness, and richness of generalist, pioneer and planted species increased with historical distance from the forest edge. Forest specialists, however, did not respond to historical edge distance. The diameter class distribution of forest specialists suggested that only few old individual trees remained in recently converted and permanent farmlands. **Discussion and conclusion:** Our findings suggest that any possible extinction debt for forest specialist species in farmland was rapidly paid off, possibly because farmers cleared remnant trees. In contrast, we found substantial evidence of immigration credits in farmland for total, generalist, pioneer and planted species. This unexpected finding may result from nurse tree effects in increasingly old farmland, and could lead to the development of a novel ecosystem, suggesting that long-established farmland in particular may have unrecognised conservation value. While forest conservation should remain the highest priority for biodiversity conservation in southwestern Ethiopia, this study suggests that conservation policies should also recognize the agricultural mosaic. A future priority could be to reintroduce forest specialist species into the farmland mosaic.

Keywords: Conservation, extinction debt, immigration credit

ID:297
Tuesday, July 11th, 2017 Tulum
Oral session: Tropical biodiversity and conservation in human modified landscapes

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Agricultural land-use diversity and forest regeneration in human-modified tropical landscapes

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Background: A major challenge in tropical human-modified landscapes (HMLs) is meeting the ever-growing demand for agricultural products while conserving biodiversity and ecosystem services. It is important therefore, to understand forest regeneration potential in abandoned agricultural fields. We aimed to: 1) quantify the diversity of agricultural land uses in HMLs; 2) assess ecological disturbance caused by agricultural land uses, at local and landscape scales; and 3) identify those agricultural land uses showing contrasting effects on forest regeneration. **Methods:** We interviewed 68 landowners to gather information on agricultural land uses and management of 156 fields. We quantified ecological disturbance associated with each field considering: size (hectares), duration of use (years), and land-use disturbance severity (i.e. frequency of fire, agrochemicals, machinery, grazing and tree cover removal). We constructed a landscape ecological disturbance index integrating disturbance inflicted by land uses and the cover of each land use. With this index and data from nine landscapes we tested the hypothesis that structural attributes (abundance, biomass, and species diversity of trees) decrease as agriculture disturbances increase in the landscape. **Results:** We found a high inequality in the proportion of land allocated to the 13 recorded agricultural land uses. Cattle pasture represented ca. 90% of total agricultural land. The disturbance gradient ranges from land uses with high (e.g. cattle pastures) to low disturbance (e.g. coffee and cocoa plantations). Three groups of land uses with contrasting disturbance were detected: 1) agroforestry systems, characterized by small size, low to intermediate duration, and low severity; 2) monocultures, with small size, long duration, and medium to high severity; and 3) extensive farming, with large size, short to intermediate duration, and high severity. Biomass and species diversity decreases with increasing levels of disturbance in the landscape. **Conclusion:** Positive balances between biodiversity conservation and agricultural production in HMLs will depend on establishing agricultural land uses inflicting low disturbance regimes (e.g. agroforestry systems). Our results may inform farmers, policy makers and land managers about HMLs where agricultural production, conservation and ecosystem services can be conciliated.

Keywords: Agroforestry, Biodiversity conservation, Ecological disturbance

ID:538
Tuesday, July 11th, 2017 Tulum
Oral session: Tropical biodiversity and conservation in human modified landscapes

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Can community-protected areas conserve biodiversity in human-modified tropical landscapes?

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Background: Scientists debate two alternative paradigms for tropical biodiversity conservation in human-modified landscapes (HML). Strict government-managed reserves (GMR) have many limitations, including little social support as they transfer conservation costs to local communities. Community-protected areas (CPA) have existed for millennia, retaining territorial control and benefits of biodiversity for local residents, but evidence of their ability to conserve biodiversity is scarce. **Method:** To test the hypothesis that CPAs are effective in conserving biodiversity, we used camera-trap data to assess differences in abundance, species richness and diversity, as well as functional (body size and trophic guild) diversity and composition of medium-to-large terrestrial mammal assemblages among CPAs, GMR, and open-access forests (OAF). CPA and OAF sites were located in Marqués de Comillas, Chiapas, México, a HML adjacent to Montes Azules Biosphere Reserve, inside which our GMR sampling sites were located. CPAs and OAFs did not differ in landscape context (forest cover, distance to towns and roads, patch size). **Results:** Our results show that the HML of Marqués de Comillas retains all of the species in the regional pool. We found no difference in species diversity among protection conditions, but species composition was different among them. Abundance of medium-sized generalist species was higher in the HML than in GMR, while large species and small herbivores were scarcer. Abundance of omnivorous and insectivorous generalist species was highest in OAF, where large predators were not detected. Thus, OAFs exhibited fewer functional groups than CPAs. We found no evidence that landscape context affected these results. **Discussion and conclusion:** We conclude that CPAs can play an important role in tropical biodiversity conservation, as they retain a higher terrestrial mammal functional group richness than OAFs located in similar landscape context. In particular, they appear to be more effective in retaining large predators, which play an important ecological role and constitute a global conservation priority. Spatial integration of these social conservation initiatives in landscape networks, as well as training communities in wildlife monitoring and management, would increase the effectiveness of CPAs for tropical mammal conservation.

Keywords: Community conservation; Human-modified landscapes; Mammals.

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Agricultural activities in a forest-dominated landscape: impacts on bats diversity and composition

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Background: In forest-dominated landscapes, land use change typically results in establishment of agricultural production activities. Further, features of agricultural land influence edge effects, generating differential responses in organisms. Bats are ideal focal taxa to investigate responses to changes in land use given their diversity and the key ecosystem services they provide. Here we examine how bat assemblages change in areas that contain two different agricultural land types. Understanding how and why agricultural land types impact biodiversity is important to identify management strategies that can alleviate possible negative effects. **Methods:** We selected two agricultural land uses, cattle pastures and papaya plantations, in a forest-dominated landscape in Peru. We sampled bat assemblages at 12 sites (six per land use) distributed over 340 km2. We examined differences in richness and abundance for phyllostomid bats in varied habitats (forest edge, forest interior, and agricultural land: papaya plantation or cattle pasture) and used general linear models to test which vegetation structure variables better explains those differences. We also analyzed similarity in assemblage composition within habitats and among sites using Non Metric Multidimensional Scaling (NMDS). **Results:** In general, edges showed higher richness and abundance in papaya plantations than cattle pasture sites. Forest edges in papaya sites generally had higher species richness and abundance than the forest interior. In addition, bat abundance was generally lower in edge than in papaya habitat. In contrast, species richness in edge was lower than forest interior in cattle pasture sites, while richness and abundance tended to be higher in edge than in pasture habitats. Canopy height and tree density may be factors driving bat abundance at the edges. For assemblage composition, habitat type was the most important factor that separated bat assemblages. Within habitat types, the agricultural land use (papaya, cattle) explains bat assemblages in the area of use. **Conclusion:** Based on their abundance and species richness, edges in papaya plantation sites are generally more diverse than cattle pasture sites. Habitat type appears to drive similarities in bat assemblage composition. Results highlight how agricultural practices can impact bat diversity and abundance in adjacent forest edges, and thus inform management decisions to target desired ecological services.

Keywords: land use, edge, Peru, Phyllostomidae

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An Evaluation of Jaguars as an Umbrella Species for Endemic Herpetofauna in Nuclear Central America

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Background: The umbrella species concept is based on the premise that habitat preservation for species with large spatial requirements should simultaneously protect sympatric species with smaller home ranges. Despite widespread application on a multitude of taxa across five continents, the effectiveness of the umbrella approach remains equivocal. Jaguars (Panthera onca) are an ideal species to evaluate the umbrella effect because they are the focal species of one of the world's largest working models of habitat connectivity, known as the jaguar conservation network (JCN). The JCN provides a unique opportunity to evaluate the effectiveness of a large carnivore as an umbrella species in heterogeneous tropical landscapes. **Method:** We tested the umbrella value of jaguars for endemic herpetofauna in Nuclear Central America (NCA), a ca. 370,000 km2 topographically diverse sub-region of the Mesoamerican biodiversity hotspot. To evaluate the umbrella effectiveness of jaguars in NCA, we downloaded species distribution shapefiles from the IUCN Red List of Threatened Species website. We then compared the extent of spatial overlap between the JCN and three distinct networks, comprised of randomly selected protected areas and random corridors. For the sampled networks, each equivalent in area, we estimated total numbers of species distributions overlapped, overlap for species classified by their IUCN status, and proportions of the species' distributions overlapped by the network. **Result:** Of the 263 regional endemics in our study area, 149 (57%) had at least partial overlap with the JCN. The distributions of 12 reptiles of conservation concern, including two critically endangered species, occur exclusively within the JCN. Dactyloidae was the beneficiary family with the greatest average overlap (39.9%). The distributions of 17 amphibians, including ten critically endangered species, occur exclusively within the JCN. The greatest benefit was observed for Craugastoridae; an average of 40.3% overlap was observed for species in this family. **Conclusion:** This analysis represents the first multi-taxon evaluation of the jaguar's umbrella value. We demonstrate greater umbrella effectiveness of the JCN than randomly selected networks and argue that jaguars can serve as an effective umbrella for co-occurring endemic herpetofauna, especially amphibians, in NCA.

Keywords: amphibian, jaguar, reptile, umbrella species

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Oral Session
Restoration of degraded tropical ecosystems

Adoption orchids for restore Mount Merapi National Park after the eruption of Mount Merapi in 2010

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The eruption of Mount Merapi in 1994, 2006 and 2010 led to the destruction of Mount Merapi National Park's (MMNP) ecosystems and gave the impact of decreasing on the type and abundance of orchids Merapi. Various conservation efforts have been done both internally by MMNP unit till in collaboration with others to restore and preserve the existence of orchids Merapi in their habitat. Orchids adoption is one of the MMNP's programs together stakeholders in the conservation of orchids Merapi. There are four objectives in orchids adoption's program, namely to save native orchids Merapi; restoration of MMNP area after big eruption in 2010; MMNP efforts to preserve the conservation area; and improving the welfare of society. The method used is in-situ conservation of orchids in the MMNP region. Orchid adoption activities carried out in the Forest Region Turgo, MMNP with an area of ± 5 hectares by the 22 adopters for the period of 2015-2016. Orchids are planted as much as 6 types, namely *Vanda tricolor*, *Pholidota ventricosa*, *Macropodanthus teysmanni*, *Eria hyacinthoides*, *Bulbophyllum flavesces*, and *Dendrobium mutabile* planted on 12 types of host trees endemic of Merapi, Puspa (*Schima wallichii*). *Vanda tricolor* is one of endangered species in Merapi, also become umbrella species of MMNP. The results of the evaluation at the end of 2016, 22 species of orchids grow well. Local communities who are involved in the orchids adoption are already carrying out their duty properly in maintaining orchids in the MMNP region, in order to restore orchid habitat Merapi. One success of the orchids adoption is growing active role of local communities of Merapi in conserving of national park ecosystems.

Keywords: orchids adoption, national park, restoration

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The efficiency of different land restoration strategies at soil ecosystem recovery in Costa Rica

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Background: It is unknown if restoration strategies used for cleared Neotropical forests involving regeneration of secondary forests or development of tree plantations restores the soil biotic composition and biomass critical for C and N sequestration to levels approaching that of the former primary forest. This study was the first in the Maquenque National Wildlife Refuge (Costa Rica) to test how efficiently such strategies were remediating damaged soil ecosystems. **Methods:** Soil samples from a primary forest (PF), and adjacent grasslands (GR), secondary forests (SF), 5-year-old (YV) and 16-year-old (OV) plantings of Vochysia guatemalensis were analyzed for %C, %N, biomass C, NO_3, NH_4, and NO_3/NH_4 ratio. Extracted soil DNA was PCR-amplified for ITS regions of fungi, processed through Illumina Next Generation DNA Sequencing to create sequence OTUs, which were taxonomically identified to genus using the NCBI BLAST database, and then clustered into known functional groups. ANOVA was used to show differences in mean values, and multivariate SIMPER, PERMANOVA, and CAP tested the hypotheses that there were differences in soil nutrients and fungal communities between habitats, and these differences reflected the effects of different management strategies. **Results:** More %C, biomass C and N ($p = 0.0498$ to <0.0001) were in the older managed site (OV and SF) and PF than in YV and GR soils, and were greater in the OV than YV soils ($p = 0.0099$ to <0.0001). In addition, there was a greater %DNA sequence contribution of generalized saprobes and complex carbon decomposing fungi in OV, SF, and PF than YV and GR soils ($p = 0.0547$ to <0.0001), and less % contribution of mycorrhizal sequences in the PF than YV, SF, GR and OV soils ($p = 0.0002$ to <0.0001). Multivariate statistical analyses showed there were differences in soil nutrient and fungal community composition between habitats, which resulted from specific land management strategies. **Conclusions:** These data show the OV soils are recovering well, and trending towards conditions of PF soils, compared to YV and GR soils. Thus, planting V. guatemalensis enhances soil ecosystem recovery of cleared forests, provides a fungal community composition that efficiently generates biomass C, increases the potential for soil C and N sequestration, while providing a sustainable forestry method beneficial to the economy and environment in the region, based on 16-year harvest rotations, and reduces the pressure need to harvest other forests.

Keywords: soil recovery, fungal communities, restoration

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Ecological restoration of arid lands: new methods from Caatinga vegetation

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Background: Restoration in drylands is a challenge due to the harsh conditions that impair plant survival. Restoration programs in Caatinga, (Brazilian semiarid tropical forest) frequently face as much as 70% plant mortality because of drought. This study investigates novel methods for dryland restoration to improve plant survival and overcome such low restoration success. **Methods:** Experiments were conducted in a 5 ha degraded area at the National Forest of Açu, northeast Brazil. Soil and plant shape treatments were applied in a split-plot design with five replicated blocks. In each block, soil treatments were randomly assigned in five 12 x 12 m plots: control; litter addition; irrigation; litter+irrigation; agroforesty (irrigation+crops). Inside each soil treatment, six native tree species were planted with the following plant shapes: small root +small shoot; small root + large shoot; large root + small shoot; large root + large shoot and seeds. Measures of survival and growth were taken every year during three years. The best technique for improving survival at lower cost was then applied at a large scale restoration program covering 3,3 ha of plantations, using 16 native tree species, 4800 trees in total. Tree survival was measured after the first dry season, eight months from planting. **Results:** As expected survival and growth were higher in treatments that received water, however, plants with large roots and large shoots had significantly higher growth and survival even in treatments where water was not applied. The seed sowing treatment was not successful, due to the harsh conditions that impair germination. Plant growth and survival were very successful when restoration was joined with agroforestry techniques. Plants achieve 80% survival after the first dry season in the large scale restoration intervention that applied the large shoot and root technique. **Discussion:** This work shows an unprecedented survival rate for restoration programs in Caatinga. Large plants with large roots have the advantage to reach deeper water sources in the soil during dry periods, while their large body size allows for high water storage in plant tissue. This work indicates that restoration programs in dry lands should avoid expensive irrigation methods by transplanting large plants with large roots in degraded areas.

Keywords: Drought, restoration, long roots, desertification

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Fruit preferences by birds based on fruit chemistry and plant selection for restoration projects

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Background: Fleshy fruits can be roughly classified as either sugar-rich and lipid-poor, or lipid-rich and sugar-poor, with most variation in fruit chemical profile occurring at the family and genus level. It has been suggested that planting sugar-rich fruits (e.g. figs) will be the most efficient way to attract and maintain fruit-eating animals in restoration projects because these fruits are usually abundantly consumed by a wide variety of frugivores. **Methods:** We searched the literature looking for studies that reported quantitative measures of feeding visits by birds to fruiting plants and the lipid content of fleshy fruits. With these data I examined the relationship between the "degree of frugivory" of bird species (i.e., how much of their diet is composed by fruit, also gathered from the literature) and their relative importance as visitors of Neotropical plants that vary in fruit-lipid content. **Result:** Fruit preference by seed-dispersing birds is non-random relative to fruit chemistry. While predominantly frugivorous birds contribute most to seed dispersal of sugar-rich fruits, predominantly insectivorous birds have a prominent participation in the dispersal of plants producing lipid-rich fruits. **Discussion:** Plant species bearing sugar-rich fruits are less likely to attract predominantly insectivorous birds that may bring to the restoration a seed pool different from the seeds carried by birds attracted to sugar-rich fruits. Given that lipid-rich and sugar-rich fruits are often associated with different clades in the Angiosperm phylogeny, the inclusion of plants with lipid-rich fruits together with plants with sugar-rich fruits will produce a higher phylogenetic diversity in restored forest, which may maximize facilitation and minimize competition among plant species thus producing a more diverse restored forest.

Keywords: seed dispersal, Neotropical plant ecology

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Landscape structure effects on plant-pollinator networks in Atlantic Forest restoration areas

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Background: With less than 16% of its original extent, the Atlantic Forest has been restored to rebuild the functional richness of biological communities. However, verification of restoration actions consider only vegetation structure and species richness, but little is known about their functionality. Pollination is an ecological process of great importance for plant reproduction and food production, and should be considered in restoration actions The objective of the present study was to evaluate the effect of the amount of forest surrounding forest restoration areas in the Atlantic Forest on the structure of the floral-plant interaction networks in these areas. Our hypothesis was that areas of forest restoration inserted in landscapes with high amount of forest have more complex and better structured networks than in areas with low amount of forest. **Methods:** The study was carried out in Antonina (Paraná) and Batatais (São Paulo), Brazil, in different contexts of vegetation cover around forest restorations. We selected five landscapes in each region, high with varying landscape contexts and sampled plants and their floral visitors for the construction of interaction networks. We then analyzed the effects of landscape structure on network metrics. **Result:** The amount of forest in the landscape had little effect on network metrics, which indicated in all areas small and not very cohesive networks. However, in areas with high forest cover, the networks had a higher weighted connectance, indicating that the landscape structure may affect the pattern of interactions between plants and floral visitors that occur in areas of forest restoration in the early stages of succession. **Discussion:** Our study suggests that the low effect of the amount of forest of the landscape on the structure of the studied nets can be due to other factors of the landscape and local factors of the restorations. It is also possible that restored forests in more advanced successional stages may be attractive to floral visitors, and the amount of forest may be more relevant in this context.

Keywords: networks, restoration, pollination, surveys, services

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Major network reorganizations punctuate the assembly of plant-pollinator communities

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Background: Species and interactions are being lost at alarming rates and it is imperative to understand how communities assemble if we are to prevent their collapse and restore lost interactions. **Methods:** Using an eight-year dataset comprising nearly 20,000 pollinator visitation records, we explore the assembly of plant-pollinator communities at native plant restorations sites in an agricultural landscape. **Results:** We find that species occupy highly dynamic network positions through time, causing the assembly process to be punctuated by major network reorganizations. The most persistent and generalized pollinator species are also the most variable in their network positions, contrary to what preferential attachment---the most widely studied theory of network assembly---predicts. **Discussion/conclusion:** Our results alter our understanding of how communities assembly and how species interactions change through time while helping to inform efforts to re-assemble robust communities through restoration.

Keywords: Robustness, restoration, mutualism, preferential attachment.

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Oral Session
Invasive Species

Soil quality and biotic factors related to the invasion of bracken fern in the Lacandona, Mexico

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Background: The Lacandon region comprises the largest tropical rainforest of Mexico. This region is highly deforested and conservation efforts are fighting against agricultural impacts reducing soil quality and promoting accelerated growth of weeds and biological invasions. *Pteridium arachnoideum* (bracken fern) is one of the most aggressive weeds in the area. It produces 2-m leaves forming dense, dark patches that make agriculture impossible and delay forest succession. Fern invasions were associated to acid soils poor in nutrients, and were believed to inhibit chemically, the establishment of other plants. For this reason this study aimed at characterizing soil factors associated to *P. arachnoideum* invasions and at understanding the influence of bracken fern on plant-soil feedback in the Lacandona region. **Methods:** We selected six zones with bracken fern invasion and collected soil samples from fern patches and other neighboring covers (i.e. secondary forest, crop, pasture, plantations). We measured bracken fern abundance as rhizome biomass and related it to soil nutrient availability, pH, and microbial functional group abundance. We conducted a pot bioassay with a standard disinfected soil and the soil from fern-invaded sites and compared the growth of bracken fern and three pioneer plant species (*Ochroma pyramidale*, *Castilla elastica* and *Leptolobium panamense*) in soil with and without the fern. **Results:** Our results suggest that there is no relationship between nutrient availability, pH and microbial community with bracken fern abundance. Also that fern-invaded soil can inhibit the growth of *C. elastica* and of the same fern, but not of the other two species. **Disussion:** Our results contradict previous observations. We demonstrated that bracken fern could grow dominantly in a wide gradient of soil quality and showed that the influence of *P. arachnoideum* on plant-soil feedback is diverse. Interestingly, the fern soil inhibited its own growth and only one out of three other species, so soil negative feedback on other species and positive feedback on itself is unlikely to explain the successful invasion of bracken fern in the Lacandona region. Bracken fern is more likely to succeed by physically inhibiting other species through shading and covering the soil and by tolerating burning control practices through its underground rhizome.

Keywords: *Pteridium arachnoideum*, plant-soil feedback

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Tuesday, July 11th, 2017 Maya
Oral session: Invasive species

Invasion of woody plants in the Hawaiian Islands along ecological gradients

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Background: Understanding the mechanisms that shape biological invasions is vital for mitigating their impacts on island forest ecosystems, which are highly diverse and provide vital ecosystem services. However, the relative importance of assembly processes that determine biological invasions at local scales is uncertain. Here we test the extent to which climate, productivity, and human disturbance mediate the strength of abiotic and biotic filters in invaded forest communities in the Hawaiian Islands. **Method:** We compiled abundance data from 216 invaded forest plots across four islands in Hawaii. For the 147 species in our data set (86 native and 61 alien woody species), we obtained wood density and adult tree size data and built a species-level phylogeny. We then calculated phylogenetic and functional similarity as the mean distance to the native community (MDNC) and the mean distance to the nearest native species (MDNN). We gathered information of potential drivers of variation in MDNC and MDNN: island identity, aboveground biomass, mean annual precipitation, potential evapotranspiration, and the human influence index. Using linear mixed-effects models, we tested the influence of climate, human disturbance, and island identity on phylogenetic and functional similarity. **Results:** We found strong effects of climate, aboveground biomass, and island identity on phylogenetic and functional similarity at local scales. With increasing mean annual precipitation, functional MDNN and MDNC and phylogenetic MDNC increased significantly. With increasing potential evapotranspiration, which varies inversely with elevation and temperature, phylogenetic MDNC and adult plant size MDNC decreased significantly. Wood density MDNC and MDNN and phylogenetic MDNN also decreased significantly with increasing aboveground biomass. Phylogenetic and functional MDNN varied significantly across islands, as did functional MDNC. **Discussion:** Our study provides evidence that ecological gradients strongly determine the relative importance of abiotic and biotic filters to the invasion process in Hawaiian forests. Where conditions are favorable, invasive species are functionally and phylogenetically distinct from native species and, therefore, appear to coexist by utilizing resources differently. In contrast, harsh conditions reduce the range of viable ecological strategies, resulting in alien species that are phylogenetically and functionally similar to native species.

Keywords: community assembly, biological invasions, islands

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Tuesday, July 11th, 2017 Maya
Oral session: Invasive species

Dogs in the Atlantic Forest: a map of the risk of invasion across the entire phytogeographic domain

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Background: The ability to predict the spatial patterns related to the distribution and expansion of invasive species is crucial to prevent and mitigate the impacts of biological invasions. Free-ranging dogs are the most abundant carnivore worldwide, being common in remnants of native vegetation, and affecting wildlife through predation, competition and disease transmission. However, large-scale assessments of the invasion risk of free-ranging dogs in remnants of native vegetation are lacking. Based on two important drivers of biological invasions (habitat loss and propagule pressure), a camera-trap dataset and censuses of dog and human populations obtained across a 300,000-ha Atlantic forest region, we generated a risk map of dog invasion for the entire Brazilian Atlantic forest. **Methods:** Our empirical dataset was obtained across 12 2830-ha landscapes varying in forest cover and human population density within the Cantareira-Mantiqueira region in the State of São Paulo, Brazil. Within each landscape, we set 8 camera traps in forest remnants for 42 days, and conducted a census of dog and human populations. We used N-mixture abundance models to evaluate the importance of propagule pressure (dog density and spatial distribution in relation to forests) and habitat loss (forest quantity, edge extension and edge density) in driving dog abundance in native forests. To generate the map of invasion risk, we extrapolated the best abundance model, chosen by AICc, to a map of Atlantic Forest remnants, using human population data, obtained from the official Brazilian census, as a proxy for dog density (correlation between dog and human populations in our dataset was r=0.63). **Results:** The best abundance model indicates that dog invasion increases with dog density and with forest loss. Extrapolating this model to the entire Atlantic forest, our risk map predicts that while 62% and 11% of Atlantic forest remnants are subjected to very high and high levels of invasion, respectively, only 27% are exposed to low or very low levels of invasion. **Conclusion:** Our results suggest that the conditions of most Atlantic forest remnants (small isolated, embedded in high-density human settlements) facilitate dog invasion, imposing a widespread, cryptic threat to wildlife beyond the well-known impacts of habitat loss and hunting. Together with native species distribution maps, our risk map can help identify priority areas for both preventing and mitigating the effects of dog invasion.

Keywords: exotic-species, Canis-familiaris, biological-invasions, habitat-loss, propagule-pressure

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Tuesday, July 11th, 2017 Maya
Oral session: Invasive species

Global-scale mechanisms of species' abundances in native and alien ranges

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Background: Biological invasions of ecosystems by alien species cause ecological and economic problems worldwide. The success of alien species in the new range is often thought to be due to more favorable environmental conditions (i.e. reduced environmental filtering), and/or novel properties of the alien species compared to the native community (i.e. reduced biotic resistance and/or higher fitness). Although many studies have tried to understand how such mechanisms allow plant species to succeed in a new range, few studies compared this to mechanisms underlying their success in the native range. **Methods:** Here, we use a global vegetation database (sPlot) and global information on alien plant species (GloNAF) to evaluate how environmental filtering, biotic resistance and fitness differences influence local abundance of alien species in their alien and native range. Specifically, we focus on the role of environmental conditions as indicators for environmental filtering, species' traits as indicators of differences in species' strategies and fitness, and species' similarity to the native community (in terms of traits and phylogeny) as indicators of biotic resistance. In total, we evaluate about 50 woody species with native and alien ranges in different continents, and that occur in at least 10 plots in both ranges. **Results and Discussion:** We find that some species can become more abundant in their alien compared to their native range, and can occur in different climate zones in their alien range. We expect that inherent traits predict species' relative abundance. Moreover, successful alien species that are relatively dissimilar to the native community would reach highest abundance because of low biotic resistance. A global evaluation of these mechanisms in both the native and alien range will provide a better understanding of why certain species become successful invaders, and could guide us in how to manage invaders and to identify possible future invaders.

Keywords: Alien species, abundance, traits, phylogeny.

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Oral session: Invasive species

Oral Session
Tropical forests and climate change

Climate-change effects on bryophyte carbon balances in the warm tropics: a new rainforest experiment

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Background: The tropics are predicted to be among the world's areas most affected by climate changes in the next decades, but data about temperature effects on tropical plant growth are very scarce, especially for non-trees and non-agricultural plants. Bryophytes are one of the important components of tropical forests and show a positive gradient of diversity and biomass with elevation. Researchers have tried to explain this with gradients in light, precipitation, temperature, or various combinations of these factors without reaching a real understanding of the underlying ecophysiological mechanisms. Due to their poikilohydric nature, bryophytes are only hydrated and hence physiologically active during a limited part of the time, depending on environmental conditions. Our hypothesis is that in the warm tropics (lowlands) low carbon gains due to high temperatures and dark (understory) or desiccating (outer canopy) conditions compromise carbon balances, thus restricting bryophyte growth. Under climatic warming, the carbon balance may become compromised even more due to increased nocturnal respiration and supra-optimal temperatures for photosynthesis, if no acclimatization occurs. As a result, climatic warming may negatively affect bryophyte distributions and abundance in the lowland tropics. **Methods/Perspectives:** In a field experiment in the rainforest of La Selva biological station in Costa Rica, we are submitting tropical lowland bryophytes to two climate-change elements: a temperature increase of 3 K and a CO_2 increase of 300 ppm. In open-top chambers in the rainforest understorey we are actively heating and/or CO_2 fertilizing five species of bryophytes in a full-factorial design with five replications, plus a non-chamber control treatment. For at least one year, changes in growth rates and in environmental responses, in particular temperature and CO_2 responses, and diel courses of carbon exchange will be recorded. The implications of the experimental and other potential future atmospheric changes for bryophyte growth will be further explored using a simulation model of bryophyte carbon exchange, which is developed as part of the project. The long-term character of the experimental study will show us if bryophytes can shift their response curves and acclimatize to climate change. It also provides a novel system for studying climate-change impacts in tropical forest ecosystems, open to studies on other organisms groups and small-scale processes.

Keywords: Bryophytes, Tropical-lowland, Climat-change, Carbon-balance, Open-top-chambers

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Wednesday, July 12th, 2017 Yucatán 3
Oral session: Tropical forests and climate change

Climate and Land Use Effects on Carbon and Nutrient Cycles at Mount Kilimanjaro

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Background: Ecosystem functions of tropical mountain forests and their ability to provide ecosystem services are particularly threatened by the combined impact of climate and land-use change. Soils, as the linkage between abiotic and biotic components of an ecosystem, are strongly affected by these changes. To understand impacts of climate and land use changes on biodiversity and accompanying ecosystem stability and services at Mt. Kilimanjaro, detailed understanding and description of the current biotic and abiotic controls on ecosystem C and nutrient fluxes are needed. **Methods:** We selected twelve sites (0.5 to 1.0 ha) along a 3400 m elevation gradient, representing typical natural forests and agricultural ecosystems of the region and quantitatively described pools and cycles of Carbon (C) and main nutrients (N, P, K, Ca, Mg, S, Si) on pedon and stand level scale. Qualitative indicators, such as composition of soil organic matter (Pyrolysis GC/MS) and microbial communities (PLFA-Analysis), were used to relate pool changes to underlying processes. Ecosystems with a highly heterogeneous vegetation cover (savanna and alpine helichrysum cushion) were intensively studied to relate above- and belowground parameters to greenhouse gas fluxes. **Results:** Annual pattern of litterfall and decomposition were closely related to rainfall seasonality and temperature. Several factors, such as decomposition rates, C & N contents, macronutrients (N, P, and K) in leaf litter and soil microbial biomass (MBC), increased at mid elevation. Land-use intensification led to 40-80% losses in topsoil C and MBC contents and increased macro nutrients in leaf litter. In ecosystems with high seasonal and spatial variations (savanna and helichrysum) C storage and N turnover was strongly affected by spatial vegetation heterogeneity. **Conclusion:** Ecosystems at mid elevation (~2000 m) represent the interception zone of optimal moisture and temperature conditions. High inputs and fast turnover control the C sequestration in these ecosystems, while climatic restrains on input and decomposition limit the C turnover in soils at lower and higher elevation. Nutrient cycles in agricultural ecosystems were accelerated by fertilization and the associated changes in dominant tree species. Consequently, land-use intensification decreases stabilization from new C inputs through increased microbial C demand and turnover and thus decreases soil C storage.

Keywords: Litterfall, Decompostion, Soil Organic Matter

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Oral session: Tropical forests and climate change

Predictive potential of functional traits on the growth performance of plants under climate change

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Background: Anthropogenic impacts are causing climatic change at an unprecedented rate. Based on species distribution models and global warming scenarios, many plant species especially in the tropics are predicted to face extinction within decades due to their expected inability two trace their climatic niche. However, little is known about the growth performance of plants under changed natural conditions. As measuring growth performance is time-consuming and technically unfeasible for large numbers of species, easy-to-measure proxies informing about the influence of climatic change on plant growth performance are urgently needed. **Methods:** We investigated the growth performance of 69 plant species occurring naturally along a strong climatic gradient on Mount Kilimanjaro, Tanzania. We collected specific leaf area, leaf dry matter content, leaf carbon, leaf nitrogen, leaf $\delta^{13}C$, leaf phosphorus, and stem dry matter content for all species within their natural habitats. We took fifteen samples per species to capture intraspecific variability. Seeds were also collected from all species in situ. Two common gardens were established at upper and lower elevations and plants grown from seeds in both gardens to understand relative changes in seedling establishment and growth under climate change. **Results:** Most plant species grew better at the upper elevation garden, regardless of whether they originated from upper or lower elevations. Plant traits clearly responded to changes in temperature and precipitation: Upper elevation species generally had a higher specific leaf area, and lower leaf and stem dry matter content than species from lower elevations. Several traits, especially specific leaf area and leaf dry matter content were related to plant growth performance under changed climatic conditions. Trait variability was a good predictor for growth performance in specific leaf area and less so for other traits. **Conclusion:** Our results demonstrate the ability of plant functional traits to inform about the ability of plants to adapt to changes in temperature, both at the germination and growth stages. Together with increasingly available data on functional traits, this allows for a significantly enhanced prediction of plants' responses to climate change.

Keywords: temperature; precipitation; SLA; biomass

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Oral session: Tropical forests and climate change

Hardest hit but most resilient: are large-seeded plants more vulnerable under global change?

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Background: Defaunation disproportionately affects large frugivores, and therefore large-seeded plants face the highest rates of fruit-frugivore mutualism disruption worldwide. However, coexistence theory and research on functional traits suggest that large-seeded plants may depend less on seed dispersal than small-seeded species. This talk focuses on two projects that elucidate how contrasting effects of plant's dependence on seed dispersal and their likelihood of disperser loss each mediate plant decline under defaunation. We report on experiments assessing plant species' dependence on dispersal in the Mariana Islands—where Guam represents an extreme example of frugivore extirpation—and a global-scale meta-analysis of plants' dependence on frugivore gut passage for germination. **Methods:** In the Marianas, we characterized the seed dispersal network on an island with an intact frugivore assemblage (Saipan) and on an island that has experienced partial defaunation (Rota). To assess plant species' dependence on seed dispersal, we used germination and seedling survival experiments to assess benefits of dispersal away from conspecifics and to high light areas, and compared germination of seeds ingested by captive frugivores to germination of undispersed seeds. Using published studies of frugivore gut passage and trait databases, we performed a meta-analysis relating seed size and the benefits plants derive from gut passage. **Results:** In the Marianas, larger-seeded species had fewer dispersers but in plant survival experiments depended less on seed dispersal. Relative to frugivory rates in the intact network, frugivory rates in the degraded network were reduced by up to 95%, even for small-seeded species. Preliminary results of the meta-analysis show wide variation in plant species' dependence on gut passage, but that in many cases small-seeded species can be much more dependent on frugivore gut-passage than large-seeded species. **Discussion:** In the Marianas, small-seeded species would suffer more strongly from disperser declines due to stronger dependence on dispersal. Worldwide, the finding of small-seeded species with high dependence on dispersal highlights the possibility of overlooked but large consequences of partial, but not complete, mutualism disruption. The low dependence on dispersal of large-seeded species could explain the persistence of large-seeded species that have lost their dispersers such as the fruits the gomphotheres ate.

Keywords: Frugivory, Seed Dispersal, Mutualism, Defaunation

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Oral session: Tropical forests and climate change

Strategies to "adapt" endangered dry tropical forest species to climate change in Mexico

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Background: Dry tropical forest is one of the most endangered ecosystems worldwide and due to climate change many species typical of this forest could be extinct within a few decades. In Mexico, anthropic pressure has been strong and continuous. For this reason, many species are now under some level of threat. To avoid a dramatic reduction in biodiversity in near future is necessary to test different strategies that implies species abilities to respond to abiotic and biotic factors that could be limiting for their survival and persistence. **Methods:** The model study were three deciduous species *Albizia plurijuga*, *Cedrela dugesii* and *Ceiba aesculifolia*. They are of interest because currently are endangered and for their importance in ecological restoration process. We evaluated their performance in three different experiments: frost tolerance, altitudinal assisted migration and interactions with nurse shrubs. For all experiments individuals were propagated in a shaded house under controlled conditions. Frost simulation was made in laboratory conditions and tested in young and old leaves with different potassium concentrations. Altitudinal assisted migration assay was done at three altitudes (2100, 2400 and 2700 m). Plant interactions were tested with juveniles of tropical species transplanted in two distances nearly three species of nurse shrubs. **Results:** The main findings were that tolerance to frost in tropical species could be enhanced by fertilization with high concentrations of potassium that reduces electrolyte leakage in young leaves and the less sensitive species to low temperatures was *C. dugesii* that was able to sprout after frost simulation. In assisted migration assay, general performance was best at medium and low altitudes but general survival was not so high probably due to climatic differences between seed sources and experimental sites, in this case *A. plurijuga* showed a better potential to be used in translocation experiments. Positive plant interactions were rapidly established between native shrubs and target species evidenced by better performance of seedling when they were nearest to nurse shrub. **Conclusions:** tropical species can be helped to face environmental challenges imposed by climate change using different strategies of management. Assisted migration could be a successful strategy if it is combined with nurse interactions and addition of nutrients. Plants translocation should be done in near localities to avoid maladaptation.

Keywords: frost, translocations, facilitation, dry forest

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Oral session: Tropical forests and climate change

Species number of vascular plants in tropical biodiversity hotspots of China and climate change

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A simple approach is suggested to project potential changes in the species number of vascular plants for biodiversity hotspots in tropical and subtropical part of China. We use the current (recent past) relationship between plant diversity and geographic variation in the climate, as well as elevation range, to project changes in regional species richness (at 100 km x 100 km resolution), concentrating on six climate scenarios for 2020, 2050 and 2080. Hotspots were sorted by their size and investigated at each time slice. First, we calculated areas in the islands in biodiversity hotspots of China where more than 5% of vascular plant species were lost and named this "area with negative changes". Areas where more than 5% were gained we named as "area with positive changes". The areas where more than 20% of species were lost and more than 20% of species were gained were named this "area with large negative changes" and "area with large positive changes" consequently. The results show a general although moderate increase in vascular plant diversity in the tropical and subtropical biodiversity hotspots of China. So to the year 2080 due to climate change Haynan Dao will be large winner with more than 20% increase in the species number of vascular plants.

Keywords: climate change, biodiversity hotspot, China

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Oral session: Tropical forests and climate change

Oral Session
Ecology, genetics, and evolution of tropical systems III

Border control: maintaining species boundaries through divergence in pollinator cues and elevation

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Background: Floral scent plays a key role in attracting specific pollinators in obligate mutualisms. Odour divergence between sister species in sympatry allows pollinators to distinguish between hosts, thus maintaining specificity. Environmental barriers may limit pollinator dispersal and relax the selective pressures driving odour blends. Coupled with scent profiles, pollinator choice experiments offer us clues as to how scent promotes reproductive isolation and maintains species boundaries in specialized mutualisms such as fig and fig-wasps. **Methods:** We collected volatile compounds of receptive figs from three *Ficus* species from the section Papuasyce, along Mt. Wilhelm, Papua New Guinea. *Ficus itoana*, pollinated by *Ceratosolen armipes*, is a dioecious species restricted to lowland forests, *F. microdyctia* is a monoecious species restricted to the highlands, its pollinating wasp, *C. kaironkensis*. The third entity is an as-of-yet undescribed species (*F. imi*) most commonly found at mid-elevations. Preliminary genomic analysis place this species as sister to F. microdyctia. Volatile profiles were identified and compared between these species. Using Y-tube experiments, we also compared behavioural responses of the pollinating wasps when offered receptive figs or air as an alternative. **Results:** Odour blends between *F. itoana* and *F. microdyctia* were distinguishable from each other while the scent from *F. imi* was similar to *F. microdyctia*. *Ceratosolen armipes* wasps were attracted to receptive figs of its host while they avoided the other two species. Wasps from *F. imi* were significantly attracted to both its host species and *F. microdyctia* figs, but chose air rather than *F. itoana* figs. Finally, *C. kaironkensis* wasps avoided figs from both *F. imi* and *F. itoana* and displayed no strong preference for figs from its host when compared with air. **Discussion:** Differences in scent profiles and the general trend of pollinators avoiding alternative fig species support the basis for species-specificity of fig pollination. These results support a defined reproductive barrier *between F. itoana* and *F. microdyctia*, while, this boundary is not so clear for pollinators from F. imi when encountering figs from its sister species *F. microdyctia*. This suggests that the barrier to geneflow between these two species is by altitude mediating pollinator dispersal, rather than by divergence in volatile signal as would be expected in the absence of a parapatric distribution.

Keywords: pollination, mutualisms, speciation, volatile compounds

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Oral session: Ecology, genetics, and evolution of tropical systems III

Changes in plant-pollinator interactions deplete plant progeny fitness in fragmented landscapes

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Over the past two decades there has been much research to determine habitat fragmentation effects on the mutualistic interactions involved in sexual plant reproduction and seed dispersal, which shape the reproductive success and genetic characteristics of remnant populations. Reduced area of remaining natural habitats and hostile agricultural matrices reduce pollinator richness and abundance. As a result plant populations produce on average less quantity of progeny in fragmented habitats. An equally important but a less-well recognized feature of plant reproduction is the genetic and biological quality of progeny, which represents the complementary aspect of the reproductive event as it determines the recruitment and survival potential of plant populations. Here we show results of a systematic literature review to determine overall habitat fragmentation effects on the genetic characteristics of progeny and on progeny performance. We found strong overall negative fragmentation effects on progeny performance in 105 unique plant species across the world. Progeny performance of pioneer species were significantly less affected than late successional species. Progeny generated in fragmented landscapes were genetically less diverse and showed higher inbreeding coefficients than progeny from continuous habitats. Interestingly, we also found a significant negative relationship between progeny performance and inbreeding coefficients: individuals with higher inbreeding coefficients showed lower performance in fragmented habitats. Our results indicate that fragmentation effects on progeny performance is mostly due to changes in mating patterns elicited by pollinators, increasing self-pollination and/or mating among relatives. We discuss the implications of these findings for long-term plant population persistence in ubiquitous fragmented landscapes.

Keywords: Reproduction, meta-analysis, plant-animal interaction, germination.

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Oral session: Ecology, genetics, and evolution of tropical systems III

Triplaris gardneriana: a case of ambophily in the Brazilian Chaco

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Background: *Triplaris gardneriana* (Polygonaceae) is a dioecious pioneer tree regarded as pollinated by insects despite possessing some traits also related to anemophily. In this study, we analyze in detail the possible roles of insects and wind on the pollination of this species, describing its reproductive biology and pollination ecology. **Methods:** Observations on the morphology and biology of the flowers, as well as pollinator visiting frequency and behavior were recorded for *T. gardneriana*, grassy-woody stepic savanna, a Chaco vegetation subtype present in southern Pantanal, Brazil. Experimental pollination treatments were carried out to determine the breeding system of this species, and aerobiological experiments were performed to put in evidence how environmental factors influence airborne pollen dispersion. **Results:** *Triplaris gardneriana* possesses floral attributes related both to anemophily and entomophily. The flowers are small, actinomorphic, trimerous and covered by pale brown strigose bracts that split during the bud phase. Inflorescences composed of a large number of flowers that produce nectar and female and male plants that grow at short distances from each other. *Triplaris gardneriana* was visited by 48 species of insects, and the most effective pollinators were the bees Scaptotrigona depilis and *Apis mellifera scutellata*. The fruit set from anemogamy treatment was 0.74, in hand pollination it was 0.98 and, in natural conditions, it was 0.95. Agamospermy treatment resulted in a significantly lower fruit set (0.15) than in previous treatments. Pollen grains dispersed by wind were found in 74% of monitored pistillate plants, located at different distances (1-10m) from staminate trees. Airborne pollen concentration was negatively correlated with relative humidity ($r = -0.25$, $P = 0.012$) and positively correlated with temperature ($r = 0.27$, $P = 0.006$). **Conclusions:** According to our observations and experimental results, *Triplaris gardneriana* is an ambophilous species, pollinated by insects and wind. This flexible pollination system provides *T. gardneriana* with the adaptive advantage of reproductive assurance when colonizing new areas where environmental conditions and pollinator communities have greater instability. This report appears to be the first on the pollination ecology of this species and highlights the importance of different pollinating agents for the reproduction of *T. gardneriana.*

Keywords: anemophily, breeding, system, dioecy, entomophily

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Oral session: Ecology, genetics, and evolution of tropical systems III

High species turnover in the arthropod community of a tropical montane forest

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Background: Species overlap decreases with distance as a result of both deterministic and stochastic processes. Recent studies have shown that the rate of spatial turnover in community composition is greatest at low latitudes. However, few studies have evaluated this pattern for terrestrial arthropods, and fewer still have examined how community composition changes with time. **Methods:** This study examines spatio-temporal diversity patterns of terrestrial arthropod communities at two sites in a tropical montane forest in Honduras based on standardized Malaise trap sampling from June to August in four consecutive years followed by DNA barcode analysis to determine species boundaries. Community composition is partitioned into spatial, temporal and environmental components of the tropical forest. Rates of temporal turnover are compared to those in an arctic ecosystem studied with similar methods. **Results:** By employing DNA barcode analysis, 24,752 specimens were assigned to 4983 presumptive species. While environmental variables had the largest impact on community variation (35%) and displayed more spatial (15%) than temporal (5%) structured effects, abundant species were more influenced by the local environment than were rarer species. Furthermore, significantly higher species turnover was detected across years in this setting than in an arctic ecosystem. Stochastic models revealed that deterministic processes were likely responsible for the observed temporal turnover, particularly for the rarer species in the community. **Discussion:** The distinct diversity patterns observed when quantifying the community with metrics that vary in their sensitivity to variation in the relative abundances of species support the view that communities are composed of core and transient species whose diversity is primarily driven by local and regional processes respectively. Results also support the conclusion that enhanced inter-annual variation contributes to the latitudinal gradient in species richness. **Conclusion:** The present study demonstrates how recent advances in diversity metrics and DNA-based methods for specimen identification allow for a better understanding of metacommunity dynamics. It highlights the need for further exploration of baseline rates of temporal turnover in varied ecological settings to better understand the processes that underpin community assembly and to inform the development of management plans for habitats at risk.

Keywords: Temporal turnover, latitudinal patterns, metacommunity

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Oral session: Ecology, genetics, and evolution of tropical systems III

Ecological consequences of the Plio-Pleistocene extinction of Caribbean mollusks

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Background: It is widely stated in the literature that a regional extinction of benthic invertebrates took place in the Caribbean Sea during the Plio-Pleistocene (5 - 0.1 Ma). The causes of this event have been generally attributed to regional oceanographic changes. However, the consequences of this extinction for marine ecosystems remain largely unknown. **Methods:** Based on a new analysis of the fossil record, we study the changes in taxonomic, phylogenetic, and functional diversity of Caribbean mollusks over the last 55 myr. We used a Bayesian approach to estimate extinction rates, a novel fossil-based method to evaluate phylogenetic diversity, and a trait-based approach to gauge the effects of this extinction on ecosystem functioning. **Results:** The decline in the taxonomic diversity of Caribbean mollusks during the Plio-Pleistocene resulted in 30% of genera loss. This extinction occurred in two peaks at 2 and 0.5 Ma. The loss of phylogenetic diversity was disproportionally low compared with taxonomic change. Similarly, this extinction event did not diminish the functional richness of communities, nor did it change their functional composition. Instead, this extinction event left highly redundant assemblages (high number of species performing similar functions). Nevertheless, post-extinction communities were also highly over-redundant (most species perform certain functions), and therefore, extremely vulnerable. **Discussion:** Our results suggest that despite the apparent ecological robustness of invertebrate communities to environmental changes of the last 55 myr, they were left highly vulnerable after the Plio-Pleistocene extinction event, and may be still declining today.

Keywords: extinction, phylogenetic diversity, functional diversity

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Oral session: Ecology, genetics, and evolution of tropical systems III

Diversification and evolution of ecological preferences in Indo-Pacific ants

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Background: The Indo-Pacific is one of the most diverse landscapes around the world. However, the interplay between abiotic and biotic factors driving the evolution and distribution of Indo-Pacific insect diversity remain largely unexplored. To understand the patterns of diversification and evolution of ecological preferences, we studied species-rich groups of ants distributed from continental Asia to South Pacific. **Method:** We reconstructed a phylogenetic relationship for over 250 ant species, representing nine genera from two unrelated lineages (*Prenolepis* genus-group and genus *Odontomachus*) using a set of nuclear and mitochondrial genes. We inferred ancestral geographical ranges, reconstructed ants' ecological preferences, and diversification rates. For selected species, we reconstructed their population genetic structure using a combination of mitochondrial DNA, microsatellites and genomic markers. **Result:** In *Prenolepis* genus group, the faunal interchange between Asia and Australia has occurred since at least 20-25 Ma., followed by dispersals to the Fijian Basin. Differences in diversification rates across clades may be related to ecological preference breadth which in turn may have altered geographical distributions. In Odontomachus ants we recovered three main global lineages with disjunct geographical distributions. The origin of *Odontomachus* coincides with the warm climate of the early Cenozoic, and its ancestral distribution in the Oriental and New World regions is in line with the Boreotropical para-tropical rain forests dominating the Northern Hemisphere. A mid-Miocene long-distance dispersal from the New World is a possible biogeographical scenario for the origin of the Indo-Pacific clade. Interestingly, some of the long distance dispersal events and relationship patterns among archipelagoes were repeated also at the population levels. **Discussion and conclusion:** Ancient dispersal conduits across the Indo-Pacific are in line with the palaeogeography of the region. For these groups of ants, the rapid orogenesis in New Guinea, and subsequent ecological shifts, might have promoted their rapid diversification and facilitated range expansions. Biotic interactions and shifts in habitat preferences may have facilitated further geographical range expansion across distinct ant lineages over the past 10 Ma. Overall, Indo-Pacific ants' diversity and distribution might have been modulated by paleoenvironmental changes as well as ecological interactions.

Keywords: biogeography, diversification, ecological shifts, phylogeny

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Oral session: Ecology, genetics, and evolution of tropical systems III

Oral Session
Effects of hurricane and fire disturbances on tropical ecosystems

Mapping hurricane-related forest change in the Yucatán Peninsula with Google Earth Engine

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Background: Extreme weather events exert a number of detrimental effects on plant productivity and their ability to provide complex ecosystem services for both natural and human systems. Since the mid-1800s, the Yucatán Peninsula has experienced more than 130 land-falling hurricanes and tropical storms, including ten Category four and five storms, with four of those ten occurring since 2000 NOAA Historical Hurricane Tracker. In the Yucatán Peninsula, there is a gradient ranging from tropical rainforest in the south to deciduous forests in the north. A major challenge in understanding the regional effects of severe weather events is our limited ability to scale data, and developing methods to accomplish this can provide new insights on how they spatially and temporally affect terrestrial ecosystems. **Methods:** Here we test the capabilities of Google's Earth Engine (GEE) platform, an emerging online platform that provides data and computational power to support global environmental data analysis. We use the complete Landsat archives to examine forest change patterns in the Yucatán Peninsula— Yucatán, Campeche, and Quintana Roo—before and after a level five hurricane, Dean, swept over the region in 2007. All data were USGS surface reflectance products, and additional methods were used to correct for any bad pixels (i.e., clouds, shadows, water, etc.). The Enhanced Vegetation Index, as well as other indices capable of detecting spectral changes in vegetation land uses, were used. A time series was created with all remaining clear observations, and the spectral trend for each index was calculated and subsequently analyzed. This was done for a series of spatial intervals beginning at Dean's epicenter and moving away from the storm in order to observe whether storm intensity was positively correlated with detected forest changes. **Results:** Our results suggest this to be true, and that GEE provides a powerful tool for efficiently conducting regional-scale vegetation change analyses. **Conclusion:** How hurricane severity and frequency will change with a warming climate is uncertain, and the Yucatán provides an excellent model system for exploring the potential impacts of severe climate-driven weather events across a strong forests ecosystem gradient. The power of Google's vast server network can be used to process massive amounts of spatial data and allows researchers to conduct regional analysis with the complete Landsat archives efficiently.

Keywords: hurricanes, tropical forests, remote sensing

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Oral session: Effects of hurricane and fire disturbances on tropical ecosystems

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Better resilient than resistant - Regeneration dynamics of hurricane-disturbed mangroves on Guanaja

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Background: Located at the interface of land and sea, mangroves provide important protection against storms for (sub)tropical coastal regions. At the same time these forests often experience severe disturbances once a storm hits. How the natural regeneration of storm impacted mangroves proceed is still a matter of debate: does - due to the extreme site conditions - regeneration follows a true auto-succession with exactly the same set of species driving regeneration that was present prior to the disturbance, or do different trajectories of regeneration exist? Considering the fundamental ecosystem services mangroves provide, a better understanding of their recovery is crucial, in particular as an increase of the hurricane intensity and/or frequency with global warming is predicted by global climate models. **Methods:** Guanaja offers ideal settings for the study of regeneration dynamics of storm impacted mangrove forests. The island was hit in October 1998 by Hurricane Mitch, one of the most intense Atlantic storms of the past century. Immediately after the storm 97% of the mangroves were classified dead by wind throw, breakage of stilt-roots or removal of leaf buds. In 2005 a long-term monitoring on the regeneration dynamics of the mangroves was initiated, employing permanent line-transects at six different mangrove areas all around the island. The transects were GPS-surveyed and flagged in 2005 and revisited in 2009 and 1016 to document changes. Along the transects all plant species, seedling numbers and amount of woody debris are recorded for statistical analyses. **Results:** Due to the pronounced topography of the island already in 2005 rather different successional pathways appeared depending on the severity of previous disturbance. On the more protected leeward side the mangroves were vital again just seven years after the storm impact. On the windward site storm impacts were significantly more severe, with only marginal traces of regeneration and diverging successional trajectories (incl. grassy and herbaceous stages) during the first decade. The sampling in 2016, however, proves even in the most severely impacted sites a swift return to true mangrove forests once established individuals are propagule-bearing. **Conclusion:** While very obviously not being resistant to storm impacts, mangroves show a high degree of resilience and are able to regenerate within relatively short periods of time even after severe disturbances via different successional pathways.

Keywords: Mangroves, Hurricane, Regeneration, Guanaja

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Cyclones, Fragmentation and Bird Assemblages; Interactions between Natural and Human Disturbances

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Background: Anthropogenic disturbances in tropical ecosystems usually occur in the context of natural disturbance regimes but our understanding of the interactions between different disturbance types on fauna is limited. In March 2006, Cyclone Larry crossed the North-eastern Australian coast, severely damaging lowland rainforests already fragmented from agricultural development. A prior study examining the avifauna of fragments provided an opportunity to a) examine the impacts of a severe cyclone on a tropical bird community, and b) compare the impacts and recovery between continuous and fragmented habitats of differing sizes. **Methods:** Three unfragmented sites, 3 large fragments (>25 ha) and 3 small fragments (<25 ha) were surveyed prior to the cyclone, and then 1-2 months, 5 months, 1 year, 2 years, and 10 years after the cyclone. Birds were sampled by strip transect during morning and evening, and a modified Braun-Blanquet cover-abundance scale in conjunction with hemispherical photographs were used to quantify vegetation structure along transects. **Results:**Immediately post-cyclone, vegetation was largely defoliated and canopy cover was reduced to below 10%. Vegetation structure recovered but remained highly disturbed 10 years post-cyclone. The bird assemblage, however, recovered far more quickly. Initially, overall bird diversity and abundance decreased, with frugivores virtually disappearing from all sites after the cyclone. Insectivores were less impacted, but the diversity of rainforest specialist insectivores dropped significantly. By 2 years post-cyclone, bird assemblages in continuous sites and fragments were comparable to pre-cyclone assemblages, with little further change after 10 years. No evidence of disproportionate species loss in any of the treatments was found. In other words, there is little evidence of an interaction between fragmentation and cyclones on bird assemblages. **Discussion:** The relatively robust nature of the avifauna to both natural and human disturbance (in comparison to other tropical regions) is probably due to the nature of lowland bird assemblages in this region (relatively depauperate and generalist), and the species sifting that had already occurred at a local scale in fragments. This study highlights the role that assemblage diversity, specialisation and disturbance history play in determining the responses of fauna to human impacts.

Keywords: Fragmentation, disturbance, birds, Australia, cyclone

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Wednesday, July 12th, 2017 Celestún
Oral session: Effects of hurricane and fire disturbances on tropical ecosystems

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Structural and Functional of Tropical Dry Forest Vegetation to a High Intensity Hurricane

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Background: As a result of climatic change, the frequency of tropical cyclones has increased in the last years provoking severe damages to vegetation and altering the structure and function of coastal ecosystems. In the Pacific coast, hurricanes could be increasing their frequency and intensity. A highly diverse ecosystem of the Pacific Coast of Mexico is the Tropical Dry Forest (TDF), which has been historically affected by anthropogenic activities that can diminish its resilience to natural disturbances. In this study we evaluated, in this TDF, the impact caused by a category 5 hurricane in the vegetation structural and functional traits of preserved and anthropogenically disturbed forests. **Methods:** In ten plots, five of preserved forests and five of forests disturbed by anthropogenic activities, we measured the impact of a high intensity hurricane in structural and functional vegetation categories. We also measured the number of dead individuals and the different degrees of damage and recovery of the surviving ones. **Results:** The 12.6% of individuals did not survive to the hurricane while the 28.2% suffered severe physical damage and the 11.9% did not suffer any damage. The structural category most affected was the corresponding to trees/shrubs with low basal area and height, which includes to the majority of TDF individuals. On the other hand, trees with low wood density and higher specific leaf area showed the higher recovery capacity. In the preserved forests the 98.6% of individuals suffered some degree of physical damage while in the disturbed forests the 88.7% of individuals were damaged. **Discussion:** Our results indicate that high intensity hurricanes are damaging to the great majority of individuals affecting significantly the structure and primary productivity of the system. This would alter the ecosystem functioning. The impact was even greater in the remnant preserved forests, probably because harder and denser stems offer more resistance to the wind. This situation could be pervasive for species associated to preserved forest, which can face important reductions in their populations. On the other hand, species with higher resprouting and recovery capacity could increase their abundance under scenarios with higher frequency or intensity of hurricanes. These findings suggest that TDF could experience strong changes in plant species abundance, forest structure, and vegetation functional composition and performance as a consequence of climatic change.

Keywords: Dry Forest, High Intensity Hurricane

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Oral session: Effects of hurricane and fire disturbances on tropical ecosystems

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Understanding fire-driven forest-savanna shifts across the tropics

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Background: Bimodalities in tree cover suggest that tropical forests and savannas can be alternative stable states under a range of rainfall conditions. A vegetation-fire feedback has been proposed as the main mechanism responsible for this. **Methods:** We use time series of remotely sensed tree cover and fire occurrence from across the tropics to construct and parameterize a spatially explicit vegetation-fire model. For this parameterization we empirically determine fire probabilities, fire-induced tree cover losses as well as post-fire recovery rates of tree cover. **Results:** The remote-sensing data show that fire probability peaks around 1100 mm annual rainfall and at low tree cover. Although fire occurrence drops sharply above around 40% tree cover, fire-induced tree-cover mortality is higher in forests than in savannas. Incorporating these observed relations in our model generates tipping points and hysteresis of forest and savanna. Our results also indicate that the stability of these alternative vegetation states depends on climatic variability, fire ignition rates, and landscape fragmentation and invasibility. **Discussion:** Our work provides a mechanistic explanation of observed tree cover bimodality in remote sensing data. It also predicts under which conditions tropical forests and savannas may undergo fire-driven tipping points and hysteresis. The model can be used to anticipate the effects of changes in rainfall patterns on the vegetation-fire feedback and, consequently, the resilience of tropical forests and savannas.

Keywords: fire; model; remote sensing; resilience

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Oral session: Effects of hurricane and fire disturbances on tropical ecosystems

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Historical fire in Amazonian forests

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Background: Amazonian forests have experienced past periods of reduced precipitation and potentially some degree of pre-Columbian human impact. These events may have resulted in fire regimes that differ from those found today and left a legacy on forest soils and vegetation. **Methods:** We address the question of what is the spatial variation in charcoal formed by historical fire and legacy effects on vegetation through a systematic large-scale evaluation of past fire and modern vegetation across the Amazon Basin? In plots spanning a basin-scale natural precipitation and soil fertility gradient, we examined charcoal in soils and potential effects of historical fire on contemporary plant assemblages. **Results:** There was large variation in charcoal across the landscape and vertically within the soil profile. The percentage of charcoal to total soil carbon increased with soil depth. We evaluated approaches to account for charcoal variation at varying spatial scales and the depths required to capture 50% of the charcoal in soil profiles. Climate, rather than historical fire, may have a stronger effect on plant assemblages. **Conclusions:** The findings improve understanding of spatial variation of charcoal and highlight the need for additional study of the long-term interaction between historical fire and vegetation.

Keywords: fire, charcoal, vegetation, soil, traits

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Oral session: Effects of hurricane and fire disturbances on tropical ecosystems

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Oral Session
Ecology of plant growth

Successional habitat preference and functional traits explain tropical tree growth independently

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Background: Tropical forest trees have been classified as old-growth (OG) specialist, second growth (SG) specialists and generalists (GEN) based on their occurrence in forests along a successional gradient (Chazdon et al. 2011, Ecology, 92, 1332-1343). Species from different successional stages typically differ in growth rates and functional traits. We ask how strongly growth and traits are related to successional habitat preferences, and if the variation in growth can be explained by differences in functional traits. **Methods:** We measured height growth and functional traits of trees planted in a multi-species reforestation trial in La Gamba, Costa Rica during the first four years after planting. Wood traits (wood density - WD and hydraulic conductivity) and leaf traits (specific leaf area - SLA, nitrogen content) measured locally were compared with non-local trait values from TRY database. We related local and non-local trait values to growth rates and habitat specialization, which was calculated either as a categorical variable (SG, OG, GEN) or as a continuous variable based on tree abundance in OG and SG forests. **Results:** Habitat specialization and wood density each explained a large proportion of the inter-specific variation in growth (r^2 = 0.42 and 0.37, respectively). The continuous variable of habitat specialization had higher predictive power than grouping trees into three classes. Locally obtained WD and SLA were better predictors of growth than data from a database. Surprisingly, habitat specialization was a very poor predictor of most trait values. As a consequence, the predictive power of habitat specialization plus WD in a multiple linear model was very high (r^2 = 0.75). **Discussion/conclusion:** Like previous studies, we found WD to be the trait strongest correlated with growth. For neotropical trees, data available for habitat preference provide a sound basis for predicting tree growth. We suggest to use a continuous variable for habitat specialization along the successional gradient. Since habitat preference and growth are only partly explained by functional traits, important characteristics that define habitat specialization and are important for growth still seem to be missing within the spectrum of traits commonly investigated.

Keywords: tree growth, traits, successional gradientID:389

Wednesday, July 12th, 2017 Uxmal
Oral session: Ecology of plant growth

Relationships of Tree Growth and Mortality to Temperature and Rainfall in Hawaiian Forests

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Background: Hawaii provides a unique and tractable combination of low diversity forests and variable climate. Hawaii has already experienced upward shifts in temperature, and changes in rainfall patterns are predicted to accelerate in this century. **Methods:** To better understand and predict the response of Hawaiian forests to climate change we developed the Hawaii Ecosystems-Climate Observatory. The observatory consists of a series of climate stations and permanent forest plots using methodology of Center for Tropical Forest Science Forest Geo. The plots represent broad climate conditions associated with representative vegetation types: lowland dry forest (LDF, Palamanui), lowland dry woodland (LDW, Mamalahoa), montane mesic forest (MMF, Puuwaawaa), and montane wet forest (MWF, Laupahoehoe). Measured environmental variables determined using climate towers included temperature, rainfall, shortwave radiation, cloudiness, soil moisture, and windspeed. To examine inter- and intra-annual climate variation and vegetation dynamics, up to five census periods are represented, depending on the site. **Results:** Across the sites, monthly rainfall and temperature varied up to two-fold from year-to-year, with up to a five-fold difference in rainfall and more than 2 degrees C difference between years. The temperature patterns were most strongly driven by consistently warmer temperatures in summer months, which was consistent across years (i.e., increase in night-time temperatures (minimum temperature). Tree mortality rates for a sitewere extremely variable among censuses, especially in the LDF and the MWF. Growth rates were highest in the MMF because this forest is dominated by the fastest growing native tree species in Hawaii (*Acacia koa*). Annual diameter growth was best predicted by photosynthetically active radiation, minimum temperature, and rainfall, based on multiple regression using data from all sites. **Discussion:** Strong associations of tree mortality and growth with climate indicates the sensitivity of these systems to ongoing shifts in climate. A longer time record is required to confirm patterns and make predictions about the effect of climate change on Hawaii's forests. An increase in night-time temperatures may lead to decreased net primary productivity, a result seen in other tropical forests.

Keywords: climate, permanent plots, interannual, intraannual

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Oral session: Ecology of plant growth

Relative growth rate and individual tree size in a species-rich tropical dry forest of Mexico

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Introduction: Individual tree growth is a key ecological process, largely responsible for biomass accumulation in forest ecosystems. Tree growth is environmentally constrained, given its dependence on resource availability and conditions for plant growth. Also, there is evidence for a self-regulated nature of this process in some environments. The aim of this study was to test the hypothesis that individual tree growth is associated to tree size in a tropical dry forest (TDF) of southern Mexico. **Methods:** In 28 permanent old-growth and secondary forests plots, mostly established in 2003, we marked and measured annually diameter at breast height (DBH), height and crown dimensions in trees ≥ 1 cm in DBH until 2016. We computed basal area (BA) and crown cover area (CCA) for each tree, and calculated relative growth rates (RGR) for these variables. For the 30 most abundant species, we used linear mixed-effects models (LMEM) to assess the effect of individual size on RGR of each variable, while controlling for plot and year. Besides, model residuals were linearly regressed as a function of the variable itself to examine patterns of variance. **Results:** For most species, LMEMs revealed significant effects neither of BA, nor of CCA, on their respective RGRs. For height, we found a weak effect of this state variable on RGR. Moreover, we observed clear patterns for the residuals of both BA and CCA when regressed on the variable itself, with the variance attaining its maximum at small tree sizes. Remarkably, RGRs were in general symmetrically distributed above and below zero along the entire gradient of individual sizes, both for BA and CCA, including those individuals with very large sizes. **Discussion:** Our results contrast with findings from other ecosystems and suggest that individual tree growth in this forest is not a self-regulated process. Individual tree size is a better predictor of growth variability than of growth magnitude itself. Though not analyzed formally, our results suggest the existence of different strategies among species: some species tended to have positive RGR values along the size range, others generally had negative values, and some others showed a balance between positive and negative values. Particularly interesting is the fact that some species do not cease to grow until their death. The overall dynamics of this community is an integrated result of these different growth strategies.

Keywords: Community; Dynamics; Growth; RGR; Variability

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Oral session: Ecology of plant growth

On the growth rate of tropical trees

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Background: The tree growth rate is essential information for understanding the dynamics of tropical forests and planning restoration programs. However, this information is limited for tropical tree species. The growth is measured as the change in the diameter of the trunk (mm yr^{-1}) between two measurements. Thus, there are a resulting relationship between the size and age, a basic assumption of the models that use initial diameter as time surrogate. However, the tree size of is not an age surrogate, being an assumption of evaluating. **Method:** We analyzed the growth in function of the initial diameter. The tree growth data are obtained from permanent plots, where individuals of different sizes coexist. We propose new method to standardize tree growth data: to eliminate measurement errors and the effect of the sick trees, we, split data for diameter class, and then we eliminate zero values and negative growth rate. Also, we eliminate the same number of data in the upper limit of the distribution, following the assumption that error is normally distributed. Before, we applied two transformations to the growth rate (relative growth rate and log transformed relative growth rate) and fit the von Bertalanffy equation using non-linear models and chose the best model based on the AIC. We gathered functional traits that potentially influence tree performance and biomass storage and these were included in the models. Finally, we used a portion of data to test the performance of the resulting models. **Result:** We found that log transformed relative growth rate showed the better fit. Also, we found that data standardization procedure proposed showed better fit than raw data. Finally, we found that wood density affect the tree growth rate negatively. **Discussion:** Here, we showed that tree growth rate is biased analyzed, if data are used in their raw form. The power increase in the model predictability is a greater advance in the methods to estimate tree growth rates and their change on time. Also, we propose that these method used in this study allow us predict and increase the credibility of models of unknown tropical species.

Keywords: Relative-growth; NLMM; Predictibility

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Oral session: Ecology of plant growth

Tree ring isotopes elucidate drivers of growth variation during a trees' life span.

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Background: Most tropical forests trees start their life in a relative dark understory, only receiving full light levels when they reach the canopy. Thus, they experience strong changes in light and water availability over the course of their life. How these changes affect the growth and functioning of tropical forest trees is important for understanding general forests dynamics. We here use tree rings and isotopes to unravel the relative importance of water vs. light for growth in tropical Cedrela trees from three sites, covering a gradient from dry to moist tropical forests. **Methods:** We collected tree ring samples from *Cedrela* trees from Bolivia and Mexico. These were used to reconstruct life-time growth patterns and to analyse tree ring carbon isotopes. Carbon isotope discrimination depends on the degree to which photosynthesis is limited by stomatal conductance; greater water stress results in lower isotope discrimination, while shading is associated with increased discrimination. Simultaneous analysis of isotopes and ring width can thus potentially help determining whether growth is limited by light or water availability. **Results:** Analysis of growth trajectories shows alternating fast and slow growth periods during the earliest life phases of trees. These slow growth periods are associated with increased isotope discrimination, indicating that growth in the juvenile phases is strongly controlled by variation in light availability. This negative relationship between isotope discrimination and growth at early life stages disappears when trees grow taller, or changes into a positive relation between growth and discrimination. This result, along with decreases in discrimination as trees grow taller, suggests that trees are becoming increasingly drought stressed as they reach their maximum heights. **Discussion:** Our results indicate that drivers of tree growth changes strongly over the course of a trees' life, and switches from being light limited to water limited. Combining tree ring and isotope analysis, as we did here, are powerful methods to obtain an improved understanding of changes in tree physiology over the course of their life-spans.

Keywords: tree rings, carbon isotopes, suppression

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Wednesday, July 12th, 2017 Uxmal
Oral session: Ecology of plant growth

Oral Session
Diversity changes in environmental gradients

Using species distribution models to inform conservation plans for Cycads in Colombia

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Background: In Colombia, we are implementing conservation plans for several groups of plants, like Cycads, within the framework of the National strategy for plant conservation. We intended to use sound scientific information on species biology to inform conservation planning. **Methods:** To evaluate the extinction risk for each species within the country, we used information on population sizes, geographical distribution and major threats; available in the literature and botanical collections, and through interviews with experts. To support the red list assessment, we elaborated species distribution models (using MaxEnt), and estimated the current and potential distribution range for each species. Using the distribution models, we estimated how much of the forest habitat has been lost for a species within its potential distribution range, as an indirect measure of population decline. Then, we used the methodology proposed by the "Open standards for the practice of conservation" to discuss with relevant stakeholders and propose a conservation action plan. **Results:** According to the red list assessment, all 21 species of Cycads are under some threat, categorized as vulnerable (4 species), endangered (9 species) or critically-endangered (8 species). The species distribution models suggest that species in the Amazonian region have large amounts of potential habitat with low threat of anthropogenic disturbance. Species in the Choco biogeographical region are moderately threatened, with large areas of potential habitat with some risk from deforestation. In the Andean and Caribe regions, most of the habitat for species has been lost, and all species are highly threatened by habitat destruction and degradation. Using all available information on population status and the trends suggested by the species distribution models, we proposed adequate conservation actions for each species, that were then discussed with relevant stakeholders to complete the conservation action plan. **Discussion:** The species distribution modelling was very useful to support red list assessment and to design conservation actions. Species distribution models were used to propose new localities for further research, to determine best sites for population protection, and also to look for appropriate sites for reintroductions and restoration efforts. Monitoring long-term trends on population dynamics and distribution is now underway to keep improving conservation strategies in the future.

Keywords: Conservation planning, Species conservation, Zamia

ID:417
Wednesday, July 12th, 2017 Tulum
Oral session: Diversity changes in environmental gradients

Altitudinal effect on community structure and composition of rove beetles

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Background: Altitude has a profound impact on species distributions and species interactions in tropics. It has been tested using both the terrestrial and aquatic insects of a range of taxonomic groups. However, ants, spiders, and ground beetles are often the choices from insects as indicator taxa to test this hypothesis in terrestrial ecosystems; because they are abundant, diverse, and cosmopolitan in distribution. We used less-studied rove beetles (Staphylinidae: Coleoptera) to understand how good the beetles are in discerning the impact of altitude on insect biodiversity. **Methods:** We sampled leaf litter dwelling rove beetles (Staphylinidae) from fragmented sacred forests of two altitudinal ranges, sea level to 150 m asl (mean altitude: 81 m; N=10) and 800 - 1000 m asl (mean altitude: 931 m; N=12) to explore the indicator property of the relatively-less used rove beetles. We characterized the sites based on altitude, area of the forest, mean canopy cover, and leaf litter depth and used the geographical distance of the sites to explain the variation in community structure of the beetles across altitudes. **Results:** Overall, 5,085 beetles belong to 96 species/morphospecies were collected; approximately 93% of the total abundance and 90% of the total species were collected from the sacred forests of high altitude. Mean species richness, abundance, and species diversity of the rove beetles were exceptionally high in high altitude sites. Geographical distance significantly predicted overall spatial variation in community structure of rove beetles across sites. While the sacred groves of high altitudes were clumped, due to similar species composition and structure, the sacred groves of low altitude scattered widely. Even though the range of the altitude was between 14 m a.s.l. and 1000 m a.s.l., the data suggest a mid elevation peak in species richness and abundance of the rove beetles. There was very less turn over of species between altitudes. **Discussion/Conclusion:** In fact, the abundance of rove beetles caught in pitfall traps was much higher than the abundance of ants. While comparing the pattern of diversity of other insect functional groups of insects across the studied sites, we conclude that the rove beetle community predicts the altitudinal variation on insect biodiversity much better than other popular insect functional groups.

Keywords: staphylinidae, altitude, Western Ghats

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Oral session: Diversity changes in environmental gradients

Testing climatic variability hypothesis in explaining elevational range distribution of moths

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Background: Climatic variability hypothesis (CVH) proposes that organisms live at higher latitude or higher elevation may experience greater climatic variability and thus develop wider physiological thermal tolerances, which enable them to be widely distributed. Robustly testing CVH requires empirical evidence of above abiotic and biotic information, which are rarely available along single geographic gradient. Here we test whether CVH holds true in explaining distribution patterns of a species rich taxa, the Macroheterocera moths in a subtropical mountain. **Methods:** We collected species and climatic data along an elevational transect in Taiwan (around 24°N, 121°W, from 0 to 3000 m.a.s.l.). Climatic loggers and light traps were set every 250 m elevational intervals, so we can obtain detail range distributions of all moth species. We set stations to measure moth thermal traits in the field. We collected moth individuals, calmed them down in glass bottles and then submerged into water baths of 50°C and -4°C, for heat and cool trails respectively. We captured thermal images while the moths lost locomotion ability and recorded thorax temperatures as their critical thermal maximum (CT_{max}) or minimum (CT_{min}) temperatures. We used linear regression to test relationships between the elevational gradient, climatic variability, thermal traits and distribution ranges, and hierarchical partitioning to test the relative importance of factors affecting thermal trait and range limits. **Results:** Over all, neither climatic variability, i.e. diurnal temperature range (DTR) nor moth distribution ranges increase with elevation. DTR did not explain thermal ranges (CT_{max} - CT_{min}) of moth species, but species with greater thermal ranges did have wider distributional extents, implying the existence of thermal constraints. There was a positive correlation between CT_{max} and ambient temperatures. Both CT_{max} and CT_{min} decrease with elevation, but the slope of CT_{max} are steeper. **Conclusion and discussion:** Our findings did not support the general predictions of CVH excepted that greater thermal tolerance may be associated with wider geographic ranges. However, CT_{max} are more likely to act as physiological constraints, rather than CT_{min}. There may be a evolutional trade-off between CT_{max} and CT_{min}. The phenomenon contradicted to most findings in the counterparts of higher latitudes and suggested that thermal adaptation underlying macroecological patterns may be differ in tropical ecosystems.

Keywords: climatic variability hypothesis, critical thermal temperature, thermal tolerance, range size, moth.

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Wednesday, July 12th, 2017 Tulum
Oral session: Diversity changes in environmental gradients

The role of niche breadth in shaping species abundance across tropical dry forests in Colombia

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Background: Variation in species abundance and distribution across regions are a central subject in community ecology. Many case studies have shown that species abundance is positively correlated with their spatial distribution across several groups of taxa. A common explanation for this pattern is that abundant species have larger niches, so that they are able to recruit successfully across different habitats, while rare species would exhibit narrower niches. This hypothesis has found some support in tropical lowland and highland forests. However, our understanding on the patterns of tree species abundance is still limited in seasonally dry tropical forests (SDTF), one of the most threatened biomes in the tropics. Here, we ask whether locally common species tend to be the most frequent species, and evaluated the relationship between tree species abundance and niche breadth across different regions of SDTF in Colombia. **Methods:** We compared patterns of species frequency and local and total abundance for over 600 tree species, and evaluated the relationship between tree species abundance and niche breadth in Colombian SDTF, based on a network of 16 1-ha plots. **Results:** Our results showed that, contrary to expectations, both local and total species abundance were negatively correlated with species frequency across plots. Abundant species tended to exhibit narrower niches than the expected based on their frequency; while rare species tended to exhibit larger niches. The most common species across plots (40 out of 611) exhibited strong dominance within plots and regions (h-index = 6.9%, a metric measuring commonness), but did not show a wide distribution across the country. **Conclusions:** Together, our results suggest that patterns of species abundance in Colombian SDTF do not match the commonly proposed hypothesis on niche breadth. One explanation for these findings is that common species are able to cope with dry conditions, yet are strongly dispersal-limited. Many of the locally rare species that occur in several plots, in contrast, might be opportunistic species, able to take advantage of environmental conditions that are not the best-suited for them. Overall, understanding drivers of species abundance in SDTF is a critical step to predict the fate of biodiversity in ecosystems facing high levels of disturbance such as tropical dry forests.

Keywords: dry forests, abundance, niche breadth

ID:430
Wednesday, July 12th, 2017 Tulum
Oral session: Diversity changes in environmental gradients

Species Traits Explain Elevational Range Shifts of Birds

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Background: Species have shown idiosyncratic range shifts under climate change. Species traits are likely associated with these variant responses but there is little consensus about what kinds of traits predict range shifts well. The inconsistent findings may be resulted from comparing diverse taxa in which different mechanisms were involved in range redistribution, or inevitably, the definition of traits varies among studies, or limited number of species restricted to certain ecosystem. **Method:** Here we conducted meta-analysis on elevational movements of birds, in which trait comparisons are sensible yet range shifts were widely reported. We collected movements of elevational range shift (m/decade) of 337 bird species, ranging from the Peru (9°24'47"S, 74°45'36"W) to the Czech (50°42'21"N, 15°40'32"E). We considered methodological attributes which might affect range shifts of species across different studies. Then, we applied species traits according to Handbook of the Birds of the World Alive, including body size, clutch size, trophic types, and diet breadth. We also obtained range size and thermal traits derived from distribution data available at BirdLife International. Specifically, we assumed that maximum and minimum temperatures at each species' breeding distribution (DT_{max} and DT_{min}) reflected its critical thermal temperatures and obtained temperature data from the WorldClim. We assessed whether these species traits explain range shifts by applying linear mixed effect model and Akaike Information Criterion to identify the best predictors. **Result:** 64% of all the species shifted toward expected direction under warming. After controlling methodological attributes across studies, we found species showed climate tracking, in comparison with those moving toward opposite direction, were smaller in body size and higher in DT_{max}. In addition, widely distributed species with smaller body size exhibited greater extent of uphill movements, while herbivores tended to shift further down than carnivores. **Discussion and conclusion:** We found that body size had better explanation for range shifts than the other species traits. This may be because smaller species have shorter life histories which are associated with fast population growth, enabling them to react rapidly to climate change. Cross-study comparison highlights the generality of certain species traits in range shifts prediction, which will be crucial to conservation practice.

Keywords: climate change, range shift, species trait, bird, meta-analysis

ID:243
Wednesday, July 12th, 2017 Tulum
Oral session: Diversity changes in environmental gradients

Oral Session
Ecosystem functioning in secondary and mature tropical forests

Species-level growth responses to chronic phosphorus addition in a tropical moist forest

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Background: Phosphorus (P) is expected to limit plants growing on highly weathered soils. The ultimate sources of P are primary mineralization and deposition, and P supplies from primary mineralization decline to negligible levels on the most highly weathered soils, leaving deposition as the sole source of exogenous P. We have added P to an old-growth tropical forest growing on a highly weathered soil in Panama for 20 years without stimulating a community-level response consistent with P limitation. Here, we explore species-level growth responses to understand why. Condit et al. (2013 PNAS) quantified the P affinities of the geographic distributions of 541 tree species across central Panama. Those regional P affinities provide insight into species-level responses in our experiment. **Methods:** We added all factorial combinations of P, nitrogen (N) and potassium (K) to an old-growth tropical forest in central Panama for 20 years. We conducted eight tree censuses, recording 83,296 measurements of diameter at breast height for 15,492 dicotyledonous trees (palms excluded). **Results:** After 15 years of fertilization, we could detect no effect of the addition of any nutrient for tree diameter growth rates at the community-level. We have explored the relationship between species-level responses to P addition and regional P affinity in preliminary analyses. Our site is dominated by species with regional affinities for low P soils. Our preliminary analyses suggest the few species present with affinities for high P soils tend to respond to P addition with modest increases in DBH growth while the many species with affinities for low P soils have a wide range of responses to P addition, ranging from modest increases to substantial decreases in DBH growth. **Discussion:** Recent meta-analyses have shown that P and/or N limit primary producers in hundreds of experiments conducted in temperate, boreal, aquatic and marine ecosystems. In contrast, neither P nor N nor K limit net primary production in our experiment conducted in a species-rich lowland tropical forest. The difference in experimental outcomes might be related to the high species richness of primary producers that characterizes lowland tropical forests. Extraordinarily large regional species pools include species specialized to low nutrient availability. Low P specialists are able to maintain high productivity despite low P availability, and some of them actually grow more slowly when P is added experimentally.

Keywords: experiment, fertilization, limitation, tree growth

ID:576
Wednesday, July 12th, 2017 Kabah
Oral session: Ecosystem functioning in secondary and mature tropical forests

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Trait-based tree responses affect productivity under experimental nutrient addition in the Andes

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Background: A pervasive question in community and ecosystem ecology is whether trait-based responses affect ecosystem functioning. The Ecuadorian Nutrient Manipulation Experiment (NUMEX) was established in 2008 in the Andean slopes of Southern Ecuador (2000 m elevation) to investigate Nitrogen (N) and Phosphorous (P) limitation the tree community and ecosystem processes. Thus, the main objective of this study is to explore experimentally how individual tree responses to nutrient addition based on 10 morphological traits, tree size and species identity, and affect productivity in a Tropical Montane Forest (TMF). **Methods:** We examined how individual tree growth responded to 7.8 years of nutrient manipulations (N, P, N+P) in NUMEX. We run Linear Mixed Models that included additive and multiplicative interactions among our fixed effects to assess how tree growth (basal area change over the study period) was affected by nutrient addition, initial tree size (basal area in cm2 when the experiment began), and functional traits in two PCA axis. We also conducted Repeated Measures Analyses to evaluate whether nutrient addition affected stand-level aboveground biomass (AGB). **Results:** Addition of N+P had the strongest positive effect on tree growth of species with traits related to fast resource acquisition and growth (high leaf N and P, low SWG, high stem conductivity). Trees receiving N presented the same pattern of response as trees in N+P experimental plots. On the contrary, P enhanced the growth rates of trees with traits associated to slow resource acquisition and growth (low leaf N and P, high SWG, low stem conductivity). Two-thirds of the tree species responded to nutrient additions, but but we did not detect size dependent responses. However, AGB did not differ among the experimental plots. **Discussion:** Functional traits and species identity were strong determinants of individual tree responses to nutrient addition in our study system. The effect of increased nutrient availability on tree growth depended on interactions among functional traits and the type or combination of nutrients added. However, trait-based responses did not affect stand-level AGB because positive responses of individuals with certain functional traits were counteracted by the lack of response of individuals with opposing traits. Thus, trait-based responses acted in concert to reduce the effect of increased nutrient availability on ecosystem functioning in this TMF.

Keywords: Experimental nutrient addition, montane forest

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Oral session: Ecosystem functioning in secondary and mature tropical forests

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Biogeography drives aboveground biomass in tropical Andes

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Background: The tree aboveground biomass (AGB) is expected to decrease along temperature gradients as consequence of reduction in net primary productivity and soil nutrient availability. There is contrasting evidence in tropical elevational gradients (as surrogates of thermal variation), suggesting that other factors such as species composition are involved. Species variation is the result of regional processes such as immigration and speciation affecting the regional species pools. Thus, these processes could be influencing indirectly ecosystem properties such as AGB. Andean tree communities are one example of repeated immigrations from different regions, from North and Southern America (temperate regions) and Amazon and adjacent lowlands (tropical regions) that are mixed along mountainsides. Here, we tested the role of immigrations on the distribution of AGB in Andean tropical mountains. We expect that tropical-temperate affiliation affect the distribution of AGB, because each one tolerates contrasting conditions along the gradient implicating weak relationship between elevation and AGB. **Methods:** We estimated the AGB for 111 0.25ha plots along six regions distributed from 200-3500m a.s.l. in the Colombian Andes. For each plot, we obtained the elevation, AGB, the proportion of temperate species (temperate abundance / total abundance). Also, we also included tree size as a parameter that allows us disentangling between current and historical factors in the AGB distribution. We used a structural equation modeling (SEM) approach to analyze this system. We used tree size and temperate proportion directly on AGB, and elevation explaining directly tree size and temperate proportion and AGB. **Results:** First, we found that AGB and elevation are positively correlated. Then, we found that AGB is explained mainly by tree size and temperate proportion. Also, we found that after controlling for these two variables, the elevation-AGB relationship is negative. **Discussion / Conclusions:** Our results suggest that tree size and biogeography are the main drivers of AGB along elevation in tropical mountains. These two variables are correlated, implicating that large trees are distributed in temperate families at highlands. Thus, we infer that pre-adaptations increase the AGB in highland more than expected by physical conditions. Here, we suggest that evolutionary history is critical to understand species composition-environment-ecosystem processes interactions.

Keywords: Thermal-tolerance; Tropical-Temperate; Tree-size; Pre-adaptation

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Wednesday, July 12th, 2017 Kabah
Oral session: Ecosystem functioning in secondary and mature tropical forests

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Changes in Productivity and Fertility Along a Successional Gradient in Andean Periurban Forests

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Background: Forests in the Northern Andes have some of the highest plant biodiversity in the world and provide key ecosystem services, yet they have suffered from centuries of intensive human intervention. In the last decades, large areas that were used for agriculture have been abandoned and are now covered by young secondary forests. However, we have nearly no information about these re-growing forests and how ecosystem processes compare to mature undisturbed forests. Our objective was to quantify changes in above-ground net primary production (NPP) and soil nutrients fluxes between young and mature secondary forests in the Andes. We expected that early secondary forest will be nutrient deficient and have lower productivity than mature forests given their long history of disturbance and resource extraction. **Methods:** We established 14 400 m2 plots in four different peri-urban locations near Bogota, Colombia, at elevations that varied between 2500 and 2950 m. We measured diameter at breast height (DBH) of individual trees and shrubs with a basal diameter > 5 cm and censused them between 2013 and 2016. Litter production was measured in 2016-7 using 10 0.25 m2 collectors per plot. Nutrient flux rates were measured with 512 Plant Root Simulator probes (Western AG) that were inserted 10 cm in the soil during one month in the rainy season. **Results**: The first axis of a principal component analysis distinguished locations with soils from calcareous origin from locations with non-calcareous soils. The second component axis separated sites based on their soil phosphorous (P) and aluminum (Al) fluxes and their NPP. Young secondary forests had significantly lower P than mature forests and their NPP was correspondingly lower. Secondary forests also had significantly higher aluminum fluxes, lower soil carbon concentration and higher bulk density than mature forests. Yet, these edaphic variables approached that of mature forests as above-ground biomass increased. **Conclusions:** Although several edaphic conditions should improve as these secondary forest reach maturity, it is unclear if P availability will increase with succession. If P stays low, NPP in forests that originated from abandoned agricultural fields will be lower than in matured undisturbed forests. Thus, future studies should experimentally evaluate the effects of P fertilization on secondary forests succession and NPP.

Keywords: Succession, Andes, productivity, soil fertility

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Wednesday, July 12th, 2017 Kabah
Oral session: Ecosystem functioning in secondary and mature tropical forests

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The potential of secondary forests: how fast do they recover in carbon, biodiversity and traits?

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Background: Over half of the world's tropical forests are not old-growth, but regrowing forests that recover from disturbances and are undergoing secondary succession. These secondary forests play an important role in human-modified landscapes, may act as reservoirs of carbon and diversity, and provide forest resources and other important ecosystem services to local people. **Method:** Here we present results of 2ndFOR, a collaborative research network on secondary forests. The network encompasses >50 sites and >1700 forest plots covering the major environmental gradients in the lowland Neotropics. **Result:** Using a chronosequence approach, we show that above-ground biomass (AGB) recovers quickly over time and that AGB recovery rate increases with the water availability of the sites. Tree species richness increases rapidly over time, highlighting the value of secondary forest as biodiversity reservoirs. In contrast, it takes a long time for species composition to recover to values of neighbouring old-growth forest, indicating the importance of conserving old-growth forest. We use a functional trait approach to analyse the mechanisms of community assembly. Community trait values recover quickly over time, but succession proceeds in different ways in dry and wet forests, with wood density increasing over time for wet forests and decreasing over time for dry forests. **Conclusion:** Although secondary forests are not a substitute for old-growth forests, they have a tremendous potential for carbon sequestration and biodiversity conservation in human-modified tropical landscapes.

Keywords: secondary forest, biomass, biodiversity, traits

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Oral session: Ecosystem functioning in secondary and mature tropical forests

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Dynamics of biomass accretion in the absence of competition in tropical successional forests

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Background: Understanding tropical forest succession is more important than ever before because old-growth forests are being replaced by secondary forests at an alarming rate, and because secondary forests are expected to accumulate more atmospheric carbon dioxide than at any time in contemporary history. However, tropical forests are undergoing a shift towards higher liana (woody vines) abundance and biomass, which may alter successional processes in secondary forests. Lianas recruit rapidly in young secondary tropical forests and may stall regeneration early in succession, thus limiting biomass accumulation. We hypothesize that lianas decrease tree biomass accumulation in early secondary forests but these detrimental effects decline as forests age. **Method:** We tested this hypothesis using a large-scale liana removal experiment in 30 forest sites ranging from 10 to 35 years old in Central Panama. Each site is composed of a liana removal plot and a control plot where lianas were not removed. **Results:** Our results showed that liana removal increased tree biomass accumulation significantly, and that tree biomass accretion was higher in younger than older secondary forests – supporting our hypothesis. However, there was substantial variation among years. In 2014-2015 the negative effect of lianas on tree biomass accumulation was clear. However, tree biomass accumulation in 2015-2016 was extremely low in both treatments, and there was no effect of liana removal during that period. **Discussion:** We suspect that low biomass accretion in 2015-2016 was due to the severe drought brought on by the El NiÃ±o Southern Oscillation (ENSO), which occurred during the 2014-2015 period. Thus, our preliminary results indicate that liana competition reduces tree biomass accumulation during succession, but abiotic factors, such as a strong drought, can reduce tree growth and biomass accretion to the point that competition is no longer a significant factor.

Keywords: natural regeneration, chronosequence, tree growth

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Wednesday, July 12th, 2017 Kabah
Oral session: Ecosystem functioning in secondary and mature tropical forests

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Oral Session
Biotic interactions in tropical ecosystems III

Mammal herbivores alter seedling traits but not diversity in a tropical forest

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Background: Overhunting threatens animal taxa across the tropics, potentially disrupting plant-animal interactions. The consequences of losing large animals on plant communities however, remain difficult to predict because the same taxon can have both negative (e.g. herbivory, granivory) and positive (e.g. seed dispersal) effects on plants. Also, impacts on plant communities may be obscured if small-bodied taxa compensate for declines in larger animal species, potentially altering plant recruitment. The net outcome of these negative and positive effects on plant populations and communities may further vary with habitat disturbance. Given that hunting and logging tend to co-occur in tropical forests, it is necessary to understand how the effects of defaunation and human-induced changes to forest structure will interact to alter plant diversity and traits. **Methods:** Experimental exclusion plots are being increasingly used to determine the cascading effects of defaunation on plant communities, but few have assessed how both defaunation and habitat disturbance affect tropical plant diversity and traits. To determine how plant traits and diversity are affected by defaunation and logging, we followed the fate of tagged seedlings in experimental exclosure treatments excluding small, medium, and large mammals in logged and unlogged forests in Malaysian Borneo from 2013 to 2016. **Results:** The logged forest contained a higher diversity of seedling genera but experimental defaunation did not further alter diversity. Animals affected one plant trait (fruit size), but not others (wood density and specific leaf area). Medium and large-bodied mammal herbivores reduced community mean fruit size among seedlings in logged forest, suggesting that in the face of habitat disturbance, mammals disproportionately kill large-fruited seedling taxa. **Conclusion:** Logging had a greater impact on diversity than experimental defaunation, though animals altered the distribution of fruit length among the logged forest seedling community. If increased herbivory of large-fruited seedling genera by ground-dwelling mammals leads to reduced seed dispersal, this could negatively affect the recruitment of these taxa in logged forest. Altered seedling community composition as a result of habitat disturbance could therefore have important consequences for the regeneration of large-fruited tree species in tropical forests.

Keywords: logging, mammals, seedling, Borneo, defaunation

ID:44
Wednesday, July 12th, 2017 Maya
Oral session: Biotic interactions in tropical ecosystems III

Credit of ecological interactions: a new conceptual framework for conservation in a defaunated world

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As defaunation spreads through the world, there is an urgent need for restoring ecological interactions and ecosystem processes. Refaunation has been used as a strategy to mitigate this issue, but we still need to improve our understanding on how many interactions can still be rewired and how this process occurs. Here, we define the new concept of credit of ecological interactions, as the number of interactions that can be restored in a focal area by species colonization or reintroduction. We also define rewiring time, as the time span until all the links that build the credit have become functional again. We expect that the credit will be gradually cashed following reintroduction in rates that are proportional to (1) the abundance of the reintroduced species, (2) the abundance of the local species that interact with them, and (3) the traits of reintroduced species. We illustrated this approach using a theoretical model and an empirical case study, in which we estimated the credit of ecological interactions brought by agouti's (Dasyprocta leporina) reintroduction in Tijuca National Park, Rio de Janeiro, Brazil. Moreover, we tested if the cashing fulfilled our predictions. In our theoretical model, population size is usually low right after release and thus at this time species show lower interaction richness. Gradually, it occupies a larger area, which enhances its potential interaction network. At some stage, most of the interactions with common species have been rewired and only the ones with the rare species remain for longer. The credit is then fully cashed when all potential interactions have been rewired. In our empirical case study, we estimated that the credit of ecological interactions following agouti's reintroduction was 65 and show how it was cashed and lowered to 42 in the first 15 months after release. As expected, agoutis rewired with common species faster. This framework provides an objective criterion for decision-making, since there has been no other established method to evaluate the success of reintroductions in restoring ecological processes. The concept is also useful for ascertaining how the benefits balance the costs of reintroduction as compared to other management options, to improve refaunation sequence and is also helpful in adaptive management. Besides that, in areas in high debt of ecological interactions, it can be applied to prevent further extinctions and the depletion of ecosystem services.

Keywords: ecological interactions, refaunation, reintroduction, rewiring

ID:58
Wednesday, July 12th, 2017 Maya
Oral session: Biotic interactions in tropical ecosystems III

Integrating foliar chemistry traits with VSWIR spectra: a promising tool to assess plant defense

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Background: Interactions with natural enemies are hypothesized to underlie both the origin and maintenance of extraordinarily high tropical plant diversity. Yet, our understanding of how plants withstand attacks from their enemies is still in its infancy, hampered by the cost and time involved in characterizing the hundreds of different secondary metabolites produced by each plant species. Near infrared spectrometers represent a promising step forward as they could rapidly characterize broad categories as well as specific secondary metabolites that mediate plant-enemy interactions. Here we attempt to increase our understanding of how foliar chemistry is represented by NIR spectra by integrating a detailed inventory of secondary metabolites with NIR spectra from a diverse, dominant tropical tree clade *Protium* (Burseraceae). **Methods:** We integrated four data sets to explore these questions: an existing published phylogeny of *Protium*, 23 leaf traits collected from 24 species of Protium from the Carnegie Spectranomics project in Peru, field spectrometer data from these same individuals, recorded in 2151 bands spanning the 350-2500 nm wavelength region, and a total metabolomics dataset from the same 24 species of *Protium* from the Berkeley project in Iquitos Peru. Using a combination of GC-MS, HPLC-MS/ELSD and NMR we quantified and identified the total chemical diversity of secondary metabolites for each species. Further, by integrating this chemical database with over 3000 insect herbivore feeding records on these species, we identified which chemicals were statistically associated with lower rates of herbivore attack. **Results:** We found that many chemicals gave strong and significant correlations with VSWIR spectral bands, and a clustering analysis shows that procyanids, sterols, sesquiterpenes, and triterpenes have particularly strong signals in leaf spectra. There was very little correlation between phylogenetic signal and leaf spectra or total chemical diversity, however chemical abundance and herbivore-active metabolites both showed significant phylogenetic signal. **Conclusions:** Leaf spectra represent a promising technique to assess plant chemical diversity and investment. Future studies that include a large number of individuals from several species and measure both detailed foliar chemistry and VSWIR on the same exact samples will be critical to develop new fast and cheap methods to assess the diversity and effectiveness of plant chemical defense diversity.

Keywords: Amazonian trees, Peru, *Protium* (Burseraceae)

ID:437
Wednesday, July 12th, 2017 Maya
Oral session: Biotic interactions in tropical ecosystems III

Landscape drivers of dispersal for a tropical small mammal in coffee farms

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Background: Agricultural production has expanded rapidly in tropical regions, transforming the landscape and fragmenting tropical forests. However, little is known about the long-term effects of agricultural production practices (i.e., management intensification) on population connectivity and dispersal. This information is crucial for the development of successful conservation strategies that will ensure connectivity between populations and prevent species regional extinction. **Methods:** Our study integrates genetic and landscape data to examine landscape factors influencing the connectivity of tropical small mammals in agricultural landscapes. Specifically, we investigated landscape factors driving the population structure of *Heteromys goldmani*, a common forest rodent, in a coffee agroecosystem. We sampled *H. goldmani* in coffee farms with different levels of management intensity (i.e., high (coffee monocultures), medium and low (shaded polycultures)) and forest fragments embedded within them. We evaluated 5 different landscape variables; (1) tree cover, (2) slope, (3) elevation, (4) distance-to-stream and (5) barriers to dispersal (streams), and measured their influence in driving *H. goldmani* genetic patterns. **Results:** Our results show that *H. goldmani* dispersal is limited in the coffee landscape, characterized by discrete genetic populations with limited gene flow. We found that all landscape variables, except streams, have a significant correlation with the observed genetic structure. From the variables evaluated distance-to-stream had the strongest correlation with genetic structure, even stronger than geographic distance. **Discussion:** These results suggest that streams do not represent a barrier to dispersal of *H. goldmani* in our study site. In addition, geographic distance does not explain the population structure patterns observed, as would be expected if there were no landscape barriers to dispersal. Areas close to the streams appear to be serving as habitat or corridors for *H. goldmani* in the coffee farms. Because these areas are steep, hard to access, and tend to be unmanaged, they represent a better-quality habitat for *H. goldmani* than the surrounding coffee farms. Our results suggest that areas surrounding streams are important for *H. goldmani* survival and connectivity within the coffee agroecosystem.

Keywords: small mammals, agroecology, landscape genetics

ID:162
Wednesday, July 12th, 2017 Maya
Oral session: Biotic interactions in tropical ecosystems III

Fruit removal by scatter-hoarding rodents of a masting palm in a fully protected Amazonian forest

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Background: Palms are highly dependent on scatter-hoarders for seed dispersal, constituting a complex ecological network in the Neotropics. Besides, indirect interactions between palms sharing the same frugivore species are expected to affect the outcome of these interactions. **Methods:** Herein we intend to evaluate patterns of rodent fruit removal of a masting palm species, *Astrocaryum sciophilum*, at a fully protected Amazonian Forest, named Nouragues Biological Reserve. We evaluated whether differences on overall availability of rodent-dispersed fruits along the fruiting season affect removal rates and timing of fruit removal of *A. sciophilum* by rodents. Moreover, co-fruiting-plant hypotheses were tested to investigate if conspecific and congeneric fruit availability affects fruit removal rates of *A. sciophilum*. **Results:** We did not find differences on fruit removal rates along the fruiting season. However, timing of fruit removal differed according to the period fruits were placed in experimental stations: fruits were slower removed by rodents when overall fruit availability was higher and faster removed in the end of the fruiting season, when overall fruit availability was decreasing. The number of *A. sciophilum* individuals around fruit removal stations did not affect rates of *A. sciophilum* fruit removal. On the other hand, when testing for effects of the presence of *Astrocaryum paramaca* around *A. sciophilum* fruit removal stations we found a negative effect on fruit removal rates: more fruits were removed in areas where *A. paramaca* was not present. **Discussion/Conclusion:** We show that overall fruit availability along the season affect the timing of fruit removal by rodents, suggesting that fruits are faster removed to be cached and consumed when fruit availability decreases. Although variations in the number of conspecific fruiting neighbors do not affect fruit removal through satiation effects, our results suggest that the presence of *A. paramaca* negatively affect fruit removal of *A. sciophilum*, either through satiation or competition. Context-dependent factors such as conspecific and congeneric fruit availability, as well as traits of the interacting species and its seed dispersers can alter the balance of costs and benefits for palms. We also highlight that since the time in the season can affect aspects of fruit removal, future studies might take into account overall fruit availability to better evaluate the net outcome of frugivore-plant interactions.

Keywords: Amazonia; *Astrocaryum*; rodents; fruit removal

ID:610
Wednesday, July 12th, 2017 Maya
Oral session: Biotic interactions in tropical ecosystems III

Herbivores on the edge: Effects of elevated CO_2 and temperature on a tropical vine and its beetle

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Background: As a result of forest fragmentation, tropical edge species have increased in abundance. Yet little is known about the response of edge species to global warming. **Method:** We investigated effects of elevated CO_2 and temperature on the vine *Merremia umbellata* (Convulvulacea) and larvae of a specialized, herbivorous beetle *Acromis sparsa* (Chrysomelidae). Larvae were reared on hostplants at 2-levels of CO_2 (normal and double) and 2-levels of temperature (ambient and ca. 4 C above ambient). **Result and Discussion:** Doubling CO_2 ($2xCO_2$) more than doubled plant biomass, whereas temperature had no effect. Leaves expanded faster in 2xCO2, but leaves grown at warmer temperatures and normal CO_2 had the greatest percentage of C. Leaf nitrogen was unaffected by the treatments. Larval growth and survivorship respond to warmer temperatures directly, but larvae also respond indirectly to the effects of warmer temperatures and $2xCO_2$ on their hostplant. Proportion of larvae pupating was disproportionately low in the $2xCO_2$ and high temperature treatment. Hostplants in high temperature and $2xCO_2$ had the greatest C:N ratio and the low availability of nitrogen probably increased larval mortality. However pupae were smaller in the elevated temperature, overall, with $2xCO_2$ interacting with temperature to increase pupal mass in elevated temperatures but decrease pupal mass in ambient temperatures. This rank order differs from effects of temperature and CO_2 on larval mortality, but high temperature and $2xCO_2$ treatment may have generated the smallest larvae, and they simply didn't pupate (and hence were not weighed). Days to pupation did not differ among treatments, but larvae reared at elevated temperatures required more time as pupae to eclose to adult. In addition, fewer pupae survived at high temperatures, but pupal survivorship was slightly better in $2xCO_2$. Because pupae were placed in a common area within a day of pupation, effects of temperature and CO_2 on pupae are residual effects on the larvae. Treatments that yielded heavier pupae were also more likely to have pupae that survived. **Conclusion:** Elevating atmospheric CO_2 and temperature together caused declines in hostplant quality and larval survivorship that were not observed when only one environmental feature was altered. This interaction will be deeply consequential to the forest edge, impacting multi-trophic systems like Merremia and its specialized herbivore that depends on its host for defensive compounds.

Keywords: host quality, herbivory, warming, survivorship

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Wednesday, July 12th, 2017 Maya
Oral session: Biotic interactions in tropical ecosystems III

Oral Session
Biotic interactions in tropical ecosystems IV

Insect Herbivory in an Altered Tropical Landscape

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Background: The Stability of Altered Forest Ecosystems (SAFE) project is a large scale international fragmentation experiment in Sabah Borneo. Replicated fragments of logged-over dipterocarp forest are being created as part of a landscape-wide development of palm oil plantations. We are examining the impacts on insect herbivores and herbivory on plots ranging from undisturbed primary forest through to mature palm plantations. **Methods:** Basic biodiversity data on moths, Orthoptera and spiders (principal predators of insect herbivores) have been collected across more than 80 locations within the experimental area. Complimentary studies of leaf loss and leaf chemistry in dipterocarp seedlings have been made by transplanting and leaf monitoring. Next generation sequencing approaches have been used to identify specialisation and generality in both herbivore and predator diets across these sites through the meta-barcoding of the animals themselves. A general model of herbivore centred interactions pulls together these studies while indicating research gaps. **Results**: Community pattern analyses show clear turnover across different forest types although highlight the great heterogeneity of biodiversity in sites with different logging histories. The studies of leaf damage and chemistry show differential impacts on plants in these sites. Molecular measures of diet in both herbivores and predators have been achieved and show landscape wide pattern. **Discussion:** Studying herbivory in a modified tropical rainforest landscape is both demanding and, necessarily, multidimensional. We present a general schematic of the plant-herbivore-predator food chain indicating key independent variables and the ecological and evolutionary feedbacks involved. We map onto this the dominant features associated with our controls (primary lowland dipterocarp forest, logged-over forest) and the landscape after transformation (logged-forest remnants, oil-palm plantations). Gaps in knowledge and plans for future projects can then be readily identified.

Keywords: rainforest, herbivory, insects, Borneo, oilpalm

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Herbivore pressure in *Piper trigonum* (Piperaceae) in a Costa Rican lowland wet forest

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Background. Herbivore pressure is the strength and quality of natural selection imposed by herbivores. Herbivore pressure is predicted to be intense in tropical habitats, especially in lowland wet forests, but neither its strength nor quality has been measured for tropical plants. Spatial and temporal variation in herbivore pressure imposed by insects was measured in an experiment of medium duration in the understory shrub *Piper trigonum* (Piperaceae) in a lowland wet forest of Costa Rica. **Methods:** Sixteen clones of each of 29 genotypes were planted into twenty-nine locations at the La Selva Biological Station, of the Atlantic lowlands of Costa Rica. Half of the clones at each location were planted into a light gap, and the other half into neighboring intact understory. In addition, half of all clones were planted into soil to which nutrients had been added. Damage to plants by insect herbivores, plant survival, growth, and potential reproduction were measured every six weeks over 13 months. Leaf area loss at each census was attributed to individual species of herbivores, either specialists or generalists, or to generalist herbivores as a class. **Results:** Selection by herbivores for survival and growth was greatest in the understory. Selection by herbivores for reproduction was greatest in light gaps. There was significant spatial variation in herbivore pressure over and above differences between neighboring understory and light gap locations. These spatial differences were associated with differences in the identity of the insects attacking the plants at a given location at a given time. Higher soil nutrients led to higher overall damage. **Conclusion:** Herbivore pressure on *Piper trigonum* varies spatially and temporally in both total amount, and damage down by individual herbivore species. The abiotic environment, light and soil nutrients, modify the selection gradients imposed by herbivores. The overall picture is one of generally intense, continuous levels of natural selection imposed by a diverse community of insects that vary in levels of specialization.

Keywords: Herbivory, Piperaceae, selection, light, nutrients

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Forest metabolomics reveals sources of chemical diversity in temperate and tropical tree communities

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Background: The vast diversity of plant chemical defenses has traditionally precluded community-level studies of chemical ecology. We take advantage of novel methods for acquiring and assembling mass spectra (MS) into molecular networks in which similarities in MS fragmentation patterns, and hence chemical structure, are indicated by proximity of compounds within the network. Molecular networks permit the quantification of chemical similarities between samples for which few compounds have been unambiguously identified, an attractive utility in chemically diverse and understudied tropical forests. **Methods:** Here, we assemble MS molecular networks for 185 tree species that represent 95% of all individuals in the Smithsonian Institution Global Earth Observatory (ForestGEO-CTFS) Forest Dynamics Plots (FDPs) at the Smithsonian Environmental Research Center (SERC) in Maryland and at Barro Colorado Island (BCI), Panama. We compare the chemical diversity and its taxonomic distribution between the 66 species in the 16-hectare (ha) Maryland FDP and 119 species in the 50-ha FDP in Panama. In addition, we assess the similarity in foliar metabolomes among congeneric species from the most species-rich tree genera at both sites. **Results:** We found a dramatic difference in chemical diversity between the temperate and tropical forest. Furthermore, the taxonomic distribution of chemical diversity differs profoundly between the temperate forest in Maryland and the tropical forest in Panama. Congeneric species in the four most species-rich genera at SERC were very chemically similar, whereas congeneric species in the seven most species-rich genera at BCI were nearly as dissimilar, on average, as species selected from the forest at random. As a result, most chemical diversity at BCI is found among species, whereas a greater proportion of chemical diversity is found among botanical families at SERC. **Conclusions:** Our results suggest that species differences in secondary chemistry may comprise important axes of niche differentiation among coexisting species of tropical trees. Furthermore, chemical differences may be especially important among members of species-rich tree genera that otherwise share many aspects of the niche. Finally, the striking difference in the taxonomic distribution of chemical diversity between Maryland and Panama suggests that the importance of chemical niche differences to species coexistence may vary strongly over latitude.

Keywords: BCI, coexistence, macroevolution, adaptive radiation

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Adaptative value of ontogenetic changes in plant defense

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Plant defense changes throughout ontogeny, mediated by internal (resources allocation) and external (herbivore preference) pressures. However, the patterns in anti-herbivore defenses are not fully predictable, since plant life history, type of defense, and herbivores modifies defense trajectories. The aim of this project is to assess the adaptive role of ontogenetic trajectories of three defenses in *Turnera velutina*, an endemic shrub that has a mutualistic interaction with several ant species. In August 2014, we established 2164 plants from 20 maternal families in 20 experimental plots of 1 m2 in the coastal dunes of La Mancha (Veracruz, México 19°36' N, 96°22'W, elevation < 100 m). We characterized the expression of trichome density, potential cyanide production and sugar content in extrafloral nectar in three stages of development: seedlings, juvenile and reproductive. We assessed the heritability of these ontogenetic trajectories of defense and performed selection analysis using the probability to reach reproduction and seed production as a proxy of fitness. We found a differential pattern of variation in the expression of ontogenetic trajectories of defense, that each ontogenetic stage prioritizes one defense attribute. Seedlings have a large genetic variation in cyanide production, juveniles have a less genetic variation in the expression of trichome density, and reproductive plants have a large genetic variation in the extrafloral nectar production. Also, we found a significant effect of the ontogenetic trajectories of defense on fitness. The results we found support the study of plant defense as a complex phenotype, which is mediated by several adaptive forces. In addition, we emphasize the importance of incorporating multiple defenses throughout development to fully understand the evolution of defense. In an applied benefit, we could identify between naturally vulnerable and well-defended stages of cultivars, which could lead to a more efficient use of pesticides and improved management practices.

Keywords: *Turnera velutina*, plant defense,

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Edges as compass: Equator-facing edges raise drought stress in plants and leaf-cutter ant abundance

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Background: In fragmented neotropical forests, the release of leaf-cutter ants (LCA; Formicidae: Attini) from bottom-up control following edge creation involves the proliferation of pioneer plant species in forest edges. Bottom-up control, however, may also be affected by the plant physiological status, as drought-stressed plant individuals are more nutritious food resource to LCA. Forest edges are considered drought-stressing environments to plants and the intensity of this effect must vary with distance to fragment boundary and edge geographic orientation, with equator-facing edges (north-facing edges in southern hemisphere) showing more intensive edge effects. Edge effects may interact with drought stress in plants and provide an alternative explanation for bottom-up disruption in LCA. We predict a lower relative water content (RWC; a proxy of drought-stress in plants) and higher LCA colony density close do fragment boundary in equator-facing edges. **Method:** To test the predictions concerning plant RWC, we established 25 transects (100 m) encompassing forest edges facing four compass directions and sampled plant individuals from four species. We measured fresh, turgid and dry weight of plant individuals to calculate RWC. Concerning LCA population density, we ran tracks through the forest across the four edge orientations registering geographical position of colonies of genus Atta. After that, we used a geographical information system to draw a buffer in the forest each 50 m starting at forest boundary and counted the number of colonies into each edge distance and registered the orientation of the nearest edge to each colony. We tested predictions with generalized non-linear models. **Results:** We sampled 296 plant individuals and mean RWC was 83.08±20.6%, with individuals on north-facing edges showing RWC 15% lower than individuals on south-facing edges. Edge distance showed no effect on RWC values. We found 57 LCA colonies and colony density in north-facing edges was 9 times higher than west and south-facing edges and 3.5 times than east-facing edges. Number of LCA colonies decreased with distance to edge and colonies density was 7 times higher on 50 m edge than on distances > 50 m. **Discussion:** We found evidence for a stronger edge effect on north-facing forest edges concerning both RWC and LCA colony density and suggest the hypothesis that LCA are able to track chemical signs to find drought stressed individuals on forest edges.

Keywords: Atta cephalotes, fragmentation, bottom-up control, tropical rain forest, plant-stress hypothesis

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Effects of phytochemical diversity on insect performance

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Background: Decades of research have now shown that the phytochemicals produced by plants play a key role in structuring interactions between plants and their insect herbivores. However, it is still unclear why plants produce such an incredible diversity of different compounds—a single leaf may contain hundreds or even thousands of different phytochemicals with no known role in primary metabolism. One hypothesis is that phytochemical diversity provides combinations of compounds that can work synergistically and provide more effective defense than any individual compound alone. In this case, phytochemical diversity per se should be a key predictor of insect performance, but we know of no studies that have experimentally tested this prediction. **Methods:** We reared four species of Lepidopteran herbivores on artificial diets in which we manipulated three key aspects of phytochemical diversity—compound richness, compound evenness, and functional diversity. We focused on phenolic metabolites due to their diversity and ubiquity in the plant kingdom. **Results:** For two of the four insect species, we found that increasing the richness and evenness of phenolic mixtures can impact performance, but only when diets were composed of high functional diversity mixtures. Phenolic mixtures primarily impacted larval development times, with no detected effects on pupal weights. **Discussion:** Our results suggest that phytochemical diversity per se can be an important factor determining insect performance; however, the effects were not detected in all species or in all metrics of performance. In general, phytochemical diversity in plants may be maintained for multiple reasons, including: 1) diverse compound mixtures may reduce insect performance more than any single compound, 2) different compounds may be effective against different natural enemies, 3) maintaining phytochemical diversity may increase the probability that plants will be defended against novel enemies.

Keywords: plant-insect interactions, phenolics, phytochemistry, herbivory, phytochemical diversity

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Tropical forests (TF) do not offers less food than anthropic habitats to blood-sucking bugs

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Background: Blood-sucking bugs (Reduviidae) of the Triatominae subfamily are vectors of *Trypanosoma cruzi*, aetiological agent of Chagas Disease. Whilst Triatomines are native to natural habitats relying on wildlife as blood sources, some species can invade rural communities and switch hosts toward domestic animals and humans, initiating the domestic dynamic of parasite transmission. It has been proposed that a decrease in natural hosts availability during dry season motivates bug dispersal into rural communities and that blood-source supplementation provided by continuous availability of animals and humans are determinants of bug infestation. However, few studies have been devoted to test this hypothesis. **Method:** Bugs were collected alive in continuous TF and in several rural communities in a region of Yucatan. Collections were conducted during dry season (April-June) in 2014-2016. Bugs were identified, sexed, measured (body length; BL) and legs extracted to quantify dry mass (DM), lipid mass (LM) and muscle mass (MM) following standard methods. We used linear mixed models to explore if BL, DM, LM and MM were dependent on Vegetation type; VT (Conserved forest, Low disturbance, High disturbance), Sex, and the interaction VT * Sex. For the analyses of DM, LM and MM, the model also tested the additive effect of BL to control for body size and the random effect of Year. **Results:** Regarding BL, females were larger than males but not dependent on VT or the interaction Sex * VT. DM was best explained by the additive effect of Sex and BL, being females heavier than males and larger individuals being also heavier. Body DM was not dependent on VT or the interaction Sex * VT. LM was also best explained by the additive effect of Sex and BL. The effect of Sex was not significant and larger individuals had more lipids. LM was not dependent on VT or the interaction Sex * VT. In contrast, MM was explained by the effect of BL, and VT. **Conclusion:** Using Triatoma dimidiata in the Yucatan Peninsula as a study model, our evidence did not support the hypothesis that TF contains not enough blood supply for bug's populations and suggest that bugs from conserved TF have a better body condition compared to bugs from rural communities during dispersal season. However, bugs from smaller towns surrounded by disturbed forest have less muscle mass that those from bigger towns. Therefore, is possible that the poor food supplementation is given in habitats with disturbed vegetation.

Keywords: Chagas Disease, Triatoma dimidiata, seasonality

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Assessing the relationship between herbivore community betadiversity and plant chemical diversity

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Background: To date, little is known about the distribution of species interactions. For plant-herbivore interactions specifically, it is expected that specialized herbivores will follow their host across most of their natural range, however, it is more difficult to predict generalist herbivore distributions. Here we assess how plant-herbivore interactions at the community level change across long geographical distances in a generalist-dominated system. Furthermore, we assess the relationship between geographical changes in plant secondary chemistry and plant-herbivore interactions. **Methods:** Ten *Protium* species (Burseraceae) were surveyed for herbivores every week for one year in two distant geographical locations: Manaus (Brazil) and Iquitos (Peru). Only confirmed feeding events were recorded. Additionally, herbivore species were DNA barcoded to confirm their identity across both sites and to determine the presence of potential cryptic species. Additionally, to assess the role that changes in chemical composition and investment could play in the geographical consistency of plant-herbivore interactions, we used a metabolomic approach to characterize the secondary metabolite composition for each *Protium* species at both locations. **Results:** Herbivore species richness and abundance per plant species were very similar across both sites, and the vast majority of herbivores where polyphagous, both in abundance (98%) and species richness (97%). Similarly, herbivore community composition at a broad phylogenetic scale was also very similar between sites. However, species beta-diversity across the two sites was extremely high (less than 1% shared species). Finally, the chemical composition of our 10 focal species showed small changes between the Iquitos and Manaus populations, but most of the secondary metabolites expressed by each *Protium* species were found at all sites and in similar amounts. **Conclusions:** *Protium* herbivore community composition was found to have a very high turnover, however, their broad phylogenetic composition appears very consistent, a pattern most likely forged by either historical co-evolutionary relationships or phylogenetic constraints. The small changes in host chemical composition suggest that chemistry is not likely to explain the high herbivore species turnover between these sites. These results raise exciting new questions on the role that herbivores and plant chemistry plays in the evolution of hyper-diverse tropical tree clades.

Keywords: plant chemistry, herbivores, beta-diversity, *Protium*

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Oral Session
Tree and liana responses to drought and other factors

Drought effects in Amazon-to-Andean forest

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Background: Increases in drought frequency and duration could fundamentally shift the composition of tropical forests, altering forest structure and ecosystem function. In the last decade, two dry events associated with the abnormal sea surface temperatures were identified in 2005 and 2010, resulting in large effects on forest structure and function of the Amazonian lowland. How Andean forests respond to drought events is unknown and the causes of tree mortality following drought remain poorly understood. The aim of this study was to explore if (1) the 2005 and 2010 droughts affected tree mortality in per-humid forests across an Amazon-to-Andes elevational gradient? And, if so (2) what tree size and taxa were more vulnerable to the droughts? **Methods:** The study site was in the Manu Biosphere Reserve located on the eastern slope of the Peruvian Andes. Field data was collected for adult trees in multiple censuses over a decade (2003-15) in 23 1-ha permanent forest plots. Mortality was modeled as a function of maximum climatological water deficit (MCWD), a measure of dry season water stress across the elevation gradient. Results show high tree mortality related to MCWD. Small diameter trees were more susceptible to drought stress as wells as taxa with low wood density. High tree mortality was found at the cloud base (~1500-2000 m). **Discussion and/or conclusion:** These results quantify for the first time the negative effects of droughts in Andean tropical montane forest. It suggests that trees will not be able to tolerate multiple droughts, or at least will go through landscape-wide bottlenecks with projected droughts.

Keywords: Tree mortality, climate change

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Amazonian forest responses to extreme drought from rapid hydraulic failure in a trait-based model

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Background: Accurate representation of tropical tree mortality from drought has been elusive in ecosystem models, yet recently reported observations from a long-term through-fall exclusion experiment in the eastern Amazon have shown evidence that mortality from sustained drought is predominantly caused by hydraulic failure. **Method:** Here we report on continuing development of the Trait-based Forest Simulator (Fyllas et al., 2014) to capture Amazonian forest responses to both moderate and extreme drought events. We incorporate recent theoretical advances and empirical findings into the simulation model to identify strategies capable of representing rapid hydraulic failure of Neotropical trees under extreme drought stress. We implement three model developments specific to improving the representation of individual tree water stress. (1) Soil water is represented in a vertically stratified multi-layer continuum, where tree access to water is modulated by individual tree size. (2) We explore three stomatal conductance routines: the two-parameter Medlyn (2011) model, a mechanistic model optimized to maintain water-use efficiency, and one optimized for carbon gain while imposing a carbon cost to compensate xylem damage repair (Wolf et al., 2016). (3) Leaf loss is dictated by the difference between leaf water potential, and lethal leaf water potential. The latter has been predicted to be correlated with turgor loss point (Bartlett et al., 2016), which has been estimated from LMA and wood density (Xu et al., 2016) which are two of core traits that determine individual tree function in the model. In this demographic version of the model, a rapid mortality pathway during extreme droughts is simulated from hydraulic failure which we implement as a minimum allowable stem water potential that is characterized on a per-tree basis as a function of wood density and tree size. A slower, or delayed mortality pathway is determined by sustained reductions in NPP, which is further modulated by leaf area loss. **Results:** The model performance is assessed with LAI, growth, and mortality data from the Caixuanã Through-fall exclusion experiment (da Costa et al., 2010) that has reduced rainfall by 50% since 2002. **Discussion:** We explore and evaluate the model's plausibility to represent an eastern Amazon forest's response to sustained drought, which is needed to forecast the potential for productivity declines from the increasing frequency of drought in the Neotropics.

Keywords: drought, traits, forest model, mortality

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Isoprene emission structures tropical tree biogeography and community assembly responses to climate

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Background: There is an urgent need to understand the physiological traits that define tropical tree responses and feedbacks to climate. Temperature and drought frequency are increasing in the tropics, and we are only beginning to understand why some tree species are resilient while others succumb. Isoprene emission from leaves has been shown to enhance plant tolerance to climatic stress. About a third of tree species make isoprene, a volatile secondary metabolite produced in the chloroplast. With analyses of tree community assembly, we test the hypothesis that isoprene emission affects species relative performance and mortality responses to climate in species-rich tropical forests. **Methods:** We analyzed changes in the proportional abundance of isoprene-emitting species (pIE) across climates throughout the tropics, and through time at three focal sites responding to anomalous high temperatures or drought. Species trait values (emitter or non-emitter) were assigned by taxon-matching to a dataset of new measurements and literature data. Missing trait values were imputed at the genus level by a probabilistic method. Bootstrap iterations allowed us to analyze the effect of trait uncertainty on the community assembly results. **Results:** Site pIE increased with mean annual temperature across the tropics (ΔpIE = 0.034 per ˚C), but decreased with dry season length (ΔpIE = −0.012 per month) (linear regressions, $p < 0.001$). The sign of each regression slope was consistent across > 99% of trait imputations. A linear model accounting for covariation between environmental variables explained 32% of variation in site pIE ($p < 0.001$). All three focal sites showed an increase in pIE through time. At the high-temperature site, pIE increased by 52%, with the sign of ΔpIE consistent across all imputations. At the two drought sites, pIE increased by 14% and 16%, but not significantly across imputations (< 97.5% positive ΔpIE). **Discussion:** Our results support a benefit of isoprene to trees under high temperatures but not drought. Enhanced tolerance of isoprene emitting species to the increasing temperatures of the Anthropocene is a mechanism for forest composition shifts. Understanding the implications of such shifts to biodiversity and climate feedbacks requires better knowledge of the basic ecology and evolution of isoprene. For example, future work should determine how isoprene covaries with other traits as a component of the integrated functional strategies of tropical trees.

Keywords: isoprene, climate, drought, temperature, physiology

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Individual and ecosystem scale responses to El Niño drought in an eastern Amazon forest.

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Background: Coupled climate-carbon cycle models indicate that Amazon forests may be vulnerable to drought, with some predicting climate change-induced collapse of the Amazon forest and conversion to savanna, while others predict resilience. Much progress has been made in understanding tropical forest drought response, but integration of individual with ecosystem scale responses remains a challenge. **Method:** Here we analyze the response of eastern Amazonian forests at ecosystem and individual scales to the El Nino-induced drought of late 2015/ early 2016 using both eddy flux measurements of net ecosystem exchange of latent and sensible heat fluxes, and the ecohydrological responses, including leaf water potentials and stomatal conductances, of individual trees of species representing a large fraction of the site's basal area. **Results:** Whole-forest water (latent heat) fluxes normally reach their annual peak during the dry season, driven by the dry-season maximum in solar energy input. However, during the 2015-2016 El Nino dry period (August 2015 through June 2016), latent energy fluxes declined relative to the average across all years, and sensible heat fluxes significantly increased, reflecting a strong shift in energy partitioning indicative of water limitation. Individuals, however, exhibited a variety of responses, consistent with a diversity of plant hydraulic strategies, with most species showing statistically significant declines in leaf water potential and stomatal conductance, but with a range across species that varied from no response to large magnitude declines. **Conclusion:** Understanding and predicting whole-forest responses to strong drought is a critical priority for tropical forests, but may depend on accurate assessment of composition of species and their associated functions and hydraulic strategies.

Keywords: Amazonia, El Nino, drought, fluxes

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Intraspecific variation of drought resistance traits along a strong rainfall gradient in Panama

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Background: Intraspecific trait variation, arising from both genetic variation and phenotypic plasticity, can significantly influence ecological dynamics and species' responses to climate change. In tropical forests, which are predicted to experience pronounced changes in rainfall patterns, the existence and extent of intraspecific variation of traits relevant for drought resistance remains poorly understood. **Methods:** We analyzed intraspecific variation of various morphological and physiological traits known or hypothesized to be important for plant drought resistance in 14 focal species. We analyzed trait variation across populations originating from a steep natural rainfall gradient in central Panama growing under common greenhouse conditions. We also analyzed phenotypic trait plasticity in response to soil moisture variation and its variation among origins in a common garden drought/irrigation experiment. **Results:** Morphological and physiological traits related to plant drought resistance varied among populations in some species and traits, but not in others. We also observed some phenotypic plasticity of traits in response to soil moisture, but it was generally low. **Discussion/Conclusions:** Overall, variation of traits for drought resistance was small and not consistent with adaptive intraspecific variation. Our results suggest a low potential for species in situ adaptation to higher frequency and intensity of drought with climate change. Our findings also imply that rainfall regimes at the site of origin does not need to be a primary concern for selection of seed sources for restoration and reforestation efforts.

Keywords: traits, climate change, regeneration, ecophysiology

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Drought Vulnerability of Neotropical Canopy Trees and Lianas

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Background: The high diversity of tropical forests complicates predictions of how canopy trees and lianas will respond to drought. Detailed physiological measurements are necessary to improve predictions, yet these measurements are tedious and time-consuming, so relatively little data is available. The DROUGHT Project, initiated in 2016, aims to elucidate how hydraulic traits related to drought vulnerability are coordinated among canopy species across the Neotropics by increasing the scope of data available. **Method:** So far, we have performed detailed measures of hydraulic conductivity, xylem vulnerability curves, sapwood pressure-volume curves, and wood density on emergent branches of 35 common liana and tree species from French Guiana and Panama. Our measurements were stratified across a broad range of wood density. Objectives included determining the range of hydraulic traits, evaluating coordination among hydraulic traits to identify strategies, and providing trait values for inclusion in predictive models. **Result:** Wood density was correlated with sapwood pressure-volume traits, including capacitance, sapwood water content and turgor loss point. Xylem hydraulic conductivity was related to xylem vulnerability to embolism at some sites, but not others, indicating variation in the xylem safety versus efficiency trade-off. Relationships between wood density and xylem vulnerability to embolism varied among sites. In general, wood density showed greater correlation with sapwood pressure-volume traits than with xylem vulnerability to embolism. **Conclusion:** Detailed physiological traits offer a way forward for predicting tropical liana and tree responses to drought. An understanding of the trade-offs and coordinated functions that separate tropical canopy species along an axis of drought vulnerability may be an important component for parameterizing Earth system models.

Keywords: Eco-physiology, Plant Hydraulics, Tree Mortality

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Oral session: Tree and liana responses to drought and other factors

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El Niño Drought Favors Tropical Liana Growth over Trees

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Background: Liana growth has been hypothesized to exceed the growth of co-occurring trees during seasonal drought, which is purported to explain the pan-tropical distribution of lianas and the peak in liana density in highly seasonal forests. Furthermore, the response of lianas to stronger drought (e.g., el Niño drought) is hypothesized to further advantage lianas over trees. Previous studies, however, were limited in their ability to test this hypothesis because they were able to measure only the growth of juvenile lianas, or the short-term seasonal physiological response of larger lianas. No study has examined how lianas and trees grow during dry and wet seasons for multiple years, and how lianas respond to el Niño drought compared to co-occurring trees. **Methods:** We measured the dry and wet season diameter growth rates of 2600 large trees and 800 large lianas from 2011 until 2016 in 8 60 x 60 m plots in central Panama. We measured liana and tree diameters at the beginning and end of the dry season (January and May), which included a particularly strong el Niño drought in 2015 and 2016. **Results:** We found that lianas grew considerably more during dry season months than during the wet season months in each of the five years. Lianas achieved a full half of their annual growth during the 4-month dry season. By contrast, trees grew more during the wet season, and they achieved only a quarter of their annual growth during the dry season. During the strong 2015-2016 wet season, tree grew little during the dry season, whereas lianas grew unimpeded. **Discussion:** Our findings support the hypothesis that lianas are adapted to grow during seasonal drought and that the majority of their growth is during the dry season. The ability of lianas to grow more than trees during seasonal droughts gives them a decided advantage in seasonal forests, and may explain why lianas density peaks in seasonal tropical forests. Furthermore, strong el Niño droughts will further favor lianas compared to trees.

Keywords: Competition, El Niño, Lianas, Panama

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What determines the abundance and impact of lianas?

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Background. Lianas - woody climbing plants - are found in a majority of the world's forests, at widely varying abundances, and are critically important to determining forest carbon stores and cycling. Yet ecologists have a surprisingly limited understanding of what determines the abundance and impact of lianas in any given forest, or variation in these among forests. **Methods:** We suggest that liana abundance is regulated and limited at three distinct and interacting scales: in the proportion of trees infested with lianas; in the liana load within the crowns of individual host trees; and in the proportion of the landscape that is in a liana-dominated, low-canopy state; and that the forest-level impact of lianas depends on all three. We develop models for the determinants of liana abundance at each of these scales, and evaluate the implications for understanding variation in liana abundance and impact across forests. **Results:** We argue that the proportion infested is best understood within a disease ecology framework (paralleling "proportion infected") in terms of rates at which uninfested trees become infested, the rates at which infested trees lose lianas, and the demographic rates of infested and uninfested hosts. The biomass of lianas within a tree crown has similar parallels to pathogen load, and can be understood in terms of selection for the highest reproductive number (new hosts infested per infested host), which necessarily must balance the benefits of higher liana load and associated resource pre-emption against the cost to the parasite of negative impacts this load imposes on its host, i.e., liana "virulence". Finally, the proportion of the landscape that is in a liana-dominated, low-canopy state can be framed with a simple box model - but we have very little understanding of the controls on transitions into and out of this state. We discuss what regulates and limits liana abundance at each of these scales in turn. **Conclusions:** Our models provide a novel framework for understanding variation in the abundance and impact of lianas among tree species, liana species, and forests; and a new way of framing many associated unsolved questions. Our analyses illuminate the critical role of liana strategies with respect to "virulence", and the importance of understanding interspecific variation among lianas and the factors that shape the relative abundance of different liana strategies.

Keywords: forest structure; host-parasite; community ecology

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Oral Session
Biodiversity inventories in tropical ecosystems II

New *Amanita* species: implications for shared biogeographic history between Africa and South America

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Background. The ectomycorrhizal (ECM) mushroom genus *Amanita* (Amanitaceae, Agaricales, Basidiomycota) is estimated to number ~1000 species worldwide, though only ~600 species have been formally described. Many *Amanita* species have broad distributions in higher latitude forests, while tropical *Amanita* species, where known, have local distributions in lowland rainforests dominated by ECM trees of Fabaceae subfam. Caesalpinioideae ("caesalps"). Collecting expeditions in rainforests dominated by the ECM caesalps *Dicymbe corymbosa* in Guyana and Gilbertiodendron dewevrei in Cameroon have uncovered ~25 and ~30 *Amanita* spp., respectively, the majority appearing undescribed. As the dominant caesalps are closely related, their fungal symbionts may share a common Gondwanan origin. The analysis and description of new *Amanita* taxa from these forests will inform the origins and evolution of ECM symbioses in these systems. **Methods:** *Amanita* species were collected annually in Guyana from 2000-2016, and in 2014 and 2016 in Cameroon. Collections were compared with published descriptions of taxa found in the literature. Macro- and micro-morphological features of putative new taxa were obtained and descriptive profiles were compiled. Multiple genetic loci were sequenced from new taxa for phylogenetic analysis. **Results:** Numerous *Amanita* species from Guyana and Cameroon are morphologically novel, common in their respective monodominant forests, and currently undescribed. Alpha-taxonomic work is ongoing. Macro-morphological features have been compiled from the various individual collections of each species, and micro-morphological features continue to be analyzed. Multi-locus DNA sequence data is currently being generated. **Discussion:** Sporocarp sampling studies have shown that Amanita is speciose in ECM caesalp-dominated forests in the Guiana Shield and Central Africa. The description of new *Amanita* species will contribute valuable taxonomic information to our understanding of fungal biodiversity in tropical ecosystems. Comparisons between morphological and genetic features of endemic *Amanita* from Guyana and Cameroon will inform potential relationships between ECM symbionts of the two regions. Biogeographical data addressing a potential shared Gondwanan history of *Amanita* will be discussed.

Keywords: ectomycorrhiza, monodominance, Gondwana, Guyana, Cameroon

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Novel solutions to advance taxonomy and systematics of aquatic insects in Central America

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Background: Central American aquatic insect taxonomy lags far behind its counterparts in North and South America. Only Costa Rica has advanced in the publication of generic-level guides, albeit only on some insect orders. The paucity of publications has left ecologists and environmental managers with few tools to taxonomically characterize their aquatic ecosystems. New technologies such as DNA barcoding have the potential to assess general levels of species richness. However, proper descriptions of new species, including their immature stages, are urgently needed, and these are not coming forth at an acceptable rate. **Method:** Crowd taxonomy (also called cybertaxonomy) can advance the description of new species using in-country, taxonomist-trained and supervised teams of parataxonomists, students, and technicians to prepare the descriptions of new species. Descriptions would be posted on-line where collaborating taxonomists can take the lead and complete them. Taxonomists get first authorship on papers and place type material in appropriate collections. The Chironomidae (Diptera), with several thousand undescribed species in the region, is an excellent example of how powerful this strategy could be. The Coffman Collection of chironomid pupal exuviae that currently resides in Costa Rica contains over 400 undescribed species from about 60 different Costa Rican ecosystems. Bi-weekly and monthly collections have yielded a wealth of new material with more species that need description. Over 2,500 larva-pupae-adult associations have been produced so far, representing many undescribed species. **Results:** We estimate to be able to describe up to 200 new species in 3 years using existing associated material. The creation of a qualified Costa Rican chironomid taxonomy team can transform the knowledge base and application to biomonitoring and conservation of aquatic ecosystems. Species descriptions would be published in open-access journals and data deposited in BOLD as well as using tools such as those provided by cybertaxonomy.eu. **Conclusion:** Crowd taxonomy can increase the capacity of Central American scientists to lead projects in biogeography, species inventories, and conservation of aquatic ecosystems through the production of Spanish-language identification guides and keys to their organisms, as well as build a solid base for the training of a new generation of Central American taxonomists and ecologists.

Keywords: Crowd taxonomy, cybertaxonomy, Chironomidae, parataxonomists

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Serranias del Guaviare, Colombia: Rapid inventory, conservation, campesinos, and peace process

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Background: In 2015 President Santos made a commitment to 2 million hectares of new protected areas in Colombia, including a potential regional conservation area in Guaviare. For decades, this region has been a "no-go" zone controlled by FARC guerillas and isolated by 50 years of civil war. **Methods:** In October 2016 The Field Museum, 12 Colombian partner institutions, 26 Colombian scientists, and dozens of local leaders and community members conducted a rapid biological and social inventory of the Serranias del Nor-Occidente de Guaviare, four rock uplifts emerging from the Orinoco basin. **Results:** Ancient art—mysterious paintings from an unknown civilization 7,000-13,000 years ago—covers the sheer sandstone rock faces. Modern colonization of the area is relatively recent, with people arriving from the Andes in the last 60-100 years to escape violence and seek their fortune. Cattle ranching and coca plantations dominate local livelihoods. For the 5,000 people living in surrounding villages and farms, the uplifts represent an important source of water, for them and their livestock. During 9 days in the field, we recorded 807 species of plants and 453 species of vertebrates—a singular assemblage of species from the Amazon, Orinoco, and Guiana Shield—with more than a dozen species new to science. **Discussion:** Strong geological, archeological, and biological arguments support creation of a 42,300-ha regional conservation area, with solid support from local campesinos. Nearby mining, oil, and road development projects—coupled with an institutional and political transformation as the peace process is implemented—add urgency to protecting the area now.

Keywords: Colombia, conservation, peace, campesinos, inventories

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Bat Monitoring in Cusuco, Honduras: Acoustic and Capture Comparisons

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Background: Neotropical bats, important components of ecosystems, are the principal predators of night-flying insects and contribute to pollination and seed dispersal; bat communities are also sensitive to habitat changes and can be used as indicators of ecosystem integrity. Anthropogenic habitat disturbance has motivated inventories of Neotropical bats, but because bats are nocturnal and aerial, surveys for species richness or population size are difficult. At Parque Nacional Cusuco, an important Honduran National Park under threat from development, Operation Wallacea has surveyed bats since 2006. In 2016, we incorporated acoustic surveys along with mistnetting to determine occupancy in different habitats and examine how well each method describes the local bat community. **Methods:** We surveyed 6 sites in Cusuco; each with 3-5 transects comprising 5 mistnets, opened for 5.5 hours per night. We deployed Pettersson's D500x ultrasonic recorders for 46 recorder-nights. These units recorded during the same time frame and near the mistnet transect. We downloaded the recordings to the program Sonobat v. 3.2.1. Sonographs generated by the program allowed visual identification of bat species. We compared the species recorded with those caught in nets. We also compared the number of bat passes recorded per night with the number of individuals caught in mist nets, keeping in mind that neither method allows us to estimate population size. We additionally examined the overlap of species between captures and recordings. **Results:** There was no difference between the number of species caught in mist nets and the number recorded, but there were significantly more recorded bat passes/night than the number of bats caught in mist nets. The amount of overlap in species was low between the two methods; less than 0.25 of the collections shared at least one species; the majority had no species in common. **Discussion:** Many biodiversity inventories are conducted to determine the uniqueness or species richness of a particular locale. These inventories generally use standardized methods (such as bird point counts) to examine species richness, population abundance, or find endemics; and are crucial to setting conservation priorities. Nevertheless, many species are so cryptic in behavior that they are difficult to survey. Bats are particularly tricky, and using both ultrasonic recorders and nets to survey these animals will yield a more complete inventory than mist net surveys alone.

Keywords: Bats, Inventories, Acoustic Monitoring, Honduras

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Biodiversity monitoring in the Calakmul Biosphere Reserve

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Background: The Calakmul Biosphere Reserve (CBR) is an UNESCO Mixed World Heritage Site of Nature and Culture of outstanding biodiversity and archaeological importance. The primary source of income for local communities is crop based agriculture and with a growing human population, forest encroachment is a concern. The only sources of water are lakes fed by rainwater, known locally as aguadas, which are disappearing in response to changing rainfall patterns. In a changing environment, biodiversity monitoring is paramount to reserve management. **Methods:** Annual biodiversity surveys have been conducted in the CBR by Operation Wallacea, a UK based non-governmental organization, in collaboration with Pronatura Peninsula de Yucatan (PPY) and the Comisión Nacional de Áreas Naturales Protegidas (CONANP) aimed at monitoring the impact of urbanization and climate change on biodiversity in CBR. The forest in CBR is not uniform and therefore data were collected across 5 different locations incorporating the latitudinal rainfall gradient, core and buffer zones. Each location contained four 2km transects along which surveys of birds, bats, large terrestrial mammals, herpetofauna and habitat were conducted between June-August from 2012 to present. **Results:** Bird and bat abundance and diversity was consistent across CBR, although the composition of feeding guilds varied considerably. Despite changes to water distribution, bird and bat abundance and diversity remain constant over time. As expected, herpetofauna diversity corresponded to the rainfall gradient across the reserve with abundance and diversity highest in the south of the reserve. Herpetofauna were the most affected by changing rainfall patterns with notable declines in herpetofauna abundance and diversity in all but the very south of the reserve. Abundance of large terrestrial mammals was initially notably higher in the core zone of the reserve in undisturbed forest far from human settlements, over time abundance has steadily increased in the more humid forest in the buffer zone of the south of the reserve. **Discussion:** Herpetofauna and large terrestrial mammals appear to notably affected by climate change in CBR, which is likely due to the disappearance of aguadas that is most prevalent in the core zone of the reserve. Wide ranging large mammals appear to have responded to changes in water distribution by ranging into the buffer zone of the reserve in search of water, where they are vulnerable to hunting.

Keywords: Biodiversity, climate change, Calakmul

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Oral session: Biodiversity inventories in tropical ecosystems II

Biodiversity threats in the Asian tropics

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Despite their high levels of biodiversity and endemism the Asian tropics are frequently forgotten in global discourse on tropical biodiversity loss. Here we explore the main threats to the regions biodiversity, evaluating their relative impact and exploring the prognosis for different parts of the region. Much of Asia has reached a point of almost no return with much of it's native biodiversity, with rates of undocumented road building in many parts of the region (i.e. 90% or roads in central Kalimantan are unmapped) symptomatic of the rapid rates of deforestation, and the rapid exploitation of native resources and species in these regions. We also discuss priorities for action and implementation, and the major barriers to implementing the necessary policy and management protocols to secure a future for the regions biodiversity. Finally we discuss the relative responsibilities of the West, as the end-buyers of many products and the role of intergovernmental agreements in trying to enforce various regulations (i.e. SDGs, Aichi targets) to try to change the trajectory of this region, and it's threatened biota.

Keywords: Conservation, deforestation, wildlife-trade, priorities, protection

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Tree diversity along elevation and forest-use intensity gradients in central Veracruz, Mexico

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Mountains are natural laboratories to study how species and communities change with elevation; they encompass sharp environmental gradients (e.g. temperature, precipitation, radiation) over short distances. Climatic variability and different forest-use intensities have a strong influence on diversity and distribution patterns of trees. In this study, we analyzed the composition and diversity of trees along gradients of elevation and land-use intensity on the eastern slopes of Cofre de Perote in central Veracruz, Mexico. We studied a total of 120 20 x 20 m forest plots (i.e. a total of 4.8 ha) located in eight study sites (between 20 and 3545 meter above sea level) within eight elevational belts of ca. 500 m. At each site, three habitats with different forest-use intensities were investigated: old-growth (OF), disturbed (DF) and secondary (SF) forest. We identified all trees with a DBH > 5 cm and measured diameter at 1.3 m and height. We recorded a total 309 tree species, from 69 genera and 127 families. The highest species richness per plot was found at 1000 m and the lowest species richness per plot was found in the uppermost belt at 3500 m. Plot-level richness was highest in OF (8,73 ± 1.67) follow DF (8,01± 1.62) and SF (5.8± 1,39). The highest species richness per belt-level was found in DF and SF at 1000 m, where Celastraceae and Fagaceae were the most abundant families. Similar results for medium forest use intensity were reported in other studies. In contrast, OF showed a peak at 500 m with 39 tree species per belt-level with Moraceae the most abundant family. The number of tree species per plot and belt level in OGF, SF and DF followed a bimodal pattern, exhibited the first peak at 500-1000 m and second at 2000 m and declined at the upper belts. The decline of tree species richness in the highlands might be due to low temperatures as well as a more difficult uptake of soil nutrients.

Keywords: species, richness, distribution, Cofre Perote

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Oral session: Biodiversity inventories in tropical ecosystems II

Oral Session
Ecology and conservation of tropical vertebrates

The history of salamanders from Volcan Nauhcampatepetl, Veracruz, Mexico

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Background: Mexico is the second most diverse country in terms of salamander species. This diversity is due the role played for the mountains regions in the diversification of plethodontids salamanders (family: Plethodontidae). The plethodontids distributed in narrows altitudinal bands; therefore, there is a high endemism in the mountains regions. Because to that, each mountain hosts a unique salamanders community, and few times is possible study its situation through the time. Our aim was evaluate the salamanders' diversity in an altitudinal gradient in the last 40 years. **Method:** The study site was the Volcan Nauhcampatepetl in Veracruz, Mexico, where the salamander community has been monitored for more than four decades. We sampled in four historic localities at different altitude (3000 m, 2500 m, 2000 m & 1000 m asl) plus two new localities at 3500 m & 1500 m asl. We estimated species richness and abundance for each altitude. To compare the diversity among the localities, we calculated the equivalent species number. Finally, we compared our results with the species richness, abundance and diversity recorded in the years 1976, 1981 & 1997. **Result:** We recorded 306 individuals belonging to 6 genera and 13 species. The intermediate altitudes (1500 m, 2000 m, 2500 m & 3000 m asl) presented the highest species richness. The 2500 m asl locality presented the highest salamanders' abundance, nevertheless, the highest equivalent species number (3.67) is presented in the 1500 m asl locality. On the other hand, the gamma diversity calculated was 5.23 equivalent communities. We observed fluctuations in the diversity trends through the years, mainly after the 1981 sample, whit low detectability of many salamanders' species. **Discussion:** Volcan Nauhcampatepetl is one of the most diverse regions in plethodontids species, due to the contribution of each one of its altitudinal bands. Until now, 18 species have been recorded in this region, all endemics to Mexico. Nevertheless, through the last 40 years, we were able to show alterations in diversity trends and most of the species are close to the extinction, some of them without description yet. Factors as habitat loss and land use change drivers these problems despite conservation efforts, additionally there is evidence of chitriodiomicosis, one driver of amphibians' extinction at worldwide, injuring the situation for these communities.

Keywords: Lungless salamanders, altitudinal distribution

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Oral session: Ecology and conservation of tropical vertebrates

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Assemblages of amphibians and reptiles in rustic cocoa plantations in southeast Mexico

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Background: The loss and degradation of tropical forests due to human activities have caused great losses of biodiversity, particularly in groups of organisms that are highly sensitive to disturbance, such as amphibians and reptiles. It is recognized that the conservation of tropical biodiversity not only depends on forest remnants, but also on other landscape elements. For example, agroecosystems in which the crop of interest is grown under the shade of a native-tree canopy are known for their high value for the conservation of numerous species. **Method:** The present study assessed the importance of shade cocoa plantations under rustic management as habitat for the assemblages of amphibians and reptiles. We sampled amphibians and reptiles, and measured 11 environmental variables, in 24 plots (12 in cocoa plantations and 12 in forest). We compared the structure and composition of the assemblages between both vegetation types, and determined which environmental variables, in each vegetation type, had a stronger relationship with assemblage parameters**. Results:** Species richness, species density and composition did not vary between vegetation types. Cocoa plantations had larger numbers of individuals of both taxa, and greater values of two diversity indices for reptiles, compared to forest. Among the environmental variables measured, litter cover, litter depth, presence of humus, maximum canopy height and density of herbs, had a positive and relationship with the abundance of amphibians in the cocoa plantations. **Conclusion:** Our results suggest that the rustic cocoa plantations studied are suitable habitat and have many environmental characteristics similar to the forest, providing good habitat conditions, at the local level, which allows the permanence of many species of amphibians and reptiles in the agroecosystem. Shade cocoa plantations could favor the conservation of amphibians and reptiles in the study region if they were to replace less 'environmentally-friendly' land uses, such as cattle pastures.

Keywords: Agroecosistems, tropical forests, diversity, conservation

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Acute Toxicity Variation of Chlorothalonil across Multiple Genera of Tropical Amphibians

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Toxicology studies can help to assess risks associated with environmental contaminants and influence management decisions. However, most toxicology studies to date have been limited to temperate species and measured under laboratory conditions. This leaves major gaps in the scientific understanding of impacts of pesticides in tropical climates where species declines are at their highest. Studies like these can be increasingly important in places like Central America, where chemicals are used at much higher rates and generally applied and managed indiscriminately. In this study, simple toxicity assays were performed under ambient laboratory conditions on 7 species of tropical amphibians to determine lethal concentrations and sub-lethal impacts on amphibian growth. Both survival and growth were significantly impacted by species and concentration. One species, D. phlebodes had the lowest LC50 value at only 11.1µg/L. Due to their bi-phasic lifestyles and sensitivity to environmental changes, amphibians can make model organisms for understanding impacts of contaminants to tropical wildlife. Knowing which species are most susceptible to pesticides and other contaminants may indicate which species we could lose first if the same agricultural practices are continually applied. This information may also help us to better understand the phenomena of global amphibian declines.

Keywords: amphibian decline, toxicology, tropical herpetology

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Large avian frugivores: A pantropical comparison of their diversity, seed dispersal and conservation

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Background: Large frugivorous birds in tropical rain forests can be comparable in size to their mammalian counterparts, with arboreal hornbills reaching the weight of a monkey and ground-dwelling cassowaries that of a bovid. These birds can also be very efficient dispersers of large seeds. But as primates and other seed-dispersing mammals are being extirpated out of ever increasing tracts of hunted rain forests, the role of large avian seed dispersers is likely to increase in these defaunated forests, so long as they can persist there. It is thus important to have detailed knowledge of this key ecological group. I aimed to comprehensively review and compare the diversity of large rain forest avian frugivores (>200g) over all four tropical continents and to assess their seed dispersing potential and conservation status. **Methods:** I selected relevant species in the literature and recorded their range, weight, habits and diet. Gape size will be measured on museum specimens. I extracted global conservation assessments from the IUCN Red List. **Results:** Preliminary results on all species but Columbidae (under collection) give a total of 302 species of large avian frugivores in tropical rain forests worlwide. America, with 148 species, has the greatest species richness, and Africa and Australasia the lowest (32 species each). Arboreal species are significantly heavier in Asia (mean weight 1.3kg) and lighter in Australasia (348g), while terrestrial species are significantly heavier in Australasia (mean weight 5.6kg) than on other continents. A total of 43% of all species are globally threatened or near-threatened. This figure rises to 62% for species weighing over 1kg. Besides, 78% of all species are declining. **Conclusion:** While their global situation is not as dire as that of primates, the conservation status of large avian frugivores is nonetheless very worrying. As dispersers of large seeds, the largest frugivore species (>1kg) are essential for many rain forest trees, and their endangerment threatens forest regeneration. Final data on diet, gape size and potential seed dispersal distance will further complete this study. I will also present world maps of species richness of large tropical avian frugivores in order to better compare their diversity across continents. Finally, I will review a pantropical set of protected areas and assess whether they are successful at protecting large avian frugivores in comparison to primates.

Keywords: Birds, Frugivores, Rainforests, Seed dispersal

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Corridors for tapirs in the Sierra Madre de Chiapas: a model based in a community monitoring program

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Background: One of the remains populations of the Baird's tapir (*Tapirus bairdii*) occur in the Sierra Madre de Chiapas (SMC), Mexico. However, the long term conservation of this population is threatened by habitat destruction and poaching. With the aim of established a long term strategy to conserve the tapir at the SMC, we identified the areas with high probability of tapir occupancy in this region and the areas of potential corridors to maintain the connectivity of this population. **Methods:** We implemented a camera trap survey during one year at the Frailescana Natural Protected Area which is a section of the SMC. This survey was implemented with the assistance of a group of monitors of the local communities trained in the camera trapping technique. We implemented occupancy models with the data obtained by camera traps combined with landscape covariates to determine the landscape characteristics correlated with the tapir occupancy. Additionally, we used the inverse of our best occupancy model to generate a resistance matrix to develop a model of connectivity through Circuit Theory approach. Finally, we categorized the areas of high probability of tapir occupancy and the potential corridors to establish conservation and management priorities. **Results:** According with the occupancy analysis the landscape covariates that best explain tapir occupancy in the SCM are elevation and terrain ruggedness (Shannon Index). This result suggests that the sites with high probability of tapir occupancy are the most inaccessible sites, located in the highest areas of the mountain ranges with rugged terrain. Additionally, we identified three habitat patches which could be occupied by tapir at the SMC, and the analysis through Circuit Theory indicated three key corridors to maintain the connectivity for tapirs at the SMC. **Discussion:** Our results showed the importance of the Frailescana Natural Protected Area to maintain the connectivity in the SMC. However, a large tract of unprotected forest located next the Frailescana Natural Reserve is crucial to maintain the connectivity for tapirs in this region, and decision-makers should encourage investment in this site for conservation, management programs, and habitat restoration to ensure the integrity of the SMC ecosystem. This study illustrates the importance to involve people of the local communities to develop sound monitoring programs and landscape plans for endangered species such the Baird´s tapir.

Keywords: *Tapirus bairdii*, conservation, Sierra Madre de Chiapas, connectivity, camera traps

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Oral session: Ecology and conservation of tropical vertebrates

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Assemblage of wild felines in a structural corridor in the northeastern of Antioquia, Colombia.

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Background: The Guadalupe-Porce structural corridor was born as a complementary conservation strategy in the northwest of the Antioquia, Colombia, with the purpose to guarantee the connectivity between two private reserves: Bajo Cauca Nechí and La Forzosa reserves. **Method:** Our main objective herein was to verify the effectiveness of this corridor. Henceforth, a feline assembly from this area with at least six different species (*Panthera onca*, *Puma concolor*, *P. yagouaroundi*, *Leopardus pardalis*, *L. wiedii* and *L. tigrinus*), was used as indicator group, because of their vulnerability to the loss habitat caused by fragmentation. 101 camera-trap stations were used to estimate the presence and relative abundance of these species. Analysis of forest cover and occupancy models were used to generate connectivity maps, displacement costs per species resistance and, specific habitats requirements. **Results:** For example, *Puma concolor* and *P. yagouaroundi* are generalist species with low displacement costs. On the other hand, *L. pardalis* and *L. wiedii*, require some forest cover for their displacement among patches. In contrast, *Panthera onca* and *L. tigrinus* are restricted to relicts of natural forests with low disturbance in both, lowlands and highlands respectively and they are characterized by high displacement costs. The habitats with low use by the species were those concentrated around urban centers. **Conclusion**: Therefore, most of the connectivity routes are have medium or low quality in terms of proper habitat that makes them susceptible to fragmentation. In order to protect these species restoration strategies must be done in order to guarantee the functionality of this biological corridor.

Keywords: wild felines, biological corridor, SIG

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Survival of jaguar and puma living in their ecological limits can be influenced by sampling area

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Background: The use of camera traps combined with statistical models is being used increasingly to assess species richness, abundance, and more recently to estimate survival of species in long-term monitoring programs. For big predators it has been proposed that the progressive increase of the sampling area would not affect the survival parameter. Those studies were conducted in habitats favorable for the species. In the present study we investigated survival of jaguar (*Panthera onca*) and puma (*Puma concolor*) in the Serra da Capivara National Park (SCNP), located in the semi-arid Caatinga biome of Brazil. The high temperatures of the Caatinga (up to 50°C) represent an ecological limit for felines. **Methods:** In 2007, we placed camera-traps covering an area of 35170 hectares in SCNP. During 2009-2011, we increased the number of cameras and the sampling area to 45310 hectares. We used a Cormack-Jolly Seber capture-recapture model to estimate survival for jaguars and pumas between 2007-2011 using two spatial configurations: 1) considering an area similar to the 2007 survey across the years and 2) considering the original sampling and the increase of area in 2009-2011. We considered constant parameters and also variations of survival (Φ) with sex. We used program MARK Version 8.1 and compared and selected models using Akaike Information Criterion. **Results:** We obtained records of 28 jaguars (15♂, 13♀) and 25 pumas (15♂, 10♀) in spatial configuration 1 and 30 jaguars (16♂, 14♀) and 31 pumas (17♂, 14♀) in spatial configuration 2. We found that in spatial configuration 1 the parameters for both sexes were similar (jaguarΦ♂= 0.840 ± 0.151, jaguarΦ♀= 0.783 ± 0.178; pumaΦ♂= 0.705 ± 0.204, pumaΦ♀= 0.724 ± 0.277) but in spatial configuration 2 there were differences associated with sex, especially for the jaguar (jaguarΦ♂= 0.911 ± 0.061, jaguarΦ♀= 0.740 ± 0.128; pumaΦ♂= 0.837 ± 0.232, pumaΦ♀= 0.911 ± 0.208). **Discussion**: Previous studies showed that the region of the Park covered in the 2007 sample is the most suitable for both species, which can explain the decrease in female jaguar survival in spatial configuration 2. The lower survival of male pumas in spatial configuration 2 may be associated with a stronger competition with dominant male jaguars. Future survival camera-traps studies of similar species should take into account the quality and suitability of habitat when increasing the sampling area.

Keywords: jaguar, puma, survival, capture-recapture, Brazil

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Oral session: Ecology and conservation of tropical vertebrates

Oral Session
Structure, function, and dynamics of tropical ecosystems

Seasonal and behavioral influences on diets of tropical ant communities in coffee agriculture

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Background: Coffee agroecosystems are constrained by a number of ecological factors, including pest damage. More than 200 different herbivores are cited as attacking coffee, several of which are considered economically important. Ants are ubiquitous in coffee agroecosystems and, while omnivorous, are also documented as important predators of multiple coffee pests. But species often shift foraging patterns depending on resource availability, and those resources vary seasonally. We performed a study of dietary niche breadth of ants in a coffee agroecosystem with various foraging strategies during the dry and rainy season. Using stable isotope analyses we compared seasonal and foraging differences in trophic signatures of ants. We hypothesized that ants that primarily forage in one vegetation stratum (i.e. trees or coffee bushes) should have a more narrow diet breath as compared with ants that forage across multiple strata. Similarly, ants should shift their strategy based on seasonal availability and should be more predaceous in the dry season as plant and nectar resources are not as widely available during the dry season. **Methods:** We collected 145 ant colonies representing eight different ant species across both the rainy and dry seasons. Four ant species were found nesting in both trees and in coffee bushes, 2 species were found only in trees and the remaining 2 were found only in coffee. For all colonies we collected leaf tissue from either the coffee or tree. The ants were collected from 20 different sites within a single 280 ha coffee farm. From each location we collected strict herbivore species and predator to provide relative comparisons of diet. **Results:** Stable isotope analysis of α´15N and α´13C revealed overall, significantly higher α´15N values in the dry relative to the rainy season. This pattern held in 6 of the 8 species when we examined the diet differences by species. Species that foraged both on trees and coffee had a significantly different diet composition than species that found exclusively on one stratum. Ant species found only in coffee had the highest overall α´15N and ants found only in the trees had the lowest α´15N. **Conclusions:** As future climatic shifts are expected to impact seasonality in these systems, this study contributes to understanding how such changes may alter ant diet preferences and predatory ant functions.

Keywords: trophic, ant, function, predation, behavior

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More than just species! Tribute to arthropod functional ecology

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Background. Arthropods represent most of terrestrial biodiversity and are known to perform most of the crucial ecosystem services. In tropical forest, especially, we have a very incomplete understanding of how arthropod communities are assembled taxonomically but above all functionally. Species that share similar functional attributes (but not necessarily a common phylogeny) may have similar effect on ecosystem functioning and are likely to have similar responses to climate fluctuations. We explore the merit of using arthropod functional classification with two examples from a macro ecological study and a monitoring program in tropical ecosystems. **Methods.** We present results of a comprehensive arthropod collection for each of the major forest habitat types found in Peru and French Guiana. We propose a reproducible arthropod functional classification among the 147 collected taxa based on similarity among 21 functional traits. Using an integrative taxonomy approach (traditional taxonomy and DNA barcodes), we also present a functional classification describing dispersal ability, seasonality and host specialization attributes and its application in long-term responses of Saturniidae on BCI Island, Panama (2009-2016). **Results:** First, we found that arthropod functional classification allows to identify seven distinct functional communities whose relative abundance contrasted strongly across different Amazonian forest habitats. In this context, functional approach provides an important complement to link patterns of species composition to differences in forest functioning across environmental gradients. Second, we explored the value of clustering saturniid species sharing similar functional attributes in biomonitoring program. Saturniidae appears rather homogeneous as far as life history is concerned, since they are all relatively polyphagous as larvae and short-lived as adults. However, our approach detected that saturniid species display distinct and contrasting functional attributes and those functional groups exhibited different time-series, possibly related to climate changes ongoing in Panama. **Conclusion:** Overall, these two studies suggest that the use of functional classification over taxonomic units may complement our ability to interpret results to our understanding of megadiverse arthropod diversity and the responses of invertebrates to environmental changes.

Keywords: arthropod, forest, functions, moth, climate

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Oral session: Structure, function, and dynamics of tropical ecosystems

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Findings from a towering orogeny: insect community structure across Ficus in Papua New Guinea

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Background: Plants, their pollinators and the insects feeding on them represent the majority of terrestrial diversity and all partners owe a great share of their diversity to intimate interactions with the others. A large proportion of this diversity comprises speciose tropical plant genera and their associated arthropod fauna, with much endemism being found in tropical montane habitats. However, few studies have been conducted in the context of species rich herbivore communities or along environmental gradients. We argue that both directions are logical steps towards understanding the real world significance of myriad plant defences. **Methods:** We collected data across a suite of key defensive traits from a community of 28 *Ficus* species growing in the lowlands and highlands of Papua New Guinea. We analysed the responses of entire caterpillar communities to plant defensive traits and/or elevation in the context of multigene community phylogenies. Within species analyses of population genetic structure were conducted for several species of *Ficus* and their pollinating wasps found growing along the 2,500 m Mt Wilhelm elevational transect. We tested for population genetic structure along our gradient in both figs and their pollinating wasps. **Results:** We showed that escalating traits (especially alkaloids and polyphenols) have a major effect on highly diverse insect communities, an enduring hypothesis that has proved hard to test. The responses of insect herbivores to these traits differed between phylogenetic specialists and generalists. The utility of different traits likely drives the formation of defensive syndromes consisting of complementary defences with contrasting evolutionary histories. We found contrasting patterns in defensive investment along our gradient, with alkaloids and polyphenols having opposing trends. We found population genetic clustering by elevation in montane *Ficus* species, corresponding to distinct turnover in caterpillar communities and pollinator populations. **Discussion:** Joint defensive syndromes create a variable defensive landscape for herbivores, shaping the hyper-diverse insect communities associated with Ficus. However, traits and herbivores can show strong turnover with elevation. Both plants and pollinator communities also show strong genetic turnover, suggesting a key role for elevation in generating plant, herbivore and pollinator diversity.

Keywords: Phytochemistry, populations, mountains, herbivores, pollinators

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Oral session: Structure, function, and dynamics of tropical ecosystems

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What factors drive leafcutter bees' plant preference for leaf foraging?

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Background: Leafcutter bees use plants not only as pollen and nectar sources, but also cut leaf discs and use them to line their nests. Which plant species they choose as nesting material and why have remained obscure, however. This information is vital if we aim to manage their habitats in a way that guarantees the persistence of these ecologically critical pollinators. **Methods:** We explored leaf choices of three *Megachile* species from a tropical humid warm climate in India by following bees and plants and recording the damage inflicted by the bees in the leaves. We asked:1) how are plant species used by leafcutter bees distributed across the angiosperms? and 2) are the most heavily used plant species natives or exotics? We compared the findings with our own findings in Southwest US desert in Arizona, and the secondary information from Canada (the only other such information available) to elucidate whether the pattern observed in the tropics was followed in other geographical regions. We used this global data to ask whether the plant choice differs across geographical regions, and if so, what drives this choice? Monitoring over 3000 plants of 208 native (60%) and exotic plants (40%, predominantly neotropical, palearctic, Afrotropical and Indo-Malayan origin) planted in the 3 sq. km. campus arboretum of University of Arizona we specifically asked whether leaf selection was predicted by clade, family, local abundance, or the geographical zone of origin of available plant species. **Results:** *Megachile* spp in tropical region used 59 species of plants belong to 49 genera and 25 families. About 77% of the plants used by the bees belong to rosid clade. 63% of the plants used by the bees were belonging to native species. Megachile in other two regions also showed a strong preference for plants in the rosid clade (70%-73% of the plants used by the bees), particularly the phylogenetic cluster of Fabales, Fagales and Rosales (together ~45%), suggesting that preferences are preserved at the higher taxa or at the root clade level. Membership in the rosid clade and Fabaceae family predicted bees' plant preferences, whereas the plant species' local abundance and geographical origin did not. **Discussion/ Conclusion:** We argue that consideration of leafcutter bees' plant preferences might help explain the underlying reasons for their cosmopolitan distribution.

Keywords: Megachile, distribution, herbivory, pollinator

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Oral session: Biotic interactions in tropical ecosystems

High degree of fission-fusion dynamics affords spider monkeys effective flexible adjustments

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Background: Spider monkeys (*Ateles* spp.) are characterized by a high degree of fission-fusion dynamics, in which group members are rarely all together but live in subgroups of variable membership that fission and fuse several times a day. They are therefore a model species to test whether fission-fusion dynamics affords the flexibility to make adjustments depending on the availability of critical ecological resources. **Methods:** We collected data at two field sites, where the longest continuous projects on individually identified spider monkeys have been carried out: Punta Laguna, Mexico and Santa Rosa, Costa Rica. Both lo-cations are highly seasonal in terms of rainfall and fruit production. Spider monkeys are mainly frugivorous, and females are the dispersing sex. We collected data by following subgroups of spider monkeys and recorded any change in subgroup composition and location, their activity patterns and social interactions. We also collected phenology data of a representative sample of trees of the most eaten species on a monthly basis. **Results:** We found smaller subgroups when food was scarcer, leading to a reduction of contest competition as aggression rates were not higher in the dry than in the wet season. Most aggression was directed by long-term resident females against newly immigrant females, possibly functioning in reducing scramble competition at the group level by limiting the number of individuals in the group. The flexible adjustment of subgroup size to food availability is reflected by larger subgroups not experiencing greater ranging costs than smaller subgroups. Other aspects of fission-fusion dynamics, such as cohesion and fission and fusion rates, increased when the foraging environment was more heterogeneous. This flexibility also allowed spider monkeys to respond to a drastic reduction of fruit availability in the aftermath of two hurricanes. Not only did they change their cohesion and ranging patterns, they also modified their activity budget and diet, with a drastic shift from fruits to young leaves. **Discussion:** Our results support the view that a high degree of fission-fusion dynamics affords spider monkeys the necessary flexibility to make effective adjustments to changes in food availability. Hence, our findings contribute to the view that the main advantage of fission-fusion dynamics is to reduce the cost of group living while maintaining its benefits. This flexibility probably allows spider monkeys to live in habitats where they could otherwise not survive.

Keywords: subgroup, cohesion, food availability, heterogeneity

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Oral session: Structure, function, and dynamics of tropical ecosystems

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Identifying the landscape sizes that best predict primate responses to landscape structure

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Background: Understanding the responses of species to changes in landscape structure is urgently needed to design adequate management and conservation strategies. Such responses can vary with the size of the area within which the landscape changes are measured. However, the most appropriate size to assess landscape effects on species (i.e. scale of effect) remains poorly known. Furthermore, the scale of effect may differ among landscape predictors, response variables, species life history traits and regional context. Here we assess the scale of landscape effects on Mexican primates. **Methods:** We assessed the spatial extent at which landscape structure (i.e. forest cover, forest fragmentation, mean inter-patch isolation distance and matrix permeability) best predicted changes in the occurrence (presence/absence) and abundance of each Mexican primate (*Alouatta palliata*, *Alouatta pigra* and *Ateles geoffroyi*). We selected four rainforest regions with different intensity of land use change and assessed 12 forest sites in each region. We verified site occupancy and estimated primate abundance. We then assessed the structure of the landscape surrounding each forest site (forest site-landscape approach) considering ten different-sized landscapes (50-1000 ha). We then evaluated the strength of the relationship between each landscape predictor and each response variable for each landscape size. **Results:** We found that forest cover and matrix permeability showed stronger effects on primates than forest fragmentation, especially when considering larger landscape sizes. The scale of effect was larger in spider monkeys than in howler monkeys, probably because spider monkeys have a larger home range size and higher vagility than howler monkeys. As expected, the scale of effect was higher for the occurrence of primates than for primate abundance. Finally, the scale of effect was smaller in more preserved regions than in those regions with lower forest cover and connectivity. **Conclusions:** Our findings support the idea that different landscape attributes operate on different response variables at different spatial scales. Therefore, the scale of effects cannot be generalized to all response variables and to all predictors. A multi-scale analysis will be required to accurately assess the impact of landscape structure on species' responses.

Keywords: Landscape heterogeneity, scale dependency, monkeys

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Oral session: Structure, function, and dynamics of tropical ecosystems

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Evidence of niche divergence among coexisting species in temperate and tropical forests

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Background: Recent studies in ecology have focused on the use of functional traits as proxy to understand fundamental mechanisms explaining community assemblage and ecosystem processes. Such studies, however, have neglected belowground plant traits, even though fine roots (< 1mm in diameter) play a key role in resource acquisition and plant interactions. At global scales, there is evidence of a trend to finer roots, longer specific root length (SRL) and higher tissue density with decreasing temperature, suggesting a strong filtering effect of freezing temperatures on the maximum root diameter species can achieve. However, these studies involved individual species and still lacking are studies of roots across entire communities. **Methods/Results:** Here, our goal was to quantify the natural occurrence of belowground functional traits in natural conditions across a latitudinal gradient. We conducted our study in a temperate hardwood forest in northeast Ohio and compared results to a subtropical hammock forest in South Florida, and an Amazonian forest in Manaus Brazil. In each area, we collected 200+ 15 cm deep soil cores and separated individual fine roots. In the case of the Amazonian forest, surface roots growing on organic matter were analyzed separately. Using image analysis techniques, we measured five functional root traits including mean diameter, SRL, root tip abundance (SRTA) and root tissue density (RTD). Additionally, we measured 17 different soil variables from each sample. **Conclusions:** Our preliminary findings indicated that 1) There is a decrease in functional trait diversity from tropics to temperate areas, with finer, denser roots in temperate forests. 2) There was a significant trend for lower SRL and SRTA and higher RTD as soil resources increased within forests, although within site variation was smaller than among site variation. 3) Root trait variation was directly correlated with species diversity, suggesting similar mechanisms limiting root diversity and species diversity at latitudinal scales. We believe that this study highlights the importance of belowground factors in shaping the structure of plant communities and opens new avenues to include root systems in modeling systems based on functional traits.

Keywords: functional traits, root traits, roots

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Oral session: Structure, function, and dynamics of tropical ecosystems

Oral Session
Fragmentation effects on ecology of plants and animals

Use of corridors and fragmented landscapes by white lipped peccaries in French Guiana

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Background: The white lipped peccary is known as a key species for neo-tropical ecosystems, including its human component. It is considered as an ecosystem engineer, their large herds moving across large areas and deeply affecting plant survival, recruitment and spatial distribution through seed predation, dispersal, trampling and rooting. They positively modify the habitat suitability of many anurans species by creating wallows; their large biomass and herd size represent crucial protein resources for large feline predators as well as forest-dwelling peoples. In some countries, controlled sustainable management also provides hide and commercial incomes. Their spatial behavior is still misunderstood over their distribution range, because probably greatly varying according to local ecological conditions. In French Guiana, the species experienced, as in some other Amazonian countries, a great decline over the last 10 years, and is progressively recovering. Most of the country is covered by continuous evergreen tropical forest, but the coastal area present different human and ecological conditions. Most of the human development occurs on this part of the department, whose environment consists in wet and dry savannas embedded with forest corridors and mangrove. **Method:** Several white lipped peccaries from two different herds were marked with GPS collars and monitored over several months (1-7). Fixes were recorded every 2-4 h and transmitted by satellite. **Results:**The study is still running to get accurate annual home range estimates and seasonal occupation, but results on habitat and paths utilization through the patchy habitat reveal fundamental traits for the conservation strategy of the species. The forest habitat is heavily preferred, and even narrow old sandy barrier forests could be of high importance for connectivity. Small patches of savanna are avoided, and open areas are crossed, when needed, at the narrowest points. These small forest patches may also be crucial for food supply, as they host high densities of palm trees. **Conclusion:** Human impact in this area may be locally strong (an international airport and the European spatial center are within the study areas), but understanding ecological requirements of this "landscape species" and controlling hunting and landscape management allows to maintain this emblematic and crucial species in the ecosystem.

Keywords: *Tayassu pecari*, corridor, habitat, conservation

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Oral session: Fragmentation effects on ecology of plants and animals

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Understanding land-cover change and its impact on biodiversity in a fragmented landscape in Ecuador

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Background: Tropical regions are experiencing complex land-cover changes. Mapping these changes is one of the hottest topics of remote-sensing research, particularly in fragmented landscapes. Accurate land-cover classifications are necessary to explore the consequences of land-cover and forest fragmentation on species diversity. This research focuses on tropical dry forest cover and associated changes in coastal Ecuador. The study region of 19,000 ha is part of a biodiversity conservation hot spot. Our objectives were to: i) understand the geographic extent of major land-cover types, which include: pastureland, old growth forest, plantation forest; ii) evaluate the impact of land-cover and forest fragmentation on tree species diversity. **Methods:** Landsat 2013 (dry season) and 2015 (wet season) images were used to classify the study area into forest, plantation forest of mostly introduced teak, pastureland, water, and built areas. As classification approach, we used a Random Forest Classifier (RF) with 94 predictor variables that included Landsat bands, band ratios, vegetation indices, and image transformations for each season. To evaluate the impact of land-cover and forest fragmentation on tree diversity, we use the generated map and tree species inventories of old growth forest (N=8) and secondary forest (N=13). We used a generalized linear mixed model (GLMM) to test the effect of species level, plot-level, and patch-level predictors on tree endemic species occurrence. **Results:** The proportion of correctly classified training points (PCC) of the RF classification was 95%, Kappa index was 94%, indicating high classification accuracy. Variables of the dry season were predominantly used to classify pastureland and forest. About equal number of variables from the dry and wet seasons were used to classify forestry plantations. The GLMM used wood density (species-level) as the only significant predictor. Distance to road and land-cover successfully helped predicting tree endemic species occurrence contingent to species identity. **Conclusions:** The RF highlights that while difficult to differentiate, forestry plantations could be classified using satellite images when seasonal data is included and through advanced classification algorithms. The GLMM indicates the importance of species traits to explain endemic species occurrence. The varied effect of distance to road and land-cover highlights a differential response of endemic species to human disturbance.

Keywords: Remote sensing, biodiversity, fragmented landscape

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Oral session: Fragmentation effects on ecology of plants and animals

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Forest fragmentation effects on vertebrate seed predators and rates of post-dispersal seed predation

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Introduction: Seeds deposited on the rainforest floor often experience high rates of predation by ground-active vertebrates. Species composition of vertebrate assemblages can be substantially altered by fragmentation, which may in turn lead to changes in patterns of seed predation and altered patterns of tree recruitment. We investigated the effects of rainforest fragmentation on the species composition of vertebrate post-dispersal seed predators, their feeding behaviour and patterns of seed predation across a community of tree species in subtropical eastern Australia. **Methods:** Across six sites in continuous forest and six sites in fragments, levels of seed predation were measured by establishing experimental seed stations using the seeds of 20 tree species. Simultaneously, vertebrate seed predators were recorded by deploying automated infra-red video cameras focused on seed stations. Cameras and seeds were deployed for five nights, after which the fate of seeds was recorded and camera data were used to identify seed predators and quantify their interactions with seeds. **Results:** Across all sites, seven vertebrate taxa were identified as "common" seed predators, occurring in six or more sites. The abundance and feeding behaviour of six taxa was significantly affected by fragmentation, however the direction of response varied among species: two small mammals (*Rattus fuscipes* and *Melomys cervinipes*) suffered reduced abundance in fragments, while two small seed-eating birds (*Chalcophaps indica* and *Leucosarcia melanoleuca*), a large mammal (*Trichosurus* sp.) and a small mammal (Rattus rattus) increased in fragments. For each taxon, levels of destructive interest shown in seeds increased in the habitat of increased abundance. As with seed predators, fragmentation effects on seed predation were highly variable among species, varying in both the direction and extent of change. Nested ANOVA results showed a strong statistical interaction between habitat type (fragment and continuous) and seed species. Five species experienced significantly greater predation in fragments, and five species significantly less than in continuous forest. **Discussion:** Fragmentation led to species-specific changes in patterns of seed predation across a community of tree species, which may be related to the vertebrate predator species turnover observed between habitat types. Consequently, long-term changes in community-wide patterns of plant recruitment in rainforest fragments are expected.

Keywords: Seed predation, mammal, bird, recruitment.

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Oral session: Fragmentation effects on ecology of plants and animals

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Rodent abundance in fragmented rainforest landscapes: testing the rodentization hypothesis

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Background: The combined effects of rapid forest loss, fragmentation, and disturbance in the tropics threaten a large number of species, but a small subset of disturbance-adapted species (winners) may proliferate in human-modified landscapes. This may be the case of some species of small (and highly fecund) rodents, which can increase in density over time, causing a series of ecological cascades associated with the increased predation of small seeds. There is, however, scarce evidence on this "rodentization" hypothesis, especially for species-rich ecosystems, such as the Lacandona rainforest, Mexico. Such a knowledge gap is largely related to the scarcity of long-term studies, which precludes the assessment of population trends through time. Here, we assessed spatial and temporal (2011-2016) variations in population trends of small rodents, and related such trends to spatial and temporal variations in landscape structure to identify some possible drivers at the landscape scale. **Method:** Using a forest site-landscape approach, we sampled 4 species of terrestrial rodents in 12 forest sites in 2011, 2012, 2014 and 2016, and assessed how variations in the abundance of individuals of each species were related to spatial changes in the landscape surrounding each forest site. We considered spatial attributes related to landscape composition (i.e. percentage of forest cover and open-area matrices) and configuration (i.e. density of forest fragments, forest edge density, and mean inter-patch isolation distance). **Results:** The total number of individuals was almost two times higher in 2016 (n =153 individuals) than in 2011 (n =78 individuals), especially the number of *Oryzomys* sp. and *Heteromys desmarestianus*, with a twofold increase in both cases. Yet, the abundance of Peromiscus mexicanus was four times lower in 2016 than in 2011. These population tendencies can be mainly related to the fact that landscape forest cover decreased through time, as the abundance of individuals was negatively and principally related to forest cover. **Conclusion:** This study reinforces the idea that landscape composition shows stronger effects on biodiversity than landscape configuration. Forest loss seems to have a negative impact on some small rodents (losers), but favor the proliferation of others (winners), thus supporting the hypothesis that there is an ongoing rodentization process in this moderately-disturbed biodiversity hotspot.

Keywords: Landscape, habitat loss, fragmentation, rodents

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Assessing the importance of landscape configuration and scale in determining large cat predation

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Background: Livestock predation by large cats represents a threat both to livestock production and to large cat conservation when retaliation occurs. While predation may be driven by the surrounding fine-scale landscape attributes, it can also be explained by the broader landscape around a kill site. Furthermore, while landscape composition is often considered for its influence on depredation, landscape configuration has been overlooked. We aimed at understanding the relationships between land-use and the risk of livestock predation by large cats (jaguar, *Panthera onca*, and puma, *Puma concolor*) at different scales. **Methods:** We collected GPS data on attack and non-attack sites in the region of Calakmul, which hosts the largest population of jaguars in Mexico, and obtained additional information relative to livestock management through 165 interviews with ranchers. We derived ecological and anthropogenic variables from a land-use map at four scales relevant for large cats (0,5 km, 2,5 km, 5 km and 10 km-radius). We also realized the first assessment of large cat impact in the region. **Results:** Depredation was the second cause of cattle losses after diseases, accounting for 588 cattle losses (26% of total losses) over two years, affecting 51 ranchers. Generalized linear models showed that the percentage of mature forest and human pressure influence the occurrence of large cat attack at all scales. However, we did not find any relationship between attack occurrence and livestock management. Aggregation of mature forests was also important to understand the occurrence of jaguar attack at larger scales, stressing the importance to consider landscape configuration in our understanding of depredation. **Discussion/Conclusion:** By considering the influence of scale on variables explaining predation, especially landscape configuration, we make it possible to better support conservation management measures at the appropriate organizational level. For instance, livestock management might be better addressed at a community level, whereas landscape fragmentation will be better tackled at a regional or state level.

Keywords: jaguar, puma, livestock-depredation, landscape, Mexico

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Effect of landscape structure on the density of a tropical palm in a fragmented biodiversity hotspot

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Background: Forest loss and fragmentation threatens biodiversity maintenance, both directly and indirectly through cascading effects. The demographic explosion of *Astrocaryum mexicanum* in Los Tuxtlas Biology Station (LTBS) Mexico is a good example, as such a proliferation of this native understory palm species apparently driven by forest fragmentation and defaunation limits the recruitment of other plant species. Yet, it is still unclear (i) whether this palm is proliferating only within LTBS or affects other forest sites within the Los Tuxtlas Biosphere Reserve; (ii) the main predictors of palm density; and (iii) the effect that changes in palm density can have on tree diversity and structure at larger spatial scales. Here, we assessed the patterns and landscape predictors of the density of *A. mexicanum* in this Biosphere Reserve, and evaluated the effect of palm density on understory trees. **Methods:** We estimated the density of adult palms in 20 forest sites distributed through Los Tuxtlas region, particularly in ten 50 x 2 m plots (0.1 ha) per site. Within each plot, we also recorded the species richness, stem density and basal area of all understory trees.Then we related palm density to two metrics of landscape composition (i.e. percentage of forest cover and open-area matrices) and two metrics of landscape configuration (i.e. number of forest patches and mean inter-patch isolation distance). Such metrics were measured in eleven buffers (landscapes) of 50 to 1000 ha from the center of each forest site to identify the landscape size that best predicted palm responses. **Results:** We recorded 846 palms in 2 ha. Palm density was more strongly and negatively related to the percentage of open-area matrices and to the number of forest patches (degree of fragmentation). Palm density also decreased with the increment of inter-patch isolation distances. The density of *A. mexicanum* was negatively associated with species richness, stem density and basal area of understory trees. **Conclusions:** Our findings suggest that palm density increases principally in well-connected forest sites exposed to lower edge effects, and that such increase can limit forest regeneration. Thus, to prevent the potential biological impoverishment associated with the proliferation of this species, we should monitor palm populations, and when/where necessary, control their populations actively managing their flowers, seeds, seedlings, saplings, and/or adults.

Keywords: fragmentation, rainforest, proliferation, recruitment, conservation

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Oral Session
Ecosystem services and tropical ecosystems

Frugivory and seed dispersal by birds provides an ecosystem service

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Background: Species interactions like pollination and pest control are well known ecosystem services. In the tropics, frugivory (eating fruit) by mobile organisms is also an important species interaction that influences plant success by increasing germination through consumption or dispersal. Yet, frugivores like birds are rarely considered and valued as ecosystem service providers through seed dispersal. As frugivore assemblages are in global decline it is critical to understand and communicate the ecological mechanisms and social dimensions of these species interactions for tropical biodiversity conservation and ecosystem service continuation. **Methods:** In this study, we use an accidental experiment on the Mariana Islands to elucidate the role of frugivory and seed dispersal for maintaining a culturally and economically important plant, the donne' sali chili. One island (Guam) has lost nearly all its native frugivorous birds due to an invasive snake, whereas nearby islands still have relatively intact bird populations. We predicted that frugivore loss would influence chili recruitment and abundance, which could have economic and cultural impacts for local people. We conducted gut-passage trials with birds, distance-dependence experiments in the forest, plant surveys on all islands, and social-economic valuation surveys. **Results:** We confirmed that birds were the primary seed dispersers using video observations, and found that gut passed seeds by birds were three times more likely to germinate, and germinate more quickly, than seeds from whole fruits. Further, we found in the field that gut passed seeds at far locations from conspecific plants had a higher survival than whole fruits next to plants. We observed lower chili abundance on Guam than on islands with birds. In a survey questionnaire of island residents, the majority of respondents reported an association between the wild chili and local cultural values and traditions. In addition, we identified a thriving market for chili products. **Discussion:** Our results provide consistent evidence that birds benefit chilies. We found spatial and condition-related benefits of frugivory and dispersal by birds, which was confirmed by low plant abundance in the absence of birds. Further, wild chilies are valuable to people in the Marianas both as consumers and producers. We provide this study as among the first to document frugivory and seed dispersal as a regulating ecosystem service in the tropics.

Keywords: seed dispersal, ecosystem services, Marianas

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Ecosystem service production is decoupled from native forest cover in novel pasture ecosystems.

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Background: Novel ecosystems are assemblages of species occurring in historically novel combinations and relative abundances, as a consequence of human activities. Livestock pasture introduced into tropical forest biomes meet these criteria, and understanding how they co-exist and interact with native forest habitat patches to contribute the multiple goals of biodiversity conservation and ecosystem service maintenance is a key priority in tropical systems. **Methods:** We explored how landscape structure influences biodiversity and associated services in novel Neotropical pasture ecosystems through a field study of dung beetle (Coleoptera: Scarabaeidae: Scarabaeinae) and beetle-mediated waste removal service rates in 12 3-km landscapes spanning across a 10-60% forest cover gradient in the Brazilian Atlantic Forest. We quantified the evidence that ecosystem service rates increase at higher levels of native habitat cover (expected if beetles in native forest fragments 'spillover' into pasture to perform services), or alternatively that ecosystem service rates increase at higher levels of introduced pasture (expected if services are being performed by generalist species characteristic of cattle pastures). We established the most appropriate spatial scale at which to model dung beetle biodiversity and ecosystem services in pasture habitats, and used generalized linear mixed models to test the influence of forest cover on dung beetle abundance and service rates, modeling forest specialist and generalist/open area specialists separately. **Results:** Overall, we found exceptionally low rates of beetle-mediated waste removal in pastures across all landscapes (~ 4%/ 48 hr), with pastures supporting exceptionally low beetle abundance, and a paucity of forest specialist beetles. We found no relationship between service rates and landscape characteristics or abundance of either forest specialist or open area/generalists. These results suggest that biodiversity-mediated ecosystem services in novel tropical pasture habitats are not provided by forest species spilling over into matrix habitat and may be decoupled from conservation management activities that increase forest cover. **Discussion and/or conclusion:** We provide evidence suggesting that linkages between ecosystem function, landscape characteristics and biodiversity cannot be assumed in all ecosystems, are context dependent and can be dismantled by management of matrix habitat.

Keywords: Novel ecosystems, ecosystem services, biodiversity

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Frugivory by mammals in continuous areas of Atlantic Forest, Brazil

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The absence of large frugivores in tropical forests can directly affect the process of natural regeneration, since these animals consume, predate or disperse seeds. As the Atlantic Forest is suffering a severe defaunation in most of its range we aimed in this study to evaluate the mammal communities and frugivory events in fruiting trees in four protected areas: Serra do Mar State Park - Itamambuca (IB) and Vargem Grande (VG), Carlos Botelho State Park (CB) and Cardoso Island State Park (CI). So were installed camera traps (video mode) under 112 fruiting trees. We sample 97.344 hours over a period of one year and we register a total of 32 species of mammals and 22 species of frugivores in total. Regarding the frequency of registrations, it presented ten distinct groups, with emphasis on the ungulates (1427), small rodents (399), followed by carnivores (173). However, large frugivore such as *Tapirus terrestris* appeared only in CB and IB. The species that consumed more fruits were Tayassu pecari (52.6%) and Guerlinguetus brasiliensis (26.1%), while the ones that consumed less fruits were the small rodents or marsupials (9.9%), *Cuniculus paca* (8.1%), *Eira barbara* (1.8%), and *Tapirus terrestris* (1.3%). Small fruits (8 to 18 mm) were consumed more in CB, VG and CI, while large fruits (30 to 40 mm) were consumed more in IB. This may have happened because VG and CI showed absence or few individuals of large frugivores and the abundance of small frugivores, such as rodents, which could favor the removal or predation of small fruits, while that IB presented large frugivores such as *Tapirus terrestris*, *Tayassu pecari, Pecari tajacu* and *Mazama* sp., favoring the removal or predation of large fruits. The areas have presented different compositions of mammal communities, for example, areas where large frugivores no longer appear, the consumption of large fruits is practically non-existent. Areas with no large frugivores could suffer several impacts in relation to the services provided by the fauna; so the knowledge of the interactions between plants and animals in native tropical forests and how the absence of large frugivorous mammals can affect the structure and the community of plants becomes increasingly necessary. FAPESP #2014/09300-0 #2014/01986-0

Keywords: Tropical forest; Dispersal of seeds

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Multi-scale effects on biodiversity and ecosystems services provision in coffee plantations

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Background: Crop pollination and pest control services in coffee plantations are among the most well know ecosystem services in agricultural landscapes. The provision of those services is usually related to the proximity and amount of nearby forest patches, which are usually considered as the main supplier areas of species responsible for service provisioning. However, despite this general knowledge, we still poorly understand how ecosystem services are related to native species composition, and how landscape structure modulates services at different spatial scales. Here we analyze how different landscape structural parameters and species composition are related to pest control and pollination in sun coffee plantations in the southeastern Brazil. **Methods:** We selected ten landscapes presenting a wide range of forest and coffee amount, and different landscape composition. In each landscape, we evaluated fruit set and herbivory in different coffee shrubs, using floral exclusion experiments for pollination assessment and flying vertebrates (birds and bats) exclusion for pest control evaluation. **Results:** Results suggest that pollination and pest control can considerably increase coffee fruit set, and that services are modulated by processes occurring at different spatial scales. Service provision is not necessarily higher close to forest patches, depending on a complex network of biological interactions, which is modulated by the interaction of forest cover at landscape and local scales. **Discussion:** In those systems where multiple species, which perceive the landscape differently, are providing ecosystem services, a multi-scale approach is needed. Our findings can be used in conservation and agricultural planning to maximize crop production while safeguarding native species and the services they provide.

Keywords: Pollination, pest control, landscape ecology

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Alternative views of payment for ecosystem service schemes: an example from Guatemala

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Background: Payment for Ecosystem Service (PES) schemes are voluntary market-based conservation approaches involving transactions between consumers and providers of well-defined ecosystem services. PES has grown in popularity over the past decade, buoyed by successful national programs. However, there is concern whether PES leads to community-level improvement re: poverty, conservation, and equality. It may lack sensitivity to local realities of cultural dynamics, power relations, and social diversity. As a result, many are looking at ways PES is contested or altered by local actors to reflect local realities. In Guatemala, the Totonicapan Communal Forest, managed by the 48 Cantones is the source for 5 major rivers. In 1996, the community contested and rejected a local non-profit organization's attempt to implement PES for watershed services. Currently, some individuals participate in one of two national PES forest service schemes; part of the forest is enrolled in programs by the municipal government. **Method:** We examine how local political, social, environmental and cultural dynamics lead to the contestation and reshaping of PES by local actors in Totonicapan. We use participatory development methods, focus groups, and interviews to address these questions: (1) What approaches have local actors in Totonicapán used to contest and reshape PES-schemes at national, regional, and local levels over the past 20 years? (2) What political, social, environmental and cultural factors influence the community's decision to contest and reshape PES and why? (3) In what ways has PES been reshaped and what do various actor groups perceive as the pros and cons of theses changes? We will further explore these questions with Guatemalan discussants at a Duke University symposium in April entitled Alternative Discourses on PES in the Global South. **Result:** There are questions surrounding the future of the community's involvement with PES, especially with the rollout of a new program called ProBosque. Contestation and reconfiguration of PES schemes is openly discussed in Totonicapán, demonstrating that PES schemes have entered a new era, where strict upstream-downstream, payee-payer relationships are no longer the norm. **Discussion:** In a community like Totonicapan, payment and incentives come not in the form of cash but in voluntary service commitments and traditions. Any PES or PES-like program must enable community members to continue their successful conservation work.

Keywords: PES contestation alternatives forests watersheds

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Pollination services to *Cucurbita moschata* crops during contrasting seasons in tropical dry forest

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Background: A decline of managed and wild pollinators has caused a reduction in fruit and seed production of crops in many regions of the planet. Studies investigating the efficiency and seasonal dynamics of pollinators on crop species will help to develop management practices to ensure global food security. In this work, we analyzed the seasonal variation in natural pollination services provided to the monoecious *Cucurbita moschata* in a highly seasonal tropical dry forest of the coast of Jalisco, Mexico. We studied the pollinator community composition, the foraging behavior and efficiency of the main pollinator of C. moschata. We also evaluated the reproductive success of C. moschata in the dry and wet season. **Method:** We studied the pollination of *C. moschata* in two fields in 2014 and three fields in 2016, during the dry and the wet seasons. We filmed flowers of C. moschata, registering the species, and frequency and duration of each visitation of the pollinators that contacted flower sexual organs. We collected pollinators of each species and analyzed the plant species composition of their pollen loads. We compared fruit and seed set of the two seasons of the following pollinator exclusion experiments conducted on virgin pistillate flowers: a) one visit of *Peponapis* spp., b) one visit of *Trigona fulviventris*, c) one and d) three visits of *Apis mellifera*, e) pollinator exclusion, and f) open pollination. Result: The main pollinators of *C. moschata* differed between seasons. During the wet season, bees of the genus *Peponapis* dominated the community, while in the dry season, the generalist social bees Apis mellifera and Trigona fulviventris dominated the community. We found differences in pollination efficiency among the main visitor species of *C. moschata*, being the genus *Peponapis* the most efficient. However, we did not find significant differences in fruit and seed set between seasons of open pollinated flowers, showing that the abundance of A. mellifera compensates its low efficiency. **Conclusion:** The community of pollinators can change throughout the year for the same crop species. In *C. moschata*, *Peponapis* spp. is a key pollinator group during the wet season, while other species provided pollination services during the dry season, when *Peponapis* spp. are absent because of diapause. Our study showed the importance of seasonality on pollinator dynamics and its implications for the management and conservation of pollination services to crops.

Keywords: Wild bees, Pumpkin pollination, *Peponapis*

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Primate-mediated ecosystem services: Implications for human reliance on forest resources in Nigeria

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Background: The world's forest ecosystems provide ecosystem services that are beneficial to humans. Depending on the nature of this reliance, the increasing degradation of forest ecosystems may lead to a substantial loss of resources valuable to humans, especially rural inhabitants in the tropics. **Method:** We combined socio-economic and ecological data to study the nature of the reliance of rural households on forest resources and their use of the forest for hunting and the extraction of other resources in and around the Cross River National Park in Cross River State, Nigeria. We also evaluated the economic implication of the ecosystem services provided through primate seed dispersal in comparison with those of other dispersal modes. **Results:** Nearly all households (147 out of 149) relied on forest resources for a substantial part of their livelihood. Contrary to current understanding, the most important use of the forest was for the extraction of fruit and/or nuts (rated most important by 120 (71 %) household), while hunting was considered important by 28 (13 %) of households. We also found that 95% and 86% of primate-dispersed trees utilized by rural households provided fruit and/or nuts and other non-timber forest products (NTFPs), respectively, showing that these trees are significantly more important for human sustenance than trees regenerated through other dispersal modes. Furthermore, we found evidence that primate-mediated seed dispersal considerably enhanced the regeneration of quality timber species. **Discussion & Conclusion:** Our results highlight the strong dependence of rural communities on forest tree resources above wildlife extraction. We thus stress the importance of maintaining viable primate populations to ensure the continuation of important ecosystem services for human wellbeing, especially for forest dependent people.

Keywords: Primates, tropics, ecosystem services

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Canopy connectivity increases ant-provided biocontrol services in a tropical agroforest

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Background: In tropical ecosystems, ants are among the most abundant and biodiverse taxonomic groups, and play important ecological roles such as predation, herbivory and seed dispersal (Longino et al. 2002). Canopy connections are important structural resources for arboreal ant communities, because they facilitate resource discovery (Powell et al. 2011, Clay et al. 2010, Yanoviak and Schnitzer 2013). In agroforestry systems, ants provide predation services, but especially in more intensive systems, with fewer trees, a lack of canopy connectivity between shade trees, or between shade trees and crop plants may hinder ant abilities to provide ecosystem services. We examined whether increasing canopy connectivity in coffee plantations increases ant activity and enhances biological control of the coffee berry borer, the most devastating insect pest of coffee. **Methods:** The present study was conducted in 20 sites within a 300 ha shaded coffee plantation in the Soconusco region in Chiapas, Mexico. The coffee plantation is located at 1100 m a.s.l. in the Sierra Madre Mountains. We used jute strings to create canopy connections between *Inga micheliana* shade trees containing *Azteca sericeasur* ant nests and coffee plants and then compared ant activity and coffee berry borer removal before and after placement of the strings, and on coffee plants with and without strings. We performed Generalized Linear Models (GLM) and Generalized Linear Mixed Models (GLMM). The models considered site as a random factor and were performed using the 'lme4' and 'MASS' packages in R. **Results:** Our results show that ant activity increases after the placement of strings in both treatment and control plants, as well as ant activity on trees. However, connected coffee plants had a significantly higher ant activity than treatment plants. This result could be explained by the relatively easy access to these linear and narrow pathways and higher recruitment rates, as has been shown in previous studies (Clay et al. 2010). The increase in ant activity could explain a higher rate of prey capture observed in connected coffee plants. **Conclusions:** We demonstrate that favoring connectivity and structural complexity at the local scale, by artificially adding canopy connections in the arboreal substrate, promotes ant activity on coffee plants, favors resource discovery and therefore increases coffee berry borer removal.

Keywords: Canopy, connectivity, ants, pests, coffee

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Oral Session
Social and economical drivers of tropical ecosystem change

Rethinking conservation: linking economic globalization to changing traditional landscapes

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Background: Economic globalization is a driving force of change to traditional landscapes. Traditional landscapes conjoin biodiversity and indigenous cultural heritages, have valuable conservation potential, and are widespread across the tropics. In México, slightly more than half (52%) of all land and 80% of forestland consist of approximately 30,000 traditional landscapes, under the stewardship of over 60 indigenous groups. These landscapes are primarily governed under the ejidal system, a common-property type of landholding involving small-scale subsistence agriculture. But, land tenure in these landscapes has been shifting from collective to individually managed parcels. In this context, ejidos are a prime example of traditional landscapes influenced by economic globalization. **Methods:** Through spatial analysis we explain how economic globalization alters political-economic and environmental relationships in Yucatán, México. We highlight shifting land tenure as a prominent mechanism driving changes to ejido landscapes, and we clarify processes of change that these landscapes experience due to economic globalization. Specifically, we use spatial analysis to show how agricultural commodity chains influence ejido land tenure, consequently drive changes to Maya livelihoods and land use, and ultimately impact ecological landscape and biodiversity patterns. **Results:** We expect to show that as ejido land tenure shifts and Maya livelihoods transition there is a dispersion of traditional land uses across ejido landscapes and increased intensification of certain farming practices within individual parcels. As a result, it is expected that land cover becomes more fragmented, and patches of land that previously harbored high levels of biodiversity are degraded and diminished in ways that have no historical precedence. **Conclusions:** Ejidos have remarkable conservation potential. More broadly, similar traditional landscapes across the tropics are equally influential, sensitive and responsive to local biodiversity conditions. If conservation is to stave off global biodiversity loss, conservationists urgently need to rethink conservation strategies, in ways that incorporate analyses of global-to-local change to better protect biodiversity at all levels.

Keywords: Economic Globalization; Changing Traditional Landscapes

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Intensive cultivation of fertile soils does not reduce the area used for shifting cultivation

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Background: The most widespread form of small-scale agriculture in Amazonia is shifting cultivation, which is generally well adapted to low-fertility soils that predominate in Amazonian uplands. When intensified, shifting cultivation systems show a decline in productivity and farmers may expand them into surrounding forests. However, in Amazonia patches of Amazonian Dark Earths (ADE) also occur; these are anthropogenic soils with enhanced carbon and fertility that resulted from the activities of pre-Columbian populations. ADE have been considered a model for sustainable agriculture, based on the idea that by recreating their high soil fertility it would be possible to sequester carbon in the soil and allow intensive agriculture, reducing the area needed for cultivation and consequently the pressure on forests. In this study, we tested the hypothesis that farmers' access to and use of ADE reduces the area they use for shifting cultivation, taking into account biophysical properties of cultivation plots and farmers' socioeconomic characteristics. **Methods:** We collected biophysical data in 145 farmers' cultivation plots (area, soil properties, fallow length) and we conducted interviews to obtain socioeconomic data (economic wealth, market orientation, livelihood strategies, labor availability) from 73 households in 7 villages in Central Amazonia. **Results:** We showed that the area used for cultivation was positively correlated with farmers' economic wealth and engagement with market-oriented agriculture. The relationship between the use of ADE and the area used for cultivation was strongly dependent on the labor availability of the household. Instead of driving specific trends in land use, fertile soils were incorporated into local livelihoods as part of an extensive repertoire of resource management activities; farmers with enough available labor managed multiple plots, combining intensive cultivation on ADE with long-fallow shifting cultivation on poorer soils. **Discussion:** Our results indicate that promoting intensive agriculture through increasing soil fertility will not necessarily decrease the area used by farmers in shifting cultivation. Research, development and policy initiatives can be more effective in promoting sustainable agriculture and in reducing pressure on forests if options for intensification ar co-developed with smallholder farmers as part - and not as a replacement - of their diverse economic and natural resource portfolio.

Keywords: Amazonia; Soil fertility;Deforestation;Agricultural intensification

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Socio-economics, efficiency and environmental impact of charcoal producers in a Mexican Watershed

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Background: In many tropical regions where charcoal production is common, it is usual for a single low efficiency rate to be applied across all producers. This is done without consideration of social and biophysical variations that may exist and could affect individual capacities and incentives to efficiently convert biomass into charcoal. Such assumptions can misestimate production volumes and environmental impacts of production, and they undermine opportunities to optimize established traditional practices that work, while eliminating those that do not. We set out to determine whether important distinctions exist between charcoal producers, the nature of such distinctions, their implications for efficiency levels and the environmental impact of producers. **Methods:** The Cuitzeo Watershed is a predominantly oak landscape. We conducted 46 semi-structured interviews of charcoal producers and measured the efficiencies of 22 kilns belonging to a subgroup of producers to test the hypothesis "producers are the same". A Principal Component Analysis was applied to determine if distinctions exist and the key variables forming producer groups. A forest impact estimate of the groups was determined based on their production levels, the associated forest area needed and the recovery rates of kiln sites. **Results:** Four types of charcoal producers were identified distinguished primarily by social variables that determined the reliability of access to the biomass and the contractual arrangements made with landowners. The size of kilns differed substantially across groups, as did annual production levels. Despite this, efficiency rates were similar and relatively high across groups with a dry yield efficiency average of 28.36% (7.72+/- SD). The impact on forests is subsequently different, with large producers (Group D) using in average more than 2 tons of biomass per kiln than others. **Discussion:** Our study shows that efficiency rates are similar across groups, but that they are higher than those currently assumed for traditional producers and can be as high as 'improved' kilns. More importantly, we show that in this area, the nature of contractual agreements determining access to biomass is key to determining producers' production strategies and thus, their impact on forests. Understanding what factors are at play in other production areas can help identify the structures and incentives needed to promote low impact while maintaining this livelihood source.

Keywords: charcoal, earth kiln, dry yield

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Values from social and ecological landscape attributes: understanding famers management decisions

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Background: Nature and its benefits are embedded in a plurality of values, between conservation and productivity aims; understand these values to nature is one of the key aspects of sustainability science and policy. Analyse the values that farmers have on the landscape and their effect on decision making is also considered crucial to boost rural development and sustainability. In this sense, environmental valuation can help to represent the rejected role of the ecosystems attributes on the economy. Our study was conducted in the south cost of the Jalisco state in Mexico in one ejido and one indigenous community, in an area well known for their high biodiversity. The main purpose of this research was to understand and explore people values from natural resource management and relate this values with socio-demographic characteristics. **Methods:** We use a choice experiment that is a stated preferences valuation technique. The attributes valued were: forest cover, superficial water, terrain slope and type of property. In addition, we include some socio-demographic and management practices questions. We conduct 199 surveys with 6 decision events per survey. To design and analyse the valuation we used the software R with the package support.CEs. **Results:** The results are represented in an econometric model called Multinomial Logit Model (MLM) that explain the utility of every attribute in the form of coefficients. The most valued attribute was the provision of superficial water. The valuation of the forest cover had negative values on the extremes (i.e. all deforested and all covered) and positive on the middle (i.e. half deforested). Also, there are important differences in the valuation by gender and type of community. **Discussion and conclusions:** The high valuation from the provision of superficial water for the productive management strategy by farmers must be considered when designing policies for conservation. This attribute lead in many cases to in situ conservation of riparian forest with no need for other incentives. Another consideration is the gender, women positively valued forest conservation more than men, this can be important to introduce conservation projects in rural communities.

Keywords: values, choice experiment, environmental valuation

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A tool for social linkage of biosphere reserves: the case of wildlife use in Southern Mexico

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Background: The social linkage of biosphere reserves (BR) is crucial for their effective implementation, since these protected areas explicitly recognize the involvement of local stakeholders in their conservation and management actions. However, when BR's official management instrument is not linked to the local realities of natural resource use, the establishment of this protected areas can generate negative social impacts, affecting the human populations that maintain a socioeconomic interaction with the protected area. **Methods:** We present a novel qualitative analysis tool, called linkage matrix, to evaluate the linkage of the official BR management program with the interests and expectations of the local stakeholders regarding one or several natural resources. As a case study, we considered wildlife use for subsistence purposes by Maya communities located in the zone of influence of Los Petenes Biosphere Reserve (LPBR), in the northwest of the Yucatan Peninsula, Mexico. **Results:** Through the application of the linkage matrix, we found that LPBR Management Program is highly inclusive (64%) of local interests regarding wildlife use. However, a limited implementation of the instrument was observed, hindering the effectiveness of management in the reserve. **Conclusion:** The linkage matrix provided elements to strengthen such management, by identifying action guidelines to improve the contents and implementation of the Management Program. Considering 1) the results of the linkage matrix in LPBR, 2) the objectives of BR aimed at conservation and development, and 3) the imperative of these protected areas to implement an official management instrument, we highlight the contribution of the linkage matrix and its potential application to other reserves in Mesoamerica and the world, as a tool to assess social linkage and, as a result, strengthen management and conservation in BR.

Keywords: biosphere reserves, management, qualitative tool

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Introducing the ecological sensitivity within human realities conceptual approach and frame

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Background: Coffee farming takes place in regions of high biological diversity and in developing countries as a cash crop (Jha et al. 2014). The commercial and international attributes encourage a yield focus often at the expense of biodiversity and positive societal outcomes (Babbar & Zak 1995). Despite intentions to improve biodiversity outcomes in these landscapes (ITC 2016; Perfecto et al. 2005) since 1990 shade prevalence has decreased while production and intensification has increased (Jha etl al. 2014). **Method:** Grounded ethnography: qualitative and quantitative secondary data and literature. **Result:** The ecological sensitivity within human realities concept and frame for application seeks to improve societal and environmental outcomes through centralising an understanding of ecological interactions, processes and adaptations. Use of the conceptual approach and framed application can improve understanding of the value of these landscape characteristics. This is suggested capable of increasing knowledge to conserve, enrich and regenerate such communities and systems, within the interests and capabilities of the people living in and working with these landscapes. **Discussion and/or Conclusion:** There are many approaches within the international coffee industry for improving environmental or societal outcomes. The conceptual approach and frame for application is introduced as complementary to and with the potential to improve existing efforts. It encourages a contextual base of information for decision making. The ecological sensitivity within human realities approach and frame for application was developed to improve environmental and societal outcomes across coffee farming landscapes at an international scale, and maintain if not improve economic outcomes (Brock & Xepapadeas 2003).

Keywords: Biological conservation; Ecological integrity; Coffee

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Oral Session
Functional diversity and functional traits in tropical ecosystems

Patch Size and Connectivity effects on the Functional Diversity of Mammals in the Atlantic Forest

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Background: Species occurrence and ecological functions are widely affected by habitat modification processes, especially in tropical forests of developing countries. The Atlantic Forest hotspot is heavily affected by these processes, and information on how much of the ecological functions are still being performed by species is necessary to subsidize conservation strategies. Here we present evidences of changes in the functional diversity of medium- and large-sized mammal assemblages across a defaunation gradient in the Brazilian Atlantic Forest, and the influence of other landscape metrics in the functional diversity of mammal assemblages, in a focal agricultural and fragmented landscape. **Methods:** To observe changes in functional diversity, we created a database of mammal assemblages (N=53), and analyze it using a functional diversity index (FD) and a meaningful set of ecological traits: physical, behavioral and dietary traits, and the environmental sensitivity of species. We aimed to obtain information on a biome scale between FD and patch size, and what other landscape metrics affect FD in a focal landscape. For standardization, we used an assemblage containing all medium- and large-sized mammals of the biome (N=83). **Results:** In a biome scale, we observed that the FD values of the assemblages increased with patch size, presenting two thresholds (at 60 and 2050 ha). At the landscape scale, we observed a meaningful amount of ecological functions in a highly-modified area, and that FD values were very influenced by connectivity at 200 m. **Discussion/Conclusion:** For assemblages in fragments below 60 ha, we recommend compliance with the Brazilian Forest Code, while for those above 2050 ha, we recommended, at least, the maintenance of large protected areas. Assemblages in fragments between these two thresholds, showed a significant increase in FD with patch size augment, and we recommend improvements in conservation planning. For the focal landscape, FD were similar to pristine areas and more preserved landscapes, indicating resistance to human pressure. Connectivity is an important landscape metric in modified areas to maintain mammal assemblages and the ecological functions they perform. Thus, the information we presented is important to subsidize conservation planning in local and regional scales, aiming to preserve assemblages, and promoting the maintenance of the ecological functions they perform. **Financial Support**: FAPESP #2014/10192-7 and #2014/09300-0.

Keywords: Mammals, Functional Diversity, Thresholds, Connectivity

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Bat Functional Diversity and Trait Filtering in a Tropical Agricultural Landscape of Southern Mexico

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Background: Many studies related to bats in the Neotropics suggest that bat abundance and richness are directly affected by land use changes and deforestation. Therefore, it is imperative to understand how bat species respond to habitat changes. Compared to species richness based on taxonomic measures the use of functional traits reflects not only interactions at population and community levels but also scales down to species and individual responses to habitat disturbances providing a broader spectrum of ecosystem interactions. **Methods:** In this study, we used a functional ecology approach to analyze bat responses to habitat disturbance in a tropical landscape, southern Mexico. For two years we recorded bats within mature continuous forest and within cattle pastures. For both habitat types bats were sampled along riparian vegetation and away. **Results:** We found that in pastures with and away from riparian vegetation the bat community was filtered by wing size, skull morphology and maximum frequency, allowing for species with small forearm, high aspect ratio, high relative wing loading, small skull and high maxFM to be present in pastures. In contrast, mature forests presented higher functional specialization and provided refugee for many species with extreme traits. **Discussion/Conclusion:** We concluded that bat conservation strategies should include remnants of mature forests within agricultural landscapes in order to preserve highly specialist species absent in other habitats. Furthermore, we provide evidence that riparian vegetation helps to increase not only species richness and abundance but also the variety of bat functional traits. Given that the relationship of the different species to ecosystem functioning differ greatly the evaluation of functional traits is essential to determine species-specific decline risk in agricultural landscapes.

Keywords: Quiroptera Riparian Pastures Functional Specialization

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Effects of climate and human disturbance on avian functional diversity are mediated by plant traits

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Background: Climate change and human disturbance are threatening biodiversity worldwide and can lead to species turn-over in ecological communities. However, it is not clear how changes in biodiversity modify ecosystem functions, especially ecosystem functions delivered by animals. Most studies on the relationship between biodiversity and ecosystem functionality (BEF) focus on small scales and are experimental, but little is known on this relationship at large spatial scales and over large environmental gradients in natural ecosystems. **Methods:** We sampled plant and bird communities along an elevational and a human disturbance gradient on Mt. Kilimanjaro in northern Tanzania. We measured corresponding morphological traits of fleshy-fruited plants and frugivorous birds to calculate indices of functional identity (FI) and functional diversity (FD) of plant and bird communities. We quantified climatic conditions, human disturbance and vegetation structure and used structural equation models to disentangle direct and indirect effects of these variables on FI and FD of bird communities. **Results:** Both FI and FD of frugivorous bird communities were consistently related to FI and FD of the plant communities. Climate had almost exclusively indirect effects on FI and FD of bird communities mediated through effects on plant FI and FD, whereas human disturbance also had direct negative effects on bird FD. **Conclusion:** Our results show that plant functional diversity is the most important driver of bird functional diversity and effects of climate and human disturbance on bird communities are almost exclusively mediated through plant communities. The degree of trait matching between interdependent trophic levels demonstrates the importance of biotic drivers for animal communities over a large environmental gradient. Our findings show that effects of global change on functional diversity of animal communities are mostly indirect and that biodiversity models need to consider these relationships between resource and consumer species.

Keywords: Climate, land-use, functional traits, birds

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Functional traits along a shade and fertility gradient in coffee agroforestry systems

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Background: A functional trait approach can contribute to the evaluation of crop responses to farm-level management practices. However, there are considerable uncertainties as to the extent and drivers of intraspecific trait variation (ITV) in crops. In a coffee agroforestry system we examined three shade and four nutrient treatments, in order to i) quantify ITV of coffee leaves and roots along soil fertility and light gradients, and ii) test if the functional biology of coffee, as described by its position along functional trait spectra, is best predicted by soil nutrients or light. **Methods:** Our study was conducted at a 3-year old experimental agroforestry site, located on a large Rainforest Alliance-certified coffee plantation in Aquiares, Costa Rica. We analysed two leaf physiological traits (mass based photosynthesis (Amass); light saturated photosynthesis (Asat)), four leaf morphological traits (leaf area (LA); leaf mass per area (LMA); leaf dry matter content (LDMC); leaf thickness (Lth)) and one leaf chemical trait (nitrogen concentration (LNC)). We also analysed three root morphological traits (average root length (D); specific root length (SRL); root length density (RLD)) and one root chemical trait (root nitrogen concentration (RNC)). These traits were measured on a total of 105 coffee plants, grown in factorial combinations of four nutrient management and three shade-tree management regimes. **Results:** Coffee leaf traits including LA, LMA, LDMC, Lth, Asat, and Amass, varied significantly as a function of light and soil nutrient management. However, with the exception of RNC, these patterns were not found in root traits. Low light in agroforestry management promoted an increase in ITV for Asat, Amass, D and RLD, while high light in coffee monocultures resulted in decreased ITV for LA, LDMC, Asat, Amass and RLD. **Discussion/Conclusion:** We show that intraspecific variation in functional traits of coffee is influenced by management and environmental conditions. We show that in heterogeneous light environments such as agroforestry systems, there is an increase in ITV, which can be expected to promote a higher degree of resource acquisition in coffee plants, and in turn, would be expected to result in greater rates of ecosystem functioning.

Keywords: Agroforestry, coffee, ITV, functional traits

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Functional diversity in the agricultural frontier: balance between conservation and agriculture

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Background: It is thought that functional diversity (FD) is the basis for linking biodiversity with ecosystem functions and services. In the tropics, the rapid advance of the agriculture frontier makes increasingly urgent the planning of landscapes where biodiversity and agricultural production can coexist. This study aimed to understand how FD of tropical rainforest tree species changes as the agriculture frontier advances, and explore deforestation tipping points beyond which FD may collapse. **Methods:** In southeastern Mexico, we quantified FD of dominant tree species (i.e. those representing 80% of total above-ground-biomass in the landscape) considering six functional traits (associated to different functions and ecosystem services), and five metrics [functional richness (FRci), number of functional species (FE), functional regularity (FRO), and functional divergence (FDvar)], including the community-weighted mean (CWM) of each trait. These metrics were quantified for trees (DBH > 10 cm) present in 11 landscapes (3 x 3 km each) that encompassed a gradient of the percentage of remnant old-growth forest cover (RFC; 7% to 100%). **Results:** Functional diversity and the CWM declined as RFC reduced, following three types of trajectories: i) concave decrease without showing a tipping point; this trajectory was documented for thirteen of 21 cases, ii) decrease to a tipping point after which FD collapses, and iii) parabolic, showing a maximum in intermediate RFC values. Tipping points occurred between 47-84% deforestation. **Discussion and conclusion:** Reduction of FD implied the loss of functional species, functional richness, and functional complementarity, and the increase of functionally redundant species with acquisitive strategies. These losses suggest negative consequences for the productivity of the forest ecosystem, for the forest resistance to invasive species and disturbances, for carbon storage of the forest and for the diversity of tree food resources for herbivore and frugivore animals. To conserve biodiversity, functions and services of forest ecosystem in human modified landscapes, it is critical: i) maintain old-growth forest cover values higher than 40%, ii) favor the persistence of long-lived second-growth forests, and iii) encourage the practice of leaving remnant forest trees within agricultural fields, and promote agroforestry systems.

Keywords: Functional complementarity, Ecosystem functions

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Soil C stocks in a tropical forest are correlated with altitude, soil and vegetation functional traits

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Background: Tropical forests and their soils play a vital role in the provision of ecosystem services. Soils regulate climate, being the main terrestrial C sink and stock. Although soil C storage has been widely studied, factors affecting soil organic carbon (SOC) have been assessed individually, leaving aside the high correlation between them. We quantified SOC stocks in a tropical forest over a 2500 m altitudinal gradient and evaluated the relative influence of altitude, soil properties, and vegetation functional traits on SOC variation. **Method:** SOC stocks were determined to 1m depth in 28 primary forest plots (0.25 ha) distributed over a 400–2900 masl gradient in Costa Rica. Spatial variation was represented as principal coordinates of neighbor matrices (PCNM). Community weighted mean (CWM) values of six functional traits were obtained for 183 species forming >70% of total basal area in at least one plot. Bivariate relations with SOC were evaluated through GLMs; while the relative influence of three sets of predictors (space, soil, and vegetation traits) on SOC was assessed using variation partitioning. **Results:** Total soil C stocks to 1 m depth ranged from 6.8-43.1 kg m-2. Total SOC and its variance increased with altitude (R2=0.64, p<0.0001) with no clear pattern for 5-20 cm depth. R2 from variation partitioning for total SOC in four depth categories (0-5, 5-20, 20-60 and 60-100 cm) were 0.55-0.65. CWM functional traits, predominantly leaf dry matter content (LDMC) and wood density (WD), had the strongest overall influence on total SOC, followed by bioclimatic and soil variables; the influence of PCNM eigenvalues was relatively low. No significant individual fractions were observed. **Discussion:** We expected the strong correlation of altitude and therefore temperature with SOC. However, CWM WD and LDMC were positively correlated with SOC, but not with elevation, suggesting that SOC accumulates in stands dominated by species that invest in tough, long-lived leaf and stem tissues. No effect of PCNM eigenvectors suggests that control of SOC is predominantly environmental and the lack of significant individual fractions from variation partitioning indicates that SOC is responding to interdependent climate, vegetation and soil factors. Our results strengthen understanding of pattern and process of soil C storage in tropical mountain forest ecosystems.

Keywords: SoilC stocks, Variation partitioning, CWM

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Oral Session
Tropical forest dynamics and functioning

Dynamics of lignin-degrader communities in a dry seasonal tropical forest

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Background: Saprophytic fungi are considered key transformative agents in litter decomposition and carbon (C) cycling owing to their collective abilities to rapidly decompose biopolymers (lignin, cellulose) using a diverse set of hydrolytic and oxidative mechanisms. The importance of saprophytic fungi in C-cycling processes raises the question of how these fungi, and subsequent C fluxes, could become increasingly vulnerable with the predicted reductions in precipitation. In this study, our goals were to: examine fungal degrader community dynamics in a tropical dry forest (TDF) in Mexico; and determine which fungi sustained lignin degradation during the dry season and their possible role in C cycling. **Method:** Traps containing a standardized lignin substrate were buried in the litter layer at nine locations in the Yucatán during the wet (1200mm rainfall) or dry-season (<200mm) from 2013 to 2015. At the end of each season, the residuum was removed, traps were re-packed with fresh substrate and reburied, and the residues were analyzed using high throughput sequencing with ITS barcoded primers. **Results:** We detected 465 fungal taxa of which 99 taxa were acknowledged lignin degraders and 38 were ectomycorrhizal (ECM) taxa. Measures of diversity did not differ significantly between years and seasons. However, there was a high turnover in community composition from year-to-year because certain taxa were abundant during a single sampling year, e.g. *Microdiplodia* in 2013; *Gymnopus* in 2015. In addition, unique fungal assemblages were also detected in dry- versus wet-seasons and certain fungi restricted to wet (*Ascomycota*) or dry seasons (*Trichoderma*, *Mortierella*). ECM fungi were similar restricted to wet (*Laccaria*) or dry seasons (*Pezizales*), or years (*Boletales*, 2015). **Discussion:** Both known lignin degraders and ECM are important in C cycling in TDF, and many of these fungi are known to possess genes encoding for peroxidases and/or laccases. However, *Trichoderma* and *Pezizales* (and possibly other taxa) are known to endure extremely negative soil water potentials. Thus, reductions in rainfall may result in degrader communities comprising primarily dry season fungi. Coupled with the exclusion of drought-sensitive species, this outcome could alter interactions among fungi and seasonal variations in community composition. How these changes feedback to influence litter decomposition and C cycling is being tested in a manipulative field experiment.

Keywords: ectomycorrhizal; diversity; community, drought; lignin

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Oral session: Tropical forest dynamics and functioning

Impacts of fragmentation on dipterocarp rainforests of Borneo

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Background: Most rainforest habitats have been fragmented as a consequence of human activities, with detrimental consequences for ecosystem functioning. Our recent studies have examined the impacts of fragmentation on the regeneration of mast-fruiting tropical trees. **Methods:**Rainforests on Borneo are dominated by Dipterocarpaceae trees which reproduce irregularly during regional mast fruiting events associated with ENSO events. During three recent masting events in Sabah (Malaysian Borneo), we examined dipterocarp reproduction (based on fruiting and seedling occurrence) in forest fragments, and we also examined predation rates of fallen fruits in fragments. **Results:** The prevalence of dipterocarp fruiting was greatly reduced in fragments, and fruiting was absent in many of the smallest (< 250 ha) highly degraded fragments. In some fragments, trees had apparently failed to reproduce in any of the past three masting events (i.e. since 2010). However, seed predation rates in fragments were about 35% lower than in continuous sites, probably because of loss of vertebrate predators from many fragments. **Conclusions:** Rainforest fragmentation disrupts tree reproduction, although this may be counteracted to some extent by those fruits that are produced escaping predation because of loss of predators in fragments. Thus impacts of fragmentation on forest regeneration are likely to be complex, depending on plant traits and biotic interactions of dominant tree species.

Keywords: fragmentation, Borneo, dipterocarp, ENSO

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Oral session: Tropical forest dynamics and functioning

Floodplains as an Achilles' heel of Amazonian forest resilience

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Background: Western and Central Amazonian forests are often considered relatively resilient to climate change, but this view is challenged by wildfires invoked by recent droughts. Understanding how different forests across the Amazon respond to fire may reveal where this vegetation state will persist in a drier future. About one-seventh of the Amazon is seasonally inundated, causing forests in these areas to differ in many ways from the dominant upland terra-firme forests. Here we ask whether seasonal inundation affects forest resilience and the risk of shifting into a fire-prone savanna state. **Methods:** We used two approaches to contrast the resilience of floodplain and upland forests of the Amazon. First, we estimated the long term relative resilience of forest and savanna in both ecosystems from the density distributions of tree cover (MODIS VCF). Second, we studied post-fire recovery of over 250 forest sites that burned during the severe droughts of 1997 and 2005 in both ecosystems using annual VCF data. We validated the basin-wide analyses of post-fire recovery with field data on tree basal area and soil variables from multiple burnt forests in the central Amazon. **Results:** We found that the density distribution of tree cover in Amazonian uplands has a single mode around 84% reflecting dense forest, with sparse tree cover being rare. In floodplains an additional mode around 34% tree cover reflects the presence of a savanna state. Along the rainfall gradient, tree cover patterns revealed that a savanna basin of attraction appears around 1500 mm of mean annual rainfall in floodplains, but only becomes apparent around 1000 mm in uplands. Our results also showed that wildfires in more than 250 forest sites across the Amazon had a stronger and longer-lasting impact on tree cover in the floodplains. Field data confirmed the slower tree basal area recovery in floodplains and in addition revealed a marked decrease in soil nutrients and fine clay particles upon fire that was absent in the uplands. **Conclusion:** Our combined results strongly suggest that Amazonian forests on seasonally inundated areas will be the first to collapse into a savanna state as climate becomes drier. The widespread distribution of floodplains at the western and central regions implies that fire-prone savannas may expand deep into this massive forest biome, threatening the resilience of entire system.

Keywords: climate-change; drought; fire; tipping-point

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Oral session: Tropical forest dynamics and functioning

Biodiversity-mediated versus Direct Effects of Environmental Change on Ecosystem Function

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Background: It is known that the decline of biodiversity can affect the performance of ecosystem process and services. However, for the past 20 years, research on biodiversity and ecosystem functioning has only implicitly considered the underlying role of environmental change, basing investigations in random species loss gradients. The use of indirect and nonrandom biodiversity manipulations (through environmental change drivers) reminds a challenge due to difficulties in separating 'true' biodiversity effects (here, biodiversity-mediated effects) from direct effects of environmental change. Furthermore, it reminds uncertain whether biodiversity-mediated effects are as expressive as direct ones. **Method:** In order to answer this question, we made a microcosm experiment using zooplankton community from a freshwater costal lagoon, located at Rio de Janeiro, Brazil. We established two independent scenarios of environmental disturbances (salinity and temperature increases) in order to manipulate zooplankton community diversity. Each scenario was composed by two levels of intensity (2.0 and 6.0 PSU; 30 and 35ºC) and a common treatment control (0.2 PSU; 25ºC), with five replicates. After 5 days, the survivor communities of each disturbance level were split into two equivalent parts: one of them came back to control conditions and the other one reminded at the disturbance level. It allowed disentangling of biodiversity-mediated and direct effects caused by disturbance scenarios on ecosystem function (here, zooplankton grazing rate - GR). GR was obtained by estimating the consumption of three microalgae species by zooplankton community. **Result:** We found that salinity and temperature increase caused density, species, and diversity loss. GR was lower in all situations of disturbance. However, GR of communities that come back to control conditions was higher than ones that reminded in environmental disturbance (except for 30ºC level). Effect size metrics showed that direct effects driven by salinity increase are higher than biodiversity-mediated ones. In temperature increase scenario, biodiversity-mediated effects were higher at 30ºC, while direct effects were higher at 35ºC. **Conclusion:** We conclude that the role of biodiversity-mediated effects in the maintenance of ecosystems processes and services seems to depend on the environmental disturbance intensity and identity, and it might be equal or even higher than direct effects caused by environmental disturbance.

Keywords: Biodiversity, Function, Disturbance, Experiment, Zooplankton

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Global Sensitivity and Uncertainty Analysis of Forest Carbon Estimates in Southwestern Amazonia

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Background: The global approach for mitigating deforestation and degradation in tropical landscapes centers on pricing carbon retained in forest lands under REDD+ (Reduction of Emissions from Deforestation and Degradation) policy. In recent years, in Brazil and Peru particularly, several projects have developed within the framework of REDD+. A requisite to negotiate incentives under REDD+ is to estimate forest biomass or its equivalent in Carbon (CO2eq). As such, methods to estimate biomass have been developed based on field sampling and tree allometry, and lately using remote sensing techniques. In all cases, uncertainty exists. Input factors such as landscape variation, forest type, sampling method end parameters used in the estimation can vary the estimated amount of biomass per unit of area. **Method:** We applied Global Sensitivity and Uncertainty Analysis (GSA/UA) to assess uncertainty in output (above-ground biomass) by producing probability distribution functions (PDFs) of input factors. We used a network of plots of 0.1 and 1 ha in Madre de Dios, Acre, and Pando in southwestern Amazonia collected from different sources. The precipitation gradient declines more steeply from west to east than from north to south of the region. We compared forest plots of Madre de Dios in the west versus plots from Acre and Pando at east. We used eight published AGB allometric equations, requiring diameter, wood density, and height, all input factors. **Results:** Biomass varied 4 fold from the lowest (233 Mg/ha) to the highest value (813 Mg/ha) across all input factors. GSA based in Morris qualitative method showed plot size, forest type, and equations in order of importance as the factors more sensitive to variation in the estimated biomass value, mostly influenced by 0.1 ha plots. The quantitative method Sobol showed plot size contributed 47%, forest type 12%, and allometric equations 6% to the total biomass variance. Equations more than double their contribution after controlling plots factor. **Conclusions:** The application of GSA/UA is important for forest carbon offset projects to monitor, verify and report CO2 reductions/emissions. It provides a framework for continuous improvement for REDD+ projects to revise conservativeness of carbon stocks, to refine methods, and extend the plot network in the diverse and unsampled landscape of southwestern Amazonia.

Keywords: Amazonia, Biomass, Forest, REDD+, Uncertainty

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Mitigation of greenhouse gas flows in tropical savanna in Brazil

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Background: Tropical savanna ecosystems are one of the most important biomes on earth because they have great biodiversity and act as the largest terrestrial sink by anthropogenic CO_2 emissions. Recent studies suggest that tropical forests play a key role not only in the C cycle, but can also contribute to minimizing global warming. Therefore, the study aims to evaluate the global warming potential (GWP) of CH_4 and N_2O in eucalypt planted forests and native Cerrado vegetation. **Methods:** The studied environments are located in the central region of Brazil (Central Plateau), in Paranoá, Federal District. In order to measure the N_2O and CH_4 fluxes, the static camera method was used from October 2013 to September 2014 in eucalyptus forest populations with different ages (E1-3 years and E2-5 years) and native cerrado vegetation (CE). The analyzes of the concentrations of these gases were carried out in the Gas Chromatography Laboratory. From the daily flows, the accumulated flows were determined by integrating the area under the curve established by the interpolation, and the GWP was calculated by converting the flows of N2O and CH_4 to CO_2 equivalent (kg CO_2 eq ha^{-1}), According to the equation: GWP = (CH_4 x 25) + (N_2O x 298) (IPCC, 2007). **Results:** Considering the annual GWP, CH_4 had a negative contribution to all the studied environments with -46 ± 34, -24 ± 23 and -16 ± 13 kg C-CO_2 eq ha-1 year-1 E1, E2 and CE, respectively. For the N_2O there was emission with a positive contribution in the annual GWP, whose values were: 129 ± 78, 255 ± 135 and 99 ± 60 kg C-CO_2 eq ha-1 year-1 for E1, E2 and CE, respectively. The GWP had contribution of N_2O flow above 70% for the period studied. Although there was variation in the magnitude of GWP values in the studied environments, no significant difference was observed. **Discussion:** Soils under forests in the Cerrado have good drainage, favoring the consumption of CH_4 and, generally, have limited levels of Nitrogen and predominant ammoniacal form, which can contribute to low values of N_2O flows. With the introduction of eucalyptus plantations, its establishment did not show significant differences in relation to GHG flows, expressed by the GWP. This may be related to the similarity between the edaphoclimatic conditions of the studied environments and the high C:N ratio of their plant material.

Keywords: climate changes, Forest soils

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Oral session: Tropical forest dynamics and functioning

Oral Session
Morphological, physiological and structural traits of tropical forest plants: from leaves to forest canopy

Valid Vc_{max} estimate can be derived using either C_i or C_c in tropical and temperate trees

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Background: Globally, plants growing in warm regions typically exhibit lower photosynthetic rates when compared to plants growing in cold environments. High limitation to photosynthesis and large CO_2 drawdown imposed by mesophyll resistance are thought to explain low photosynthetic rates observed in warm-adapted plants. Alternatively, the drawdown of CO_2 imposed by mesophyll resistances might be similar between warm and cold-adapted species; thus invalidates the role of mesophyll resistance in explaining the difference in photosynthesis. **Methods:** Using a combination of leaf gas exchange and carbon isotope fraction, mesophyll conductance of several Australian tropical and temperate evergreen moist forest trees, grown in common environment, was estimated. Maximum Rubisco carboxylation capacity, Vc_{max} was obtained from CO_2 response curves. **Results:** Consistent with broader findings, tropical trees exhibited significantly lower photosynthetic rates and Vcmax than their temperate counterparts. Photosynthesis rate and diffusion conductances correlated strongly across tropical and temperate trees. The tropical and temperate species fell on a common photosynthesis-mesophyll conductance relationships and the drawdown of CO_2 imposed by stomatal and mesophyll resistances were independent of mesophyll conductance. Limitations to CO_2 diffusion imposed by mesophyll resistance were relatively constant across tropical and temperate species (~13%), irrespective of photosynthetic capacity. More importantly, we found that Vcmax estimation on the basis of intercellular CO2 concentration, was equivalent to that on the basis of chloroplastic CO_2 concentration, when using appropriate Michaelis-Menten constant for carboxylation and oxygenation for both tropical and temperate species. **Discussion:** Our findings indicate that tropical moist forest trees are not penalised by low mesophyll conductance, hence the lower photosynthetic rates of tropical moist forest trees are unlikely to be caused by lower mesophyll conductance. Rather, lower photosynthetic rate of tropical species could be ascribed to lower nitrogen investment in Rubisco. Our study provides a justification to continue the use of intercellular CO_2 concentration instead of chloroplastic CO_2 concentration to parameterise the biochemical model of photosynthesis, provided that appropriate kinetic constants are applied.

Keywords: mesophyll conductance, carboxylation capacity

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Oral session: Morphological, physiological and structural traits of tropical forest plants: from leaves to forest canopy

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Dissecting leaf habit, photosynthesis and leaf life span in seasonally dry tropical forest trees.

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Background: Leaf longevity (LL) and habit are usually closely linked, but in dry tropical forests (DTF) it is possible to find tree species with contrasting phenology but similar LL. We examined aspects of the physiology of leaves of six tree species with contrasting phenology but with LL shorter than one year in a SDTF in Costa Rica. We hypothesized that deciduous (D) species have higher assimilation (A), less investment in leaf structure, and greater nitrogen concentrations and retrieval than evergreen species. **Methods:** We measured the vegetative phenology, LL, gas exchange and maximum A (Amax), the efficiency of N use during LL, and their relationship with leaf mass per area (LMA). **Results:** LMA varied from 76 to 164 g cm^{-2} and showed a positive correlation with LL; N content varied between 3 and 19 g Kg^{-1} among species, being higher in deciduous trees with shorter LL. The species showed different developmental patterns of A, leaf [N] and retrieval. Amax occurred earlier in D species, reached maximum values at the end of leaf expansion, and A did not decline monotonically as leaves aged. The response of A to N was linear but stronger in species with longer LL regardless of their leaf habit. N was withdrawn from leaves while conditions were favorable for A. Amax of leaves of longer LL was lower and declined with leaf age, but this was more pronounced in D species, and strongly correlated to decreases in stomatal conductance (gS). **Conclusion:** Despite the observed relationship between Amax and N, gS was the main controller of A. Photosynthetic N use efficiency increased with Amax and was lowest in species with lower Amax. In SDTF, leaf physiology does not predict leaf habit, and no evidence of a trade-off for a mass-based leaf economics spectrum was observed especially among dry-season flushers, which may recover the cost of leaf construction early in the growing season, making LL highly irrelevant for the carbon budget of leaves. Leaf N allocation that optimize C gain under water scarcity likely decoupled LMA from LL and leaf habit. Despite reduced variation in LL due to the severity of the dry season, different combinations of functional traits encompassing the whole organisms produced contrasting leaf habits, and there was no unique physiological response specifically linked to different phenologies. Albeit phylogenetic differences among species, there was no obvious relationship between physiological patterns and discrete phenological categories.

Keywords: Phenology, Leaf economics spectrum

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Architecture of the leaf: venation and shape dynamics in tropical forests

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Background: Leaf venation patterns and leaf shape are very diverse and can vary drastically even within a single genus. This variation implies that leaf architecture plays many functional roles associated with different environmental and phylogenetical factors. Work on understanding the form, function and distribution of these traits is still scarce, particularly in tropical forest ecosystems. Here, for the first time we explored the relationships between venation traits and leaf shape, their likely ecological drivers and functional significance. We hypothesised that due to environmental filtering the variation and distribution of leaf venation and shape traits varies with climate, specifically, with differing hydraulic and irradiance environments. **Methods:** We reported measurements of vein density, vein loopiness and leaf shape for more than 90 dominant tree species occurring in seven forest communities spanning along 1200-2200 mm precipitation gradient in Ghana. The values for venation traits studied were extracted from microscopic images of chemically cleared leaves. Leaf shape features were defined using phylogenetically constrained geometric morphometric techniques. **Result:** We found that vein density and loopiness significantly decreased along the increasing precipitation gradient. Leaf shape traits, in particular leaf roundness and elongation were correlated with venation traits. Tropical savannas developed significantly smaller and more orbicular leaves, while leaves in the wet evergreen forests often were elliptic and oblong. Similarly, leaf asymmetry and presence of strongly elongated leaf apex were more frequent in the forests with the highest levels of rainfall. These patterns were more pronounced in leaves sampled from sun exposed branches. **Conclusion:** Despite the broad ranging phylogeny, the results of our study agreed with the hypothesis that species adapt their leaf architecture to different hydraulic environments to facilitate more efficient leaf water movement. Better understanding of selection on leaf venation networks and leaf geometry is fundamental as these traits have important implications for drought tolerance, coexistence of species and carbon balance of leaves.

Keywords: venation, geometric morphometrics, traits, ecosystems

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Physiological performance of tropical trees in current and future temperature regimes

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Background:Rising temperatures may severely impact lowland tropical forests by bringing tropical trees closer to their physiological thresholds. Given the importance of tropical forests in the regulation of the earth's climate it is important to understand how rising temperatures affect the capacity of tropical trees to take up and store carbon. **Methods**: We measured photosynthesis and dark respiration in relation to temperature in the canopy of two tropical forests in Panama for >40 tree and liana species, including pioneers (e.g., genus *Cecropia*) and late-successional species (e.g., *Manilkara bidentata*). In addition, we experimentally determined the capacity of photosynthesis and respiration to acclimate to temperature in a growth chamber experiment with two pioneers and one late-successional species. **Results:** Photosynthesis and respiration rates differed enormously across species, consistent with species differences in ecological strategies. However, the key temperature-response parameters—the optimum temperature for photosynthesis (TOpt), and the slope of the increase in respiration with rising temperature—were very consistent across species. Photosynthesis peaked around 30–31°C, or mean daily maximum temperature, and respiration more than doubled for every 10°C increase in temperature (Q10≈2.3). The decrease in photosynthesis above TOpt was largely driven by reduced stomatal conductance, not by biochemical limitations. TOpt increased by ~0.5°C for every 1.0°C increase in growth temperature, while photosynthesis at TOpt did not change systematically. As a result, photosynthesis at growth temperature decreased with increasing growth temperature. Respiration acclimated by downregulation of the respiratory capacity and a reduction in Q10. **Discussion:** Our results indicate that 1) Physiological temperature responses can be scaled up with simple, site-specific parameter estimates, even in hyperdiverse tropical forests, and 2) Moderate warming is unlikely to have a strong direct negative impact on the carbon economy of tropical trees, but indirect effects of warming through rising atmospheric drought are likely to govern the response of tropical forests to climate change.

Keywords: Photosynthesis, Acclimation, Warming, Carbon, Trees

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Oral Session
Ecology of tropical secondary forests

How humans structure Amazonian secondary forests in Atacapi, province of Napo, Ecuador?

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Background: Amazonian forests are well known for mitigating climate change by catching carbon dioxide, hosting a great part of global biodiversity, and being clear-cut for settling monocultures and livestock putting thousands of species at risk. However, little is known about how different land-uses alter further recovery of such forests.**Method:** We counted, marked, measured, and identified all trees at least 10cm diameter at breast height on four one-hectare plots which land-use histories were exhaustively reconstructed using ethnographic-historical, and socio-economic methods. **Results:** Plots A (12-15 years-old), B (22-25 years-old), and C (35-37 years-old) were pastures and oligocultures for feeding human populations vigorously growing in relation to oil-exploration (1967-1980); then food demand declined so plots were abandoned. Plot D (35-40 years-old) was used for self-consumption agriculture (in Kichwa indigenous language chakra-and ushun periods) per six years (more than 50 planted species), then used for extracting resources -including fruits, medicine, and logs during fallow (purun period). Tree-diameters averaged 22.89cm (SE=0.61) for plot B, and 23.50cm (SE=3.30) for plot C being larger compared to plots A (19.47cm, SE=0.61) and D (19.41cm, SE= 0.39) -which were similar. Similar results were found for total basal area and above ground biomass. Species richness changed as follows: plot A=29, plot B=35, C=489, and D=79 species; Shannon-, Simpson's, and Fisher's α-diversity indexes varied in the same order namely A<B<C<D. Many of the species are traditionally used for wood, food, and medicine. **Discussion and conclusion:** Narrow tree-diameters on plot D suggest that management during purun kept forest structurally young so the Amazon may include forests chronologically older than the age suggested by their tree diameters. The high density of individuals on plot D suggests a vigorous gap regeneration. Compared to field abandonment, traditional land-use during secondary succession can delay above ground biomass recovery, but enhances the recovery of species diversity. Amazonian peoples have devoted millennia to develop a culture where plant diversity is desirable for their own food security, medicine, and housing even during historical episodes where monoculture has been promoted. Apparently, mitigating a climate change generated outside the Amazon has not yet become part of the interest of indigenous land-users in our study site.

Keywords: Ethno-ecology, land-use history, secondary succession.

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Land-use dynamics influence carbon sequestration potential in tropical second-growth forest

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Background: Many countries have made major commitments to reforestation under the Paris Climate Agreement, and recent studies have illustrated the potential for large amounts of carbon sequestration in tropical second-growth forests. However, carbon gains in second-growth forests are threatened by non-permanence, i.e. release of carbon into the atmosphere from clearing or disturbance. The benefits of second-growth forests require long-term permanence, but estimates of carbon potential rarely consider the spatio-temporal landscape dynamics of second-growth forests. **Methods:** We used remotely sensed imagery from a landscape in the Peruvian Amazon to examine patterns of second-growth forest gain and permanence over 28 years (1985-2013) and modeled probabilities of forest regrowth and clearing as a function of landscape factors. To assess how estimates of carbon sequestration potential vary under different assumptions about second-growth forest permanence, we simulated future trajectories of carbon sequestration using the model parameters. We compared this with the amount of biomass that would accumulate under the assumption of second-growth permanence. **Results:** By 2013, 44% of all forest cover in the study area was second growth and more than 50% of second-growth forest pixels were less than 5 years old. The amount of neighboring forest and variables related to pixel position (i.e. distance to edge) were important for predicting both clearing and regrowth. Forest age was the strongest predictor of clearing probability and suggests a threshold response of clearing probability to age. In our simulations, estimates differed by 900,000 tonnes, equivalent to over 80% of Peru's commitment to carbon sequestration through community reforestation under the Paris Agreement. **Discussion/conclusion:** Though the study area has more than 40,000 hectares of second-growth forest, only a small proportion is likely to accumulate significant carbon. Instead, cycles between forest and non-forest are common. Our results illustrate the importance of considering landscape dynamics when assessing the carbon sequestration potential of second-growth forests. Looking to past dynamics of second-growth forests can help identify where second-growth forest is threatened by non-permanence and where to focus reforestation programs. Monitoring the fate of new second-growth forests will also be important to ensure that the carbon promise of second-growth forests can be achieved.

Keywords: secondary forest, carbon, remote sensing

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Rainfall interception by secondary forests on abandoned pastures in northwestern Costa Rica

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Background: Secondary forests are a major forest cover in the tropics, but their effect on ecohydrological processes has been rarely studied. **Methods:** We used a functional approach to assess if forest type and canopy functional properties drive rainfall interception and its spatial variability. Canopy functional properties and throughfall were measured in 0.12 ha plots in two floristically different types of secondary forest (n = 18) in northwestern Costa Rica. Throughfall was measured within each plot using 21 fixed collectors spaced every 10 m in a systematic grid square sampling pattern. **Results:** Independently of forest type, median interception was 15% of gross precipitation (range 2-28%) during our 45-day study period. Its median coefficient of variation (CV), as a measure of within-plot spatial variability, was 128% (39-1023%). Results indicate that taxonomic and functional composition of dominant species may differ without having an effect on rainfall partitioning. At the plot level, rainfall interception was positively associated with community-weighted mean leaf thickness, while interception CV was mainly associated with the abundance and three-dimensional distribution of canopy elements (number of stems, canopy height variability, leaf area index variability). **Conclusions:** We found lower interception values for these forests restored by natural secondary succession on abandoned pastures than those reported for other tropical lowland secondary forests in Costa Rica. Our results suggest that weighted mean leaf traits, particularly those associated with leaf structural resistance, are as important as canopy structural elements in the partitioning of rainfall by the forest canopy. This study supports the importance of taking canopy functional properties into account when assessing ecohydrological processes like interception and further develops the possibility of a functional approach for evaluating hydrological ecosystem services provisioning.

Keywords: interception, throughfall, community-weighted mean

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Tree Recruitment Life-Stage Determines Regeneration Potential in Tropical Pastures: A Meta-Analysis

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Background: Forest recovery in degraded pasture is regularly inhibited or arrested in fragmented tropical landscapes, yet differences in regeneration potential between early tree life-stages and major successional groups remains unclear. Here multiple pasture regeneration barriers were compared among early recruiting tree life-stages and successional groups. **Methods:** An extensive literature search for early tree recruitment life-stages and their corresponding regeneration potential measured in abundance was done February 2016 using ISI Web of Knowledge. Data that examined how regeneration barriers altered tree species abundances in pastures was analyzed in a meta-analysis that included 140 independent studies from 34 articles. Successional species were grouped into pioneers and persistent types for a sub-group meta-analysis. **Results:** As compared to forests, younger recruitment life-stages appeared to be more vulnerable in pastures. Pioneer species followed this trend but persistent species did not being susceptible to later recruitment stages. **Conclusion:** Mitigation of regeneration barriers in degraded tropical habitat should consider species successional types and their recruitment potential across different life-stages. Introduction of non-pioneer species at earlier stages of recruitment, such as seeds, can yield higher recruitment rates then their pioneer counterparts.

Keywords: meta-analysis, pastures, forest recovery

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Does response diversity influence resilience to extreme events in secondary successional forests?

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Background: Response diversity, defined as the variable responses of species to environmental change, has been proposed as a key determinant of ecosystem resilience. A high response diversity should provide greater resilience because as species vary in their sensitivity to disturbance, some may thrive while others may not, thus ensuring at least some continuity of function. We test this hypothesis in secondary tropical dry forest plots of different successional age that vary in species diversity and levels of structural development. The system experienced a strong disturbance in the form of a Category 3 Hurricane in 2011. We assess the resilience of human-modified forests to this subsequent natural disturbance by estimating resistance, the ability to absorb disturbance, and elasticity, the ability to recover. **Methods:** Resilience of aboveground biomass was quantified using inter-annual data four years prior- and post-hurricane. In each plot we calculated resistance as the maximum difference between pre- and post- hurricane values, and elasticity as the rate of recovery post-hurricane. We assessed response diversity from variations in species' litterfall response to annual fluctuations in precipitation during the transition period between the wet- and dry-season, using data collected over five years prior to the hurricane. **Results and Discussion:** The two resilience components, resistance and elasticity, varied independently among our forest plots, suggesting these measures of resilience are decoupled. We find that historic reductions in basal area through human intervention may not necessarily reduce system resilience, and may in some cases enhance the capacity to absorb hurricane disturbance. This implies forests can withstand some level of human intervention and structural change, and persist through multiple subsequent disturbances. We hypothesized that, in accordance with theory, sites with greater response diversity to climate should also be more resilient to disturbance, however we find a negative relationship between response diversity and rate of recovery. We speculate this may be due to an interaction with climate change, and suggest our understanding of mechanisms that confer resilience might need reevaluation as anthropogenic pressures intensify.

Keywords: extreme climatic events; carbon dynamics; litterfall; resistance; tropical dry forest

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Natural regeneration of valuable timber species after three different clearing treatments in forests

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Background: Quintana Roo, Mexico, is more than 70% forested and harbors important populations of jaguar, tapir, monkeys and pumas. Most forest land is held communally, through ejidos (land grants to groups) that range in size from about 4000 ha to more than 70,000 ha. More than 150 ejidos manage their forests, harvesting mahogany (Swietenia macrophylla) and other species to sell as timber. Outside their forest areas, communities practice slash and burn agriculture to produce subsistence crops. Sustaining the forest and its biodiversity depends on sustaining its value, so regenerating commercial species is vital to forest conservation as well as local livelihoods. However, selective timber harvesting does not create favorable regeneration conditions for sun-loving species like mahogany. **Methods:** To evaluate silvicultural options for forest regeneration, 24 half-hectare experimental clearings were created in community forests using three different treatments on 8 clearings each: 1) slash and burn agriculture; 2) mechanical clearing (trees were felled using bulldozers); or 3) clear felling. Mahogany seeds and seedlings were planted in subplots in the center of each experimental plot, as well as under the forest canopy in control plots, and remeasured periodically. After 10 years, trees of all species that had regenerated naturally within these clearings were also identified and measured. **Results:** After 5 years, all mahogany seedlings had died in control plots. After 10 years, slash and burn was found to be the best treatment for mahogany, favoring the highest rates of survival and growth. Seed fall from neighboring trees of other species has transformed these former clearings into diverse young forests. An evaluation at 11 years revealed that 80 tree species had become established on former slash and burn clearings, where 39% of the basal area was made up of commercial hardwoods. These species accounted for only 6% of the basal area on the clearings created through clear felling alone, where less valuable softwoods accounted for 20% of the basal area. **Discussion/Conclusions:** The patterns of regeneration revealed that slash and burn agriculture can be compatible with forestry and contribute to the restoration of diverse and valuable timber stands. The challenges are convincing forest managers that agriculture can be integrated into forest management, and a sufficient land area to allow for long enough fallows that the trees can grow to harvestable size.

Keywords: regeneration; silviculture; forestry; mahogany; fire

ID:378
D-Thursday, July 13th, 2017, Merida
Oral session: Ecology of tropical secondary forests

Oral Session
Population and community dynamics

Effects of changing rainfall patterns on tropical forest biomass and mortality

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Background: There is wide variation among climate model projections of how precipitation patterns may change over tropical forests by the end of this century. In this study, the Ecosystem Demography model (ED2-hydro), was used to explore the risk these different predicted precipitation scenarios pose for the aboveground biomass (AGB) and mortality rates of mature tropical forest trees belonging to different plant functional types (PFTs). ED2-hydro is a land surface model that includes demographic and plant hydrodynamic processes and that enables dynamic competition between four PFTs—early- versus late-successional groups subdivided into drought-tolerant versus -intolerant groups—to occur along water and light resource gradients. **Methods:** ED2-hydro was used to simulate the 50-ha plot at Barro Colorado Island (BCI), Panama. The model was driven with local meteorological observations reconstructed to represent 7 contrasting precipitation scenarios: observed rainfall, greater rainfall, reduced interannual variation, longer dry seasons, recurring El Nino droughts, drier dry seasons, and drier wet seasons. **Results:** ED2-hydro predicted that plant available soil water (PAW) varied considerably among the precipitation scenarios. In the simulations, PAW was regulated by both the mean and variation in precipitation, but was buffered by increased rooting depth. Accordingly, ED2-hydro predicted that changes in the mean or variation of PAW differentially altered mortality rates of the four simulated PFTs at BCI, which in turn led to shifts in relative AGB. Less variable precipitation reduced AGB of drought tolerant PFTs, while a significant reduction in mean precipitation or greater variation caused by more extreme and frequent droughts reduced AGB of drought intolerant PFTs. ED2-hydro predicted, however, that total ecosystem AGB was marginally altered by all of the precipitation scenarios except for an intensification of the dry season, which led to a significant loss of AGB. **Conclusion:** Model predictions are consistent with the intermediate disturbance hypothesis where variation in precipitation that includes El Nino-related droughts and anomalously wet years is important for promoting functional diversity of AGB across PFTs; but, less variation, a significant reduction in the mean, or more frequent and intense droughts may be destabilizing to diversity in AGB across PFTs.

Keywords: Biomass, precipitation, drought, modelling, mortality

ID:411
D-Thursday, July 13th, 2017, Celestún
Oral session: Population and community dynamics

Traits govern density-dependent mortality during seed-to-seedling transition

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Background: Among multiple mechanisms governing tropical diversity, negative density dependence (NDD)—greater mortality of individuals in the vicinity of conspecifics—has found much empirical support. Resulting from competition for common resources or shared natural enemies, the strength of NDD varies among species. Although species' functional traits govern both resource acquisition and defense against natural enemies, few studies have explicitly tested how traits influence variation in NDD among species. Pathogens and insects have been implicated as important natural enemies causing NDD during the seed-to-seedling transition. In closed-canopy forests, slow-growing, well-defended species are likely to better withstand natural enemies, thereby subject to lower NDD than less well-defended species. We examined the correlation between traits and strength of NDD during seed-to-seedling transition. Specifically, we tested whether species with traits related to slow growth, shade-tolerance and defence against pathogens experienced lower NDD during seed-to-seedling transition than species with traits related to quick growth and low investment in defence. **Methods:** We tested our hypotheses using 20 years of data on seed rain and seedling establishment of 170 tree species in a seasonally wet tropical forest of Barro Colorado Island, Panama. We used a two-level Bayesian mixed-effects model in JAGS. In the first level, we estimated the parameter representing strength of NDD per species from the functional form of the equation governing seed-to-seedling transition, with random intercepts for plot and year. Per species NDD parameters were then modeled in relation to four traits—seed mass, leaf mass per area, wood density and maximum height. **Results:** We found that species with well-defended leaves had lower NDD than species with thinner leaves. Surprisingly however, we found that strength of NDD was unrelated to seed size or wood density. **Conclusion:** Our results highlight how NDD could reinforce niche differences among species with different traits, thus promoting species coexistence. Growth–survival trade-offs, governed by traits, can influence community structure through variation in regeneration success. Trait-based tests of NDD can provide clearer insights into mechanisms of diversity in human-impacted forests where fragmentation and edge-effects alter the conditions for species recruitment and the factors regulating NDD.

Keywords: NDD, diversity, traits, coexistence, forest

ID:411
D-Thursday, July 13th, 2017, Celestún
Oral session: Population and community dynamics

Demographic fate of an endemic epiphytic orchid in a post-hurricane context

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Background: Hurricanes are dramatic natural events with a heavy influence on the ecological dynamics and structure of tropical forests worldwide. For epiphyte-orchid populations, the hurricanes might be devastating, especially because their canopy exposure and absence of underground storage organs or seed banks that ensure survival and regrowth. Demographic and spatial analyses are fundamental for assessing their status and, if required, planning effective population management strategies, especially in frequently-disturbed habitats. **Methods:** We evaluated the short- and long-term post-disturbance population dynamics of *Encyclia bocourtii*, an endemic epiphytic orchid in the Guanahacabibes National Park, Cuba, after hurricane Ivan. Using Integral Projection Models, we calculated both the deterministic and stochastic population growth rates using demographic data gathered between 2007 and 2013, and the case-specific transient dynamics for each yearly period. Using a transfer-function framework we identified the orchid size-stages that should be reintroduced, relocated or especially protected to assist the recovery of the population in the short-term, as well as the best spatial arrangement in relation to other common epiphytes and host-tree species. **Results:** Our results show that the population was seriously affected by the disturbance, with an immediate reduction of 63%. Both deterministic and stochastic projections predicted an annual decrease of ca. 7.5%. The projected density considering both asymptotic and transient dymamics shows that in 4 out the 6 studied periods *E. bocourtii* is not safe from the extinction. E. bocourtii shows an aggregated spatial pattern with phorophytes standing in close proximity, and a random pattern with other epiphytes, which displays an overdispersed pattern. **Discussion:** An effective conservation scheme of *E. bocourtii* in Guanahacabibes requires ex-situ and in-situ propagation, reintroduction of intermediate and large-sized reproductive orchids, relocation of reproductive surviving individuals from affected trees on to suitable host trees after disturbances, and new plantations of the main host trees in affected areas.

Keywords: IPMs, Population-dynamics, Management strategies, Cyclones.

ID:405
D-Thursday, July 13th, 2017, Celestún
Oral session: Population and community dynamics

Assessing roadkill events to reduce wildlife mortality in roads of the Mid-Magdalena Valley Colombia

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Background: Wildlife roadkill is a human-related problem having important social, economic, and ecological consequences. In Colombia, detailed information about potential causes of this phenomenon are scarce. This study aims to to assess mortality, analyze the spatial and temporal distributions of mammal-vehicle collisions in the Mid-Magdalena Valley, a region of high species diversity and endemism for this taxonomic group. **Method:** We monitored mammal roadkills in the Middle Magdalena Valley in central Colombia, along a segment of 240 km of the national road. For each roadkill event we recorded several biotic and abiotic variables supposed to be relevant for wildlife-vehicle collisions. We used the 2D Ripley's K statistic to evaluate the dispersion of roadkill events in space using the software SIRIEMA v2.0. To identify regions of high functional connectivity for wild-mammal species using the software Circuitscape 3.4.5. Additionally, we used cost-weighted distance modeling as the basis for identifying the best linkages connecting habitat for focal species. **Results:** Our first estimates suggest that at least 550 mammals are killed each year in national road in the Middle Magdalena Valley. Belonging to five orders, nine families and 13 species. Species susceptible to roadkill in the study area include Didelphis marsupialis, Cerdocyon thous and Tamandua mexicana. The analysis of the spatial distribution, allowed us to define that roadkill events were significantly aggregated spatially in Route 2. In this case, two areas were identified as road kill hotspots. Were identified areas of high functional connectivity for species, that allow propose to environmental authority a taxa-specific mitigation plan aimed to minimize the negative impacts related to this phenomena on mammal species. The best linkages connecting habitat for focal species, produce maps of cumulative movement cost, reflecting barriers or mortality risks encountered, as animals move outward from habitat. **Conclusion:** In general, our project will contribute to understand the potential factors promoting spatial and temporal mammal roadkill patterns and to identify mammal roadkill hotspots in the study area by using standardized and accurate methods to monitoring wildlife-vehicle collisions.
We expect that species from other taxa inhabiting the study region and identified as sensible to roadkill also will benefited with our project.

Keywords: Mammals, wildlife-vehicle collisions, Functional connectivity

ID:494
D-Thursday, July 13th, 2017, Celestún
Oral session: Population and community dynamics

Production dynamics of cultural grasslands in humid tropics of North East India

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Background: Grasslands cover around 40% of the World's terrestrial area and plays significant role in global carbon cycle. Biomass production in relation to carbon management has been studied for diverse grassland types. Imperata grassland of North East India has been little explored. Imperata grasslands are culturally important land use in rural landscapes for its monetary benefits and other uses. We aimed to assess the seasonal pattern of biomass production, the eventual pathways for the produced biomass and affect of customary fire management system on ecosystem carbon cycle. **Methods:** Above ground and below ground plant component were harvested according to Oliveras et al., 2013 and Anderson and Ingram, 1993 at monthly interval. Above ground parts were weighed in the field and sub-samples were subsequently oven dried at 70Â° C to constant weight. Litterfall samples were collected at monthly interval and decomposition were studied according to Olson, 1963. Total soil respiration (g C m^{-2}) was measured at monthly intervals using the alkali absorption method of CO2 by soda lime (Keith and Wong, 2006). The soil organic carbon concentration was determined by wet oxidation method (Jackson, 1958). **Result:** The annual net primary production was estimated at 886±85 g C m-2yr^{-1}. The missing carbon were from (i) harvesting of standing litter 332 g C m-2$year^{-1}$ (ii) harvesting of above ground live biomass 25 g C m^{-2} yr^{-1}, (iii) heterotrophic respiration 193 gCm-2yr^{-1} and (iv) carbon released to atmosphere through fire 25 gCm-2yr^{-1}. The net ecosystem production was estimated 91 gCm-2yr-1.**Discussion:** Comparatively high biomass production during pre-monsoon and monsoon over post monsoon season is attributed to nutrient return in soil immediately after fire in February. Post fire effect might have killed roots and rhizomes leading high below ground litter production during March to August. High autotrophic respiration may be due to high below ground biomass production (35-70 gm^{-2}). Fire consumed the surface litter in March which hindered the surface decomposition. Annual total biomass carbon production was estimated at 886 gm-2. Annual heterotrophic respiration of 193 gm-2 was found major pathway to escape carbon from the system that impacted on annual production. Present study reveals that NEP of Imperata grassland in North East India is (91±10) gC m-2yr-1 and it was greatly influenced by the seasonal trends and management strategies.

Keywords: Imperata, Ecosystem production, Biomass production

ID:369
D-Thursday, July 13th, 2017, Celestún
Oral session: Population and community dynamics

Oral Session
Biological and social bases for sustainable use of non timber forest products

A Functional Trait Approach to Agroecology: Identifying Avocado Trees with High Water-Use Efficiency

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Background: Many tropical crop trees are represented by a single variety, making them vulnerable to climate change. Functional traits, which are easy-to-measure characteristics that represent more complex physiological processes, can be used to identify varieties with desirable attributes and contribute to better understanding and management of agro-ecosystems. Water-use efficiency is a trait that describes the carbon gain per water loss and is an important measurement for selection of plants with low water consumption. We studied functional traits related to water-use efficiency and hydraulic conductivity in avocado varieties. **Methods:** We measured leaf carbon isotopic composition in 24 avocado varieties to determine water-use efficiency. To validate carbon isotope measurements, we also measured leaf photosynthetic gas exchange of water and carbon, and leaf and stem functional traits of varieties with the highest and lowest carbon isotope composition. Finally, we compared these traits to hydraulic conductivity to understand water supply to leaves for gas exchange. **Results:** Our results showed large variation in avocado varieties grown at a single location. A broad spectrum of leaf carbon isotopic composition was found among varieties and it was correlated with water-use efficiency and other gas exchange parameters. We identified varieties with high efficiency of water use that can be implemented in cultivation where water supply is limited. **Discussion/Conclusion:** Water-use efficiency and hydraulic conductivity combined to enhance our knowledge regarding water supply and use in avocado leaves. Identifying varieties of tropical tree crops that are efficient in terms of water use is critical for maintaining a high level of food production under limited water supply. Plant functional traits, including carbon isotopes, appear to be an effective tool for identifying species or genotypes with particular carbon and water economies in managed ecosystems.

Keywords: Agroecology, Carbon isotope composition, WUE

ID:237
D-Thursday, July 13th, 2017, Uxmal
Oral session: Biological and social bases for sustainable use of non timber forest products

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Enterprise based conservation of non-timber forest products and livelihood in Western Ghats, India

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Background: The Non- timber forest products (NTFPs) provide livelihood for millions of forest dwelling communities. Soliga indigenous community in Western Ghats earns 30-40% cash income from NTFPs. Enterprise based conservation has been encouraged with Soliga community to bring livelihood security under the Forest Right Act. This in turn would increase community stake in the conservation. Income generated will go back to the community in the form of an incentive to conserve and monitor the resources. **Methods:** Project has been implemented in three protected areas of Western Ghats. Three decentralized processing units have been established with community participation, adding value to honey, gooseberry, soapnut, soapberry and wild mango by making number of products. Participatory Resource Monitoring (PRM) has been conducted with activities consisting of assessments of resource production, extraction, regeneration and adaptive management being carried out by the community. **Results and discussion:** Participatory resource mapping was conducted in 35 villages in which 700 people participated. In all 3272 person hours of training were conducted for men and 2352 person hours for women on sustainable use of forest resources. Processing units have started generating income. Harvesters were involved in estimating percentage of the bee colonies before and after harvest as part of PRM. Their PRM techniques indicated that percentage of harvest was 55, 72 and 66 in Cauvery WLS, BRT Tiger Reserve and MM Hills WLS respectively. **Conclusions:** Enterprise linked conservation would involve community in conservation and monitoring. PRM was helpful to understand the resource status, their variations and helps in taking appropriate conservation measures. It would also help the community to understand dynamics of bees and improve honey harvest techniques. Enhancing income from the sustainable harvest of NTFPs can help in maintaining local livelihoods and provide economic incentives to conservation. Maintaining long-term participation and interest requires ensuring resource tenure.

Keywords: Enterprise, Participatory resource monitoring, NTFPs

ID:257
D-Thursday, July 13th, 2017, Uxmal
Oral session: Biological and social bases for sustainable use of non timber forest products

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Chronic defoliation on reproductive success of a tropical dry forest palm in Sonora, Mexico

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Background: In the tropics, palms represent some of the most important non-timber forest products. Especially, leaves are widely used in the manufacture of handcrafts and roofs of houses. *Brahea aculeata* is a micro-endemic palm of northwest Mexico threatened by its intensive exploitation and its populations are reducing. In this study, we evaluated the effects of different treatments of leaf harvesting on foliar (FA) and reproductive (RA) attributes in adults in the tropical dry forest ofÁlamos, Sonora, northern Mexico. **Methods:** During 2014-2015, applied three harvesting schemes simulating the traditional management to evaluate the effect on individuals and on the population: i) High harvest (HH), involves a cut of all leaves including meristematic leaves, ii) Low harvest (LH), in which all leaves, with the exception of the two newer are harvested and iii) control palms, without any harvesting treatment (C). Harvesting was applied every semester. We registered leaf length, leaf production, flower/fruit production, seed germination and seedling growth. **Results:** Harvested palms drastically reduced their reproductive success producing a lower number of flowers (up 80% in second year) and fruits (90%), presenting a low or null percentage in seed germination, as well as low seedling growth. Regarding the FA individuals from the HH and LH presented larger leaves (10% larger), greater production of new leaves (40% in first year), compared to control individuals. In 2015 we registered a slight decline in all treatments, however the harvested individuals maintained the highest averages. Relationship among leaf (size and production) and reproductive attributes (flower and fruit production) was positive for first year, but was negative for second year indicating a significant trade-off among the reproductive and growth function. **Discussion/Conclusion:** Leaf harvesting in *B. aculeata* alters the patterns of resource allocation, causing a strong decrease in the reproductive success of this species, by allocating less resources to seed production and its vigor, which was reflected In a decrease in the number of seeds and their germination. Our results suggest trade-offs between the vegetative and reproductive function, which is accentuated by the cumulative effect of chronic harvest. This type of studies is essential to understand the population dynamics of species under management, and contribute to sustainable optimal harvesting schemes of *B. aculeata*.

Keywords: Leaf-harvesting, tropical dry forest, trade-off

ID:319
D-Thursday, July 13th, 2017, Uxmal
Oral session: Biological and social bases for sustainable use of non timber forest products

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Nontimber Forest Extraction as a Driver of Ecological Change in Peruvian Amazon

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Background: Despite the increased attention on identifying factors driving ecological change in the Amazon Basin and their effects on ecosystem goods and services, the harvest of plant-based non-timber forest products (NTFP) has received little consideration as a contributor to regional ecological change. Harvest of fruit from the dioecious palm, *Mauritia flexuosa* (aguaje) is an example of a highly-valued NTFP where concern about the ecological implications of harvest has existed for many years, but for which the scope and scale of harvest and its implications for region-wide ecosystem change remains unclear. We sought to better understand the scale and scope of *M. flexuosa* fruit harvest in the Peruvian Amazon. Our objectives were to: (1) quantify the amount of *M. flexuosa* fruit entering the Iquitos market and (2) trace the source of fruit entering Iquitos to document spatial and temporal patterns of extraction across the region. We discuss the role of NTFP harvest as a contributor to ecosystem change, and explore prospects for sustainable management. **Methods:** We recorded sacks of aguaje arriving into major ports of Iquitos for 1 year, and conducted interviews and reviewed boat registries that documented the source and amount of aguaje entering Iquitos. Using GIS we created a map showing spatial and temporal patterns of aguaje extraction. In addition, we conducted fieldwork to understand the social, ecological, and economic factors influencing aguaje extraction in rural communities. **Results:** Our estimates indicate that over 8,217 mT of aguaje was imported over 1 year. Over 267 communities spread across six major rivers sent fruit to Iquitos. There was pronounced spatial and temporal variation in harvest. Our method underestimates the amount of fruit harvested, as our numbers do not include fruit that was harvested, but not marketable. Not only is a massive amount of fruit harvested across a large region, most harvest is destructive, resulted in male-biased aguaje stands. **Discussion:** Results suggest that the harvest of NTFP is another driver of ecological change in the Amazon Basin. Aguaje is an important food source for a wide range of wildlife and current harvest rates indicate a widespread reduction of fruit availability. This may further compromise stressed wildlife populations and further degradation of tropical forests in the region. Recommendations for sustainable use and management of aguaje will be discussed within this context.

Keywords: NTFP, Peru, Buriti

ID:478
D-Thursday, July 13th, 2017, Uxmal
Oral session: Biological and social bases for sustainable use of non timber forest products

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Overcoming barriers to the sustainable use of native orchids in the Colombian Andes

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Background: Orchids dominate the global trade of live plants, however wild plant extraction is a threat to the conservation of commercial species and as a precautionary measure all species are included in the CITES appendix with legal reinforcements at the national level. In Colombia, more than 4000 orchid species have been reported and their sustainable use is a promising option for the rural population, at present underutilized. **Method:** We conducted an assessment of the biological, socio-economic and normative aspects related to orchid use in a province located in the Andes of Colombia, characterized by a high richness of species and a long history of use for ornamental purposes. Based on the analysis of this information we identified barriers for the conservation and sustainable use of orchids by local producers and measures to overcome them. **Results:** Use of orchids in the region is mainly commercial, although producers that cultivate them for education, conservation and collection purposes were also identified. Producers however do not follow national normative due to unfamiliarity or difficulty to follow legal procedures, and this restricts them to participate in formal commercial channels, as well as expositions. Orchid richness is unknown by local actors and from the 900 species found in the Cundinamarca province, 68 are commercially used, although found in low frequencies and there is a need for cultivation methods that allow a higher production of plants. Wild populations of commercial species are scarce as a result of plant extraction and at present access to wild plant material of all orchids is highly restricted, although it is still occurs. To overcome these barriers, a set of species was prioritized according to their potential for sustainable use to study the demography and genetics of wild populations, and develop protocols for conventional and in vitro propagation. In addition, knowledge appropriation by local actors has been promoted by means of workshops and technical trainings, as well as the joint construction of guidelines aimed at conserving and sustainably using orchids in the region. **Discussion and/or conclusion:** Strengthening relationships between local actors and underlying the role of producers in the conservation of native plants in the region has shown to be a fundamental condition, which can be applied to the use of other wild plants as a restrictive normative by itself does not guarantee the sustainable of the resource.

Keywords: ornamental plants, conservation, nurseries, guidelines

ID:597
A-Monday, July 10th, 2017, Tulum
Oral session: Biological and social bases for sustainable use of non timber forest products

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Using *in situ* symbiotic seed germination to restore over-collected medicinal orchids in Southwest China

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Due to increasing demand for medicinal and horticultural uses, the Orchidaceae is in urgent need of innovative and novel propagation techniques that address both market demand and conservation. Traditionally, restoration techniques have been centered on ex situ asymbiotic or symbiotic seed germination techniques that are not cost-effective, have limited genetic potential and often result in low survival rates in the field. Here, we propose a novel in situ advanced restoration-friendly program for the endangered epiphytic orchid species Dendrobium devonianum, in which a series of in situ symbiotic seed germination trials base on conspecific fungal isolates were conducted at two sites in Yunnan Province, China. We found that percentage germination varied among treatments and locations; control treatments (no inoculum) did not germinate at both sites. We found that the optimal treatment, having the highest in situ seed germination rate (0.94%1.44%) with no significant variation among sites, supported a warm, moist and fixed site that allowed for light penetration. When accounting for seed density, percentage germination was highest (2.78%2.35%) at low densities and did not vary among locations for the treatment that supported optimal conditions. Similarly for the same treatment, seed germination ranged from 0.24%5.87% among seasons but also did vary among sites. This study is the first to report on the cultivation and restoration of an endangered epiphytic orchid species by in situ symbiotic seed germination and is likely to have broad application to the horticulture and conservation of the Orchidaceae.

Keywords: restoration-friendly cultivation, compatible fungi

ID:635
D-Thursday, July 13th, 2017, Uxmal
Oral session: Biological and social bases for sustainable use of non timber forest products

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Oral Session
Conservation iniciatives and tropical biology research

An analysis of conservation success of ATBC Declarations since inception

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The Conservation Committee of ATBC has instigated annual declarations, beginning at the 2005 ATBC Uberlândia Conference in Brazil. This became known as the Uberlândia Declaration. Declarations typically deal with significant topical conservation issues in the ATBC annual conference host country, but some have also dealt with regional or global issues. Declarations are prepared during the annual conference by the Conservation Committee with assistance from in-country conservation experts. To date there are 14 ATBC Declarations from across the world, providing us an opportunity to examine their overall effectiveness. We examine the conservation success (or failures) of the 14 Declarations through interviews of individuals who led the various declarations. We evaluate management and policy responses, and whether there was any local NGOs involved in the response process. We also consider any media coverage at local, national and international scales. Finally, we document any peer-reviewed publications that may have emanated following the Declarations. The goal of our study it to demonstrate the conservation value of ATBC Declarations and to present strategies to improve their future efficacy.

Keywords: ATBC, conservation success, impact, Declarations

ID:479
D-Thursday, July 13th, 2017, Tulum
Oral session: Conservation iniciatives and tropical biology research

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How does nationality influence the productivity and impact of tropical biologists?

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Background: Scientists have long been fascinated by the ecology and evolution of tropical ecosystems. While much of this research was historically carried out by scientists from developing countries, recent decades have seen the rapid globalization of Science, Technology, Engineering, and Math (STEM) fields and the increased productivity of researchers based in the Global South. This has led to a surge of interest in evaluating the global engagement of these emerging scientific communities as well as their impact on the direction of STEM fields. Here I review changes over the last thirty years in the geographic diversity of tropical biologists - i.e., where they are from and where they work - and their engagement in different components of the scientific community. Specifically, I review their prevalence and role as (a) authors of scientific articles, with an emphasis on research emerging from sites of long-term research, and (b) as the editors of scientific journals. **Method, Results, and Discussion:** Changes in the productivity and authorship of tropical biologists was assessed with a review of >7000 articles published in 55 ecology, evolution, and conservation journals, while the participation of scientists from tropical countries as editors was assessed using 30 years of editorial boards composition from a subset of 25 of these journals. While productivity by scientists from tropical countries has increased dramatically in recent decades, my results also suggest a limited number of scientists from the Global South are truly engaged in deciding which ideas and scientists will play central roles in the development of their field. This can have a major impact on the scientific community in tropical countries and the types of knowledge scientists generates; I propose several ways in which researchers, editors, and academic societies can work to rectify this geographic imbalance in scientific engagement.

Keywords: global south, productivity, impact, publication

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Search for orphaned legacy tropical forest datasets

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Background: Tropical forest tree inventories and plot projects have generated large amounts of data over many decades. The information is scattered among different institutions, some of which no longer function, and among people, some of whom have retired or moved away from inventory work. Some of the data are available only on paper, some are digitized but in old formats, and some are still undiscovered. These data sets may become lost and with them our ability to assess historical changes that can inform research and policy development for land use change and landscape resilience. We are compiling information on these "orphaned" tropical forest datasets that should be digitized or transformed to an up-to-date digital format. The goals are to locate such datasets, and then to secure the data and make it and its metadata available on a publicly accessible website. **Methods:** Through various lists, websites, and newsletters, we are requesting information on these orphaned tropical forest data sets based on compilations of metadata such as TROPIS and ATROFI-UK, and searches of development agency projects. Discovery is iterative, building on suggestions received. The inventories and plots located will be cross referenced against lists of curated datasets such as Forestplots.net and others under the Global Index of Vegetation-Plot Databases (GIVD), to determine which datasets are not already in a long-term data repository. **Results:** To date, we have approached c. 30 newsletters, listservs, and websites to announce the search. ATROFI-UK has metadata on 28 studies in need of up-to-date digital curation. TROPIS refers to > 6000 plots with uncertain curation status. From individual researchers so far, we know of c. 20 inventory and plot-based studies in need of curation, in countries ranging from Vanatu to Ghana to Belize. We continue to receive suggestions that should lead to other data sets. In contrast, www.forestplots.net, is a digital repository of data for c. 2000 tropical plots, and GIVD archives metadata on > 183,000 tropical plots, most of which seem to be curated for long-term access. **Discussion/conclusion:** These legacy datasets are invaluable for understanding how tropical forests, biodiversity, and carbon storage change through time, including the cumulative impacts of changes in land use and climate. We strongly believe that the past can help inform the future.

Keywords: legacy, tropical forest, inventory, plot

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The Ancient Maya and the Modern Forest: Mutualism of History and Ecology

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Background: Ancient Maya civilization flourished in Belize until a steep decline circa 900 AD. Heavily managed landscapes, possibly including tree management by the ancient Maya, reverted to forest. Since the Maya decline, our research area in northwest Belize, Central America, has remained in subtropical, old-growth forest, growing on a landscape of ancient cities, farmed fields, and other ancient features. We asked two questions: 1) How has ancient Maya land use affected the distributions and abundances of tree species in this modern forest and 2) can characteristics of the modern forest suggest how the ancient Maya farmed the landscape? **Methods:** We inventoried 3,969 trees ≥ 10 cm dbh (c. 150 species) and quantified soil and topographic variables in 207, 400-m2 plots over several square kilometers of forest on variable topography and on various ancient Maya features. **Results:** To answer our question on ancient land use and the modern forest, we note that for most of the modern, dominant tree species we have no clear evidence of use or cultivation by the ancient Maya. Thus we cannot say that tree species composition in this forest has developed mainly from ancient, active management of trees. However: 1) we know that ancient Maya agriculture significantly changed soil and topography in some places; 2) our data show that trees have strong species-specific preferences for different soils and topographic situations; thus 3) we believe that forest composition in the modern, regrown forest in this area partly reflects changes in soil and topography caused by the ancient Maya. To answer our question on how characteristics of the modern forest suggest how the ancient Maya farmed the landscape, we note from our ecological data the great heterogeneity of soil and topographic situations that relate to variation in the modern forest. Some archaeologist believe that the ancient Maya skillfully exploited such environmental variation to achieve a fine-tuned and productive agriculture that supported their great cultural achievements. **Conclusion:** In this interdisciplinary mutualism, Maya history helps explain the modern forest, and studies of the modern forest may help explain Maya history.

Keywords: ancient Maya, landuse, tree species

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Unintended multi-species co-benefits of community-based conservation in lowland Amazonia

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Background: Freshwater ecosystems are one of the most threatened environments worldwide, and various strategies have been proposed for their conservation. Despite the increasing threats from large dams, land-cover change, and overexploitation of aquatic species, these environments remain relatively neglected. **Methods:** Here we show a robust ecological assessment of one of the largest community-based conservation initiatives in Brazilian Amazonia, focused on the giant freshwater turtle (*Podocnemis expansa*). We analyze the population trajectory of this target species using a 40-year dataset, and adopted a multi-taxa approach, evaluating 14 protected and 14 unprotected. We sampled caimans, large catfish, aquatic megafauna, migratory and resident birds, iguanids and invertebrates. **Results:** Community-based protection had a strong positive effect on the reproductive success of *P. expansa* (58 times more nests on protected beaches). Poaching activity in "no-take" beaches was around 2% against 99% in unprotected beaches, even inside formal protected areas. Therefore, the mere creation of sustainable-use protected areas is not enough to protect this target species, but local communal protection can ensure an impressive population recovery. We also found a drastic effect of community based protection on non-target taxa; beach protection explained 70-85% of variation in abundance, even considering a set of key environmental variables (e.g. beach area, beach slope, sand type). **Discussion:** We demonstrate that community-based protection of fluvial beaches represents an effective population recovery tool for overexploited and threatened species, such as black caimans, large migrant catfishes and migratory birds. Finally, we highlight an important window of opportunity to ensure effective large-scale aquatic biodiversity conservation across Amazonian floodplains.

Keywords: community-based-management, freshwater-turtles, sustainability

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Oral Session
Human development and tropical ecosystems

Revealing patterns of shared thinking on the science-practice interface in Ecology and Conservation

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Background: A debate on how to improve the interface between science and practice in Ecology and Conservation has surfaced in the last decades. While many have argued for the existence of a "science-practice gap" and called for "evidence-based conservation", others questioned these concepts, arguing they assume linearity in science communication, neglecting other knowledge types and the intricate processes of decision-making. This suggests the existence of a variety of ways of thinking the science-practice interface among relevant actors. To systematically assess the viewpoints of both scientists and practitioners on the science-practice interface, we conducted a Q-method study. We focus on a tropical developing nation, where robust science-practice relationships are most needed, as many current conservation issues involve these countries. **Method:** We asked scientists (ecologists hired at universities) and practitioners (technicians from the federal environmental agency) across all five regions in Brazil to rank their agreement with 48 statements describing how the science-practice interface should be. We then used PCA to identify 3 groups of people whose responses were correlated, representing shared ways of thinking on the science-practice interface. **Results:** The predominant viewpoint was shared among scientists and practitioners who saw the interface as a space for integration of scientific and strategic knowledge to tackle environmental issues. The second was held mostly by practitioners assigning great importance to science in decision-making and calling scientists to conduct relevant research. The third was shared by scientists who were less willing to engage in collaborations, allocating to practitioners the responsibility to correctly interpret science, seen as vital to understand complex problems. **Conclusion**: All participants agreed that both scientists and practitioners give relevant contributions to the science-practice interface. Divergences lied on the specific roles assigned to scientists, practitioners and the knowledge they hold. Except for the third viewpoint, there was high willingness for direct dialog, but several stressed the need for organizational structures stimulating interaction, though there was no consensus on the most effective structure. By uncovering patterns of shared thinking, we identified points of consensus and conflict to be considered when creating paths for dialog between science and practice in Ecology and Conservation.

Keywords: sicence-practice-gap, science-communication, decision-making, Q-metodology, social-sciences

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Small landholder agroforestry and forest use in ethnically diverse communities in South India

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Background: Malai Mahadeshwara Hills Wildlife Sanctuary (MMHills WLS), a biodiversity hotspot in South India, is surrounded by small communities inhabited by the indigenous Soliga and Lingayath. In this rainfed agricultural region, differences in how landowners interact with the forest and their agricultural land have important implications for biodiversity preservation. We believe small landholder agroforestry, combining shorter rotation agricultural crops with trees, near protected forest has the potential to contribute to ecosystem services and to the livelihood of the local communities. **Methods:** We surveyed 90 landowners in 13 villages representing two ethnic groups in the MMHills WLS to better understand the role of agroforestry in traditional South Indian farms in forest landscapes. We conducted oral interviews with an equal number of Soliga and Lingayath households in a range of elevations surrounding the Sanctuary and identified, measured, and mapped all trees on the land of each household. **Results:** The average landholding is 2.95 acres and agriculture is dominated by the production of finger millet (ragi), beans (avare), brown mustard (sasive) and maize (jola). Rainfed agriculture dominates the area: only 6% of farmers have access to irrigation. We found a total of 1,514 trees of 137 species on the land of these farmers. The number of trees per property ranged from 1 (7 landowners) to 142 (1 landowner) with about half (48%) of the landowners maintaining 9 or more trees on their property. Home gardens also play an important role in the incorporation of trees into the landscape, accounting for approximately 10% of the abundance and 1/3 of the diversity of tree species. We found significant differences between the Soliga and Lingayath groups: Soliga collect more non-timber forest products, but claim fewer uses for the collected species, they maintain fewer livestock, make less money from the sale of items from their agricultural land, and receive more government support than members of the Lingayath community. **Discussion:** Small farmers play a significant role in biodiversity preservation in South India by protecting and planting native and economically important tree species on their land and through their dependence on intact ecosystems in the surrounding landscape. Agroforestry systems have a positive environmental impact this area.

Keywords: South India, Agroforestry, biodiversity, ecosystem

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Bushmeat consumption and nutrition in Amazonia

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Background and objectives: Although undernourishment has decreased in developing countries in the last decades, some regions remain a concern, such as the Brazilian Amazonia, home to a high proportion of children suffering from nutrient deficiencies. This region is famous for its large remaining forest with high biodiversity, but people inhabiting both its rural and urban areas suffer from chronic underdevelopment. Biodiversity can play a key role for nutrition in the region due to the availability of wild foods. Specifically wildmeat, which has been suggested to improve nutrition, as it is an important source of calories, protein, lipids and micronutrients. Some studies have even suggested that wildmeat consumption is likely to prevent anemia. However, there is still scarce evidence of it in tropical forest regions, especially in Amazonia. We expect that the role of bushmeat on nutrition is not homogeneous throughout the region, as bushmeat consumption varies between municipalities and it is likely more important for the poor and in rural households, where the availability of domesticated types of meat is limited. In this work, we report on the relationship between bushmeat consumption and anemia (accessed through hemoglobin levels) in children under 5-years-old in four different municipalities in Brazilian Amazonia. **Method:** We collected data on the hemoglobin levels of 590 children in urban and rural areas of these municipalities, in two distinct seasons (wet and dry). In addition, we collected data on household bushmeat consumption, the consumption of fish and domesticated types of meat, as well as household's socioeconomic variables (e.g. income and education) that are importantly related to health. **Results**: We found that anemia rates varies between municipalities and rural and urban areas, being more common in rural areas and in more remote municipalities. **Discussion:** Those are the areas where wildmeat availability is higher, which suggest a much more complex relationship between bushmeat consumption and anemia, which we will be exploring in this work.

Keywords: nutrition, micronutrient, anemia, wildmeat, bushmeat

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High Andean Biodiversity food for everybody, innovation as a strategy for the ex situ conservation

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Background: The Colombian's Andean Region owns a wide phytogenetic resource, which could be used in a dietary level. However, it is nowadays one of the most threatened zones due to the depletion of its ecosystems, narrowing the availability and usage of native vegetable resources. One possible solution to this problem is to promote the building and appropriation of knowledge about these species, through methods that allow us to know, conserve and use them in a sustainable way. It is remarkable the necessity to achieve the previous using the gastrobotanic innovation as a strategy for the conservation of ex situ species of the natural patrimony of Bogota D.C. **Method:** In this context, the Botanic Garden of Bogotá Jose Celestino Mutis, in alliance with the Institute of food science and technology of the National University of Colombia, brought the project High Andean Biodiversity to everybody's dish (BAPT acronyms in Spanish), which aims to prompt the local cuisine, rescuing the use and traditional knowledge of the vegetable species promissory for the gastronomic industry in Bogotá D.C. The implementation of this protect covers three components of investigation: bioprospection, propagation and the integral utilization of species. with the purpose to obtain phytofunctional products, an innovatory gastronomical offer and the reintroduction of the vegetable material in to the highly fragmented ecosystems. **Result:** The BAPT project identified and classified 20 species which belong to 15 botanic families (Amaranthaceae, Basellaceae, Caricaceae, Compositae, Chenopodiaceae, Lamiaceae, Oxalidaceae, Passifloraceae, Rosaceae, Ericaceae, Solanaceae, Symplocaceae, Tropaeolaceae, Verbenaceae y Winteraceae). The biopropecting studies identified bioactive compounds in the edible parts of the species to obtain nutraceutical products. The propagation protocols reveled the effectivity of the sexual reproduction in the fruity, aromatic and pseudocereal species. The protocols also highlight the importance of ex situ conservation of tubers and roots. **Discussion and conclusions:** The incorporation of the 20 identified species with nutritional potential offers a unique range of flavors, textures and aromas. Furthermore, the nutritional contribution and the antioxidants provided by them make their derivatives and secondary culinary uses functional foods. Therefore, this encourages the production for self-consumption and maintenance of the areas where they are produced.

Keywords: gastrobotanic, phytogenetic Andean resources, bioprospecting

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Resilience of peri-urban secondary forests in Andean forests

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Background: An increasing extent of tropical forests are in some stage of recovery from past human disturbance. In this context, evaluating the regeneration potential of secondary forests is key to understand resilience in tropical landscapes. This is particularly important in peri-urban areas, where human impact is considerable. Here, we use data on tree and shrub taxonomic composition across multiple life stages to evaluate the regeneration potential of successional stands near Bogotá city (Colombia), one of the most populated urban areas of South-America. **Method:** We used a network of 20 20x20 m permanent plots established in early and late secondary forests across four locations. We measured diameter at breast height (DBH) of individual trees and shrubs with a basal diameter > 5 cm. Inside each plot we also established four subplots of 2x2 m where all the seedlings > 5 cm in height were tagged. **Results:** Overall, we censused 5473 individuals of adults, saplings and seedlings belonging to 85 tree and shrub species, a surprisingly high number for such a disturbed region. Seven of these species are endemic to Colombia and at least another one (Prunus buxiflia) is categorized as vulnerable. Our results showed that early secondary stands may approach a similar taxonomic composition to that of late secondary stands. Location was the most important factor determining species and functional composition, followed by successional stage, and then life-stage. Although some species occurred in all plots, each location was characterized by a set of a few locally dominant species. Interestingly, within a plot, species that were dominant at the seedlings stage were different to those that dominated the tree stage, suggesting an important successional species turnover. **Discussion and conclusion:** Overall, several mature forest species were successfully regenerating in secondary stands, demonstrating that fragments of young secondary forest in this peri-urban area have the potential for maintaining species diversity and ecosystem function in highly human-impacted Andean forest.

Keywords: secondary/ Andean forest, regeneration potential

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Oral Session
Coral and other aquatic systems

Optical traits: a morpho-functional approach to explain coralline niche distribution in coral reefs

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Red coralline algae are cosmopolite macroalgae able to colonize contrasting light environments and with the ability to precipitate CaCO3 within the walls of their vegetative cells. In coral reefs, the three most distinctive coralline algae growth-forms: rhodoliths, articulated and crustose algae (CCA) are essential for ecosystem functioning and typically occur from highly-illuminated to light-limited habitats. The carbonate structure is key for their ecological success as it provides protection against herbivores and resistance to water motion. However, the potential role of the carbonate skeleton to enhance thallus light absorption efficiency through multiple scattering of light, similarly to the effect documented for scleractinian corals, has not been yet investigated. In this study, we characterized for the first time the optical properties of three coralline species: the rhodolith Neogoniolithon sp., the CCA Lithothamnion sp., and the articulated alga Amphiroa tribulus, in relation to basic structural traits: pigment content and thallus mass area (TMA, g dw m^{-2}). The thickest thalli of the rhodolith (highest CaCO3 content and TMA) presented the highest pigment light absorption efficiency (a*Chla; m^2 mg $Chla^{-1}$) and the highest metabolic rates per area, which can explain their success in shallow, highly illuminated and oligotrophic reef environments. By contrast, the thinnest CCA, a low-light specialist, presented the highest light absorption efficiency per unit of mass (a*M; m^2 g dw^{-1}) and metabolic rates normalized to mass. Yet, the success of the CCA in low light habitats is supported by its higher ability to return the solar energy collected into new structural growth. Finally, the ecological success of the articulated alga Amphiroa tribulus, which showed intermediate values in light absorption efficiency, metabolic rates and TMA, and a specialized bifacial thallus, may rely on other levels of algal complexity. This growth-form presents flexible non-calcified segments (genicula), which allow the formation of more complex canopies, and thus, construct the largest light collector at the organism/canopy level. This characteristic significantly enhances photosynthesis and carbonate production per individual. Our morpho-functional approach highlights the utility and explanatory power of the optical traits to understand species abundance and niche disversification of corallines in the reef habitat.

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Oral session: Coral and other aquatic systems

Influence of sediments and tungsten traces on the Pseudodiploria corals from the Gulf of Mexico

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Coral reefs are under intense conditions of stress caused by the anthropogenic activities in coastal areas and the increase of human population. Water effluents from urban and industrial areas carry large amounts of sediments and pollutants affecting corals populations, inducing bioerosion, increasing diseases and promot- ing the development of algae that compete for space with corals. In the Veracruz Reef System National Park (VRSNP) coral reefs are strongly affected by human activities carried out in the area. Gallega and Galleguilla reefs are among the most affected by wastewater discharges from the industrial (petrochemical and metal- lurgical) and urban areas in their vicinity. To assess the potential impact of this contamination on corals in the VRSNP, a chemical composition and morphology study of 76 Pseudodiploria colonies collected in reefs Gallega, Galleguilla, Isla Verde and Isla de Enmedio, was performed. Fragments of ~10 cm2 were collected and boric acid at 0.5 % was used to remove tissue from the skeleton; once clean, the morphology of each sample was determined with a scanning electron microscope (SEM). Subsequently, to test the chemical composition, an energy dispersion spectroscopy of X-ray chemical microanalysis (EDSX) was performed in the SEM. We found that corals from Gallega and Galleguilla reefs, located closer to human populations, presented high levels of tungsten and the skeleton exhibited multiple perforations. In contrast, corals from the farthest offshore reefs (Isla Verde and Isla de Enmedio) exhibited lower levels of tungsten and fewer perforations in their skeleton. These results demonstrated that anthropogenic activities in the NPVRS are affecting corals skeleton, highly damaging and promoting their bioerosion. The presence of traces of tungsten in the skeleton of corals is an evidence of the damage that waste discharges are causing to coral reefs. Discharges of large amounts of contaminants promoted the growth of harmful species that grow and develop into the corals skeleton, causing its bioerosion, and making them susceptible to disease and physical damage. This study is the first evidence of the effects of contamination on these species; therefore, further studies are necessary to determine the impact of pollution on their biology and survival.

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Oral session: Coral and other aquatic systems

What if we miss one mangrove?

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Background: The connectivity among marine environments is a fundamental ecosystem service, once it ensures the maintenance and viability of natural resources. Marine currents facilitate the dispersal of populations, enhancing gene flow, intensifying marine connectivity. Mangrove degradation occurs all over the world and generates direct consequences for traditional human communities that survive on its resources. It can also compromise adjacent mangroves as they function as stepping-stones, which is little considered in the literature. The traditional knowledge about connectivity between mangroves reinforces the systemic view of its conservation and should be incorporated in the definition of Marine Protected Areas focused on these environments. Thus, this study investigated the perception of coastal fishing communities of Southeastern Brazil about the connectivity among mangroves in which they fish and other mangroves in the coast. The perception faced the possibility of exhaustion and recovery of local resources. **Methods:** Fifty-seven semi-structured interviews were conducted in 9 different municipalities, over 1200km, whose answers were separated into analytical categories and compared with respect to: whether the inhabited mangrove is isolated (composed of only one river) or complex (more than one river); whether it is impacted or not impacted (based on the informants' view); and if there were loss and retrieval of any resource extracted from the mangrove. **Results:** The geographical structure and the conservation status of the mangrove influenced in the local knowledge about connectivity, whether it happens by migration or by dispersal between areas. Familiarity with connectivity processes is more evident for those who live in complex or more preserved mangroves, as well as when the loss and retrieval of resources were experienced by the fishermen. **Conclusion:** The traditional knowledge of these coastal fishing communities includes the perception of connectivity between mangrove environments. Therefore, itis a relevant point to be considered in conservation decisions.

Keywords: Environmental-Perception; Connectivity; Mangrove; Traditional-Communities; Araçá-Bay;

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Oral session: Coral and other aquatic systems

Environmental DNA: a promising tool for fish biodiversity assessment in Brazilian basins

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Background: The unequivocal identification of species is crucial for management and conservation purposes. Due to difficulties of traditional species identification and monitoring techniques (e.g. decline in taxonomic expertise, absence of unambiguous identification of cryptic species and specimens at early life stages) environmental DNA (eDNA) has been widely described as a promising tool for biodiversity assessment. In megadiverse countries this technique could allow the correct and fast biodiversity assessment contributing to management and conservation actions. **Methods:** To test the use of this tool in detecting fish biodiversity we conducted analysis using filtered water and sediment samples from 7 sample sites preserved in both molecular grade ethanol and sílica beads. Amplifications were conducted using partial sequences of the mitochondrial genes COI (340bp) and 12S (106p). **Results:** Illumina MiSeq analysis obtained for both markers allowed the detection of different fish species including native (e.g. *Hypomasticus garmani*, *Prochilodus hartii*) and introduced ones (e.g. *Prochilodus argenteus*, *Astronotus ocellatus*). Sediment samples yielded the largest number of eDNA copies and species identification and filters preserved in silica beads provided better results than the ones preserved in ethanol. Reads obtained for the ribosomal gene 12s were not variable enough to allow the distinction of some closely related species (e.g. Prochilodus spp.) and the data available in the Genbank could not provide an unequivocal identification (i.e. 100% of similarity with more than one species). **Discussion/Conclusion:** Universal COI primers allowed a reliable identification and distinction of closely related species, however due to the universality of the primers too many microplanktonic reads were obtained. Thus, eDNA can contribute to fish biodiversity assessment and a primer design for the mtDNA gene COI focused on vertebrates could allow a robust metabarcoding data contributing to fish species monitoring in Neotropical rivers.

Keywords: eDNA, environmental DNA, neotropical, fish

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Urbanization effects on leaf-litter decomposition & aquatic macroinvertebrates in tropical streams

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Background: Urbanization is a major anthropogenic impact to tropical ecosystems, as it alters ecosystem function and dynamics. In the case of stream ecosystems, urbanization alters organic matter inputs, changes the water chemistry, and alters the hydrology, thus changing biotic diversity and ecosystem function. Puerto Rico is an ideal location to assess the effects of urbanization on streams, as the island is ~40% urban. The objective of this study was to determine how leaf-litter decomposition and aquatic macroinvertebrate assemblages changed along an urban gradient. **Methods:** We conducted the study in the Rio Piedras watershed, that drains to the San Juan Metropolitan Area delimiting a clear urban gradient from which we selected six small streams and three pool habitats per stream. Six 5g leaf-litter bags were placed in each pool and one pack was collected on six different sampling dates. We determined leaf weight change, the rate of decomposition and macroinvertebrate assemblages colonizing the leaves by dates. Insects were identified to the lowest taxa possible to evaluate diversity per leaf bag. **Results:** After 44 days we found that the high sediment streams have the lower decomposition rates, in which 1% of the leaf-litter is decomposed per day leaving about 58-67% of the leaf intact; the second most urbanized streams decompose between 1-1.5% in which 59-73% of the leaf was not decomposed and the less urbanized streams decompose 3-4% per day with only 21-42% remaining of the leaf-litter at the end, to which the presence of shedding macroinvertebrates also contributed. **Conclusions:** The amount urbanization on the watershed clearly reduced leaf decomposition, affecting ecosystem function. The mechanisms appear to be the increase in sedimentation and changes in biota as urbanization increases. High sedimentation result in low oxygenation, creating an anoxic environment that limits macroinvertebrate colonization. A major reason for the change in decomposition is the lost of key groups of detritivorous macroinvertebrates, such as leaf shredders (Phylloicus pulcrus: Trichoptera) in highly urbanized streams. There was an analogous increase in macroinvertebrates with high pollution tolerance (e.g., Chironomidae: Diptera; Annelidae; Thiaridae: Mollusca).

Keywords: decomposition, leaf-litter, macroinvertebrates, streams, urbanization

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D-Thursday, July 13th, 2017, Maya
Oral session: Coral and other aquatic systems

POSTERS

Posters
Biodiversity inventories in tropical ecosystems

Evaluating Multiple Spatial Scales to Understand the Distribution of Anuran Beta Diversity

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Background: We partitioned the total beta diversity of the species composition of anuran tadpoles to evaluate if species replacement and nestedness distributions are congruent at different spatial grains and extents across the Brazilian Atlantic Forest. Our first objective was to evaluate whether species replacement and nestedness values are congruent considering similar spatial scales within and among regions of the Brazilian Atlantic Forest. Our second objective was to understand if ecological processes such as species sorting and dispersal limitation are congruent within and among different regions considering similar spatial grains and extents. **Methods:** We alternated the sampling grain and extent of the study area (among ponds at a site, among ponds within regions, among sites within regions, among sites within regions pooled together) to assess the importance of anuran beta diversity components. We then performed variation partitioning to evaluate the congruence of environmental descriptors and geographical distance in explaining the spatial distribution of the species replacement and nestedness components. **Results:** We found that species replacement was the main component of beta diversity, independent of the sampling grain and extent. Furthermore, when considering the same sampling grain and increasing the extent, the values of species replacement increased. On the other hand, when considering the same extent and increasing the sampling grain, the values of species replacement decreased. At the smallest sampling grain and extent, the environmental descriptors and geographic distance were not congruent and alternated in the percentage of variation explaining the spatial distribution of species replacement and nestedness. At the largest spatial scales, the biogeographical regions showed higher values of the percentage explaining the variation in the beta diversity components. **Conclusion:** We found high values of species replacement independently of the spatial resolution, but the processes driving community assembly seem to be dependent on the spatial scale. At small scales, both stochastic and deterministic factors might be important processes structuring anuran tadpole assemblages. On the other hand, at a large spatial grain and extent, the processes restricting species distributions might be more effective for drawing inferences regarding the variation in anuran beta diversity in different regions of the Brazilian Atlantic Forest.

ID:16
Monday, July 10th, 2017
Poster Board: 1

Structure of herpetofaunal communities in eastern Madagascar

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Background: Understanding the distribution of herpetofaunal communities along certain environmental gradients can provide useful information for their conservation. However, such knowledge is relatively lacking for the tropical forest of Madagascar. **Methods:** We investigated how the composition and structure of herpeto faunal communities are influenced by the habitat topography and distance from water source. To do this, we carried out an intensive inventory of amphibians and reptiles in two sites in the Special Reserve of Mangerivola, eastern Madagascar. Three standard sampling methods (direct observation, systematic search and pitfall-trapping) were applied in each site. **Results:** In total, we identified 41 species of amphibians and 20 species of reptiles. Our data show that the abundance and species richness of both taxonomic groups varied greatly along the elevational gradient and was influenced by the distance of the inventory location to water source. **Conclusion:** Region of humid forest of Madagascar is rich of herpetofaunal communities. Results suggest the importance of considering environmental parameters in establishing conservation actions for the continuing existence of herpetofaunal community in Madagascar. In addition, conservation of all habitats along the gradient is important to protect different species composition of all habitats along the gradient.

Keywords: Herpetofauna, structure, distribution, tropical, Madagascar

ID:85
Monday, July 10th, 2017
Poster Board: 2

Ensemble of the bat acoustic reference library SONOZOTZ-AMMAC

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Background: A group of Mexican researchers, specialized in bats studies, have started the project 'Ensemble of the acoustic reference library for Mexican insectivorous bats'. The main objetcives are to develop a standardize protocol to record bat echolocation calls to be used as a reference for species acoustic ID; to create the first reference library for bat echolocation calls in a megadiverse country and one of the richest on bat species; and to create a free online platform to upload and share any bat acoustic data worldwide. **Methods:** We developed a national interactive workshop with the bat experts to discuss and develop the recording protocol based on the expertise of the researchers with different species and habitats. We also performed several workshops across the country to train human resources for bat sampling techniques, echolocation calls recording strategies and sound analysis. Then, we performed a systematic and homogeneous data collection following the protocol and adjust it based on the field recording experience. Field work was planned to cover a wide range of intra- and inter-specific call variation of the insectivorous bats distributed in Mexico and to represent the great environmental heterogeneity in the country. The platform consists of a graphical interface which allows authenticated users to associate metadata and media files (sound and images) to field observations. The resulting data structures are stored locally as a SQLite database for offline persistence and can be inserted into a centralized non-relational Mongo database located at the National Commission for the Use and Knowledge of Biodiversity (CONABIO) using the same application. Result: We have collected 276 echolocation calls of 20 insectivorous bat species belonging to six families following the designed protocol and an extra of 2184 recordings from 96 species (70% of the species recorded in Mexico) belonging to the eight families that occur in México. We trained 45 people from across the country during the workshops that included researchers, students, NGO's and federal agencies representatives and independent biologists. **Discussion:** Our project provides the first public bat acoustic library ensemble on a systematic way to enhance data quality to be used for species acoustic ID. Moreover, the platform created will be of free access and could be fed to increase and extend the library call representation beyond Mexico.

Keywords: Biodiversity; Chiroptera; distribution; echolocation; ultrasounds

ID:236
Monday, July 10th, 2017
Poster Board: 3

Population density estimates of forest duikers differ greatly between survey methods, Cameroon

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Background: In Central Africa, forest duikersare the main prey for local hunters. Overhunting will pose severe threats to the livelihoods of the local people as well as to duiker populations. Estimating duiker populations is essential for many conservation programs, but the results are often controversial. **Methods:** We estimated forest duiker population densities in Southeast Cameroon using three survey methods: dung counts and diurnal direct observation over 338.2 km, and nocturnal direct observation over 334.7km. Result: Nocturnal observation resulted in the density of 59.8 individuals km^2 for blue duiker, which is among the highest densities ever reported in Central Africa and is much higher than estimates by dung counts (6.9 km^2) and diurnal observation (3.5 km^2). Nocturnal observation of red duikers also resulted in larger estimates (9.0 km^2) than other methods (5.2 by dung counts and 2.5 by diurnal observation). **Discussion:** Our results suggest that nocturnal observation is crucial for monitoring populations of blue and red duikers in this study area, and more broadly for the development of adaptive management regimes in hunting forests where duiker densities are likely underestimated due to the common use of dung count surveys alone.

Keywords: Diurnal observation, nocturnal observation, Dung.

ID:408
Monday, July 10th, 2017
Poster Board: 4

Floristic composition and regeneration in a fragment of the montane seasonal semideciduous forest

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Background: Floristic and phytosociological studies assists in the resolution of the main forest and agricultural troubles, environmental impacts mitigation, scientific results generation, recovery, conservation e management of communities and of natural ecosystems. This way, it is intended to analyze the composition of arboreal species, the phytosociological structure of the vegetation and the regeneration stages of the secondary vegetation at Mata Atlântica. **Methods:** The study was made in a fragment of Montane Seasonal Semideciduous Forest located at Minas Gerais State, Brazil. To characterize the floristic composition and the phytosociological structure, it was used simple casual sampling, by inventorying 15 plots (10m x 50m) to measure arboreal individuals with minimum diameter at breast height (DBH) of 5cm. In the sampling of the natural regeneration, 15 sub-plots (5m x 5m) were analyzed to measure arboreal individuals with DBH lower than 5cm and minimum total height (Ht) of 1,5m.Standards of vertical structure distribution and of diametric distribution were analyzed, as well as usual floristic composition and phytosociological structure indexes, like: Density, Dominance, Basal Area, Volume, Importance Value Index, Shannon Diversity Index (H'), Simpson concentration (C), Equitability Index of Pielou (J) and Mixture Coefficient of Jentsch (QM). **Results:** With the sampling of 1,855 individuals it was find the following results: Density of 11,036 n.ha-1, Basal Area of 42.753 m2.ha-1 and Volume of 211.037 m3.ha-1.The fragment shows high alpha diversity. The arboreal stratum propounds the following indexes: H' = 4.39 nats.ind-1, with Jackknife confidence intervals between 4.38 and 4.73 nats.ind-1; C = 0.99; J = 0.86; QM = 1:09. For the natural regeneration, the diversity indexes were: H' = 4.09 nats.ind-1, with Jackknife confidence intervals between 4.06 and 4.89 nats.ind-1; C = 0.98; J = 0.89; QM = 1:03.The boles have presented exponential distribution in "inverted-J", what is a characteristic of uneven-aged stands. The forest fragment was classified as a medium stage succession of the secondary vegetation. **Conclusion:** The analyzed forest fragment shows highs including richness and diversity, with characteristic standard of the diametric distributions of arboreal uneven-aged stands. There was predominance of the medium phase of the regeneration of secondary vegetation at the forest fragment studied.

Keywords: Floristic composition, natural regeneration.

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Poster Board: 5

Structure of the floral nectaries in two Clusiaceae from the Atlantic rainforest

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Clusiaceae s.s. present two subclases (Ruhfel et al. 2013). One of them includes the pantropical tribes Garcineae and Symphonieae. Members of Garcineae are dioecious with capitate stigmas while representatives of Symphonieae are hermaphrodites and have poricidal stigmas. In both tribes, nectar is the flower resource and insects and birds, the pollinators. *Garcinia brasiliensis* and *Symphonia globulifera* are Atlantic rainforest nectariferous shrubs and trees. However, information concerning to the structure of their nectaries are missing. Here we analyzed their development, anatomy and ultrastructure. Samples were prepared according to standard methods for plant anatomy, scanning and transmission electron microscopies. Histochemical tests were also performed. Carpellar origin was suggested to G. *brasiliensis* nectaries. In staminate flowers the nectary has a rounded shape and occupies a central position in the flower. In pistillate flowers, the nectaries originate from the dorsal sides of the carpels and progressively develop a disk-like projection at the ovary base. In S. *globulifera* perfect flowers, nectary is a 5-lobed disc-like structure, positioned between petals and androecium tube, and originated from the outermost whorl of stamens. Nectaries from flowers of both species have one-cell-layerd epidermis with stomata and parenchyma with resiniferous cavities and canals and drusiferous idioblasts, being vascularized by xylem and phloem (G. *brasiliensis*) or only by phloem (S. *globulifera*). Epidermal and parenchyma cells in secretory stage present sinuous walls, voluminous nuclei each with an evident nucleolus, dense organelle-rich cytoplasm and a vacuome composed of one well-developed vacuole and/or numerous small ones. Mitochondria with conspicuous cristae, rough endoplasmic reticulum, sparse dictyosomes, vesicles and multivesicular bodies, sometimes near to or fused with the plasma membrane, and amyloplasts (G. *brasiliensis*). The sieve tube elements have nacreous walls (S. *globulifera*). The vacuoles may present electron-dense inclusions (probably phenolic substances). Nectaries of the two species, from the structural point of view, differ especially by the absence of xylem and amyloplasts in S. *globulifera*. It was suggested two alternative routes to the origin of the nectar carbohydrates: direct transport from phloem (S. *globulifera*) and starch accumulation during nectary development and its hydrolysis during secretion (G. *brasiliensis*).

Keywords: *Garcinia*; *Symphonia*; anatomy; histochemistry; ultrastructure

ID:442
Monday, July 10th, 2017
Poster Board: 6

Assigning fine-scale floristic units to Seasonally Dry Tropical Forests in Central Brazil

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Background: Seasonally Dry Tropical Forests in Cerrado are at the center of a floristic confluence and their tree communities resemble the flora of surrounding floristic domains. However, the specific contribution of different tropical biomes to the diversity of tree lineages in SDTFs remains unclear. Here, we discussed how abiotic heterogeneity might influence floristic turnover in SDTFs of Central Brazil and assigned fine-scale biogeographic units to address the uniqueness of SDTF plant communities in Cerrado. **Methods:** We used clustering and ordination analyses to define floristic units among 84 SDTF sites based on species composition and relative abundances. The variance partition was used to estimate the relative effect of climatic and environmental variables on tree beta diversity. We further used generalized additive models to observe non-linear relationships between the floristic variation and the abiotic factors. The biogeographic trends of SDTF species in Cerrado were analyzed based on the distribution of indicator species across different floristic domains. **Results:** We found high beta diversity levels among SDTF tree communities in Cerrado. Soil fertility mostly predicted the variation in species composition, followed by annual mean precipitation and mean temperature during the dry season. Most floristic units shared species with neighboring floristic domains in Brazil. Three floristic units reinforced the uniqueness of the SDTF flora in Central Brazil. **Conclusion:** The woody species composition of SDTFs in Cerrado is strongly influenced by the flora of neighboring biomes. Beta diversity among SDTF patches is also a result of the climatic and environmental heterogeneity across spatial gradients. We concluded that many SDTF floristic units are exclusive to Central Brazil, as they should not be treated as extra-Cerrado vegetation.

Keywords: Beta diversity, tree community, Cerrado

ID:471
Monday, July 10th, 2017
Poster Board: 7

Tree diversity and their floristic affinities of the subbasin Cuixtla, Jalisco-Zacatecas, Mexico

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Background: The Cuixtla subbasin (SCC, by its Spanish initials) belongs to the Lerma-Santiago hydrographic region. It is located in Mexico in the center of Jalisco and south of Zacatecas, in the Sierra Madre Occidental and Trans-Mexican Volcanic Belt confluence. Different plant communities have established in SCC: temperate forest, grassland, tropical dry forest (TDF) and riparian forest. SCC in an area that has never been studied in a botanical perspective. In this study, we documented the diversity of trees that SCC shelter and we evaluated the distribution of all taxa. **Methods:** During the course of 2014 - 2016 we made 27 field collections with the goal of keeping a record of the floristic diversity that this plant community shelters. We identified plants by means of specialized literature and expert consultation. Herbarium specimens were deposited in the herbarium of the University of Guadalajara (IBUG), and other collections (ej; CIIDIR, IEB). We analyzed geographic affinities of tree flora and identified species in some threatened species categories. **Results:** 145 tree species were identified. TDF was the vegetation type with the highest tree diversity (120 spp.), while Riparian Forest had the highest number of protected species (3 spp.). Here, we report 6 new distribution records for Zacatecas and 2 for Jalisco. The most diverse families are Fabaceae (22 spp.), Burseraceae (10), Fagaceae (8), Malvaceae (7) and Ericaceae (6). The most diverse genera are *Bursera* (10), *Quercus* (8) and *Ficus* (6). 58% of tree species are endemic to Mexico, of which, 5% are restricted to the western side of México. The SCC shares 20% of tree flora species with Central America and only 4% with North America. We found 14 species that belong to a threatened species category. **Conclusion:** Tree flora in this geographic region has a high level of endemisms at the country level and with a mostly tropical affinity. Some species belong to threatened species categories, therefore, it is necessary to increase the knowledge not only in the floristic domain, but also in other biological groups in order to propose conservation strategies which currently do not exist for this region.

Keywords: Biodiversity, Geographic distribution, Endemism, Tree

ID:616
Monday, July 10th, 2017
Poster Board: 8

Posters
Biological and social bases for sustainable use of non timber forest products

Harvest pressure shadows link human population density with hunting-driven extinction

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Background:and methods: Excessive hunting pressure is the leading cause of mammalian and avian endangerment, particularly in the tropics. A variety of mechanisms have been proposed that could explain the continued pursuit of increasingly overexploited and rare species, particularly when such species are highly valued, yet most focus on single-species bio-economic models. However, in the quasi-open access systems typical of the developing world, hunters target a wide range of species simultaneously. By recognizing that hunters can harvest any species within a portfolio of hunted game, one can identify the range of effort levels each species can sustain based on straightforward demographic and mass-action parameters. In addition, emerging survey techniques in human subjects research allow practitioners to be more agnostic to the actual drivers of hunting and instead focus on reported functional responses to wildlife catch rates. **Results:** I will present a mathematical model that uses simple expectations of population growth, harvest rates, and hunter functional responses to identify thresholds of risk for different species that are all co-exploited. I will also present data from several sites within tropical East Asia and at larger regional scales to demonstrate how this model can be applied for future, adaptive and anticipatory management efforts.

Keywords: theoretical ecology; tropics; hunting; conservation

ID:161
Monday, July 10th, 2017
Poster Board: 9

Ecological, economic and social evaluation of mexican oregano

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Background: Mexican oregano (*Lippia graveolens* H.B.K.) is a non-timber forest product (NTFP) of great importance because it is marketed as a condiment and its essential oil is used in the pharmaceutical industry (Huerta, 1997). In Mexico, its leaf is harvested wildly, mainly by rural and indigenous communities. In the northwest of the state of Yucatan, it is harvested during the rainy season, mainly by women. The objective of this work was to evaluate the main ecological, economic and social factors that influence or determine the use of oregano. **Methods:** Sampling of oregano plants was carried out in 54 plots to evaluate the production of oregano and to measure the environmental factors that could influence the availability of the species. Interviews were carried out in 30 households, to know the economic and social factors that determine the harvest by the community. Statistical methods were used to determine the relationship between environmental factors and oregano production; the characteristics of the household, and the income obtained from its sale. **Results:** A yield of 86 kg ha-1 was obtained. It was found that the availability of the resource is influenced by the stoniness of the soil. It was also observed that most of the households in the community harvest oregano. The cash income obtained from the sale of this product represents 15% of its annual per capita income on average. Households most dependent on the sale of oregano are the households with the lowest per capita annual cash income and are characterized by having a young and underschooled head of household. **Conclusion:** The knowledge of the ecological, economic and social configuration of NTFPs, contributes to generate strategies for sustainable planning. Contributes to the conservation of the species and helps the economic and social development, of the households and communities that depend on their commercialization.

Keywords: NTFP, oregano, sustainability

ID:575
Monday, July 10th, 2017
Poster Board: 10

Posters
Biotic interactions in tropical ecosystems

Enemy-mediated Indirect indirect interactions in tropical forest tree communities.

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Background: Understanding the processes that maintain and structure the diversity of tropical forest plant communities is essential to understanding what drives diversity at higher trophic levels and to predicting how these important ecosystems will respond to environmental change. While the importance of host-specific enemies in structuring tropical forest plant communities is widely acknowledged, indirect interactions mediated by plant enemies with less specific diets have rarely been studied in tropical plant communities. **Methods:** We will present results from a study focusing on the tree genus *Cordia* on Barro Colorado Island (BCI), Panama. On BCI, a large proportion of the newly germinated *Cordia* seedlings are attacked by the Target Beetle, *Ischnocodia annulus*. Our field studies were designed to test whether herbivory rates on focal *Cordia* species are elevated in the presence of congeneric species and to assess over what spatial scales any conspecific and congeneric density- and distance-effects take place. To address these questions, we placed potted *Cordia* seedlings in different contexts in the field and scored them for beetle attack over a period of up to 8 weeks. **Result:** Our results suggest that herbivory on *Cordia* seedlings is influenced both by the presence of conspecific and congeneric individuals in the neighbourhood. Seedlings attacked by *Ischnocodia annulus* are more likely to die, suggesting that this enemy can have an important effect on patterns of recruitment. In future work we aim to use information from our field based studies to parameterise models that will assess how variation in levels of herbivory and the natural histories of host species sharing enemies are likely to affect forest diversity in the long term. **Discussion:** Our study provides evidence for conspecific negatively density-dependent seedling herbivory in a tropical tree species (*Cordia alliodora*), in line with predictions of the Janzen-Connell hypothesis. Our results also hint at the potential for enemy-mediated indirect interactions such as apparent competition between *Cordia* species. Understanding how non-specific enemies forage in relation to the densities and spatial distribution of their host species is necessary for understanding how they affect the distributions and coexistence of prey species.

ID:13
Monday, July 10th, 2017
Poster Board: 11

Distribution and abundance of planktonic gastropods in Pacific waters off Colombia, September 2005

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Background: Holoplanktonic gastropods are important due to: 1. High abundance within the zooplankton, where they feed upon other mollusks, fish larvae, and copepods; in contrast, they are prey of fish, turtles and jellyfish, among other predators. 2. Energy transfer through the water column via vertical shift. 3. Shelled species play an important role in the carbon cycle, so probably long-term variations in their distribution/abundance may reflect the effect of global climate change in the oceans. Pelagic mollusks inhabiting the Colombian Pacific Ocean (CPO) have been poorly studied. The aim of this research was stablish the genera composition and to quantify their distribution and abundance in relation with some abiotic variables. **Methods:** This study was conducted during September 2005 in 20 stations distributed along the CPO. Zooplankton was collected with a bongo net (1.85 m length, 0.60 m opening diameter, 294 and 520 Âµm mesh size nets) by oblique tows of 169.39 m mean-depth. All planktonic gastropods were sorted and preserved in 4% buffered formaldehyde in sea water. Cluster based on unweighted pair group average linkage (UPGMA) and Principal Component Analysis were performed on log(x+1) transformed data to explore possible correlations among abundances and mean values of temperature, salinity and dissolved oxygen (DO) in the mixed layer, thermocline and sub-thermocline. **Discussion:** Holoplanktonic gastropods were found in the 20 sampling stations. General abundances were higher in neritic waters (60.3%). 1251 specimens were collected and identified belonging to 13 genera of the Orders Neotaenioglossa, Thecosomata and Gymnosomata were identified. Atlanta (40.7%), Creseis (23.4%) and Corrolla (19.2%) were the most abundant and widely distributed (all stations). Taxonomic composition was similar to the only one former data on these organisms in the CPO. ACP showed some relative significant correlations among taxa and abiotic variables, especially with the temperature in the thermocline (-0.41) and subthermocline (0.37), and salinity and DO in the sub-thermocline (-0.37 and -0.31, respectively). So, these organisms could be more influenced by temperature (0.53), similar to other regions. Nictemeral differences in all abundances were attributed to the vertical migratory behavior of these organisms.

Keywords: zooplakton, gastropods, Pacific, Colombia

ID:25
Monday, July 10th, 2017
Poster Board: 12

Effects of galls on morpho-physiological traits in fruits of *Parkinsonia praecox* in an arid region

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Background: Galls are atypical plant growths that provide nourishment, shelter and protection to the inducer or its progeny. Fruit and flowers are poorly represented as host organs for galling insects. We evaluated 1) if the presence of galls on fruits affects their morphological traits (length, diameter, thickness, and biomass) of *Parkinsnia praecox*; 2) if the density of trichomes and stomata, likewise the stomatal conductance (gs) of fruits are affected by the presence of galls. **Methods:** We measured the length, diameter and thickness of fruits. Simultaneously, we quantified the water content and biomass, stomata and trichomes density on infrutescences with and without galls. Finally, we measured the gs on both groups. **Results:** Our findings showed that approximately 20% of fruits per branch were galled. Thickness, diameter and water content of galled fruits were greater compared to healthy fruits. Length and biomass of healthy fruits were higher. Density of trichomes on galled fruits was higher, while the stomata density was not statistically different between galled and healthy fruits. Furthermore, the gs rates of galled fruits were almost 3 times higher than in healthy fruits. **Conclusion:** The presence of galls negatively affects the natural development of P. *praecox* fruits, perhaps leading to a lower plant fitness. Galling insects may stimulate the elicitation of signaling molecules, like phytohormones that promotes stomata opening and water loss in galls, in order to favor the water and nutrient continuum from the host plant to the gall.

Keywords: galls; fruits; stomatal-conductance; water-content; biomass.

ID:41
Monday, July 10th, 2017
Poster Board: 13

Host-parasite interaction and impact of mite infection on mosquito population

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Background: Parasitism and predation are ecological interactions, acting either alone or concomitantly with various biological control processes of pests and parasites. Such is the relationship between mosquitoes and parasitic mites that we have investigated in the present study. There are better options available to biologically control mosquito larvae but none is available to use against adult mosquitoes. The present study stands alone, since it explores possibility of using parasitic mites against adult mosquitoes. **Methods:** Male and female mosquitoes were collected from 200 sites from the State of Uttar Pradesh, located at 26.8500° N, 80.9100° E in North India. The 8954 individuals of mosquitoes, belonging to 26 species, were collected: Eight species of mites i.e., *Arrenurus acuminatus*, Ar. *gibberifrons*, Ar. *danbyensis*, Ar. *madaraszi*, Ar. *kenki*, *Parathyas barbigera*, *Leptus* sp., and *Anystis* sp., were parasitic on mosquitoes. **Results:** Eight species of mites namely: *Arrenurus acuminatus*, Ar. *gibberifrons*, Ar. *danbyensis*, Ar. *madaraszi*, Ar. *kenki*, *Parathyas barbigera*, *Leptus* sp., and *Anystis* were parasitic, which preferred host's thorax for attachment as compared to the head, pre-abdomen or appendages. The parasitic load of mites and infection intensity varied with mosquito species. Similar to other biological control agents, parasitic mites also possess beneficial traits, such as wide spread occurrence, effective dispersal capability, moderate host preference, preference for attachment, and significant parasitic load to make differences in mosquito populations. **Conclusion:** The present study suggests phoretic relationship between parasitic mites and mosquitoes. Wide occurrence, intensity of infection, parasitic load, and attachment preferences that mites possess have suggested positive role in the biological control of adult mosquitoes. Species of *Arrenurus* and *Parathyas* have shown detrimental effects on *Coquillettidia* and *Aedes*. *Arrenurus*, *Parathyas*, *Anystis*, and *Leptus* possess beneficial traits of biological control agents e.g., wide host range, population abundance, and high rates of attachment, infection and infection intensities. The present study sets the path of future studies on host-parasite relationships of mites and mosquitoes specially in tropical ecosystems.

Keywords: Mosquito, mites, parasitic, interaction, infection

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Chaetognatha found in Colombian Pacific waters during 2004 and relation to some variables

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Background: Chaetognaths are an important component of zooplankton. Within carnivorous zooplankters, they play a major role both in their biomass contribution and in their impact on zooplankton communities as one of the main predators of copepods. As indicators of water masses, chaetognaths are suitable for the study of the effects of physical processes acting at the mesoscale on the dynamics and variability of zooplankton populations. In the Colombian Pacific Ocean (CPO) they remain insufficiently investigated. This research offers data for helping to understand the distribution and abundance of these organisms in an area characterized by high oceanographic variability at the mesoscale. **Method:** Sampling was conducted during September 2004 in 24 stations. Zooplankton was sampled with a conical net (50 cm diameter) fitted with 363 µm netting. The tows were performed horizontally to a one meter-depth. Samples were preserved in 5% buffered formalin. CTD measurements (Sea Bird Electronics-19) were conducted for temperature and salinity data. Chaetognaths were extracted from subsamples. Comparisons among stations were conducted by factor and cluster analysis. When it was required, data were log(x+1) transformed. **Results:** Higher abundances of chaetognaths (mean= 3528 ind. m-3) occurred at nearshore stations and lower abundances (mean= 2590 ind. m-3) at offshore stations. 13 of the 16 species, most epipelagic, registered for the study area, were found. *Flaxisagitta enflata*, *Zonosagitta bedoti* and *Ferosagitta robusta* were the most abundant and frequent ones (28.0, 15.6 and 9.6%. 24, 23 and 22 stations, respectively). Night vs. day abundances were different in all species. In the factor analysis, the 3 first factors together accounted for 60.1% of the variability in the original data. Cluster analysis showed both agglomerations of nearshore and intermediate stations. **Discussion/conclusion:** The general distribution pattern of the species showed higher abundances in neritic waters. The most significant correlations of the species were with temperature (0.61) and zooplankton biomass (0.88). The difference percentage of populations suggested that chaetognaths undergo diel vertical migration. The numerical top position and widespread horizontal distribution of *F. enflata* agree previous investigations in the CPO. Results were similar to other regions of the world.

Keywords: zooplakton, chaetognaths, Pacific, Colombia

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Poster Board: 15

Evidence of seed consumption by fishes and their potential role as dispersers in the Amacuzac River

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Background: Morelos is the main center of cultivation and trade of ornamental freshwater fishes, and where more exotic species established impacting natural ecosystems. Their effects are commonly evaluated as the change in community structure and the decline of native species; however its potential role as seed dispersers has not been evaluated so far. Fruit consumption by fishes is well-documented in many regions of the world. The Amacuzac River, which crosses a seasonal dry forest environment, is home of 11 exotic and 8 native fish species. **Methods:** We reviewed the ichthyology collection of 2015 and analyzed the stomach contents (15-30 specimens/species). Once seed consumer species were identified, in 2016, we performed field samplings focusing on those particular species. We calculated the number of individuals with seeds and evaluated differences among fish species, seasons (wet and dry), and 7 localities. We classified stomach contents with seeds according to four categories and compared the pattern of seed consumption among fish species, season and locality. **Results:** From the collection analyses, we found seeds in 4 species (73 out of 1408 individuals), of a total of 13 species collected; seed consumers belong to two natives, *Astyanax aeneus* and *Notropis moralesi*, and two exotic species, Amatitlania *nigrofasciata* and *Aequidens rivulatus*. Combining data of two years for these species, 18% of individuals consumed seeds of 26 plant species, from which 10 genera were identified. The Poaceae was the most representative family of seeds found in fish tracts. There was a marked effect of season on both, the number of individuals with seeds and the percentage of seed consumption, the wet season showing the highest values. The number of individuals with seeds did not significantly differ among localities or fish species, but the percentage of seed consumption did. A. *aeneus* and A. *nigrofasciata* were the most frequently seed consumers, but the four species had a similar pattern of seed consumption (1% -25%). This pattern was constant in all localities, but during the wet season fishes included other categories. **Conclusion:** In this seasonal riparian environment the wet season represents the time when fish consume higher numbers of seeds, suggesting it is the time when its dispersal potential is greater. However, ex-situ controlled studies are recommended to effectively evaluate the role of fishes as seed dispersers in the Amacuzac River.

Keywords: Ichthyochory, dry forests, riparian corridors

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Ant-seed networks: Can harvesting ant benefit a seed?

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Background: Describing the structure of neglected network, as ant-seed networks, is an important step but it is not enough; we also need to understand the traits of these interactions. Here, we evaluated the character of the interaction between a harvesting ant, *Pogonomyrmex naegelli*, and *myrmechorous* herb, *Microstachys serrulata* (Euphorbiaceae). **Methods:** We survey for ants carrying seeds in palm swamps areas (into Brazilian Savanna), over a year (May 2015 to June 2016), and built ant-seed networks. Thereafter, we focus on understanding how occurs *Pogonomyrmex-Microstachys* interactions. We tested whether ant community and P. *naegelli* foragers present seed preference (seeds with and without elaiosome). *Pogonomyrmex naegelli* nests were excavated to search for M. *serrulata* seeds and to collect nests soils. The chemical composition of nest soils was compared with random sites. We also evaluated the number seedlings and adults individuals of M. *serrulata* around of nest and in random sites. **Results:** We recorded only 38 ant-seed interactions, comprised 9 ant species and 14 plant species. *Pogonomyrmex naegelli* was the ant with higher number of interactions, carried seeds of almost all plant species recorded, mainly seeds of *Panicum cervicatum* (Poaceae) and *M. serrulata*. *Microstachys serrulata* it was the plant species that had the higher number of seeds removed by ants, mainly by P. *naegelli*. In general, the ant-seed networks exhibited a nested, non-modular pattern of ant-plant interactions and an lower level of network specialization. The ant community and P. *naegelli* foragers had preference for seeds with elaiosome. We found a lot of seeds of *S. myrtilloides* inside the nests, visually intact and without the elaiosome. Soil analyses indicate that no difference was found for essential plant macronutrients and soil pH. However, the amount of seedlings and adults individuals of *M. serrulata* were higher around of ant nest than random sites. **Discussion:** The ant-seed network exhibited the same patterns found in other ant-plant networks. Here, we provided evidences that harvesting ant, *P. naegelli* can benefit the seeds of *M. serrulata*, acting as seed dispersers. Thus, P. *naegelli* plays a dual role in ant-seed networks in the Brazilian Savanna, since that other seeds removed by *P. naegelli*, do not present attractive structures as elaiosome, being probably predated. These studies are important for understanding and preserve these ecological interactions.

Keywords: myrmecochory, *Pogonomyrmex*, dispersal, Euphorbiaceae, interactions

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Plant-herbivore interaction networks in human-modified tropical landscapes

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Background: Complex interaction networks (CIN) organize biological communities and their analysis can contribute to understand how communities are assembled, and to assess what are the implications of disturbances on CIN for ecosystem functioning. In particular, plant-herbivore CIN are critical for ecosystem energy flows. However, how human disturbances, forest fragmentation and succession affect the structure and composition of these networks has been poorly studied. **Methods:** This study aimed to assess the effects of land use change on the structure of plant-herbivore CIN. For this, we used a gradient of human modified landscapes in the Lacandon tropical rainforest region, Southeast Mexico. We selected four landscapes units (LU, 1 km2 each): conserved (100% old-growth forest, OGF), slightly modified (70% OGF), intermediate modified (25% OGF) and severely modified (19% OGF). In each LU we established nine plots (40 x 50 m) that consisted of five parallel transects (50 x 2 m). In each transect, all immature Lepidopterans found on herbs, shrubs, vines, lianas, trees and ferns were collected from the ground to 2 m high in six bimonthly censuses between May 2016 and April 2017. Caterpillars were identified using barcode techniques. We quantified different structural CIN metrics per LU, and assessed changes in these metrics among LUs using ANOVA. Result: In total, we recorded 1,969 caterpillars belonging to 560 morph-species, associated to 230 host plant species. The conserved LU was the most diverse in Lepidopteran species, host plant species, and plant-herbivore interactions, followed by intermediate, slightly and severely modified landscapes (ML). We observed the highest diversity of common and abundant species of lepidopteran, host plants and their interactions in conserved LU. However, in this case the slightly ML had the lowest diversity. **Discussion:** As expected, the conserved LU better maintains plant- herbivore interactions. However, among MLs, the highest diversity in such interactions was not found in the slightly modified landscape but in the intermediate one. This result might be explained by the fact that the composition of this landscape was more heterogeneous than in the other MLs. This suggests that CIN in MLs may be more responsive to the landscape heterogeneity rather than to the deforestation level in the landscape.

Keywords: biological communities, food webs, lepidoptera

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Interactions of *Heliconia aurantiaca* with its floral visitors in a fragmented tropical landscape

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Habitat fragmentation does not only impact species abundance and richness but also biotic interactions. Plant pollination has shown to be strongly affected by fragmentation. In the Neotropics, herbs of the genus *Heliconia* (Heliconiaceae) are an important component of the understory as species in the genus interact with a large number of animal species in several ways. The aim of this study is to describe for the first time the interactions of *H. aurantiaca* with its floral visitors, namely pollinators and nectar robbers. In southeastern Mexico, we selected four fragments and four continuous forest sites. Using *H. aurantiaca* as a model system, we performed focal observations in different flowering plants to record the hummingbird species, their number of floral visits, and foraging behavior. We also collected the arthropods found on the flowers. We determined the potential of all visitors as pollinators. Furthermore, we used a network approach to describe the effects of forest fragmentation on the patterns of interactions involving *H. aurantiaca* and its floral visitors, as well as to assessing the stability of this interaction in both habitat types. We recorded a total of 31 floral visitor species: 7 hummingbird species and 24 invertebrate species. The number of visits from hummingbird species differed significantly between habitats. There were no significant differences in the duration of visits made by hummingbirds between both habitats. Only one hummingbird species appeared as a potential pollinator, and the other six species were nectar robbers. Species richness and abundance of invertebrate visitors did not differ significantly between habitats. Four ant species were dominant in both habitats. We found a significant nested pattern in the H. *aurantiaca*-floral visitors network for continuous forest and fragments. The attributes of ecological networks in both habitat types showed similar connectance and interaction diversity. Our ecological networks showed a nested pattern, suggesting an increase of the robustness of the network and being less prone to the effects of habitat fragmentation and species extinction.

Keywords: biotic interactions, habitat fragmentation, heliconia

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Trophic interactions of flies in Aroid infrutescences in a Mexican tropical rain forest

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Background: In Aroid species, plant-insect trophic interactions have been poorly studied. Particularly, there are few studies on insect assemblages that feed on the reproductive structures of these plants. *Richardiid* flies are usually considered saprophagous. However, the study of the interaction between *Beebeomyia tuxtlaensis* (Diptera: Richardiidae) with *Dieffenbachia oerstedii* (Araceae) was recently described, in which the larva feeds on the developing spadix. The aims were as follows: Identify the Araceae species used as hosts by *Richardiid* species; and characterize the assemblage of other phytophagous insects which they interact. **Methods:** In the region of Los Tuxtlas, Mexico, we collected mature infrutescences of 17 Aroid species along four sampling events (2015 - 2016). In the laboratory, infrutescences were kept in breeding chambers for obtaining adult insect specimens. Result. In seven Aroid species of genera *Rhodospatha* (1), *Dieffenbachia* (2), Philodendron (3) and *Xanthosoma* (1), four *Richardiid* species of the genera *Beebeomyia* and *Sepsisoma* were found. In these infrutescences, trophic interactions with other 28 insect species of Coleoptera (6 species); Diptera (20 species); Lepidoptera (1 species); and Orthoptera (1 species) were also recorded. Our results showed that *Richardiid* species have specialized interactions with their hosts: *Beebeomyia tuxtlaensis* infested the infrutescences of *Dieffenbachia oerstedii* and *D. wendlandii*; *B. palposa* was found in *Xanthosoma robustum*; an undescribed species of *Beebeomyia* was found in three *Philodendron* species; and one *Sepsisoma* species was breeding on *Rhodospatha wendlandii*. **Discussion:** *Richardiid* flies have specific relationships with Aroid species of closely related groups, since the development of the larvae depends on the reproductive structures. Therefore, these plants could be key points in the diversification of these flies.

Keywords: phytophagous insects, Araceae, Diptera

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Dung beetle activity affects the establishment of seedlings from the seed bank

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Background: In tropical forests seeds are incorporated into the seed bank through biotic and/or abiotic factors. Germination and seedling establishment are greatly influenced by the position of a seed within the seed bank, and often biotic and/or abiotic factors will again be needed to bring deeply buried seeds closer to the surface to allow for germination and establishment. Dung beetles are well known for accidentally burying seeds present in vertebrate dung. Yet through their tunneling behavior, and the consequent soil excavation, seeds already buried in the soil may also be moved upwards, which in turn may promote germination and establishment. We conducted a field experiment to assess if dung beetle activity promotes seedling establishment from the seed bank. **Methods:** The experiment was carried out in the rainforest of Los Tuxtlas biological station (México). We chose 30 independent sites and in each we established 5 small circular plots (0.28 m2) by inserting bottomless buckets 10 cm into the soil. One of five treatments was assigned to each plot: (a) single placement of 50 g of dung and access to beetles, (b) repeated placement (4 times in 6 months) of 50 g of dung and access to beetles, (c) single placement of 50 g of dung and exclusion of beetles, (d) repeated placement of 50 g of dung and exclusion of beetles, and (e) no dung. The repeated dung placement had the purpose of simulating sites where mammals defecate recurrently over time. Every two weeks for 8 months we registered and marked newly emerged seedlings of woody plant species. **Results:** We registered 689 seedlings belonging to 70 species. The number of seedlings was affected by the treatment according to our prediction, i.e. more seedlings established in plots where dung beetles had been active. Also, more seedlings were observed in the recurrent-dung treatment than in the treatment with single placement of dung. **Conclusion:** Our results show that interactions between dung beetles and seeds in tropical forests are not only restricted to secondary seed dispersal. The dung-burying behavior of dung beetles has many known ecological consequences, although most remain to be quantified in tropical forests under field conditions. The effect of dung beetles on seed bank dynamics and the stimulation of seedling establishment from the seed bank adds another function to the already long list of ecosystem processes in which these conspicuous insects play an important role.

Keywords: Los Tuxtlas, Scarabaeinae, seed bank

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Morphology and histology of extrafloral nectaries induced by galls on *Croton antisyphiliticus*

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Background: Galls are plant tumors that typically are induced by insects to provide food and shelter for their larva. In the Cerrado of Brazil, we encountered leaf galls on *Croton antisiphylliticus* (Euphorbiaceae). The EFNs on the galls are defended by ants, which protect the plant against herbivores or predators. Normally, the leaves of *C. antisyphiliticus* present extrafloral nectaries (EFNs) distributed in pairs on the edge of leaves, but the leaf galls have much more EFNs on the whole surface. We analyzed the morphology, histology and structure of EFNs of leaves and galls induced by *Apion sp.* (Curculionidae) on *C. antisyphiliticus*. **Methods:** We describe the morphology of the EFNs, the trichomes and stomata on leaves and galls using a scanning electron microscope. The weevil gall inducer morphology was examined similarly. Using standard techniques of histology, the structure and anatomy of EFNs on leaves and galls were analyzed by means of the EFNs dimensions, secretory epidermis and nectary parenchyma. **Results:** *C. antisyphiliticus* supports up to 4 leaf galls per plant. Each gall may occupy the entire leave. The average number of EFNs in galls is 25.3 ± 5.1, while leaves have 5-8 pairs of EFNs. The EFNs of leaves are associated to the margin and petiole; while the EFNs of galls are randomly distributed. Trichomes of leaves and galls are unicellular and multicellular, however are more abundant on galls. Stomata of leaves and galls are actinocytic, but in galls these exhibit a layer of epicuticular wax. The weevil gall inducer, *Apion* sp., is characterized by the long cylindrical trochanter and the inner tarsal claw shorter and finer than outer claw. The structural organization between EFNs of leaves and galls is almost the same. The smallest EFNs are located on the leaf margin. In general, the secretory epidermis of EFNs is single-layered, with columnar cells, dense cytoplasm and conspicuous nuclei. Nectary parenchyma has numerous anticlinal and internal periclinal walls. Vascular bundles are composed of xylem and phloem, reaching the nectary parenchyma. **Conclusion:** This system provides an opportunity to study the dynamics of complex multitrophic interactions because we notice that the EFNs on galls are functional, producing nectar. It illustrates a case of further host manipulation and resources capture. The ecological role of ants in the leaf galls is still unknown.

Keywords: Insect-galls, Curculionidae, Euphorbiaceae, Brazilian-Cerrado, Extrafloral-nectaries

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Patterns of change in body condition in Neotropical migratory birds in shaded systems in the Andes

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Background: Despite the widely accepted idea that shaded plantations are valuable habitats for Neotropical migrants in disturbed landscapes, little empirical evidence is available in relation to the quality of this habitat for Neotropical-Nearctic migratory birds in the Andes. **Methods:** We evaluated the suitability of shaded plantations for overwintering Neotropical-Nearctic migratory birds by examining diurnal and seasonal variation in body condition of migrants in these agroforests in the Andes. During October to April 2008-2009 and 2009-2010, we mist-netted eight species of Neotropical-Nearctic migrants in shaded plantations in the Colombian Andes. **Results:** Body condition improved throughout the day for Cerulean Warbler (*Setophaga cerulea*), Blackburnian Warbler (*Setophaga fusca*), Tennessee Warbler (*Leiothlypis peregrina*), and especially Canada Warbler (*Cardellina canadensis*). Similarly, body condition improved across the season for Tennessee Warbler, Rose-breasted Grosbeak (*Pheucticus ludovicianus*), and Summer Tanager (*Piranga rubra*). **Discussion/conclusion:** Our results provided additional evidence that several common Neotropical migrants, including species of conservation concern such as Cerulean Warbler and Canada Warbler, may improve their body condition in shaded plantations. However, about half of the species assessed in this study did not show any significant improvement in their body condition (e.g. Red-eyed Vireo). Furthermore, on average, species were in poor condition (i.e. body condition scores were negative) in these coffee farms. Thus, the extent to which this agricultural system represents high quality habitat should be looked with caution. Overall, our data contribute novel information on daily patterns of body condition improvement for several common migratory birds in Andean shaded plantations.

Keywords: Shaded-plantations, Agroforestry, Body-condition, Migrants, Andes

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Exotic plants as key resources for frugivorous birds in anthropized environments

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Background: Cities concentrate many human activities dramatically transforming the original natural systems. One of the changes is the presence of exotic species, which can drastically modify biotic interactions and their influence on ecological processes. Here, our aim was to evaluate the role of exotic plants in the maintenance of the native bird community in an anthropized environment. **Methods:** We built a plant-bird frugivory interaction network inside the university campus of the Universidad Nacional de Colombia, Medellin section. The network structure was tested through nestedness using WNODF metric, and modularity with QuaBiMo algorithm. The structural and functional role of the plant species was tested using three different centrality measures: centrality degree (related to the number of bird species that feed on them), betweenness (related to the species' capacity to feed bird species of different guilds), and closeness (related to the plant's capacity to feed generalist bird species). Given that, in general, the centrality measures are correlated, suggesting that the same species play similar roles in different structural features of the network, we used a principal component analysis. The first principal component was used as a new general centrality measure that synthesizes most the information of the analyzed centrality metrics. We also evaluated which variables explain the species' importance inside the network using the plants' ecological traits: abundance, origin (native, exotic) and fruit production (abundant, moderate and low). **Results:** The network was not significantly nested (WNODF: 0.31, $p>0.5$), but it was modular (modularity: 0.48, $p<0.001$). Nine central species were identified inside the plant community, of which 77% were exotic plants. The abundance partially explains the importance of the species ($R^2=0.19$; df=1, 20; F=4.7; p=0.04), and there are differences in the importance of the species by fruit production (ANOVA, F=5.5; df=2, p=0.015), but not by origin (ANOVA, F=3.7; df=1, p=0.071). **Conclusion:** Our results suggest that the exotic plants play an important role in the diet and maintenance of the frugivorous bird species in the evaluated network, nevertheless, this importance can't be explained only by the plant's origin. Traits associated with these species such as an abundant fruit production and their abundance of individuals, make them key resources for the maintenance of the native frugivorous birds in anthropized environments.

Keywords: Networks, interactions, frugivory, urban

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Species identity influences secondary removal of seeds of neotropical pioneer tree species

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Background: Plants face a variety of obstacles to recruitment including producing enough seeds, surviving dispersal, and reaching suitable microsites for germination and growth. The dispersal process may also occur in multiple steps with primary dispersal moving seeds from the maternal plant to the soil surface, and secondary dispersers further incorporating seeds into the soil seed bank. The extent to which different species in the same location experience secondary dispersal is often unknown, and while secondary dispersal of seeds into the soil profile is frequently reported, it is unknown whether seeds experience the same potential for further movement from both the soil surface and in the topsoil. We investigated whether species identity and dispersal mode (animal or wind) influenced the rate of seed removal of 12 pioneer tree species. We examined removal rates for seeds placed on the soil surface and within the topsoil. We predicted that animal-dispersed seeds would experience higher secondary removal rates than wind-dispersed seeds. We also investigated whether removal rate on the soil surface was correlated with removal rate within the topsoil. **Methods:** We placed caches of 12 pioneer species on the forest floor and 6 within the first 2 cm of topsoil at 5 sites on Barro Colorado Island, Panama. Caches on the soil surface were collected after 47 hrs while caches within the topsoil remained for 4 weeks prior to collection. **Results:** Species identity significantly influenced the secondary removal rate of seeds both on the soil surface and within the topsoil. However, there was no correlation between being removal rates in the two environments. Primary dispersal mode significantly influenced secondary removal rates of seeds, with animal-dispersed seeds removed at higher rates than wind-dispersed from both environments. **Discussion:** Species identity did not always influence removal the same way on the soil surface as it did within the topsoil, indicating that the identity of the secondary dispersers may be different between the two locations. Tree species identity accounts for more variation in secondary removal rates than dispersal mode implying that generalizations made using dispersal mode alone do not accurately describe observed patterns.

Keywords: seed dispersal, soil seed bank

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Relationship between plant population structure and seed dispersal mode in a heterogeneous landscape

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Plant species distribution patterns in heterogeneous landscapes may differ between species with divergent dispersal strategies given differences in relative contributions of dispersal vs. recruitment limitation to local populations. A trade-off between dispersal modes and light tolerance strategies has been shown for herbs, implying that reproductive and vegetative life-strategies are coupled. However, if this relationship is general and holds in forests with low gap dynamics is not clear. We asked: (1) Do species with similar seed dispersal modes have similar population structure across microhabitats? (2) Is light or hydrology the main determinant of population structure at the local scale? (3) Do species with similar dispersal modes present similar aggregation patterns at local and landscape scale? Four species of Marantaceae on two main dispersal mode groups (ants, vertebrates) were studied in a central Amazonian forest. We mapped all the individuals of studied species in 87 plots spread in three topographic habitats (plateau, slope and valley) and measured distance from the nearest drainage and canopy openness. Individuals were classified as seedlings, juveniles and adults. Abundance patterns of studied species differed between valleys and slope/plateaus, independently of dispersal mode. Distance to drainage affected more the abundance patterns of life stages than light, and there was no association of population structure with dispersal modes. Distribution of the ant-dispersed *Monotagma spicatum* was auto-correlated at very small (0.6 to 1.1 m) scales. Adults of all species were more spatially aggregated at the landscape scale and species dispersed by vertebrates had more spatial aggregation of saplings disconnected from adults and juveniles. Ant dispersed species had divergent spatial patterns, *M. densiflorum* presented an aggregation pattern similar with the vertebrate dispersed species while spatial pattern of *M. spicatum* suggested more limited seed dispersal. We suggest that population structure and herb life strategies are more than a dichotomy between light and shade environments that separate the two main dispersal modes in Marantaceae. In shaded environments, herbs may be more affected by recruitment limitation than by seed dispersal, even for those species that are mainly dispersed by ants. The spatial patterns we found suggest that all studied species have a combination of seed dispersal by vertebrates and invertebrates.

Keywords: Marantaceae, zoochory, Amazonia, herbs, recruintment

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Impact of defaunation on invertebrate communities and ecosystem processes in an afrotropical forest

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Background: Overhunting has reduced large-bodied vertebrate populations in the tropics. This process, known as defaunation, has been shown to trigger cascading effects in tropical forests, including diminished seed dispersal services, altered seedling demography, and increased rodent abundances (Kurten 2013). Another consequence of defaunation, which has received little attention, could be indirect impacts on understory invertebrates. Loss of large terrestrial herbivores could alter invertebrate communities indirectly by transforming the understory vegetation and influencing microhabitats. If the invertebrate community is altered by defaunation, this could have important consequences given the critical role that invertebrates play in multiple ecosystem processes. **Methods:** We investigated how defaunation is associated with: 1) changes in understory vegetation density, 2) altered terrestrial macroinvertebrate communities, and 3) the rates of three important ecosystem processes (litter decomposition, seed predation, invertebrate predation) and the contribution of macroinvertebrates to these processes. In tropical forests in Gabon, we used a series of experiments in 15 sites of faunally intact forest and in 18 analogous sites of defaunated but otherwise undisturbed forest. Litter depth and understory vegetation density were measured in each site. Using in situ exclosure experiments, we compared seed and invertebrate predation rates and assessed the relative contribution of macroinvertebrates versus small mammals to these processes between the forest types. Using in situ exclosure treatments (excluding macroinvertebrates, fungi, or neither) with litter bags, we compared litter decomposition rates and the relative contribution of fungi and macroinvertebrates to litter decomposition between forest types. **Results:** Defaunated sites had significantly fewer termites and denser understory vegetation. Defaunation had differing effects on the contribution of invertebrates to litter decomposition, invertebrate predation, and seed predation. **Discussion:** Results suggest that defaunation may have far-reaching indirect impacts on understory communities, but functional redundancy between understory faunal species may buffer some negative impacts. Future research should focus on understanding specific mechanisms triggered by defaunation that may impact termites and other invertebrates, and associated consequences.

Keywords: defaunation, cascading effects, invertebrates, ecosystem processes, tropical forests

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Facilitative interactions among cultivated papaya and surrounding flora via shared pollinators

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Many valuable crops for human consumption rely to some extent on pollinators to set fruit and seeds. However, the current pollination crisis is affecting crop yields; this is particularly true for pollinator-dependant crop such as dioecious species. Pollination services to crops may be indirectly benefited by remnants of natural vegetation in the surrounding landscape via positive interactions such as pollinator sharing. Most currently available research suggests that the interaction among crops and surrounding vegetation via sharing pollinators is often positive for crop yield, however, the result of this interaction is context dependent and neutral or even negative (competition) outcomes of this interaction are also possible. In this study, we evaluated the indirect effect of co-flowering on heterospecific pollen transfer and reproductive success in cultivated papaya (*Carica papaya*), a dioiecious plant species. We identified shared pollinators among papaya and the co-flowering plants in surroundings by direct observation and recorded the frequency of visits per plant species. We also quantified the size of the load of heterospecific (HP) and conspecific (CP) pollen on papaya stigmata. Finally, we evaluated the effect of heterospecific and conspecifics pollen loads on fruit set, weight, as well as seed set. We found 21 co-flowering plant species with papaya, these species interacted with 35 species of floral visitors (5201 interactions where recorded) from which, 11 species interacted with papaya. We counted 30,302 pollen grains (29,807 CP and 495 HP) on the floral stigmata; the number of CP grains was higher than the HP. Finally, there was no evidence of pollen interference because HP transfer did not affect fruit weight and number of seeds. In conclusion, papaya shared several flower visitor species with a high proportion of co-flowering plants in the study area. Despite this fact and heterospecific pollen transfer, papaya reproductive success was not affected which suggest a facilitative interaction among native plant species and focal crop.

Keywords: Carica papaya, co-flowering, facilitation, pollinators

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Endosymbiont plasticity in *Jatropha curcas*

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Background: Soil is a major source of bacterial symbionts in plants. Select bacteria colonize the rhizosphere and subsequently the endosphere, where they can infect the entire host and reside asymptomatically as endophytes. The composition of the bacterial endosymbiont community is influenced by the soil microbial community, environmental factors and host biology. *Jatropha curcas* (Euphorbiaceae) is a drought-tolerant biodiesel crop plant that is native to dry areas of Central America. We investigated how soil factors and local environmental conditions contribute to the endophytic bacterial community assembly in *J. curcas* seedlings in a field and greenhouse setting. **Methods:** We grew jatropha seedlings in three sites across the Azuero peninsula of Panama and in soil from those areas in a greenhouse. We later extracted DNA from the soils and roots and leaves of the plants to create 16S libraries of the symbiotic bacterial community. We then created a rb-RDA model to determine the contribution of environmental measures and soil microbial diversity to the endosymbiont community. **Results:** Plants assembled unique endophytic communities at different sites in the field within leaf and root tissues, but greenhouse-grown plants using soil from these localities showed a convergence of endophytic communities. Roots hosted more diverse communities in the field than in the greenhouse, but this pattern did not hold true for leaves. We found that the environmental measures and the soil microbial community each explained a significant amount of variation in the root bacterial community structure (24% and 11% respectively). Our model selected K, P, Rainfall, Mg, Ca and Al as significant environmental predictors of root bacterial community. **Conclusion:** The bacterial microbiome of *J. curcas* is plastic and the endosymbiont community (and therefore endosymbiont effects) may vary by the host location and stress level. In the field, where the ambient environment was not constant and where environmental stresses are the strongest, we saw divergence in community based on location. However, this divergence was not observed to the same degree in the greenhouse. One interpretation of this is that stress alters bacterial colonization method and success rates. Furthermore, our model selected major plant nutrients and rainfall as significantly explaining endosymbiont community composition.

Keywords: jatropha, microbiome, soil, nutrients, endophytes

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Belowground interaction on aboveground tri-trophic interactions depend on cross type in *R. nudiflora*

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Background: Recent studies have helped us to understand the relationships between belowground and aboveground biotic interactions mediated by plants. However, most of the studies have ignoring the effect of intra-specific plant genetic variation on the effect of belowground interactions and its consequences on aboveground tri-trophic interactions, and on the plant reproductive success. **Methods:** In an common garden experiment using selfing and outcrossing offspring of the perennial herb *Ruellia nudiflora* (Acanthaceae) growing with and without arbuscular mycorrhizal fungi (AMF), we measured individual and interactive effects of cross type (i.e. selfing vs. outcrossing) and AMF inoculation on the proportion of fruit attack by a specialist pre-dispersal seed predator of *R. nudiflora*, the proportion of predated fruits with parasitic (carnivores) wasps, as well as the contribution of the parasitoids on the seeds "saved" of the predators. **Results:** AMF inoculation increased significantly plant growth and fruit production, affecting the aboveground tri-trophic interactions. We observed a significant interaction between AMF and cross-type on the proportion of fruits attacked by predators: in absence of AMF outcrossing offspring had a higher proportion of fruit attack than in the presence of AMF, while the selfing offspring did not show significant differences in the presence or absence of AMF. We did not find significant effects of the cross type, AMF or their interaction, on the proportion of fruits with parasitoids. However, the proportion of "saved" seeds by the parasitoids in the presence of AMF was higher in outcrossing offspring than in selfing offspring, but in the absence of AMF the selfing offspring increased the proportions of "saved" seeds. **Conclusion:** Our results showed that intra-specific plant genetic variation controlled by the cross type, mediates belowground and aboveground interactions, affecting the feedback dynamics of tri-trophic interactions that explain the reproductive success of R. *nudiflora*. These results showed the importance of considering the genetic "origin" (self vs. cross) of the offspring in plant species with mixed mating system, on the belowground and aboveground biotic interactions.

Keywords: Multitrophic interactions, genetic variation, inbreeding

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Occupancy models for determining habitat use in specialist and generalist Neotropical bird species

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Background: Monitoring of threatened, endangered or species restricted to specific ecosystems is crucial for understanding habitat use, the factors determining species distribution, and co-occurrence with other species. Here, we assessed the association between Dwarf Jay (Cyanolyca nana) detections, habitat characteristics and co-occurrence with other bird species in a communal reserve. First, we assessed the association between habitat characteristics and the probability of detection of Dwarf Jay using occupation models. Then, we examined the differences in habitat use and patterns of co-occurrence with Steller's Jay (*Cyanocitta Stelleri*), Gray-barred Wren (*Campylorhynchus megalopterus*) and Woodhouse's Scrub Jay (*Aphelocoma woodhouseii*): **Methods:** We performed an acoustic monitoring program for one year using an autonomous sound recording system to detect the presence of the focal species across 3000 hectares. The monitoring program consisted of 10 surveys, approximately every 39 days. In each survey, we placed 20 recorders and collected sounds for five days. In each of the sampling sites (sites with a recorder), we characterized the habitat by taking measurements such as THE vegetation type, tree density, elevation, among others variables. **Results:** Preliminary results indicate that the Dwarf Jay habitat occupancy was of the 40% of sites surveyed and related positively with both high elevation and pine forest. However, Woodhouse's Scrub Jay habitat occupancy was of the 40% of sites survey and related with both low elevation and dry scrub. Unlike Dwarf and Woodhouse's Scrub Jay, Steller's Jay and Gray-barred Wren showed a generalist pattern, their habitat occupancy was of the 90 y 85 %, respectively. **Conclusion:** Our results suggest that the Dwarf and Woodhouse's Scrub Jays are habitat specialist, while Steller's Jay and Gray-barred Wren are generalist. By assessing occupancy patterns, we can generate detailed distribution maps and predict changes in distribution with climate change, contributing to national and international conservation strategies. Finally, our study, a relatively novel monitoring technique, will inform local conservation managers and shed light on life history aspects of a limited range endemic species.

Keywords: Occupancy, Bird, Specialist, Generalist

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Diversity and effectiveness frugivores in a population of the *Pilosocereus leucocephalus*

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Background: Frugivory is a complex interaction influenced by environmental conditions, the reproductive phenology of plants, and the efficiency of their dispersers. In arid and semi-arid ecosystems, columnar cacti produce fruits with a high variety of water and nutrients that attract vertebrate visitors. Columnar cacti are keystone species in those environments and a key resource to numerous animals. The aim of this investigation was to determine the α-diversity and to assess the consumption effectiveness of two guilds (nocturnal and diurnal) of frugivores on the fruits of the woolly torch (*Pilosocereus leucocephalus*). **Methods:** We devised an index of effective removal (IER) that provides a weighted measure of visit time over the quantity of fruit removed. We used the IER to quantify the removal of each of the 69 cactus fruits tracked during the April-September 2015 fruiting season. We put cage-like exclosures on immature woolly torch fruits to keep frugivores from removing unripe material. Once ripe, we removed the exclosures and tracked the visitation of diurnal (from 7:00–19:00 hrs) and nocturnal (from 19:00–7:00 hrs) guilds using camera traps. **Results:** We obtained a total of 2,162 hrs of footage (14:47 hrs of them with effective removal of fruit material). Between guilds, the highest number of visitors is that of diurnal species (n=11, all birds) vs. only four nocturnal (three bats, one rodent). Because the IER is the quotient of fruit removal over time, the most significant values are those approaching zero. The most effective species removing fruit is the brown jay (*Psilorhinus morio*, IER=0.03 ±0.01), whereas the least effective was the Mexican deer mouse (*Peromyscus mexicanus*, IER=2.80 ±1.47). Species and guilds have highly significant differences in fruit removal effectiveness. **Discussion:** The significance of this work is two-fold: (1) camera traps can be used to track patterns of frugivory (to our knowledge, this is the first report of the use of cameras to track frugivory in cacti), and (2) birds play a key role in the fruit dispersal of this columnar cactus. Both of these findings are essential in the understanding the population dynamics of the woolly torch and in elucidating the ecology of a little-known process.

Keywords: Bird, mammal, Camera traps, Veracruz.

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The effects of fragmentation on insect herbivory rates in tropical rainforest

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Background: Human-modified landscapes are ubiquitous and often made up of remnant fragments of natural ecosystems nested within an agricultural or urban matrix. It is important that the impacts of modification on key ecological processes are understood in order to maximize biodiversity conservation and develop sustainable management practices. Herbivory is a fundamental ecosystem process as it mediates the transfer of energy between primary production and higher trophic levels. In the tropics, the majority of herbivore damage is carried out by invertebrate species. Insect herbivores, therefore, not only make up an important aspect of biodiversity in these speciose areas, but also contribute greatly to ecosystem functioning. Previous research on insect herbivory has relied heavily on quantifying leaf damage at single points in time. To overcome this limitation, an experiment to test the effects of fragmentation on herbivory rates has been established within the Stability of Altered Forest Ecosystem (SAFE) project in Malaysian Borneo. **Methods:** Seedlings of two species of dipterocarp were planted in twelve recently fragmented 1-hectare forest and twelve sites in continuous forest areas, in 2015. Repeated scans were made in situ and leaf damage was quantified in order to determine rates of damage and provide a better understanding of this dynamic interaction over time. Leaf damage was categorized according to chewing damage which could be attributed to insect herbivores and pathogen damage. At the end of the experiment, leaf material was collected and total phenolic content was measured. **Results:** 269 of the original 576 seedlings survived until the end of the experiment. We present results showing percentage leaf damage caused by chewing insects and pathogens at multiple time points. Trends in both damage types differ according to species identity with one species showing an increase in herbivore damage in fragmented forest while the other species shows a decrease. **Discussion:** The results of this study will contribute to understanding the effects of fragmentation on insect herbivory, which remain uncertain, and provide evidence of the extent to which this key ecosystem process is disrupted due to anthropogenic habitat modification.

Keywords: Insect herbivory, fragmentation, folivory, tropical rainforest

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How do dung beetles influence the fate of seeds in the Amazon forest?

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Background: Seed dispersal is a crucial process for plant regeneration. In rain forests many seeds are dispersed through defecation by mammals and dung beetles (Scarabaeidae: Scarabaeinae) are key secondary dispersers. The site of seed deposition after dung beetle activity can have important consequences for the seed's final fate. In this study we addressed the following question: 1) Do mimic seeds have different deposition patterns, after dung beetle activity, depending on seed size, which might in turn affect seed fate differently? **Methods:** The study was carried out northern Brazil. We established 48 transects and placed three experimental 'arenas' in each. Arenas consisted of a forest floor area 1m in diameter delimited with a nylon fabric 20 cm high. In the center of the arena we placed 200 g of dung in which small, medium and large seed mimics were imbedded. After 24h we registered the number of seeds in four possible deposition patterns:(1) not visible and within the soil excavated by beetles; (2) clean and visible on the forest floor; (3) still embedded in dung ; and (4) unknown (assumed to have been buried by beetles). According to previous knowledge we assumed that these depositions patterns form a gradient in terms of the effect they have on seed fate; the gradient goes from mostly positive effects for depositions (1) and (4) to more negative effects for depositions (2) and (3). **Results:** Seed deposition after dung beetle activity was dependent on seed size. For small seeds the 'unknown' deposition was the most common, and thus we assume that most small seeds are buried. Medium and large seeds were found in higher proportions visible on the forest floor. The assumed effect of dung beetle activity for the fate of small seeds was mostly positive, compared to the effect on the fate of medium and large seeds. **Discussion:** We show that defecated seeds can have different deposition sites after dung beetle activity. Our assumption of a more positive fate for seeds that were not found and for seeds within the excavated soil is based on a lower probability of predation for seeds not visible on the forest floor. Conversely, seeds visible on the forest floor and those that remain in the dung (which is known to attract rodents) are assumed to have a lower survival probability. Yet, future studies will be necessary to determine if these seed deposition patterns are indeed related to long-term seed fate and seedling success.

Keywords: Scarabeidae, ecological function, mimic seeds

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Effect of moisture and biotic interactions on seedling recruitment and diversity in tropical forests

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Background: Tropical forests species performance changes substantially with precipitation as a consequence of interspecific differences in responses to water availability. Species performance is also influenced by reduced individual survival in areas of high conspecific density. Such conspecific negative density-dependence (CNDD) is central to stable species coexistence. Natural enemies, and specifically soil fungal pathogens, are key contributors to CNDD among tropical forest plants. Because fungal pathogens and other microbes respond strongly to water availability, changes in water availability are expected to alter plant-pathogen interactions, and thereby plant performance and CNDD. Responses of plant-pathogen interactions to temporal variation in rainfall and the consequences for tropical forest species performance and diversity are virtually unknown. **Methods:** Using mixed effects models, we analyzed 16 years of seedling census data for Barro Colorado Island (BCI), Panama, to investigate how first-year seedling survival responded jointly to CNDD and interannual variation in soil moisture as an indicator of water availability. Using model estimates of CNDD per year, we also related changes in species diversity to interannual variation in the strength of CNDD. **Results:** We found a significant interaction between CNDD and soil moisture. Seedling survival in areas of high conspecific density was lower in wetter than in drier years while survival in areas of low conspecific density was higher in wetter than in drier years. Model estimates of CNDD per year were negatively related to reductions in the diversity of seedlings one year after their emergence. **Discussion:** The interaction between CNDD and soil moisture supports the hypothesis that increased rainfall could increase plant-pathogen interactions in tropical forests because wetter conditions favor pathogens and promote the incidence of infection. It also supports the hypothesis that higher soil moisture reduces seedling mortality by alleviating drought-stress, which is known to kill many seedlings in tropical forests. Our results further show that interannual variation in the strength of CNDD relates to changes in local species diversity. We conclude that the effects of a key abiotic factor, water availability, interact with those of a key biotic factor, conspecific density, to create a complex spatio-temporal mosaic of conditions with important consequences for seedling recruitment and species diversity.

Keywords: Drought, Conspecific-Negative-Density-Dependence, Seedlings, Survival, Diversity

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Can plant-pollinator network metrics indicate environmental quality?

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Background: Plant-pollinator interaction networks may be more informative than the diversity of species in the evaluation of the effects of environmental change. Considering that networks vary with ecosystems integrity, their changes may help to predict the consequences of anthropogenic impacts on biodiversity and ecological processes. This characteristic highlights its use as environmental quality indicator. However, to employ interaction networks as ecological indicators it is necessary to identify the most sensitive metrics and understand how and why they vary with environmental changes. This review aimed to identify, in empirical studies, which network metrics have been evidenced as being more sensitive to environmental quality changes. **Methods:** We surveyed published empirical studies in WOS, Scielo and CAPES databases using the key-words "environmental degradation"; "habitat loss"; "habitat fragmentation"; "interaction"; "mutualistic network"; "network"; "plant"; and "pollinator". Result: Available empirical data indicated that degree, nestedness and connectance don't have simple, linear or unidirectional responses to habitat degradation. Conversely, interaction asymmetry and species reciprocal specialization index (d') showed consistent responses to environmental changes. Species roles changed from generalists to specialists under different conditions. In addition, specialists with morphological and behavioral constraints were lost with lower environmental quality. The identity of interacting species and their role in the network, with a further specification of most affected groups and interactions, are the properties with greater potential to indicate environmental quality changes. **Discussion:** Most of the available studies focused on metrics at the network level, but several studies and this review indicate that the patterns at the network level can be better understood in the light of metrics analyzed at the species level. Our results provide information that enrich the network analysis, highlighting the need to consider important features that are often neglected. Information compiled here are important for deciding how to look at empirical data and what to look for, as well as to indicate some caveats when interpreting data on plant-pollinator interactions with a complex network approach. Network metrics can be good indicators of environmental quality if the underlying ecological causes of their numerical changes are carefully analyzed.

Keywords: environmental-quality, pollination, networks, mutualism, indicator

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Patterns of ornithocorous-fruit nutritional content in a Periurban park

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Background: Seed dispersal by birds is one important ecological interaction. In these interactions, fruit offer three main types of nutrients: carbohydrates, lipids, and, proteins. Has been reported that plants species in urban areas tend to have fruits that are more abundant and constant throughout the year than species in unmanaged areas. This fact could mislead us to think that managed plants are a better food source for birds than those in unmanaged sites. However, very few papers have been published on the nutritional value of fruit resources in these management categories. This investigation aims to respond: how different is the nutritional content of fruits of managed and unmanaged areas? We hypothesize that fruiting species in unmanaged areas provide more carbohydrates and lipids than unmanaged ones. **Methods:** This investigation took place in a periurban park in Xalapa, Veracruz, Mexico. To estimate fruit availability, we walked transects in search for fruits we have recorded as a food resource for birds. We collected thirty fruits from each plant species available, and evaluated sugar content, size, number of seeds, and consistency in the categories (hard, medium, and soft), evaluated its availability in the categories: high (HA), medium (MA), low (LA), and very scarce (UN). We collected fruits of the most abundant species to analyze the percentage of water, carbohydrates, proteins, and lipids, and analyzed them following the Luff-Schoorl, micro-Kjendahl, and Soxhlet extraction methods, respectively. **Results:** We found 12 species of plants used by birds. Of these, three are managed in this park (three HA, three MA, four LA, and two UN). The availability of different nutrients among species is heterogenous but its combined contents reveal a large presence of carbohydrates followed by lipids, and overall fewer proteins. Most of the nutrients available from unmanaged species come from *Psittachantus schiedeanus* and *Phoradendron* sp., and a managed specie Phoenix sp. **Discussion:** These results indicate that, plant species with ornithocorous syndromes in managed areas (a small proportion of the total surface of the park) provide a more constant source of nutrients to birds. Unmanaged species provide nutrients in a fashion that is patchy in space and time, besides being less nutritious overall. Our work can provide recommendations for the enrichment of periurban parks as bird habitat and the management of its flora.

Keywords: Frugivory, periurban park, nutrient-content

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Hidden treasures - the application of bomb-radiocarbon analysis in insect collections

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Bomb-radiocarbon analysis has found many useful applications in ecological studies. However, the time is running out for bomb-radiocarbon applications in ecology as the atmospheric concentration will fall under the pre-bomb concentration within the next decades. The collection of new material will not be possible anymore. Insect collections shelter an immense quantity of specimens stored in alcohol. It was not known if this alcohol can be efficiently removed and if the stored specimens can be used for diet age studies. We show how the alcohol can be easily removed from those specimens and how this this helps exploring the trophic structure of food webs by comparing their isotopic radiocarbon signature. Therefore, we stored body parts of various specimens from different feeding guilds in alcohol and other parts of the specimens were kept only oven dried as control. After several weeks in alcohol the specimens were taken out of the alcohol, oven dried and their 14C signature was analyzed. The diet age was estimated by comparing the radiocarbon content of the body of the insects with records of the long-term decline of radiocarbon in atmospheric CO_2 since the 1960s (the radiocarbon 14C 'bomb spike'). We could successfully remove the storage media and there was no significant difference between the diet age of parts of the insects that were stored in alcohol and parts that were preserved by oven drying. Hence, specimens from collections can be used for isotopic food web studies even after years in alcohol.

Keywords: collections, bomb-radiocarbon, atmospheric-decline, fossil-fuels

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Effects of plant resources on frugivores and seed dispersal functions using diversity measures

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Seed dispersal is an important ecosystem function, which in tropical forests is often performed by frugivorous birds organized in mutualistic networks with fruiting plants. To date, no study has tested how the diversity of plant resources shapes the diversity of frugivores, and how the interactions between both components influence seed dispersal functions. A mechanistic understanding of the relationship between plants and their frugivore partners is however essential to project potential consequences of global changes on key ecosystem functions, such as animal seed dispersal. In this study, we seek to test how the diversity of fruiting plants and frugivorous birds affect rates of seed removal using structural equation models. We specifically aim at comparing how different measures of diversity of the plant and frugivore community (i.e., species richness and abundance, functional diversity and identity) affect the respective measure of seed removal (i.e., species richness and abundance, functional diversity and identity of removed seeds). We build our analyses on a comprehensive dataset of bird and plant diversity and plant-frugivore interaction networks recorded over two years in a tropical montane forest in Southern Ecuador. Our study will disentangle the mechanisms that shape seed dispersal functions in tropical forest ecosystems and will provide recommendations for the conservation of an important ecosystem function.

Keywords: mutualistic interaction networks, functional diversity

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Oppositely skewed sex ratios in host and symbiont of an African insect-rodent mutualism

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Background: Sex-biased ratios that arise between closely interacting partners has several explanations. For female-sex-biased ratios, the Local Mate Competition hypothesis predicts reduced competition between related males if more females are available, and if female offspring are the dispersing sex. **Results:** We studied the unique relationship between the earwig *Hemimerus vosseleri* (Insecta: Dermaptera: Hemimeridae) and the rodent *Cricetomys gambianus* (Mammalia: Muridae), a rodent. Following capture of 29 C. *gambianus* rats in the East Usambara Mountains, Tanzania, we removed, preserved and counted all *H. vosseleri* that inhabited the fur of these rats. Dissection of the digestive tract of 32 H. *vosseleri*, together with use of a staining technique of on gut contents, showed that food items eaten included rat skin tissue, mites, and fungal spores/hyphae. Focusing on the earwigs and their hosts, we then found that there were close to nearly four times more as many earwigs on average on male than as on female rats. Of particular interest, on a given rat host, there were four times as many female than male earwigs. Genotyping 51 individual *H. vosseleri* using microsatellites showed that 25.5% of them were haploid; the majority of which were males (21.6% of the 51). Males were also kin-related and did not express outbreeding. Only a minute proportion of females were haploid (3.9%), but were otherwise kin-related or outbred. **Discussion:** This distinctively skewed sex ratio, in addition to the results from the molecular analysis, strongly suggests facultative parthenogenesis in H. *vosseleri*. We reason that the viviparous reproduction system, feeding and locomotory adaptations, and food derived off from their rat hosts points to a mutualistic relationship with *C. gambianus*. This, in turn, benefits *C. gambianus* individuals by ridding them of pests and pathogens, such as mites and fungi. To maintain this mutualism on male rat hosts, which is risky due because of their more extensive mobility and susceptibility to higher mortality than females, *H. vosseleri* earwigs employ facultative parthenogenesis to produce males in the event thaton they are needed. Female earwigs are thus the dispersing sex, establishing new colonies on their rat hosts. Along with a female-biased sex ratio, these results altogether support the Local Mate Competition hypothesis.

Keywords: host mutualism parthenogenesis sex-ratio

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How food availability influences feeding interactions between black howler monkeys and plants?

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Background: Most studies of primate behavior have focused on animals independently of their relationships with the environment, disregarding important interactions with plants. In this study, we evaluated how phenology of plants shape the structure of interaction networks between howler monkeys and the plants they use for feeding. **Methods:** We studied feeding behavior in six groups of howler monkeys (*Alouatta pigra*) during three seasons in Tabasco, Mexico and conducted phenological surveys to determine how food availability influences feeding interactions. For the network analysis we used four parameters: nestedness, diversity of interactions, links per monkey, and network specialization. For each season we associated with a GLM analysis, phenophases percentage with the number of interactions per species and with a Kruskal-Wallis test we compare the four network parameters. **Results:** We found a high diversity of monkey-plant interactions and a nested and specialized network pattern invariant of seasonality. Feeding interactions were dependent of phenological changes, which implies that howler monkeys consider the availability of the phenophases in the trees, particularly fruits and leaves. We found no differences in the four network parameters per season. Feeding preferences (Fabaceae) are influenced by the availability of this family in the site of study. **Conclusion:** As far as we know this is the first study that includes a network analysis approach when studying interactions between monkeys and plant phenology. Overall, the results represent a valuable conservation tool because they highlight the importance to identify not only important plant species for feeding, but also important key interactions between monkeys and plants in a disturbed area.
Keywords: Howler monkeys, phenology, plant-animal interactions

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Interactive effects of increasing aridity and anthropogenic disturbance on seed dispersal by ants

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Background: Land-use intensification and climate change are considered the main drivers of loss of biodiversity and ecosystem services around the globe. Both factors may modify the quantity and quality of partners that take part in ecological interactions, thereby undermining ecosystem services resulting from these interactions. This study aims to investigate how chronic anthropogenic disturbance (CAD) and aridity affect the seed dispersal services provided by ants in Brazilian Caatinga. **Methods:** This study was conducted in areas of Caatinga at Catimbau National Park, Pernambuco, Brazil. Within an area of 214 km2, we established twenty plots that encompass gradients in both anthropogenic disturbance and precipitation. At each plot, we offered diaspores of six plant species representing the morphological range of seeds that are dispersed by ants in the region. We then quantified overall seed removal rate and dispersal distances. **Results:** We observed 20 ant species removing our diaspores, but 62% of seed-removals were by a single species, *Dinoponera quadriceps*, which transported diaspores the longest distances (up to 27.5 m). Increasing anthropogenic disturbance and aridity do not have a similar or interactive effect on the composition of ant seed dispersers, and on the quality of seed dispersal services. We found that increasing aridity reduce the quality of seed dispersal services (i.e. seed removal rate and seed dispersal distance) by reducing the abundance of the high-quality seed dispersers, but CAD did not affect the abundance of the high-quality seed dispersers and ant-mediated seed-dispersal services in Caatinga. **Conclusion:** Our results suggest low sensitivity of high-quality seed dispersers to CAD, but high sensitivity of high-quality seed disperser to aridity. Despite a high diversity of seed-dispersing ant species, Caatinga has only a very limited number of high-quality seed dispersers. This may represents a limited functional redundancy in disperser ant species, resulting in low disperser resilience in relation to aridity. Mean annual rainfall in the region is projected to decrease by 40% under global climate change, which means likely reductions in seed-dispersal services. This has important implications for plant recruitment and, consequently, for the composition of plant communities.

Keywords: mutualism, dry forest, climate change, human disturbance

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Florivory in tropical species: Comparison of floral damage and insect richness in related species

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Background: Florivory is defined as any type of damage, caused by a consumer, in developing flower buds or mature flowers. These damages can have significant negative impacts on plant reproduction and fitness. In this study florivory levels and insect richness associated to flowers were evaluated in three species of tropical plants of the family Bignoniaceae. The difference in florivory levels of one of the host species in anthropic and preserved areas was also compared. **Methods:** Forty-eight individuals were evaluated in this study, belonging to the species *Handroanthus orchraceus* (n = 20), *Handroanthus heptaphyllus* (n = 8) and *Pyrostegia venusta* (n = 20). Three hundred flowers of *H. orchraceus* and H. *heptaphyllus* and all flowers of P. *venusta* (n = 168) with true florivory signs were analyzed. Damage was calculated as the ratio between the floral area removed and the total floral area for each flower of each species. Florivorous insects were determined by direct observation of flowers, sampled and taken to the laboratory for identification. **Results:** The levels of floral tissue removed was different amongst the three species (H = 114.20, p = 0.0001). *H. orchraceus* was the species that experienced the most loss of floral tissue (12.4%) and *H. heptaphyllus* (3.2%) the lowest. Amongst the two populations of *H. orchraceus*, from preserved (n = 9) and anthropized areas (n = 11), no significant difference was found in florivory levels (U = 19.35, p = 0.289). *H. heptaphyllus* showed the highest percentage of damage caused by nectar robbers (57.6%), followed by *H. orchraceus* (42%) and *P. venusta* (31.5%). The richness of florivorous insects was smaller and significantly different in H. *orchraceus* (DMG = 2.5) in relation to the other two species. The coefficient of similarity of Jaccard (Cj) showed that the tree plants species showed low similarity regarding the community of florivores. **Conclusion:** The results showed that even phylogenetically related species exhibit different levels of florivory, which can be explained by differences in the communities of associated florivorous insects. However, among different populations of H. *orchraceus*, the levels of florivory found indicated that anthropization is not a factor capable of increasing flower damage. Because florivory is still poorly understood in tropical species, our study contributes to the knowledge of plant-florivore interactions in widespread plant species.

Keywords: florivory, insects, floral damage

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Is selfing ability associated with geographic range size and niche breadth in *Ipomoea*?

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Background: It has been proposed that self-fertilization facilitates the colonization of plants to new habitats, since it allows reproduction in environments where pollinators or conspecifics are absent. However, inbreeding from continuous selfing may lead to reduced genetic variation and decreased fitness, which might hinder the ability to disperse to new environments. We evaluated these contrasting hypotheses in a group of *Ipomoea* containing both SC and SI species. We predicted that self-compatible species would have larger distributions and greater ecological niche breadth than their self-incompatible (SI) relatives. **Methods:** We characterized the breeding system of 60 species of *Ipomoea* subgenus *Quamoclit* through field pollination experiments and visualization of pollen compatibility through epifluorescence microscopy. To estimate range size and niche breadth we developed Ecological Niche Models (ENM) based on herbarium records and online databases. Finally, we tested for correlations between breeding system and niche models using phylogenetic comparative methods based on a molecular phylogeny. **Results:** We found that most study species SI and evolutionary transitions are unidirectional towards SC breeding systems. Furthermore, range sizes are consistently larger for SC than SI species. Concordantly, ENMs for SC species displayed a larger breadth compared to SI species. **Discussion:** Results indicate that SC species are better able to colonize and survive in new environments than SI species. This could perhaps be explained by the ability of SC species to reproduce via outcrossing and selfing, generating genetic variation while ensuring reproduction when pollinators or mates are scarce. Results also suggest that inbreeding depression is probably low in selfing *Ipomoea* species, a hypothesis that should be further explored. We conclude that breeding system is an important determinant of plant distribution and ecological niche evolution and needs to be incorporated into plant conservation management strategies.

Keywords: *Ipomoea*, Niche, range size, selfing

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Ant-plant sociometry: how tree and colony structure interact and give rise to emergent behavior

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Physical attributes of an ant colony's structure can influence its collective behavior. However, in the context of an ant-plant symbiosis, the tree in which colonies nest defines many physical attributes of colony structure. An Azteca colony's nest structure is tied to the *Cecropia* tree it inhabits, with tree structure determining where the colony nests in the stem's hollow, segmented internodes. Little is known about how the colony is distributed and organized and how this might affect the colony's ability to respond to threats or opportunities. How might host tree dimensions, spatial distribution, worker body size, and genetic diversity affect the emergence of a collective personality? I measured five colony-level behavioral traits in the field and assigned personality scores to each colony. After harvesting the trees and determining the spatial distribution of workers and brood, I measured head width and thorax length of a subset of workers. I then extracted DNA from another subset of workers and determined colony genetic diversity. This study provides insights into how ant-plant structural relationships may contribute to plant protection and the strength of the mutualism.

Keywords: mutualism, behavior, personality, sociometry

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Assymetry in pollen flow: A case study between a distylous plant and bees in Brazilian Cerrado

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Background: Distyly is sex polymorphism in plants where populations include two floral morphs (pin and thrum) with reciprocal placement of anthers and stigmas (Reciprocal Herkogamy-RH). Pollinators play an important role in the functionality of distyly, since RH facilitates the deposition of pollen grains on specific body parts of the pollinators. This study aimed to study the functionality of the distylous system in the pollen flow and in the deposition of pollen grains in specific parts of the body of the pollinators of *Psychotria nitidula* cham. & Schltdl. (Rubiaceae). **Method:** Data collection occurred in the transition of two followed years in a Tropical semidecidous forest in the Central Brazil. Information about the floral morphology, RH, morph ratio, incompatibility system (IS), nectar production, production and pollen transfer, amount of inflorescences, flowers, fruits and seeds, the floral visitors (bees) and their pollen loads were obtained. **Result:** The studied population presented the pin and the thrum morphs in isoplethy, the production of flowers, inflorescences, fruits and seeds was the same for both morphs, but the reciprocity indices indicated only the present of RH between the lower whorls of the flowers. The IS was of the heteromorphic type, with the formation of fruits occurring only through legitimate pollinations. There were no differences between the morphs in the nectar production and in the fruit production. The only pollinators that presented pollen deposition on specific body parts were the short-tongued bees, the main visitor being the exotic bee *Apis mellifera* Linnaeus. The pollen flow mediated by pollinators was completely asymmetrical, the thrum morph received more legitimate pollen than the pin morph. **Conclusion:** Some factors may explain the asymmetry in the pollen flow and the non-deposition of pollen in specific parts of the long-tongued visitors. Such as the presence of reciprocal herkogamy of the lower whorls, that could enabled a greater effectiveness in the pollen flow, an ineffective action of an exotic pollinator and the sexual interference in the reproductive structures, since the pin morph pin played a male function and the thrum a female. Therefore, it is believed that deviations in characters, regarded as crucial for the maintenance and function of distyly, not always affect the reproductive success and cause imbalance in morph ratio, particularly when the incompatibility system is active, as found in *P. nitidula*.

Keywords: heterostyly, floral polimorphism, reciprocal herkogamy, Cerrado

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Toxins or Medicines? Algal diets mediate parasitism in a freshwater host-parasite system

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Background: Understanding the causes and consequences of disease outbreaks in organisms requires understanding the role of the environment in shaping parasite-host interactions. Daphnia are exposed to a wide array of phytoplankton and parasites in freshwater ecosystems and this exposure can vary both spatially and temporally. Phytoplankton also vary both in nutrient quality and secondary metabolites. The chemical arsenal of phytoplankton can confer benefits such as defense against herbivory and other microbes, therefore raising the question of whether these metabolites can defend *Daphnia* againts its parasites. We investigated the role of food quality on disease emergence and transmission, focusing on the consequences of toxic food consumption by *Daphnia* on host and parasite fitness. **Methods:** We fed *Daphnia* 8 species of algae (4 green algae, 3 cyanobacteria) that differed in lipid content and toxin production. *Daphnia* were infected with either a) *Metschnikowia bicuspidata* (fungal parasite), b) *Pausteria ramosa* (bacterial parasite), c) co-infection (both parasites) d) no infection (control). We followed infection for 30 days and later measured prevalence and spore yield of each parasite infection, offspring production (fitness) and survivorship of host. **Results:** We found that both toxins and nutrient quality influence disease in Daphnia, but that these effects differ by parasite species. Diet influenced prevalence of *Metschniknowia* infections with Anabaena and Microcystis diets preventing infections. *Pasteuria* prevalence was not influenced by diet. Conversely, spore fitness was not impacted by diet for *Metschnikowia* infections, whereas diet influenced the number of spores produced in *Pasteuria* infections. **Conclusion:** This research shows that consumption of resources that contain toxins can positively influence herbivore fitness in the presence of parasites. Thus, indicating that phytoplankton biodiversity may influence disease in natural lake ecosystems.

Keywords: Daphnia, disease, microcystis, phytoplankton,herbivory

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Mutualistic bees may avoid the impact of pollen thieves by visiting flowers earlier in the morning

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Background: Many angiosperm species show low reproductive success, which may be a consequence of the pollen limitation experienced by plant populations in natural conditions. The balance between mutualist and antagonist visits to flowers may be an important part of this scenario. Pollen thieves, for example, may reduce the amount of pollen that could be dispersed by pollinators, directly affecting the male component of reproductive success. *Jacaranda caroba* (Bignoniaceae) showed pollen limitation, producing around four times less fruits in natural conditions as compared to pollen supplementation (previous data). In this study, we investigated pollen depletion by pollen thieves and its potential consequences on pollen limitation in our focal system. **Methods:** We performed this study at 'Santa Barbara Ecological Station, São Paulo state, Brazil. Firstly, we classified bees as pollinators or pollen thieves based on their behaviour during resource collection. We conducted a pollinator exclusion experiment, using metal cases with meshes that only allowed pollen thieves access to flowers. After three days, we counted and compared the number of pollen grains remaining in the anthers with the number of pollen grains from bagged flowers (all visitors excluded) (N = 15 flowers). Then, we registered bee visitation all along the day (60 hours of field observations). **Results:** Flowers were visited by two distinct functional groups, pollinators (medium-sized bees, *Bombus morio*) and pollen thieves (small-sized bees, *Trigona spinipes* and *Plebeia* sp.). Each *J. caroba* flower produced a mean of 28850 ± 7216.5 pollen grains, and pollen thieves removed 54% of them during the flower lifespan. Pollinator *B. morio*, showed a peak of visits between 8:00 - 9:00 h, while pollen thieves' activity peaked after 9:00 h. **Discussion:** Pollen thieves removed more than half of the pollen load per flower, which may represent a significant reduction of gametes available to be transferred by pollinators. However, the peak of pollinator visits took place just before the pollen collection by small bees. So, in this scenario, pollen exploitation by pollen thieves may have a small or no impact on the reproductive success of *J. caroba*. These findings highlight the importance of considering the temporal structure of mutualist and antagonist visits in order to better understand pollen limitation in natural populations.

Keywords: Antagonists, Bignoniaceae, Mutualists, Pollen thieves

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Florivory and pollination in an ornithophilus species

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Background: Florivory, or damage to flowers by herbivores, can have a direct impact on plant reproduction via reduction of the amount of gametes available for pollination, or it can have an indirect impact via the reduction of pollinator visitation, denoting less pollen transfer to receptive stigmas. Based on this, we hypothesize that corolla damages would have a negative impact on pollinator visitation and would, as a consequence, affect the sexual reproduction of an ornithophilous neotropical vine, *Pyrostegia venusta* (Bignoniaceae). So, we aimed to investigate if alterations in floral shape, one of the presumed floral advertisements, affects hummingbird pollination. **Method:** Firstly, we assessed natural florivory levels in 40 *P. venusta* individuals, aiming to obtain the patterns of floral damages in natural populations of this hummingbird-pollinated species. Then, we manipulated 45 newly opened flowers to simulate the most common and rarest patterns of floral damages observed previously, and to test if those damages affected the number of pollen grains deposited onto the flowers' stigmas. We stained the stigmas as a whole with aniline blue and potassium acetate (Dafni et al. 2005), then, we counted the pollen grains in each stigma under microscopy of fluorescence. Later we performed Kruskall-Wallis test to compare the number of pollen grains deposited onto the stigmas of control and manipulated flowers with simulated common and rare damages. **Results:** Commonly, we observed small corolla damages, of 1-3% of corolla tissue removed. We observed higher percentage of damages in a smaller proportion, being the largest one of them also the rarest one, of approximately 60% of corolla tissue removal. After the experimentally simulating these damages on the flowers, we noticed that, neither the small (1-3%) nor the large damages (>50%) affected the number of pollen grains deposited onto the stigmas of *P. venusta* flowers ($H = 1.1013$; $p = 0.5766$). **Discussion:** Based on our unexpected results, natural levels of florivory seemingly does not affect hummingbird visitation. This finding suggests that the integrity of floral shape is not crucial for hummingbirds to locate flowers. This raises new questions about which selective pressures act on the complex florivore-plant-pollinator intersection.

Keywords: floral herbivory, florivory, hummingbird pollination

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Measuring pollinator movement via multipaternal pollen in fragmented tropical forests

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As more than 90% of tropical plant species are animal-pollinated, the disruption of dispersal services may be one of the greatest threats to tropical biodiversity posed by deforestation. Despite the high occurrence of multi-paternity pollination in tropical plants, particularly successional species, most fragmentation genetics studies analyze a single sire's pollen movement per dispersal event and therefore cannot speak to the potentially different dispersal patterns of multipaternal species. Additionally, few studies have explored the implications of forest fragmentation on the effectiveness and movement of specific pollinator species, therefore much could be learned about such changes from pollen carryover in the pollen loads pollinating multipaternal plants. To explore changes to pollinator movement in fragmented habitats, we examined dispersal distances and sire diversity per pollen load that fertilized the multipaternal fruits of tropical pioneer tree *Miconia affinis* using microsatellite markers and paternity analyses. We tested the response variables against landscape factors that displayed variation between three study sites including: conspecific density, local kinship, mother tree size, and pollinator species. We predicted that (1) pollen dispersal distances will be greater in less dense landscapes with smaller, less related trees, irrespective of the pollinator species, and (2) pollen loads dispersed from smaller trees in lower local kinship neighborhoods, by larger-bodied pollinators, will promote greater sire diversity. Dispersal distances significantly increased as conspecific density decreased and sire diversity per pollen load significantly decreased as the size of the mother tree increased. The majority of long-distance dispersal events took place in the more fragmented landscapes, while mothers in the more forested landscapes received pollen mostly from nearby donors. While pollinators are capable of and do engage in long-distance dispersal events, studies have shown that they more frequently engage in shorter foraging bouts when offered dense, resource-rich patches. This may also indicate that pollinators visit a lower number of sires in patches with large mother trees. Lastly, pollinator species was not found to have an effect on dispersal distances nor sire diversity, indicating that most pollinator species within this system engage in the long-distance dispersal of genetic diversity across fragmented landscapes.

Keywords: pollination, genetics, movement, fragmentation, multipaternity

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Diversity of acorn-predating weevils and their effects in seed survival in two tropical oaks

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Background: Pre-dispersal acorn predation affects seed viability and modifies recruitment and relative abundance of coexisting *Quercus* species. Large acorns are more predated, since they provide more resources for larvae development; they also suffer more superinfestation, which reduces the probability of seed survival. The relationship between seed size and infestation has not been analyzed in tropical oaks, and diversity of acorn weevil species is largely unknown. Thus, we analyzed abundance and diversity of weevil species in acorns of *Quercus magnoliifolia* and *Q. glaucoides*, as well as the impact of this predation on embryo survival. **Methods:** Acorns were collected in Morelos, Mexico, from June to October 2013. Each one was measured and its volume calculated. Larvae emergence was recorded one month, and then acorns were opened for embryo observation. Mitochondrial DNA was extracted from a random sample of 51 larvae. Using DNA taxonomy different species were identified, and diversity of acorn weevils was calculated. Generalized mixed linear models were used to analyze the effect of oak species and seed size on probability of infestation and superinfestation, as well as the effect of oak species, seed size and superinfestation on embryo survival. **Results:** Acorns of *Q. magnoliifolia* were less abundant than those of *Q. glaucoides*, and also fell earlier, during a shorter time interval. Five weevil species were identified: four in the genus *Curculio* and one in Conotrachelus; diversity and equitability were higher in *Q. glaucoides*. These results show a high diversity of acorn weevils in these tropical oaks, since two weevil species per oak species have been reported in Spain, and one to three *Curculio* species per location in California. Seed size was significantly larger in *Quercus magnoliifolia* than in *Q. glaucoides* (4.28 and 1.22 cm3, respectively), and the proportion of weevil-infested acorns was also higher in the former than in the later species (0.61 and 0.48, respectively); superinfestation followed the same pattern. In *Q. magnoliifolia* weevil infestation was high in all seed sizes but in *Q. glaucoides* it increased with seed size. *Q. magnoliifolia* acorns survived better weevil predation than those of *Q. glaucoides*. The larger seed size of *Q. magnoliifolia* is associated with higher weevil predation, but it also allows high embryo survival, while the smallest acorns of *Q. glaucoides* escape predation, but those infested do not survive.

Keywords: *Quercus*, *Curculio*, Conotrachelus, seed size

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Functional traits, chemical defenses and their distribution across habitats in *Protium* (Burseraceae)

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Background: Understanding how the functional characteristics and phylogenetic relatedness of tree species influence their spatial distribution in highly diverse tropical forests represents an important challenge in ecology. Here we aim to test two main hypotheses: (1) Competition for enemy-free space has generated divergent selection of anti-herbivore chemicals among co-occurring tree species (competitive exclusion effect); (2) conversely, functional traits related to resource acquisition and resistance to stress have undergone convergent selection among species co-occurring on similar soil conditions (habitat conservatism and filtering effect). **Methods:** We use large-scale distributional data collected in 38 0.1 ha plots in Peru that sample three widespread habitats (white-sand, terra firme and flooded forests) in geographically-replicated blocks. Our analyses focused on 39 species from the genus *Protium* (Burseraceae), an abundant taxon widely distributed over the Amazon basin and represented among the three habitat types, and for which we have accurate phylogenetic information. We include detailed data on ca. 600 chemical compounds assumed to be involved in defense against herbivores, in order to test hypothesis 1, and 14 functional traits to test hypothesis 2. **Results:** We found no evidence that within-plot chemical dissimilarity was higher or lower than expected by chance on any habitat, but other analyses demonstrated a significant negative relationship between phylogenetic distance and chemical dissimilarity. As for functional traits, white sand plots were characterized by dissimilarities always higher than expected by chance, while the opposite pattern was found for terra firme plots. In addition, a positive relationship was found between phylogenetic and functional trait dissimilarity. **Discussion:** Our current results suggest that habitat filtering for functional traits may induce trait divergence or convergence among co-occurring species, depending on soil fertility conditions. In parallel, no strong interpretation can be drawn at the moment regarding the effect of competitive exclusion (trait divergence effect) for enemy-free space. Our study will contribute to better understand to the role of natural enemies and abiotic factors in structuring congeneric plant assemblages in tropical forests.

Keywords: herbivores, habitat, tree species distribution

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Host-parasite interaction networks across a deforestation gradient

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Background: Tropical deforestation is a global environmental change driver, with demonstrated impacts on biodiversity. However, how native forest loss influences key species interactions, including those between hosts and parasites, remains surprisingly poorly characterized to date. Dung beetles are fecal detritivores, whose interactions with mammal feces for feeding and nesting have led to their frequent obligate ecological role as the intermediate host for a series of important mammal macroparasites. Understanding how these intermediate host-parasite interactions occur over space, and are influenced by forest cover has both basic and applied importance in ecology, conservation and livestock management. We examined the influence of native forest loss on host-parasite networks using a well-replicated landscape-scale analysis in the Brazilian Atlantic Forest. **Methods:** We selected twelve independent 3km landscapes in the Atlantic Forest of São Paulo State, Brazil, constraining all landscapes to similar soil types and elevation, but spanning a 10-60% forest cover gradient. We distributed eight points within each landscape using a stratified, random proportional selection process based on largest fragment size. At each point, we collected data on dung beetle community structure using standardized methods (i.e. baited pitfall traps), and later dissected infectious stage (L2 and L3) helminth larvae from beetle individuals. We modeled the influence of forest loss on beetle-parasite interaction network structure (defined as connectance and linkage density) through generalized linear mixed models, incorporating landscape-scale forest cover as a random effect. **Results:** We captured 2,598 beetle individuals in 35 species across 11 genera, as well as 11 parasite morphospecies across the 12 focal landscapes. Preliminary analysis suggests that native forest cover loss has idiosyncratic effects on host-parasite network structure. These results were likely influenced by the extensive invasion of both domestic dog and Eurasian boar (javali) into the relatively depauperate mammal (and associated macroparasite) community across the 12 landscapes. **Discussion:** Our study advances an understanding of the influences of changing tropical forest landscapes on key species interactions. We discuss the implications of these results for both infectious disease dynamics, and the paradoxical importance of maintaining host-parasite relationships in working tropical landscapes.

Keywords: interaction network, macroparasite, Atlantic Forest

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Mammal-dung beetle interaction networks across a deforestation gradient

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Background: Tropical deforestation is a global environmental change driver, with demonstrated impacts on biodiversity. However, how native forest loss influences key species interactions, including those between mammal fecal donors and dependent fecal detritivores, remains surprisingly poorly characterized to date. Abundance evidence suggests that primary extinction of mammals in a given site produced secondary co-extinctions of dung beetles. However, this has never been assessed in ways that enable us to understand (1) how beetle-mammal networks are structured, (2) how network topology influences the procession of co-extinction, and (3) to what extent networks estimated by different techniques demonstrate consistent network topology. We examined how native forest loss influenced the structure of a key ecological interaction network composed of tropical mammals and their dependent dung beetles, using a well-replicated landscape-scale analysis in the Brazilian Atlantic Forest. **Methods:** We selected twelve independent 3km landscapes in the Atlantic Forest of São Paulo, Brazil, where all landscapes were constrained to similar soil types, elevational ranges and slopes, but spanned a 10-60% forest cover gradient. We distributed eight sampling points within each landscape using a stratified, random proportional selection process based on largest fragment size. At each point, we simultaneously collected data on dung beetle and medium and large-bodied mammal community structure in 2015, using well-replicated and standardized methods (i.e. baited pitfall traps and camera traps). We used environmentally constrained co-occurrence modeling to estimate the structure of mammal-beetle interaction network structure at each sampling point, and generalized linear mixed models to examine the influence of forest loss on mammal-beetle networks. **Results:** We captured 2,598 beetle individuals in 35 species across 11 genera, and registered 19 mammal species across the 12 focal landscapes. Preliminary analysis suggests that native forest cover loss was associated with reduced network connectance, primarily through reduced species richness of dung beetles (rather than through effects on mammals). **Discussion:** Our study advances an understanding of the influences of changing tropical forest landscapes on key species interactions. We discuss the implications of these results with respect to the implications of biotic homogenization for species interactions.

Keywords: deforestation, Atlantic Forest, interaction network

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A twig-nesting ant transplant experiment: habitat and ant impacts on colony survival and composition

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Background: Understanding community assembly of tropical ants has long intrigued ecologists. Several factors contribute to assembly including (at the local scale) habitat, nest site availability, and competition and (at the regional scale) dispersal limitation. Yet, little manipulative work has examined drivers of community assembly. Here I take advantage of an effectively sessile animal community (arboreal twig-nesting ants) in a relatively uniform environment (a coffee farm) to explore multiple factors driving community assembly. I used a nest transplant experiment to study whether habitat differences (coffee shade management), interactions with a canopy dominant ant (*Azteca sericeasur*), or interactions with other twig-nesting ants influence colony survival of transplanted twig-nesting ants. **Methods:** I selected 30 sites each habitat; half contained an Azteca colony. In each site, I selected four coffee plants; from half I removed twig-nesting ants. On each plant, I added four artificial nests with colonies of *Nesomyrmex echinatinodis* and one of three *Pseudomyrmex* species. I collected nests 2-4 months later and identified occupants. I used GLMM and ANOSIM to examine whether a) proportion of occupied nests, b) proportion of nests occupied by the same ant species, c) proportion of nests occupied by each transplanted species, and d) composition of occupants differed with coffee habitat, Azteca, or twig-nesting ant presence. **Results:** Habitat, Azteca, and twig-nesting ant presence influenced nest occupation; only habitat influenced ant composition. Continued nest occupation was higher in low-shade coffee, but nests were more likely to contain a new ant species. Both *P. simplex* and *P.* PSW-53 were more likely to stay in nests in the high-shade coffee. Continued nest occupation (overall and by *N. echinatinodis*) was higher near Azteca. Species composition shifted from transplanted communities for all treatments (habitat, Azteca, twig-nesting ants); however, final communities only differed in high- and low-shade coffee. **Discussion:** High-shade coffee sites have lower nest-site limitation and more resources, and may provide a more stable environment for some ant species. In low-shade sites, low resources may have encouraged higher rates of nest turnover. Azteca presence can limit colony founding, but here encouraged continued occupation by some species, a new finding. In sum, habitat filters and Azteca presence appear to have stronger influences on twig-nesting ants.

Keywords: agroecosystem, assembly, coffee, Mexico, Hymenoptera

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Salt Marsh Provides Conditions for Mutualism between *Melongena corona* and *Batophora* Algae

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Background: At the interface of water and land, intertidal environments manifest differences between marine environments and their inhabitants. Coastal habitats, characterized by tidal fluctuations, subject inhabitants to swings in water and air temperatures, salinity, wave exposure, desiccation, solar radiation, and other abiotic factors (Chen and Richardson, 1987; Findlay, 1981; Garrity, 1984). Further inland, marine species are found in salt marshes, mangrove swamps, and seagrass flats. Although better protected from wave and water extremes, salinity in these habitats can be highly variable (Bertness/Pennings, 2001) and food sources are limited. In salt marshes, animal production is high because macrofauna are locally specialized, but diversity is low (Montague et al., 1981; Montague and Weigert, 1990). Unlike their coastal conspecifics, populations of *Melongena corona* Gmelin in salt marshes were observed growing beds of (*Batophora oerstedii*) algae on their shells so lush that they alter the conch's appearance. Dense *Batophora* give the conchs a plant-like appearance, making them indistinguishable from the *Batophora*, itself. This study seeks to assess whether or not *Batophora* algal growth impacts *M. corona* size. Initial findings led to two hypotheses about the size of M. *corona* with *Batophora* epibionts. First, it was hypothesized that *M. corona* size differed between habitats. Second, it was hypothesized that *M. corona* size could be affected by the presence of *Batophora* on their shells. Identifying an effect is a necessary step toward elucidating mechanisms responsible for the effect. **Methods:** *M. corona* in different habitats were measured for size and algal growth. Next, in both the lab and the field, algae was cleared from shells to assess regrowth time. **Results:** One-way ANOVA analyses determined that *Batophora*-hosting M. *corona* were significantly larger in size and algal growth than conspecifics in other intertidal habitats (all, $p<.001$). **Discussion:** From the results, it is proposed that *Batophora*-hosting *M. corona* use their epibionts for mimicry and develop a mutualism that enables both species to thrive in this environment. Further study is warranted because this mutualism can shift ecosystem dynamics and have conservation implications for other conch populations.

Keywords: mimicry, epibiont, mutualism, intertidal, gastropod

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Molecular methods enhances traditional approaches to understand a bird-plan frugivory network

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Background: Frugivory between birds and plants plays a key role in the stability and diversity of populations and communities. Within a natural environment, different species of birds and plants interact with each other and generate complex networks of interactions. To build such plant-bird networks, most studies have widely used focal observations of free-ranging birds feeding on fruiting plants and analyses of seeds found in bird feces. The latter approach, however, is often ineffective, since it omits 60% of the samples without seeds. **Methods:** Our investigation aims to understand the basic patterns of assembly between birds and plants in a periurban Neotropical park in Xalapa city, Mexico. For this, we collected focal observations and excreta from birds captured with mist nets. We physically examined bird feces in order to find ornitocorous fruits and also used molecular methods (i.e., sequencing, barcoding, and cloning DNA) to quantify the largest possible number of interactions. **Results:** We found more than 90 interactions from all three methods. We found that the frugivory network is composed of 25 birds and 12 plants. The least effective method is the search and identification of seeds in excreta (from 35 feces, only six had seeds: 14 of *Smilax*, five of *Cestrum*, one of *Lycianthes*, one of *Rubus*, and an unidentified Solanaceae); focal observations and molecular work vastly enhanced our findings. Four species of birds, *Myiozetetes similis*, *Campylorhynchus zonatus*, *Turdus grayi*, and *Dumetella carolinensis* play a central in this network of highly interacting species, whereas the dominant species among plants are *Phoenix* sp., *Psittacanthus schiedeanus*, and *Phoradendron* sp. The interactions network studied shows an asymmetric distribution. **Discussion:** Each of the methodological approaches used provides a different perspective of the frugivory network. Molecular methods increase precision in the identification of species and is key to elucidate unconfirmed interactions. The complementarity between different methods generates a more complete description of the network.

Keywords: Interactions, network, periurban, molecular methods

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DNA metabarcoding identified high diversity of pollen in the diet honey bees in tropical forests

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Background: A global loss is now widely recognized in the colonies of *Apis mellifera*, mainly due to the reduction of floral resources, pathogens, intensification of agriculture and use of pesticides. Given the impending decline, it is crucial to implement effective methods that allow us to identify availability, quality and quantity of floral recoursesthat may affect the health and fitness of the honey beecolonies. **Methods:** Here we used a DNA multilocus metabarcoding approach for identifying floral composition in mixpollen samples collected from honeybee hives, *Apis mellifera* in different regions of México. Improved understanding of the quantitative capacity of various plant metabarcode regions, primer sets and reference data sets is needed to ensure that such applications are fast, simple and accurate. We applied the ITS2 and ITS1loci, to characterize 24 samples of pollen collected from honeybee hives, and sequenced all samples together on an Illumina NextSeq550 flow. Result: Two hundred thirty-five plant species plant were identified using plant metabarcode regions from reference databases, where ITS2 and ITS1 identified most of the pollen samples at species level. Our results showed that *A. mellifera* (mainly Africanized genotypes) obtain a high diversity diet of pollen from a high diversity of plants blooming 1 km in radius around beehive areas. A high diversity diet with a high diversity of protein content was also found for the beehives analyzed. Our analysis also showed that *A. mellifera* (mainly Africanized genotypes) obtained its food sources both from a wide variety of wild and cultivated plants. **Conclusion:** This is one of the first studies to show the use of floral resources by bees in the tropics and contrasts with few other studies from temperate regions. The main result indicated that in a tropical scenario where plant diversity is higher than in temperate regions, apoly-floral diet of bees is greater than the limited flower use shown in few temperate areas. *A. mellifera* (mainly Africanized genotypes) are able to exploit floral resource from a wide variety of wild and cultivated plants blooming around them. Metabarcoding proved as a useful ecological technique to identify use of floral resources in agricultural or natural landscapes and to evaluate the impact of floral composition in colony success.

Keywords: DNA metabarcoding, ITS1-ITS2, pollen identification.

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Impact of decadal persistence of pioneer tropical seeds on seed-associated fungal communities

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Background: Neotropical pioneer trees require high-light environments for successful seedling establishment. Their seeds often persist in the soil seed bank (SSB) for periods ranging from several weeks to decades. How they survive despite extensive pressure from seed predators and soilborne pathogens remains an intriguing question, in part because seeds lack the dynamic defenses characteristic of plants after germination. The aim of this study was to compare communities of fungi that occur in seeds that have persisted for decades in the SSB and those from recently buried seeds. We hypothesize that persistence in the soil is linked with distinctive seed-associated fungal communities. **Methods:** We used data from the 50-ha Forest Dynamics Plot at Barro Colorado Island, Panama, to identify locations where reproductive trees of two pioneer species (*Zanthoxylum ekmanii* and *Trema micrantha*) had occurred over the previous 30 years. Seeds from the superficial layer of soil (< 3cm) were collected, identified, and divided in two groups. Germination rate was quantified for one group of seeds. Each seed in the other group was surface-sterilized and cut in half. One half of each seed was used to measure viability via tetrazolium staining. The other half was plated on a standard medium to isolate cultivable fungi. Haphazardly selected seed coats from viable seeds were 14C-dated to estimate the time of persistence in the SSB. Community structure of seed-associated fungi was compared to that from recently buried seeds of the same species. **Results:** Fungal communities differed between plant species. Fungal communities in old seeds (> 10 years) differed from those associated with recently buried seeds (1 - 18 months) in both species. When both age classes were compared, fungal communities from old seeds showed larger differences between viable and non-viable seeds than recently buried seeds. **Discussion:** Long-persistent seeds use physical and/or chemical defenses to interact with microorganisms they encounter in the soil. Our findings reveal the importance of a previously understudied aspect of seed survival in the SSB: temporal dynamics of seed-associated fungal communities appear to be crucial in our understanding of the long-term survival of seeds in tropical forests and therefore, its influence on plant community assemblages.

Keywords: Seed persistence, Seed-associated fungal communities

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Mycorrhizal fungi associated with *Swietenia macrophylla* in conservation area of Quintana Roo

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Background: Illegal logging, soil loss, anthropogenic and natural disturbances have affected the natural regeneration in natural populations of mahogany. Establishment of commercial plantations is an option to the high demand of wood quality and decreases pressure to mahogany natural populations. However, this forest species too is affected by *Hypsipyla grandella* (Zeller) (Lepidoptera: Pyralidae) that is one of the most important pests in tropical forestry. Arbuscular mycorrrhizal fungi (AMF) have been proposed as an alternative in ecological restauration and forestry systems due to they increase survival rates and confer plague and diseases resistances. Nevertheless, the physiology and community composition of AMF in mahogany trees is still poorly understood. **Methods:** The study was carry out in the conserved zone Laguna Om in South Quitana Roo, Mexico. In this work, we evaluated the level of colonization, richness and abundances of spores of AMF of three trees of mahogany (seed trees) in situ. Glomeromycota nuclear small subunit (SSU) rRNA gene fragments were amplified using universal primers and we established trap cultures with Zea mays and Sorghum sp. to confirm the species identity of AMF. Root samples showed AMF and dark septate fungi (DSF) colonization. The percentages of AMF colonization were vesicles 48%, hyphae 81%, arbuscules 12% and the presences of DSF was in 51% of the root samples. Were identified, within the roots of mahogany and soil samples, five species *Glomus* (4) and *Diversispora* (1). **Discussion:** *Swietenia macrophylla* showed high levels of colonization of both AMF and DSF. Due to the high demand of wood of mahogany and illegal overexploitation is essential to undertake complementary strategies to increase commercial plantations. The knowledge of distribution and AMF diversity in natural populations of mahogany would help to the selection of the potential species of AMF in sustainable agriculture and conservation.

Keywords: caoba, meliaceae, fungi, deforestation

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Extrafloral nectaries-bearing plants as a driving force behind spatial ant nesting patterns

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Background: Food supply is broadly recognized as being of influence on foraging behavior, abundance and distribution of ant colonies, therefore, the nesting site selection should adjust the position to optimize resource intake which determines colony's success. The production of food by plants in order to attract ants is well documented, especially in interactions mediated by extrafloral nectaries (EFNs), frequently in an opportunistic relationship. Nevertheless, many specialist nectar feeders have digestive systems designed to intensify the exploitation of such resources. Since our understanding about the effect of, and to what extent, the nectar has on ant colony establishment remains scarce, here we investigate the role of extrafloral nectar as a driver of the physical structure of ground-nesting ant communities, in Brazilian Caatinga, where a large proportion of plant species produce EFN. We hypothesize that the availability of EFN-bearing plants is an important driver of the distribution of nests of ant species heavily dependent on nectar. **Methods:** EFN-bearing plants were mapped according to the XY axis in 20 plots (20 x 20 m) at Catimbau National Park, Northeast Brazil. We also mapped ant nests in each plot by following returning foragers attracted to twenty tuna baits which were placed on the soil for 2 hours. We divided ants according to the intensity they use extrafloral nectar: 1) heavy users: ants that process large amount of extrafloral nectar; 2) occasional foragers: they may feed on extrafloral nectar less than heavy user ants; and 3) no nectar: ants that do not feed on plant exudates. **Results:** We recorded 28 EFN-producing plant species, and 257 ant nests. Heavy nectar user ant species nested closer to EFN-bearing plants than occasional foragers, which in turn nested closer to EFN-bearing plants than no nectar species. We also find significant differences in the distribution of the nearest distances between ant colonies and EFN-bearing plants between heavy nectar users and occasional foragers, as well as between heavy nectar users and no nectar users. All nests of heavy nectar users were located closer to 4 m from ENF-bearing plants, while occasional foragers and no nectar species nested up to 7 m from EFN-bearing plants. **Discussion:** Our study provides empirical evidence that the availability of EFNs-bearing plants can attract nests of some ant species to near to plants, having an important influence on ant species distributions.

Keywords: Central place-foragers, optimal foraging

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Natural regeneration of the Tropical Dry Forest in actively managed firebreaks.

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Background: Tropical Dry Forests (TDF) are among the most endangered ecosystems of the world and their remnants are in constant anthropogenic pressures; intentional fires are one of the biggest threats to the conservation of this ecosystem. Natural regeneration processes are limited by several factors, such as high temperatures, reduced humidity and fire. The Guanacaste Conservation Area in Costa Rica has taken important actions against fires, including actively managed firebreaks. These firebreaks are dominated by an invasive grass species (*Hyparrhenia rufa*) and some randomly dispersed, isolated trees; trees that could be an important nucleation site for seedling recruitment and survival. Our goal was to determine the effect firebreak trees have on the regeneration process of the tropical dry forest. **Methods:** We conducted our study in the TDF of Santa Rosa's National Park. We haphazardly selected pairs of *Crescentia alata*, *Guazuma ulmifolia* trees along a 2 Km firebreak and established we established a similar number of 4m^2 control plots occupied only by *Hyparrhenia rufa*. Diversity, seedling density, crown tree cover, canopy closure and dispersal syndrome of woody seedlings were recorded in every treatment. We also correlated the abundance and richness of individuals with canopy closure and crown tree cover. **Results:** We found a total abundance of 1822 plants and a total richness of 41 species in 837 m2 of sampled area. Abundance was higher in the open area as well as plant density. On the other hand, species richness and diversity were higher under *C. alata* and *G. ulmifolia* canopy. We identified 14 tree species, from which 11 are zoochoric, 2 are anemochoric and 1 is autochoric; most of the species were growing under *C. alata* canopy. In addition, *C. alata* canopy area and the abundance of individuals are correlated. **Discussion:** Remnant trees play an important in role on seed germination and seedling recruitment in spite of frequent disturbance at firebreaks. Furthermore, most tree species found in shaded areas under remnant trees are animal dispersed so we could infer that isolated trees are being used by birds or mammals for perches or shade. We propose that facilitation mechanisms enhanced by isolated trees could be considered as a tool for strategies to restore the tropical dry forests.

Keywords: firebreaks, nurse plants, facilitation

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Human disturbance and rainfall effects on the temporal stability of ant-EFN bearing plant networks

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Background: Both anthropogenic disturbance and climate change are major drivers of altering the stability of mutualistic networks driven by species extinctions and change in species abundance. Such stability is affected not only by changes in species composition in different sites but also by changes in species that interact with plants over the time. Here, we investigated how both chronic anthropogenic disturbance (CAD) and rainfall can influence the temporal stability of ant-EFN bearing plant networks in Caatinga dry forest. **Methods:** We sampled mutualistic ant-EFN bearing plant networks in sixteen 20 m x 20 m plots along CAD and rainfall gradients in 2014 and 2016 in Brazilian Caatinga dry forest. We then measured the temporal stability of ant- EFN bearing plant networks by computing temporal differences in four network metrics related to interactions specialization: (1) interaction evenness, (2) generality, (3) vulnerability and (4) H2'. **Results:** We found a total of 33 attendant-ant species and 23 EFN-bearing plant species interacting in both years of study, of which 45% and 43% of the total species pool of attendant - ant and EFN-bearing plant species, respectively, interacted in only one of the years of survey. From two out of four network metrics, the stability patterns of ant-EFN bearing plant networks were shaped by the environment. The stability of generality was affected by the synergistic effect of CAD and rainfall, in the way that in wetter sites the stability declined four times with increasing of CAD, while in drier sites the stability only reduced twice with increasing of CAD. In turn, vulnerability was affected by the additive effect of CAD and rainfall. The stability of vulnerability decreased between 50 and 100% in plots with more than 40% of CAD and declined between 10% to 100% in plots with rainfall less than 700 mm. **Discussion:** Our results suggest that both CAD and rainfall are important drivers shaping the stability of ant-EFN-plant networks, especially when considering their additive and synergistic effects. The reduction of ant-EFN bearing plant networks stability in human-modified habitats and under expected climate change can have important implications for protective-service outcomes and their evolutionary trajectories in Caatinga dry forest.

Keywords: disturbance, climate change, mutualistic interactions

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Environmental stress determines termites nest cohabitation in a tropical mountain

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Background: It is well known that termites are engineers of ecosystems and this title is also because their nests can house a diversity of invertebrate organisms. The mechanisms that explain dynamics of nest invasion are poorly understood. Currently, it is well documented that the nest size helps in termitarium cohabitation (species-area relationship). However, one study has created a stress-modulated symbiosis hypothesis, which the harsh environment makes easier the living-together of termitophiles and termite. Here, it was tested if the increase of stress (bottom-up mountain) and nest volume affects the richness and the abundance of cohabitants. **Methods:** The study was realized in one mountain, Serra do Cipó, localized in Espinhaço mountain range in state of Minas Gerais, Brazil. The study was conducted along an elevational gradient of tropical savanna and rupestrian grassland (800 m a.l.s. - 1400 m a.l.s.). Serra do Cipó is well known for its high plant and animal biodiversity and a large number of endemic species (OCBIL Theory). Were collected 20 termite nests of Nasutitermes cf. coxipoensis, a very common termite specie in the study area. They circumference and height were measured and all aerial parts were removed. They were placed in plastic bags and took for laboratory screening. In lab, the nests were brokens in small pierces and sifted through tree different mesh sieves. The material retained in the thicker mesh (0.3 mm) and the filtrate in the finer mesh (500 nm) was discarded and the remainder stored in 80% alcohol. **Results:** In 20 nests were found 483 organisms, morphotyped in 66 specimens containing larvaes, pupaes, nymphs and adults individuals. Both richness and abundance were as increased with the elevation. Otherwise, the nest size didn't affect the diversity. **Discussion:** Our assessment provides important hints to understand the symbiotic links and the invading dynamics involving termites and termitophiles. It is possible that the stress caused at higher elevations makes the nest an important shelter for invertebrates fauna diverse, where it finds a more stable environment in relation to factors external to the nest. The results of this study show the importance of termites as ecosystem engineers, once they increase the local biodiversity inside their nests and open new prospects for the understanding of the biotic interactions. Thus being one more evidence that stress can modulate symbiosis between termite and cohabitant.

Keywords: Amelliorated Habitat, Association, Nest Intruders, Termitophiles

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Food availability influences population dynamics of rodents in a netropical savanna grassland

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Background: One of the most important factors regulating the abundance of species is food availability. However, it is not known how different classes of food resources affect population parameters of different species. Rodents are a very abundant and diverse animal group in tropical ecosystems, playing important ecological roles as seed predators and dispersers, and prey resource in food webs. Moreover, they are bioindicators because they respond rapidly to environmental changes. The aim of this work was to evaluate if seasonal food availability is an important driver of population changes in abundance, survival and encounter probability of two rodent species from a grassland brazilian savanna. **Methods:** A monthly capture-recapture survey to estimate abundance and survival rate was conducted during the year 2012, using 50 sherman traps disposed for 5 consecutive days in grids of 1,82 ha in two grassland cerrado fields. Each month, food availability was estimated by measuring arthropod, grass seed and fruit mass in the study area. **Results:** Generalized linear models showed that seasonality had direct and indirect importance for both species dynamics. Abundance and survival of *Calomys tener* were positively influenced by fruit availability, and its capture probability did not change over the year. Abundance of *Necromys lasiurus* was positively influenced by seed availability, while its survival was constant over the year, suggesting that there might be other factors besides food availability driving population changes in this species. Its encounter probability was lower in the area with more food availability, suggesting that the bait may be less attractive to rodents in such case, therefore, influencing the encounter parameter of *N. lasiurus*. **Conclusion:** Although species differed on their responses to distinct classes of food, in general, this kind of resource was an important factor to explain the variation of population parameters of grassland savanna rodents.

Keywords: Cricetidae, cerrado, seasonality, abundance, survival.

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Poster Board: 65

Flying Dead

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Background: The European honey bee, *Apis mellifera*, is the most valuable pollinator of agricultural crops around the world. *A. mellifera* has shown adaptive potential to diverse climates. However, they have an array of predators, parasites, and pathogens in each new environment. Within these selective pressures, the parasites are very important because they can be acquired by some bees and then dispersed in the group. Here we report for the first time in Mexico the infection on *A. mellifera* by the phorid fly *Megaselia scalaris* and the behavioral manipulation on bees due to the fly infection on the hive. **Methods:** During our research work, we identified different pathogens associated with the colony collapse disorder. We monitored the beehives in different apicultural regions of Mexico with RFID micro-sensors to study the behavior and population dynamics of a healthy and infected hive. A phorid fly in particular call our attention because bees were presumably infected with it. In the laboratory, we used this flies to experimentally infect or not some honeybees in cages. Then we used molecular techniques to determine the phorid species. **Results:** The phorid fly (determined morphologically and molecularly) was *M. scalaris*, and as far as we know, this has not been reported officially in Mexico. Micro-sensors data showed that bees infected with the fly, compared to those not infected, had an altered behavior: their activity was greater at afternoon, and most of them did not came back to the hive. The experimental procedure revealed molecularly the presence of the fly inside the exposed bees but not in the control not exposed. **Discussion:** We propose that *M. scalaris* may have an opportunistic behavior: their larvae may be kleptoparasites on stored food, but when their densities increases, they may facultatively feed on the pupae and adults of honey bees. The genus *Megaselia* has been recently reported to be active at night, which could influence the activity pattern of infected honey bees. We suggested that M. *scalaris* may change the bees behavior, probably to reach larger distances of dispersion and thus maximize their fitness. This data give an insight into future pathogen-host interactions and imply future research toward the role of Phoridae species as a potential parasite of honey bees and conservation strategies to prevent the loss of pollinators due to emerging parasites.

Keywords: CCD, parasites, micro-sensors, behavior, Phoridae

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Poster Board: 66

Vegetative connectivity and ant communities: a review

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Background: Arboreal ants dominate forest canopies both numerically and in terms of arthropod biomass. The ability to take advantage of hemipteran honeydew and nectar allows the creation of large colonies and provides the energy for patrolling and defense of large, exclusive territories. The community assembly of arboreal ants is complex and studies aimed at determining the drivers of ant community assembly in forest and plantation ecosystems have yielded varying and sometimes apparently contradictory results. Studies of effects of vegetation structure and connectivity on arboreal ant populations could help demystify community assembly rules since they mediate both interspecific competition and access to resources. **Methods:** A series of keyword combinations was used to conduct searches for relevant papers in the "Web of Science" and "Google Scholar" scholarly search engines. Abstracts were read of peer-reviewed literature that was deemed of possible relevance based on literature titles. The implications of various vegetative structural features on arboreal ant communities from 20 papers published since 2007 are reviewed and findings compared. **Results:** The reviewed papers observed or used their findings to propose relationships between vegetative structure and connectivity and ant foraging behavior, territorial defense, species distribution, interspecific and inter-colony competition, and community assembly. Other structural features of trees and canopies, as well as habitat phytophysiognomy, were related to species richness in most studies. While populations in most studies were reported to conform to expectations of the "ant mosaic hypothesis," some did not. **Discussion:** Structural diversity at the tree and canopy level appear to increase species richness regardless of the ecosystem or canopy type, most likely because the number of potential nesting resources increases with the architectural and age diversity of available trees. Canopy homogeneity and uniformity in tree age and structure seem to limit species richness, but not inhibit mosaic formation. While papers alternately proposed that canopy connectivity encouraged and discouraged the formation of exclusive territories by dominant ants, it seems likely that both the type of canopy and the part of the canopy that is considered play a role in which effect is observed.

Keywords: Connectivity, arboreal ants, phytophysiognomy

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Poster Board: 67

Diurnal variation in dung beetle community dynamics: is competition a driving force?

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Background: Competition acts as a powerful selective force in shaping and maintaining the community dynamics of species. Species sharing same resources find it difficult to coexist in the same ecological niche. Interspecific competition often leads to competitive displacement of one species. **Methods:** We tested this hypothesis by studying the diurnal variation in community structure and composition of dung beetles of tropical rainforest fragments and adjoining home gardens in two seasons in a rural environment. These two habitats are different in terms of their physical and vegetation structure and composition and use. While the sacred forests are closed relic primary rainforests with limited anthropogenic and grazing pressure, the home gardens are open orchards and often used to maintain livestock. We sampled dung beetles using dung baits in day and night in dry and wet seasons from 12 paired sites. We used relative abundance, species richness, biomass, and community structure and composition of dung beetles in two diurnal periods to study community dynamics of two habitats. **Results:** Dung beetle abundance, species richness, and biomass were significantly higher in home gardens than sacred forests. In both habitats night sampling in wet period yielded more species, abundance, and community-level mean weight (CWM) of dung beetles. The generalized linear mixed models predicted that a) the habitat type has a strong effect on dung beetle richness and abundance, and a weak effect on CWM of dung beetles, b) habitat type, season, and diel period have an interactive effect on abundance, and c) habitat and season have an interactive effect on CWM of dung beetles. The nocturnally-active dung beetles of two habitats were more similar than the diurnally active dung beetles. The striking turn over of species was observed in home garden between day and night (dissimilarity=93%), which has a striking difference in temperature between day and night. In sacred groves, relatively less turn over of species was observed between the diel periods (40%), perhaps due to stable temperature maintains inside the forest between the two diel periods. Interestingly, 43% of species caught in home garden during night were similar to that was collected from sacred forest in day. **Conclusion:** The results suggest that the competitive partitioning of dung beetle communities might be explained by the thermal tolerance of the species.

Keywords: dung beetle, competition, India

ID:170
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Poster Board: 68

Posters
Ecology, genetics, and evolution of tropical systems

Food availability and sex as determinants of patterns in the fission-fusion dynamics of *A. geoffroyi*

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Some social species present fission-fusion dynamics (FFD) that seems to improve foraging efficiency. FFD is defined as the extent of variation in spatial cohesion, party size, and individual membership in a group over time. In this study we aimed to shed light on the way FFD allows to cope with changes in food availability, taking into account the sex of individuals. We studied a group of spider monkeys ranging from 27 (2009) to 48 individuals (2014). The study was done during three 12-month periods, on a fortnightly basis. Every 20 min, we identified the members of the subgroup and estimated the inter-individual distances between all members. We evaluated food availability fortnightly by sampling trees of the 10 most important food species for spider monkeys. We used a social network approach, based on association and proximity patterns. Association indices were: SRI_SG (Simple Ratio Index, SRI, considering all the individuals in the observed subgroup); Network density; Modularity by sex; and Strength of association of females to females (SAF) and of males to males (SAM). We measured proximity indices for individuals in close proximity (SRI_0, individuals at 0-2m), located 3-7 m from each other (SRI_5); and using the coefficient of variation of the inter-individual distances (CV_IID). Food availability was represented by the variance of the number of fruiting trees, and the Index of Fruit Availability of *Ficus* spp. (IFA_F) and *Brosimum alicastrum* (IFA_B). We used linear mixed models to test the relationships between the association or proximity indices and food availability. Association patterns changed with food availability and sex. During the rainy season, association among individuals decreased with increasing IFA_B, while network density increased with IFA_F. Modularity by sex increased with IFA_F and with the variance of fruiting trees in rainy seasons, whereas the reverse was true in dry seasons. SAF increased with the variance of fruiting trees during dry season, but decreased with increasing IFA_F for low variance of fruiting trees. We conclude that association patterns respond to changes in food availability, but vary with the sex of the individuals as a response to biological and behavioral differences between sexes. On the contrary, proximity patterns were minimally affected by changes in fruit availability, suggesting that social factors are more important than food availability in determining intra-subgroup spatial cohesion.

Keywords: Food availability, sex, fission-fusion

ID:511
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Poster Board: 1

Marmosops incanus' abundance is related to environmental suitability and richness of small mammals

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High environmental suitability may increase species abundance via increased reproductive success and survival rates and decreased extinction rate. Climate is an important driver of species occurrence and may affect local abundance. However, local factors such as primary productivity and biotic interactions may regulate its local abundance. We studied the relation between local abundance and suitability, throughout the geographic range, of the Gray slender opossum (*Marmosops incanus*) that is a marsupial common in the Brazilian Atlantic Forest. We hypothesized that suitability predicts the maximum local abundance when it considers only climatic factors, but it predicts abundance linearly when taking into account productivity and potential competitor richness. **Method:** We compiled 59 presence records and 29 sites with species' relative abundance and richness of non-volant small mammals' from scientific collections and published studies. Environmental suitability was estimated by Ecological Niche Models (ENMs) using two sets of predictors: 9 climatic variables (ENMCLIM), and climatic plus 3 productivity variables (ENMENV), derived from Normalized Difference Vegetation Index. ENMs were calibrated using MaxEnt and evaluated by the Area Under the ROC Curve (AUC). We used linear and quantile regressions (with 0.75, 0.90 and 0.95 percentiles) to predict local abundance according to (1) each ENM, (2) each ENM including richness as a covariate, and (3) only richness as the predictor. We ranked the best models based on corrected Akaike information criterion, including a null model. **Results:** ENMs were highly significant (AUC > 0.88). We did not find any significant linear model and they are not better than the null model. For quantile regressions, our models were also not better than the null model at 0.75 percentile. At 0.90 and 0.95 percentiles, both models including richness as a covariate were the best models (ΔAICc < 0.94, w > 0.36). **Discussion and Conclusion:** Our results show that abundance of *M. incanus* is not linearly related to suitability, even when considering productivity and potential competitor richness. The maximum abundance of this species can be described by local suitability and community richness, but others factors are still lacking to precisely predict its abundance. We suggest that habitat disturbances from anthropogenic activities in the Brazilian Atlantic Forest may be a potential factor affecting relative abundance of *M. incanus*.

Keywords: Altantic-forest, ecological niche model, Gray-slender-opossum

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Poster Board: 2

Environmental and historical factors as drivers for population divergence in oaks

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Background: The morphological variation of the species is result of phenotypic and physiological responses to environmental gradients, which are consequence of the common historical processes in the assemblage of communities. This study evaluates morphological intra-specific variation in different oaks, which were selected because of their wide geographic or altitudinal distribution and because they inhabit different types of environments. We tested if there are similar trends in the foliar variation among populations with similar environments or with common historical processes. In addition, we emphasize the potential use of morphometric (traditional and geometric) and geostatistical tools for intra-specific variation analysis in oaks. **Methods:** Approximately, 200 populations of five species of oak were sampled in Mexico. Ten individuals were collected and digitized from 10 individuals per population. A series of morphological attributes (length, width, specific leaf area, thickness, stomatal surface, stomatal opening, among others) were measured to perform traditional morphometry analysis. Simultaneously, along the contours of the leaves, a series of landmarks were drawn for analysis of geometric morphometry. To analyze whether if morphological divergence among populations is due to environmental or historical differences, analyzes of variance were performed among populations cluster by their environmental similarity and among populations belonging to different biogeographic provinces. A discriminant analysis was performed to determine the foliar attributes that allow explaining the morphological divergence between populations. These attributes were interpolated using geostatistical techniques. **Results:** The variance within populations is high, does not exist an evident morphological divergence among population from different environments. In this sense, it seems that the environment does not determine strong changes in leaf morphology, vary with respect to geographic and precipitation gradients. However, in each population always dominates one shape over others. The morphological divergences, with statistical support, was identified among populations belonging to distinct biogeographical regions. Microscopic features have provided greater evidence for support the biogeographic divergence among populations, which could even be considered as different taxonomic entities.

Keywords: population divergence, morphometry, geostatistic, biogeography

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Tuesday, July 11th, 2017
Poster Board: 3

Spectral Reflectance of Pioneer Species of the Tropical Dry Forest

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The studies of disturbed tropical forests have become highly important to understand the regeneration processes operating in them. These studies require techniques allowing acquiring the knowledge about such processes in a rapid and simple way. One of these techniques involves the characterization of the leaf spectral reflectance that allows us to infer plant morphological, biochemical and functional traits. In this study we characterized the leaf spectral reflectance of tree species associated to early successional stages ("pioneers") of the tropical dry forest (TDF), one of the most endangered and less studied tropical systems in the world. In the TDF of Chamela (Mexico), we studied 21 tree abundant species associated to seven sites of early succession. These species were characterized by assessing their functional traits and spectral signatures (400 to 2500 nm). We then identified the regions of the spectrum with the lowest intraspecific variability in spectral signatures and the regions with the highest interspecific variability, which are potentially useful to discriminate among species. The spectral data showed close correlations with the specific leaf area (SLA), leaf water content and chlorophyll content in almost all the evaluated sections of the spectrum. The SLA was positively related to the near infrared reflectance, probably because in compact leaves the incoming photons have less opportunities of dispersion. The SLA was also positively related to reflectance between 900 and 1200 nm, which can be explained by the lower water content of thinner leaves. The lowest intraspecific variability in spectral signatures was found in the near infrared and short wave infrared, while the highest interspecific variability occurred only in the near infrared. The SLA and spectral signature of a group of pioneer legumes was clearly different to the rest of the evaluated species and families. The spectral signature of legumes such as *Mimosa arenosa* could be used as an indicator of early successional stages in hiperspectral images because of its distinctive behavior, its low intraspecific variability in determined regions of the spectrum and the high abundance of this species in these sites. The spectral signatures were useful to group or discriminate plants based not only in their functional traits but also in their phylogenetic relations, emphasizing the possibility of identifying functional and phylogenetic plant groups with spectral data.

Keywords: Plant Spectral Reflectance, Dry forest

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Poster Board: 4

Puma concolor roadkill in Southeastern Brazil: the sex bias impact on population genetic diversity

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Background: Fauna roadkill has been increasingly recognized as an important source of fauna mortality. For instance, in Brazil, about 475 million individuals are death per year. Species with large home range requirements and long distances dispersal behavior are more susceptible to this treat. The first impact of roadkill is the population decline and, in the long term, reduction in gene flow and genetic diversity can also be observed as negative impact on population. We evaluated sex bias on road-killed cougars (*Puma concolor*), a top predator distributed throughout American continent. We also verified if there was differential genetic contribution from each sex to the local population genetic diversity. **Method:** We collected tissue samples of 41 road-killed animals, in the northeastern São Paulo State, Brazil. We confirmed the sex by molecular analysis to calculate the sex proportion of road-killed cougars. Then, we amplified nine microsatellite loci to estimate the allelic richness (by rarefaction method for different sample sizes), allelic frequencies and endogamy for each sex to infer about its genetic contribution. **Result:** From all the evaluated cougars, 27 were males (65.9%; χ^2=12.8, p=0.03). The allelic richness (AR) was higher in male individuals than in females (AR=6.5 for males; AR=5.2 for females). The females presented more alleles at high frequency and a higher endogamy coefficient (Fis=0.041 for males, p=0.10; Fis=0.119 for females, p<0.01) than males. **Discussion:** Our findings demonstrated a sex bias for male deaths on cougar roadkill. This bias is probably due to the higher dispersal behavior of males to establish territories, while females are philopatric. The current scenario of intense forest loss and fragmentation increases the need in dispersal to stabilize a suitable area and it rises the number of road-killed animals. The genetic results reinforce the female philopatry, since the females exhibited more endogamy than males. The high AR value and the more balanced alleles frequencies in males highlight their importance to maintain the allelic frequencies variation, to introduce new alleles in the population and to prevent increase of endogamy in the local population. In this sense, we suggest that the high proportion of male road-killed will negatively impact the genetic diversity in the long term. Preventing roadkill is essential to maintain gene flow, genetic diversity and population persistence. **Support:** FAPESP, CNPq, IDEA WILD, NGC.

Keywords: apex predator, gene flow, conservation.

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Poster Board: 5

Influence of landscape structure on the density of titi monkeys in a fragmented Neotropical forest

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Background: Tropical landscapes are increasingly altered by extensive land-use worldwide. Such emerging landscapes have different structure, depending on the type and amount of different land covers (landscape composition) and on their spatial arrangement (landscape configuration). Understanding the relative impact of these two components of landscape structure on remaining species is essential to improve management and conservation scenarios. We evaluated the influence of landscape configuration (i.e. density of forest patches and forest edge density) and composition (i.e. forest cover) on the density of black-fronted titi monkeys (*Callicebus nigrifrons*) in a fragmented region from northeast of São Paulo State, Brazil. **Method:** We estimated the density of titi monkeys in 14 forest patches (0.25-3.41 km2), and measured all spatial metrics within ten buffers surrounding each patch to identify the landscape size that best predict the density of titi monkeys. We then used generalized linear models to investigate the effect of landscape structure on titi monkeys density, considering the scale of strongest effect of each landscape attribute. **Result:** Titi monkeys density ranged from 0 to 12 groups/km^2, and was principally and negatively associated with forest cover, the composition landscape attribute. The density of titi monkeys also increased with the increase of fragmentation (density of forest patches) in the landscape. **Discussion:** Our findings support the hypothesis that landscape composition has stronger effects on biodiversity than landscape configuration. Also, in agreement with recent evidence about the positive effects of fragmentation on biodiversity, our findings indicate that the higher the density of forest patches in the landscape, the higher the density of primates. The effect of habitat loss on titi monkeys density was reinforced by the degree of fragmentation, which resulted on a crowding effect on the populations due to reduced patch size and forest amount. These findings suggest that primates in fragmented forests may show a metapopulation dynamic that can be favored by the increment of forest patches (and potential subpopulations) in the landscape. Preventing further deforestation and the disappearance of forest patches is of paramount importance to increase the availability of resources, reduce inter- and intra-specific competition and maintain healthy primate populations. Support: FAPESP, Idea Wild.

Keywords: forest fragmentation, habitat loss, population

ID:148
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Poster Board: 6

Genetic diversity and population structure of Formosan Reeves' muntjac in Taiwan

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Background: Formosan Reeves' muntjac (*Muntiacus reevesi micrurus*) is the smallest deer species on the subtropical island of Taiwan. It is widely distributed in forests from coast to mountain areas at elevations greater than 3,000 meters above sea level. However, rapid urbanization and development resulted in some populations isolated in small and fragmented areas. The purposes of this study is to understand the genetic diversity and population structure of *M. r. micrurus* in Taiwan by analyzing the mitochondrial cytochrome b and D-loop sequences. **Methods:** We extracted *M. r. micrurus* DNA from 151 fecal samples collected from eight forested areas across the species range in Taiwan, of which six were located along the North-South-orientated central mountain range and two were from small and isolated areas. Result: Combining the two gene sequences with 1140 bp in cytochrome b, and 918 bp in D-loop, we identified 31 haplotypes, of which 29 were unique to single area. Overall, the haplotype diversity was extremely high (h = 0.92) while the nucleotide diversity was low (Ï€ = 0.23%). Tree analysis indicated that *M. r. micrurus* formed a monophyletic lineage with respect to its sister taxon, *M. r. reevesi*, from southern China. Pairwise exact tests suggested the presence of a significant population differentiation, which followed a pattern of isolation by distance. Also, AMOVA showed that significant genetic variance occurred in all hierarchical levels examined while areas were grouped according to their proximity and connectivity. The haplotype network showed that all haplotypes were connected with each other by up to seven mutational steps. In general, most haplotypes sampled from the same or adjacent areas tended to be more similar. Haplotypes in the interior position were sampled from central and northern Taiwan while haplotypes from the two isolated areas were almost all exterior. **Discussion:** Our results suggest *M. r. micrurus* in Taiwan comprises a single evolutionary lineage. The high level of genetic diversity and population differentiation indicate a restricted gene flow among populations. Maintaining the connectivity between adjacent habitats is important for its future conservation.

Keywords: muntjac, fecal DNA, control region, gene flow, Taiwan

ID:554
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Poster Board: 7

Genetic and morphological differentiation in *Rhizophora mangle* L.

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Background: Mexico is the fourth country in the world with the largest mangrove extension and 55% of which is located in the Yucatan peninsula. At a local level, hydrology, topography and nutrient availability result in structurally different ecotypes. In the Yucatan Peninsula, the scrub mangrove, characterized mainly by trees of low height, is the most extensive ecotype. Its size is generally attributed to frequent flood, hypersalinity and deficiencies of nutrients such as phosphorous. However, it has also been suggested to be a result of genetic differentiation. Until now, no studies on the genetic structure of *Rhizophora mangle* ecotypes have been done. The objective of this work was to evaluate the genetic and morphological variation of tall and scrub populations of R. mangle in the Yucatan Peninsula, and its relation with salinity and availability of phosphorus. **Methods:** The genetic structure of 13 tall and scrub populations of *Rhizophora mangle* was analyzed with 9 microsatellites through a Bayesian and principal coordinate analyses. Also, we analyzed the variation of five morphological characters and their relationship with salinity and availability of phosphorus. To find relationship between genetic, morphological and environmental variation, multivariate analyses were performed. **Results:** The Yucatan Peninsula presents a moderate genetic differentiation in *R. mangle* populations, which is divided in two groups that correspond to the oceanographic regions comprising the Yucatan peninsula; the Gulf of Mexico and the Caribbean Sea. The Mantel test revealed a weak relationship between genetic differentiation and geographic distance. In the Caribbean there was also a substructure of the populations corresponding to genetic differentiation between tall and scrub mangrove ecotypes. The trees' height presented a negative relationship with salinity and a positive relationship with the availability of phosphorus. However, these relationships are not observed in all populations, especially in those with genetic differentiation in the Caribbean Sea. **Conclusion:** This work presents the first results of the genetic structure of *R. mangle* in Yucatan Peninsula. We also present the first evidence of genetic differentiation between tall and scrub ecotypes, which opens the way for exhaustive future research.

Keywords: mangrove, ecotype, scrub, microstalites

ID:602
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Poster Board: 8

Divergence times and evolutionary patterns of extant biodiversity in the Brazilian Cerrado

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Background: Biodiversity levels in the Cerrado (Brazilian savanna) are higher than in any other tropical savanna, but most research on temporal biogeographic patterns in the region have only been published in the last decade. Divergence times estimated using molecular clocks are crucial to understand the evolutionary processes that generate biodiversity. This temporal perspective allows correlating historical and geomorphological events with patterns of lineage diversification, and building a biogeographic scenario for the local biota evolution. Neotropical temporal diversification patterns are mainly based on rainforest studies, biasing our understanding of regional evolutionary patterns. To fill this knowledge gap, we compiled all published information on divergence times in the Cerrado, and analysed them in light of described Cerrado Quaternary and Neogene events. **Methods:** Following the methodology of Rull (2008, Mol Ecol 17, 2722-29), we exhaustively searched for papers that estimated divergence times of monophyletic lineages inhabiting the Cerrado. We compiled divergence times, number and type of loci, checked whether species were Cerrado endemics, and if the existence of cryptic species was reported. We correlated divergence times with published data on Quaternary climate change and Neogene neotectonics. **Results:** Data was available for Amphibia, Angiospermae, Aves, Insecta, Mammalia and Reptilia. Most Aves, Angiospermae and Mammalia lineages diversified in the Quaternary, and other groups mainly diversified in the Neogene. Reptiles showed the oldest divergence times, with most lineages arising in the Miocene. The youngest Angiospermae, Insecta and Mammalia lineages arose in the Pleistocene, around 0.1 million years ago. Apart from Aves and Insecta, most papers used multilocus data. Cerrado endemics of Angiospermae and Mammalia showed a higher percentage of Quaternary lineages, while Amphibia and Reptilia kept their overall diversification pattern. Most cryptic species were reported for Reptilia followed by Mammalia, Amphibia, Aves and Insecta. **Conclusion:**Our results contrast with the current patterns reported for Neotropical biota diversification timing based on rainforest studies, especially for reptiles and mammals, which showed opposite diversification patterns. Origin of biodiversity in the Cerrado appears to be mainly linked to the uplift of the central Brazilian plateau in the Neogene, and to climatic fluctuations in the Quaternary.

Keywords: Molecular clock, Neogene, Neotropics, Quaternary.

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Poster Board: 9

Genetic and phenotypic variation associated to climate in *Quercus deserticola* on Mexican Highland

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Background: Mexico is considered a center of species diversification for the oaks (*Quercus* species), with an important number of species occurring within the Tran Mexican Volvanic Belt (TMVB) in association with different habitats. However, the impact of the interaction between historical and current climatic variation and geological complexity on the genetic and phenotypic diversification within Mexican oak species has been scarcely investigated. **Methods:** Here, we used chloroplast DNA microsatellite markers and a geometric morphometrics analysis of leaf shape variation to understand the patterns of differentiation and gene flow between populations of the Mexican endemic white oak *Quercus deserticola*, which inhabits dry and xerophilous highlands mostly along the TMVB. Furthermore ecological niche modeling at past, present and future scenarios were performed to evaluate the influence of environmental variables and geological events on the evolutionary history of its populations. **Results:** Results showed high genetic structure (RST =0.75) among populations and morphological variation showed two morphological clusters of populations associated to the west and east of the TMVB. Mantel tests showed a strong association between environmental variables and the morphological variation of leaves. Ecological niche modeling indicated climatic conditions to have changed little from the Last Interglacial (140-120 ka) to the present, however future climatic scenarios (over 2050 to 2080 date) showed a reduction in the current conditions. **Discussion:** Gene flow seems to be low among populations; subsequently the climatic oscillations and geological activity during the Pleistocene could have impacted in different ways. Then, it might be that alternating periods of connection and disconnection between different habitats along the TMVB: first, allowed the gene flow between populations followed by long isolation periods where gene flow was interrupted; later, populations were highly structured as consequence of TMVB geological movements or to low seed dispersion capacity. **Conclusion:** Our results are congruent with an isolation with-migration pattern. The variation in leaf shape appears to be a local adaptation to different microclimates. Climatic conditions to *Q. deserticola* varied little from past to the present; future climate changes will impact its distribution, reducing its habitat unless protective measures are taken.

Keywords: Climate change, phenotypic traits, *Quercus*

ID:204
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Poster Board: 10

Population history of *Lagonosticta sanguinodorsalis*, inferred from mtDNA sequence data

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Background: The Rock Firefinch (*Lagonosticta sanguinodorsalis*) is a range restricted species, described as recently as 1998 by Robert Payne. I was thought to be endemic to the Jos Plateau, Central Nigeria, with isolated populations on the in Northern Nigeria and North-east Nigeria. More recently, a population has also been discovered in northern Cameroon. Being a recently described species, the reason for the scattered distribution of this species is unknown. The evolutionary history, population size changes and geographic origin of individuals and populations can be reflected in DNA sequence variation, and therefore molecular analyses can give understanding of present-day distribution, especially in species where little studies have been carried out. This study seeks to understand the distribution history of the Rock Firefinch. **Methods:** I sequenced the region I of the control region of the mitochondrial DNA of 64 Rock Firefinches from 10 locations. **Results:** I found 11 haplotypes. Both haplotype (Hd) and the nucleotide (π) diversities were highest in the centre of the distribution in Nigeria (Kagoro population) and lowest in the most isolated population in Cameroon. Pairwise population differentiation (FST) was positively correlated with the geographical distance between populations, indicating isolation-by-distance. Isolation-with-migration models indicated that the size of the population in Central Nigeria was approximately an order of magnitude larger than the population in Cameroon. The analyses further suggested a recent split between the large Central Nigerian and the Cameroonian populations. **Discussion:** My results suggest that there have been high level of gene flow between Nigeria and Cameroon in historical times, however, this is no longer the case. Distance tends to be the barrier between these populations. These two populations might have survived the unfavourable conditions of the arid periods in different refugia and are yet to expand to recolonise their previous range. The Rock Firefinch population was probably a large widespread population in the past, however, with climatic oscillations, it was been faced with harsh weather conditions that caused it to retreat to refugia and in the present day, it can said to be recovering from the decline experienced during the harsh period and recolonising suitable habitats one at a time, hence the reason for its present distribution.

Keywords: Rock firefinch, demographic expansion, mtDNA

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Poster Board: 11

Selective capture of prey to the offspring of the piscivorous guild of birds in the coast of Yucatan

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Background: Coastal wetlands are recognized for their productivity and biological diversity. Among the vertebrates, one outstanding component is represented by the birds, which use these environments as a source of food, rest, and nesting. Variables related to the hydrology and food availability are associated with the reproductive success of piscivorous birds; during nesting, they require a high and continuous availability of fish to ensure the survival of their young. Fish, therefore, play an important role in the structure of these biological communities since they limit the population dynamics of their predators. **Methods:** Stomach contents (n = 38) obtained from chicks of seven birds species (*Egretta rufescens, E. thula, E. tricolor*, *Phalacrocorax brasilianus*, *Cochlearius cochlearius*, *Ardea alba*, *Platalea ajaja*) was obtained from February to June 2016. All prey types (n = 689) were identified to the lowest taxonomic level and calorimetric analyses of each type were performed to determine the yield of gross energy. To assess the relationship between prey and bird size, morphometric data of chicks (n = 176) were obtained. **Results:** Overall, the guild feeds on 6 families and 12 species of fish; the main prey types belongs to Poeciliidae (*Belonesox belizanus*, *Gambusia yucatana*, *Poecilia velifera*) and Cyprinodontidae (*Cyprinodon artifrons*, *Floridicthys polyommus*, *Jordanella pulchra*), followed by Fundulidae (*Fundulus grandissimus*, *F. persimilis*), Cichlidae (*Cichlasoma urophthalmum*), Atherinopsidae (*Menidia* colei) and Gerreidae (*Eucinostomus* spp). The most consumed species were *C. artifrons*, *P. velifera* and G. *yucatana*. The size range of the consumed species was 10 a 99 mm. The species with the highest caloric value was *P. velifera*, particularly the females. **Conclusion:** There is quantitative indication that the capture of fish then offered by the parents to their chicks is selective with respect to the species and, in some cases, the sex of the individuals consumed. This selective feeding allows to maximize the amount of energy ingested which is necessary to satisfy the nutritional requirements of fast-developing chicks. Dynamics of fish populations is a key factor to guarantee the success of the offspring especially when considering that some preferred prey types are endemic species with narrow distributional ranges within the coastal wetlands of Yucatan.

Keywords: aquatic birds, prey, fish, wetlands

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Poster Board: 12

Fruiting phenology in a tropical dry forest: effects of abiotic factors and functional traits

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Background: Environmental variation has a relevant role in the temporal patterns of fruiting in tropical dry forests. However, the influence of abiotic factors could relate with different reproductive and life history attributes, but very little is known about the factors related to the date of fruit ripening of plants, especially for non-arboreal species. We report, for the first time, the influence of both plant functional attributes and abiotic climatic factors, taking into account the species phylogeny, on the date of fruit ripening of the plant species in a Neotropical dry forest community. **Methods:** We recorded during 24 months the fruiting phenology (date of ripening fruit) for 55 tree species, 49 herbs, 24 shrubs, 15 lianas and 8 vines in a Mexican dry forest. We evaluate the relationships between the mean angle of fruit ripening, abiotic factors (precipitation, temperature, day-length) and functional attributes (growth form, dispersal syndrome, size and time for fruit development) using phylogenetic least squares models (PGLS). **Results:** More species had ripe fruits during the dry season (92 %) than during rainy months. Abiotic factors (day length and precipitation) more than variables related to fruit developmental morphology (size and time required for ripening) have a strong effect on the time of fruit ripening. However, the influence of all four variables depended on plant growth form and seed dispersal syndrome. In most relationships, the phylogenetic signal was weak, except for the relationships of fruit size with a time of fruit ripening and dispersal syndromes. **Conclusion:** The results support that temporal patterns of fruiting are explained mainly by abiotic factors. However, we found diverse phenological responses of fruiting reflecting different reproductive strategies associated with the growth forms and seed dispersal syndromes.

Keywords: Dispersal syndrome, Fruit size, Growth forms, Phylogeny

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Poster Board: 13

White-lipped peccary home-range size in hunted and non-hunted areas in the Maya Forest

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The white-lipped peccary WLP is a social ungulate that forms large and cohesive groups which range widely in Neotropical forests from Argentina to Mexico. Populations of this species have declined throughout Mesoamerica during the last 50 years at alarming rates. Because they occur in groups as large as 50 individuals, they need large areas to persist. We investigated home-range size and population density using GPS-Satellite radio-collars data from 3 groups in the Maya Forest of México and Guatemala. Peccaries often search for ponds within the Maya Biosphere Reserve (MBR) in Guatemala, the Calakmul Biosphere Reserve (CBR) and ejido Nuevo Becal (NB) in México. The MBR and CBR are protected areas, and NB is an area with a human presence where hunting of ungulates is common. We captured and radio-collared individuals from 3 groups of WLP's during the dry season of 2015. In total, 6 WLP's were captured by chemical immobilization with ketamine and xylazine hydrochloride delivered by dart rifle from a concealed position adjacent to the pond. Home-range sizes were estimated for each group by the fixed-kernel (FK) and Minimum Convex Polygon (MCP) methods. Using the FK, for the MBR we estimated a home-range area of 99 km2 to 95% and 17 km^2 to 50%. For the CBR, we estimated a home-range area of 88 km^2 to 95% and 19 km^2 to 50%. In NB, we estimated a home-range area of 140 km2 to 95% and 38 km2 to 50%. Group's home-range size using the MCP was 138 km^2, 62 km^2 and 154 km^2 for MBR, CBR and NB respectively. Home-range size in the MBR during the rainy season are larger compared to the dry season. This same pattern has been reported in CBR, which are two protected areas. In contrast, in NB, where hunting of ungulates is common in the dry season, the white-lipped peccary group modified their movement patterns during this time, with larger home-ranges in the dry season. This change in the movement pattern of the group of peccaries in NB indicates that the hunting that takes place in this site has an influence on the behavior of this species. White-lipped peccaries in the Maya Forest area live in small groups and range over larger areas than in other, more humid forests within the range of the species. Our data suggests that conservation actions for the species will need to include protection against hunting, restrictions on road development, and need to focus on landscape conservation of large, continuous and ecologically intact areas containing a mosaic of habitat types.

Keywords: Guatemala, kernel, Mexico, *Tayassu pecari*

ID:396
Tuesday, July 11th, 2017
Poster Board: 14

Stingless bee (*Teragonisca angustula*) foraging activity and success in dynamic resource environments

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Background: The tropics are exemplified by highly dynamic resource environments that are driven by intrinsic and human-mediated forces. The availability of floral resources is intrinsically determined by climatic differences between two seasons. Additionally, human mediated land use change, like agricultural intensification, can result in short-term mass flowering pulses and disturbances, and thus contribute to resource environment dynamics. Stingless bees are among the most prominent, native, pollinators in tropical systems. Still, many stingless bee species are threatened due to habitat modification. We sought to understand how resource environment dynamics and nesting substrate (ie. placement of nest in dead wood, trees, cement, etc) affects stingless bee foraging activity. **Methods:** We conducted this study in a coffee agricultural landscape in the Soconusco region of Chiapas. We located nine feral nests of *Tetragonisca angustula*, an abundant stingless bee species in the coffee system, across two different farms with varying resource environments. We then examined foraging activity, during both the dry and rainy season, by quantifying foraging traffic at the nest entrance (#foragers/min) and foraging success (i.e., relative proportion of pollen/nectar/resin brought back) at hives along a gradient of resource availability (abundance of shade trees). **Result:** We found that total per-nest foraging activity was marginally correlated with the abundance of trees within a 20m^2 area around the hive (R^2=0.72; =0.06). We also found that nest substrate correlated with foraging activity and which resources were being brought back to the hive. **Discussion:** These results suggest that the environmental resource context influences foraging activity of stingless bees in coffee agroecosystems. Pollen and nectar are important nutritive resources whereas resin is important for nest building. Differential resource use between resource contexts could suggest that both resource availability and resource requirements vary between resource environments.

Keywords: stingless bees, foraging, resource environment

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Genetic variation in maned wolf in protected and unprotected fragments in Tropical Savanna

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Background: The Brazilian tropical savanna (Cerrado) is the second largest biome in South America, one with the most biodiversity in the world and one of the most threatened. A typical mammal of this savanna is the Maned wolf (*Chrysocyon brachyurus*). It is a very important species in this biome, because it controls its preys' population size and helps in the dispersion of seeds. In this context, our work aimed: a) to evaluate the presence of the Maned wolf in two tropical savanna fragments; one in a protected area and the other one in an unprotected area; b) to calculate genetic diversity and relatedness among the individuals in both areas. **Methods:** During the period of one year, it was collected 74 Maned wolf scat samples in the both cerrado fragments. Thirty-four scats were sampled in the unprotected fragment (1400 ha) and 40 were sampled in the protected area (2300 ha). Both fragments are apart by 60km and are surrounded by a highly anthropized landscape. Scat DNA was extracted using QIAamp DNA Stool Mini Kit (Qiagen) and three mitochondrial genes were used for species identification. Afterward, nine microsatellite loci were amplified for individual identification, assessing genetic variation and relatedness. The samples were individualized using Identity probability (PID) for each locus. AMOVA was used to assess genetic variation partition and relatedness value among individuals was computed. **Results:** We identified 17 individuals in the unprotected fragment, and two of them were recaptured, while 24 individuals were identified in the protected area, and six of them have recaptures. The AMOVA analysis showed that almost all the variation is present among individuals (99%) and 1% within the individuals. Kinship values higher than 0.5 (parent-offspring or full sibling) were only observed in 18% of the individuals analyzed in the unprotected area, and 14% in the protected one. **Discussion:** The analysis showed that both areas represent a single population, agreeing with what was expected, since the areas are separated by a distance of 60 km, which is easily covered by the species. Likewise, kinship values confirmed that most the individuals are not residents, since most of them were unrelated. The data from this study are evidence that the remnants, protected and unprotected, become important areas for biodiversity conservation, especially in heavily intervening and highly anthropized areas. Support: CNPq, IDEA WILD.

Keywords: AMOVA, remants, anthopized areas, cerrado

ID:263
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Poster Board: 16

Accounting for geographical patterns of Mexican coniferous diversity

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In this study we used a trait-based approach to assess trade-offs among adaptations to environmental variables. We expected that climatic factors would limit the distributions of conifer species, while functional traits would reveal adaptations to particular environments. We constructed a community trait matrix using georeferenced occurrence data from a national forest survey combined with herbarium records. This was merged with morphological trait data extracted from literature descriptions and online databases. Traits were chosen as being related to tolerance of stressful conditions such as extreme temperatures and low precipitation. Environmental data were extracted from the WorldClim database. A phylogeny was constructed using three markers, matK, rbcL, and 18S from GenBank, using maximum likelihood analysis to estimate the optimal topology and penalized likelihood to estimate divergence times. The environmental relationships with the geographical distribution of each community trait were assessed with random forest models. PNC was tested in each trait using phylogenetic generalized least squares. Pearson correlations were performed to assess correlations between the geographic distributions of each trait. The results show strong evidence of environmental filtering among Mexican conifers which limits diversity of traits and species richness in montane forests. Environmental stressors such as temperature extremes and low precipitation result in stronger environmental filtering and restrict the geographical distribution of traits. Trade-offs were found among traits related to shade and drought tolerance. Drought tolerance, which was inferred through high wood density as functional trait, showed the strongest phylogenetic signal, and is the major factor determining the distribution and diversity of coniferous species in these high-elevation forests.

Keywords: conifers, trait evolution, niche conservatism

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Ectomycorrhizal fungi in the tropical dry forests of the Yucatan Peninsula

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Background: Many tropical dry forests are dominated by plant species that host arbuscular mycorrhizal fungi (AMF) while the ectomycorrhizal (ECM) symbiosis was assumed to be restricted to the temperate regions. However, increasing evidence shows ECM symbioses in lowland tropical forests in families including the Fabaceae and Nyctaginaceae. Even so, there are few studies with which to make any conclusions about the diversity of ECM fungi and their ecological roles in these forests. In this study, we used sequencing and stable isotope analyses to assess the diversity and mycorrhizal status of macrofungi, and identify putative host tree species for ECM in a tropical dry forest in the Yucatan Peninsula, Mexico. **Methods:** Sporocarps of putative ECM and saprophytic fungal species as well as root tips colonized by ECM were collected during the wet seasons from 2012 until 2015. Sequences of the internal transcribed spacer (ITS) regions of the ribosomal DNA were used to identify fungal species from fruiting bodies and root tips. Samples of sporocarps and leaves from tree species were also analyzed for δ13C and α15N by ion-ratio mass spectrometry (IRMS). **Results:** A total of 119 species of fungi were identified based on morphology and molecular-based techniques, of which 44 were considered ECM as they have been found in symbiotic associations with trees in other systems. The sporocarp community was dominated by the Boletaceae (12 species) but most ECM species (e.g. *Clavulina*, *Amanita*, *Russula*, *Sebacina*) were recovered infrequently, and there were few conspecific taxa. ECM and saprophytic fungi generated distinct patterns of stable isotopes, with differences in α15N values between fungal groups being the most informative. ECM fungi were generally enriched in α15N whereas saprophytic fungi were depleted α15N; this result is consistent with previous IRMS studies of ECM. Matching sporocarp with plant δ13C values indicated that Ceiba (Bombaceae) and Neea (Nyctaginaceae) were potential hosts of ECM fungi. **Conclusion:** Our results highlight a diverse ECM community comprising ECM fungal lineages that are known to dominate temperate ecosystems. However, the incidence of ECM fungi in what is generally considered an AMF-dominated forest also suggests that the presence of a tree hosting ECM (or ECM + AMF) could alter tropical forest structure and function, especially nutrient cycling.
Keywords: Sequencing; IRMS; diversity

ID:421
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Community analysis in social networks, a strategy for analyzing biogeographical complexity

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Background: The Mexican Transition Zone (MTZ) has been defined as a set of mountains systems that has allowed a strong exchange between Neartic and Neotropical species. This biotic exchange has resulted in a complex historic association of the biota that make them, being particularly interesting the role of the Trans-Mexican Volcanic Belt (TMVB), whose geological origin is the most recent in Mexico. TMVB has acted as a "bridge" that facilitated the dispersion of species among the different mountain systems of MTZ. This has resulted in multiple reticularity relationships that has prevented analyze the complex biogeographical relationships of the area. **Methods:** Was developed a database of 54,294 records of 201 species of plants and animals occurred in the TMVB which belong to different phylogenetic groups, with different dispersion capacities and from different montane ecosystems. Overlap of distribution areas was estimated through Kernel densities, according to latitude and longitude axis. The overlapping matrix was used to analyze by means of social networks, the structure of the communities through the Girvan and Newman algorithm, which proposes that the joining edges between highly clustered communities are very similar to each other. Hence, cutting these edges communities should separate. Different overlapping thresholds were used to estimate robustness of communities, as well as jackknife test to identify fundamental species in the community structure. **Results:** It has been possible to establish a clear separation between neartic and neotropical species under a scheme of nesting of the communities. Most of the larger communities are supported by ferns species for the neotropical case and by conifers for the neartic case. Mammals and insects shape the strongest communities in the analysis of communities within networks, and correspond to species with more restricted distribution in central Mexico. **Discussion:** The structure of the community within a network reflects the self-organization of the species in terms of the different historical components that have shaped MTZ biota distribution. Characterize and understand this structure could be fundamental for the study of the dynamic processes that occurs in these networks and their importance in the evolutionary history of biota.

Keywords: Network analisys, mexican transition zone

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Distribution and genetic diversity of wild populations of *Carica papaya* at its centre of origin

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Background: *Carica papaya* represents the third most cultivated tropical crop around the world. Mesoamerica has been considered the centre of origin and domestication for papaya, mainly because wild populations of undomesticated papayas still inhabit the region and the Maya are believed to have been the first to use and cultivate the species. Wild populations of domesticated crops constitute the genetic reservoir for the evolutionary potential and genetic improvement of the species; however, for papaya little is known about the punctual distribution and levels of genetic diversity of wild populations of this important crop. Moreover, there is a lack of information about events and consequences of gene flow between wild and domesticated papayas. **Methods:** Using the location of wild plants of papaya from herbariums and field samples, we determined the punctual distribution of wild papaya with environmental niche modelling. Moreover, using nuclear and chloroplast molecular markers, we evaluated the genetic diversity and structure of 24 populations of wild papaya throughout its natural distribution in Mexico and compared it to domesticated plants (*Maradol papaya*). We also estimated migration rates among wild populations and cultivars. **Results:** Based on 88 locations of wild individuals and populations of C. papaya, we determined the punctual natural distribution of papaya ranging from the Northern tropical forests of Mexico to the North of Costa Rica. We found high genetic diversity in almost all wild populations and long migration rates among them. Cultivated populations showed very low genetic diversity and gene flow events to wild populations. Finally, we detected a lack of ancient genetic structure with the chloroplast markers, but a recent one with DNA microsatellites. **Discussion:** This study represents the first effort to determine the punctual distribution of C. papaya in its wild form, as well as the first evaluation of the genetic diversity and structure of the species. Although we found high genetic diversity throughout its natural distribution in Mexico, we also found recent genetic structure, suggesting that anthropogenic disturbances in recent times are a threat to the conservation of the species in the wild. Moreover, we found evidence of gene flow from cultivated to wild populations, raising concern about the ecological and evolutionary consequences for this crop of great cultural and economic importance in Mexico.

Keywords: papaya, genetic diversity, gene flow

ID:327
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Trait variability of *Gaultheria serrata* at different scales in mountaintop areas of Southeast Brazil

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Background: Process that occurs in different ecological scales can affect intraspecific variability of different ways. However, feel studies have investigated the magnitude in which these different process influence trait variation and covariation at intraspecific level. Thus, we chose *Gaultheria serrata* (Ericaceae), a common endemic species of Brazilian high-altitude grasslands, to test the importance of regional and local scales to understand the factors controlling variation and covariation in intraspecific functional traits. **Methods:** We selected 3 mountaintop areas (regional scale) at southeast Brazil and 3 localities within one mountain (local scale) to access intraspecific trait variability. Using six leaf functional traits and height of 15 individuals per locality and mountain, we compare populations with ANOVA and SMA analysis. We also evaluated differences in covariation behavior in regional and local scales using PCA analysis and assessing phenotypic integration of each population. To quantify the major source of variation we conducted a variance partitioning analysis using the sum of squares of each trait in regional and local scale. **Results:** We observed differences in leaf area and total chlorophyll between localities, and differences in leaf area, succulence and thickness among mountains. We also observed differences in slopes in SMA analysis between specific leaf area and leaf thickness among mountains. According to PCA, populations within a mountain do not differentiated in trait covariation patterns. On the other hand, at regional scales we can identify a structure in trait covariation according to the mountain (i.e. individuals of a same mountain have similarities in trait covariation). We also identify different tendencies in variability extent and phenotypic integration between sites at the two scales. Finally, we observed higher variability within mountains (i.e., 95% to leaf dry matter content) and within localities (i.e., 96% to specific leaf area). **Conclusion:** The main differences in trait mean values and covariation patterns were observed at regional scales. These results suggested that environmental variability between mountains and probably the isolation, lead to functional differences at regional scale. However, the majority intraspecific variability is found within mountains, highlighting the importance of each mountain to *G. serrata* conservation.

Keywords: Functional ecology; Trait covariation; Ericaceae

ID:144
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Diet of oilbirds in southern Colombia: temporal variation, fruit choice and seed morphology

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Background: Oilbirds are specialized nocturnal frugivores inhabiting Neotropical forests and they have the potential to play key ecological roles as long distance seed dispersers. However, some components of their efficiency as seed dispersal agents are still unknown. In this study, we focused on the diet composition of a population of oilbirds in Cueva de Los Guacharos National Park (Colombia), by assessing temporal variation, examining nutrient composition and measuring seed morphology. **Methods:** We used 6-10 seed traps in a cave from 2011 to 2016, making usually a 5-day census 1-3 times each year and a 12 mo evaluation in 2015 to document within year variation. We found seeds of 59 species (including 17 named species, 19 identifico just to family and 23 morphospecies that were not assigned to family level). **Results:** We found a clear dominance of Arecacea and Lauraceae families. Intra-annual variation in species richness reflects the fact that more biomass and seed numbers are deposited in the cave in periods of nesting (January - June), as well as phenological patterns in nearby regions. From published information, it is clear that preferred species include a high representation of lipid-rich fruits. Seed size varied enormously (range: 0.01 to 5.99 gr dry mass), being the largest seeds up to 18 mm width and 42 mm long. Dispersed seeds showed a negative isometric relationship between width and length, suggesting adaptation to endozoochory. **Discussion:** Overall, we found a diverse diet and that oil birds provide efficient seed dispersal in terms of seed quantity; however, many aspects of dispersal quality remain to be determined.

Keywords: Behavior, frugivory, seed dispersal, Arecaceae.

ID:225
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Genetic Assessments for the Endangered Black Lion Tamarin *Leontopithecus chrysopygus* (Primates)

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Background: Captive populations play an important role in the conservation. The knowledge of genetic variation is fundamental for making conservation decisions. The maintenance of wide genetic diversity allows the conservation of the evolutionary potential, ensuring populations can adapt to a wide spectrum of environmental conditions. Genetic diagnosis for both captive and wild populations of endangered species is extremely important, as it can inform management recommendations for reproduction in captivity that aim to minimize the negative effects of potential genetic diversity loss in both wild and captive environments. **Methods:** A total of 63 black lion tamarins (BLT) was analyzed using 15 microsatellites. Of these, 16 animals were from the Zoological Park Foundation of São Paulo State, 17 from the Primatology Center of Rio de Janeiro, four from the São Carlos Ecological Park, and 10 were from a wild population (Buri), in Brazil. The 14 remaining captive samples were from the Durrell Wildlife Conservation Trust (England), and two were from the La Palmyre Zoo (France). The expected (He) and observed (Ho) heterozygosity were determined by using GenAlex. Allelic richness (Ra), inbreeding coefficient (FIS) and population differentiation (FST) were computed using Fstat. P-values for all tests were corrected for multiple comparisons using the sequential Bonferroni procedure. Population structure was examined through Principal Component Analysis. **Discussion:** Our data revealed that the genetic diversity levels for the captive and wild populations of BLT are comparable to one another and also to the levels described for other *Leontopithecus* species. In addition, the results showed that a differentiated allele fixation process has been promoting genetic differentiation among some groups in captivity. He estimated for both captive groups and the wild population showed respectively lower and higher values, than those observed for other wild BLT populations previously evaluated. Ho was significantly greater than He in all groups, indicating tendency to outbreeding. Fis did not deviate significantly from random mating, neither per locus nor population. The negative average Fis reinforced the excess of heterozygosis for Brazilian and European captive groups, and for the wild population. The data described here could be used in programs aiming to minimize the relationship by selecting reproducers based in both molecular and genealogical data.

Keywords: Genetic diversity, *Callitrichidae*, conservation programm

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Human disturbances and rainfall effects on plant-insect herbivore interactions in the Caatinga

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Background: Remaining areas of natural ecosystems in the most tropical semi-arid regions of the world are exposed to chronic anthropogenic disturbance imposed by exploitation of natural resources for human subsistence. Although poorly investigated, chronic anthropogenic disturbance may reduce community diversity, disrupt ecological interactions, degrade soils and even cause climate change at a regional scale. Caatinga suffers of chronic disturbance due to the extraction of timber and non-timber forest products as well as the extensive livestock production. In addition, predictions of climate change for the region include a 40% -reduction in precipitation levels and increased temperature up to 6°C until 2100. The objective of this study is to investigate the effects of increased chronic anthropogenic disturbance and reduced precipitation on plant-herbivore interactions, from a perspective of ecological interaction networks. **Methods:** We sampled herbivorous insects on woody vegetation using entomological umbrellas in ten Caatinga areas with different levels of chronic anthropogenic disturbance and precipitation (i.e. 510-940 mm) at the Catimbau National Park, PE, Brazil. Result We collected 1620 individuals (herbivorous insects), sorted in 251 morphospecies interacting with 55 plant species in a total of 1438 interactions. The overall plant-herbivore network showed higher values of specialization and compartmentalization when compared with null models. Chronic anthropogenic disturbance did not affect the structure of herbivorous insect community and plant-herbivore interaction network metrics. Precipitation did not affect herbivorous species richness and diversity, but reduced the number of compartments with precipitation reduction. **Discussion:** Our results indicate that precipitation reduction may have more influence than increased chronic anthropogenic disturbance on plant-herbivore interaction networks in the Caatinga. This finding suggest that areas with higher levels of precipitation support more plant-insect herbivore modules and thus can be more stable to disturbances than drier areas.

Keywords: compartmentalization; herbivory; networks; plant-animal interaction.

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Movement patterns of two endangered ungulates of the Maya Forest

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Background: As part of an ongoing research on Baird's tapir (*Tapirus bairdii*) and white-lipped peccary (*Tayassu pecari*) ecology and movement in the Calakmul Biosphere Reserve in Southern Mexico, we are reporting home range estimates of an individual Baird's tapir captured in May 7 2011 and that have been followed until mid 2015, and of two groups of white-lipped peccary that were followed for four months in 2015 and four months in 2016. **Methods:** The tapir was captured in a pond inside the reserve and was equipped with a VHF collar. The signal failed to transmit in the following month but with the help of a network of camera traps deployed in nearby water bodies, we were able to monitor this individual for four years. We have estimated the Minimum Convex Polygon and constructed a buffer around camera traps locations where this animal was photo-captured. White-lipped peccary were captured in the same place and two iridium Telonics and Vectronics satellite radiocollars were attached. The units were programmed to take fixes every two hours and every 12 hours respectively. **Results:** For the tapir and with few available records (<30) but that spanned over four years we have estimated a home range that varies from a core area of 4.17 km2 to a potential full home range of 39.93 km^2 and an intermediate estimate of 23.93 km^2 for all locations since it was captured. This individual moved 10.5 km from the site it was captured. Home ranges of the two groups of white-lipped peccary estimated with the minimum convex polygon ranged over 42 km^2 to 46 km^2 with maximum distances moved of 8.8 and13.2 km. **Discussion:** The home range estimates reported here for the tapir are larger than previously reported for this species. This is the first report on the home ranges, travel capacities, and distances for the Baird's tapir in the Calakmul Region. Home ranges of white-lipped peccary are smaller than previously reported for the same area and shows the intensive us of some areas. Conservation of both species in Calakmul requires large areas of mature forest. Calakmul and the contiguous Maya forest of Guatemala and Belize are the largest and more important forest for the conservation of these two endangered ungulate species in Mesoamerica.

Keywords: *Tayassu pecari*, *Tapirus bairdii*

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Morphlogical divergence in a tropical oak of wide geographic and elevational distribution

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Background: Mexico is considered as one of the main centers of diversification of the genus *Quercus* in worldwide. In this study, we analyze the intraspecific variation and the population divergence in *Quercus elliptica*, a red oak with tropical affinity of wide geographic distribution in Mexico and Central America, which occurs in both humid temperate and sub-humid tropical habitats, being one of the red oaks with the widest elevational range (800-2400 masl). **Methods:** Approximately, 45 populations were sampled in Mexico, Guatemala and Honduras. Ten individuals were collected and digitized from 10 individuals per population. A series of morphological attributes (length, width, specific leaf area, thickness, stomatal surface, stomatal opening, among others) were measured to perform traditional morphometry analysis through Principal Component Analysis (PCA). Simultaneously, along the contours of the leaves, a series of landmarks were drawn for analysis of geometric morphometry. To analyze whether if morphological divergence among populations is due to environmental or historical differences, analyzes of variance (ANOVA) were performed among populations cluster by their environmental similarity and among populations belonging to different biogeographic provinces. A discriminant analysis (AD) was performed to determine the foliar attributes that allow explaining the morphological divergence between populations. These attributes were interpolated using geostatistical techniques. **Results:** The scores between first and second principal component among environment and morphology PCA are high correlation. The morphological variables that explain the greatest variation of the principal components are the length and width of the leaf, the length of the petiole, and long / wide quotient, these variables are correlated with latitude, longitude and altitude. It is evident that the separation of major importance occurs between populations of low altitudes (<1200 masl) and of altitudes superiors to 1500 msnm. ANOVA indicate significant differences between low mountain populations from the Pacific and Gulf slopes, compared to high mountain populations. The geostatistical analyzes generally show two strongly separated groups that reinforce the results, although in the DA the correct allocation of groups is 60%. The results indicate that *Q. elliptica* has a clear morphological divergence among its populations.

Keywords: Divergence variation, Ecology, Morphometry, Biogeography

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Distinct phylogeographic patterns in the Mexican oak *Quercus glaucoides*

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Background: The genus *Quercus* is one of the most important groups of woody trees in the North hemisphere. This genus contains at less 500 species in the world, present in different ecosystems. Several phylogeographic studies have been done in order to gain insight into the effects of past heterogeneous climate and geological activity on the population history of American oak species. In Mexico, most oak phylogeographic studies have focused on red oaks (section Lobate) distributed mainly in temperate forests. The results of these studies have shown a relatively low intra-specific genetic differentiation among populations and high levels of genetic diversity for the chloroplast DNA (cpDNA). For this study, we focused on the phylogeography of *Quercus glaucoides*, a species with ecological affinities to tropical dry areas, to infer the effects of the climatic changes of the Pleistocene and recent volcanic activity in Central Mexico on its distribution and historical demography. **Methods:** We extracted DNA from leaf samples collected from nine populations localized in the Sierra Madre del Sur (SMS) and the Trans Mexican Volcanic Belt (TMVB). Sequences of cpDNA region TrnC-psbM were amplified. Also, nine nuclear microsatellite (nSSR) loci were analyzed. Both sets of markers were used to estimate genetic diversity and structure indexes, as well as to infer historical demographic patterns of the species. **Results:**A total of 84 sequences were obtained with a length of 741 pb with five variable sites. The haplotype diversity was 0.612 and the nucleotide diversity was 0.00127. Genetic differentiation (GST) was 0.86; meanwhile genetic differentiation estimating the distance among haplotypes (NST) was 0.85. Tajima's D and Fu's Fs neutrality tests were not significant. However, mismatch distribution showed a recent demographic expansion. For nSSRs the fixation index (FST) was very low (0.064). Moreover, a clustering Bayesian analysis did not show any genetic structure in the populations analyzed. **Conclusion:** The low values of genetic diversity are signal of a historical bottleneck. The high levels of structure in the cpDNA confirm the idea of a past fragmentation and a low distance dispersal capacity. These results suggest that distribution of *Quercus glaucoides* was reduced during the last glaciations, leading to the fragmentation of the populations.

Keywords: Phylogeography, Dry-forest, Oak

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Rodent assemblages in early successional stages of tropical dry forest succession

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Background: The Tropical Dry Forest (TDF) is one of the most threatened ecosystems in the Neotropics as it has historically been used for agriculture and human settlements. In this scenario, it is urgent to identify the drivers structuring the assemblages of species playing critical roles in the ecosystems. Rodent assemblages, for example, have positive effects in forest succession as seed dispersers but they have also negative effects as plant consumers. In this study we characterize rodent assemblages inhabiting early successional stages of a Mexican TDF, identifying the potential drivers, at the local and landscape level, determining assemblage's composition and structure, species abundance and body condition. **Methods:** We sampled rodents bimonthly during two years in 14 localities: 12 early successional sites and 2 old growth forest sites. In each site we used 100 large folding traps per night. **Results:** Our results reveal an epiphenomenal and highly specific rodent response to variation in vegetation and landscape attributes, which was largely modulated by seasonality and determined by the focal spatial scale being considered. The omnivorous species were favored by the vegetation structure simplification and the increase on the understory density, which may offer them more refuge and trophic resources. On the other hand, the granivorous species (*Liomys pictus*), was highly sensitive to variation on vegetation composition, and negatively affected by a reduction on vegetation structural complexity, probably because trees are one of the major elements represented on their diet. At small spatial scales we found a higher diversity of rodents in areas with lower coverage and connectivity of forest. This could be explained by the higher abundance of most rodent species toward sites with depauperated vegetation. However, at larger spatial scales, we found a higher diversity of rodents in sites surrounded by a high coverage and connectivity of forest, probably because large forest patches act as a major source of species toward sites under regeneration, while the forest connectivity favors the colonization process. **Discussion:** Our findings showed that preserving remnants of the original vegetation in anthropogenic landscapes, is critical for controlling rodent populations, avoiding the rapid faunal homogenization (rodentization) characteristic of disturbed ecosystems, which has pervasive implications for forest ecology, ecosystem services and human health.

Keywords: rodents' assemblages, early successional stages

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Use of molecular markers to study conservation of *Guadua sarcocarpa* in the Brazilian Amazonian

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Background: The Brazilian Amazonian has a great forestry vocation, however, the complexity of the forest presents itself as a challenge, both for conservation and for sustainable use. The substitution of highly explored species to species with great economic and logging potential such as bamboo has been an alternative, especially with respect to bamboo rich regions such as the Brazilian Amazon. The open forests with bamboo, "Tabocais", in Acre, are uncommon in the Amazonian, but they covers extensive areas in the Southwest of the basin Amazonian. To know the genetic structure at species of *Guadua* with the use of molecular markers is necessary to subsidize the use and its conservation. **Methods:** For this study, 50 individuals from a natural population of *Guadua sarcocarpa* were collected in Sena Madureira city, Acre - Brazil. The laboratory procedures were carried out in the Molecular Biology Laboratory at Brazilian Agricultural Research Company - Embrapa, Acre. The DNA was extracted following the 2% CTAB (Cetyl Trimethylammonium Bromide) protocol, developed by Doyle and Doyle, with adaptations. 17 SSR (Simple Sequence Repeats) loci of three different species (*Guadua* angustifolia, *Oriza sativa* and *Saccharum* spp.) were tested to investigate the polymorphism occurrence in the collected individuals. After the PCR reaction, the amplified fragments were separated on polyacrylamide denaturing gel (5%) in a vertical vial containing 1X TBE buffer under 1600 volts and 85 mA for one hour. The coloration of the fragments (Alleles) was done with silver nitrate, using a protocol developed by Creste et al. (2001). **Results:** Of the 17 primers tested, seven were monomorphic for this species, being: ESTB41, ESTB60, ESTB119, RM332, RM31, FJ444934, FJ476076 / 476077. However, the primers ESTB45, ESTC66, RM309, FJ476071, FJ444935, FJ444931, FJ444932, FJ444929, FJ444930, FJ444936 were polymorphic, being a total of 58 alleles were found, with values from 3 to 10 alleles and an average of 5.8 alleles per loco. **Conclusion:** The markers that demonstrated polymorphism enables to evaluate the diversity and genetic structure of *Guadua sarcocarpa*, and they can be a important tool for the conservation of this species in natural populations.

Keywords: conservation, molecular markers, bamboo, transferability

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Effect of CO_2 increasing on two species native of Cerrado

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Background: It is expected that by the end of this century these concentration will reach up to double the level of those from the pre-industrial time. Given this scenario, several studies have shown that the buildup of CO_2 will drastically affect the growth and chemical composition of various plant species. The present study investigated the physiological responses (growth, polyphenol concentration) to CO_2 increase in two species of tropical native species, *Baccharis dracunculifolia* and *Baccharis platypoda*. **Methods:** The present study was carried out in four open-top chambers (two chambers: 720 ppm - CO_2 enrichment; two chambers: 360 ppm - CO_2 ambient) installed in a greenhouse in the Campus of the Universidade Federal de Minas Gerais (19° 30'S, 44° 00'W), Brazil, in April/2009. The seedling of 8 weeks of each species were distributed randomly in open top chambers (number of individual per chamber of each species= 40) and maintained during 13 weeks. After that, we measured the height, number of leaves, and leaf polyphenol concentration. The date of all parameters did not present normal distribution. Mann-Whitney test was used to evaluate the differences between the CO_2 treatments for the all parameters analyzed. We evaluated the correlation between height and polyphenols concentration for each CO_2 treatment using Spearman test. **Results:** The growth of *B. platypoda* did not differ between CO_2 treatments, although the number of leaves was 20% higher in CO_2 enrichment treatment. Individuals of *B. dracunculifolia* under CO_2 enrichment were 30% taller ($P < 0.05$), supported a larger number of leaves (27% more, $P < 0.01$). The leaf polyphenol concentration did not differ the CO_2 treatments for both plant species. There was a strong association between height and polyphenol concentration for both species grown under CO_2 enrichment treatment (B. *platypoda* $r^2 = 0.70$, $P < 0.001$ and *B. dracunculifolia* r2 = 0.63, $P < 0.05$). However, this correlation was not observed for the individuals under CO_2 ambient treatment ($p > 0.05$). **Discussion:**The results indicate that the increase of the CO_2 concentration has the potential to modify metabolism (better development and polyphenol concentration) and can differ among plant species. The results will help to future predictions about the effects of CO_2 increase on the vegetal biodiversity of the Cerrado and its conservation.

Keywords: Cerrado; *Baccharis*; CO_2 concentration

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Posters
Ethnobiology: application in biodiversity conservation

The influence of National Parks on poverty traps for human populations living in dry forests

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Background: Protected areas are an important tool to protect biodiversity, however, if social development is not considered then biological conservation targets tend not to be achieved. In this study we assess the relationship between poverty and conservation goals in dry forests using the Catimbau National Park (Brazil) as model system. **Methods:** We conducted 81 structured interviews with households between January and July of 2016 to assess socioeconomic, resource management and land-use variables. We used non-parametric analysis of variance to test differences in socioecological variables between families living inside, outside the Park and both (double dwelling). **Result:** Almost half of the interviewed families living inside the Park were below the poverty line in comparison to less than 10% in the other scenarios. About 84% of families were involved in agriculture but only 1% of the family income came from agricultural sales. Most of the families (72%) were receiving support from the governmental grant program and non-governmental organizations. The formal education of the families was generally low, on average fewer than five years. Families living inside the Park had less monetary income and home infrastructure compared to outside and in double dwelling families. Outside families used less firewood and were raising extensively less goats. Almost 70% of the families living inside the Park had no water security (no water tank and no external water supply). **Discussion:** Our results suggest that the Park can generate more susceptibility to poverty for families living inside (less monetary income, more isolation and more dependence on firewood and on external support). On the other hand, the Park can generate poverty alleviation for families living in double dwelling conditions (opportunities to use park natural resources while accessing external infrastructure). Isolation, restrictions of land use and water scarcity inside the Park mean that people tend to have lower socioeconomic standing and fewer opportunities to change. Therefore, we suggest the combination of low educational levels, poor environmental conditions and land-use restrictions can generate a poverty trap for families living in National Parks in dry forests. In this context, poverty also can jeopardize the conservation outcomes especially in scenarios of climate change.

Keywords: Conservation; Caatinga; Ethnoecology; Protected Areas

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Comparison between Hunters' Knowledge and Transect Surveys of Game Species in an African Rainforest

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Background: Human activities alter the composition and abundance of wildlife populations. A common awareness of these changes by stakeholders, including local people is essential for sustainable management. **Methods:** Hunters (n= 255) from two adjacent community hunting zones (CHZs) in Southeast Cameroon were interviewed about the changes that occurred in the composition of the animals caught in snare traps since their beginnings in trapping, and their drivers. We also conducted nocturnal surveys of mammals along 226 km of line transects. **Results:** Highest densities were found for the blue duiker (63.1 animals km^2), the tree pangolin (6.6 km^2) and red duikers (5.6 km^2). The comparison of the perceived trends in game composition to the trends from transect surveys and carcass records which were conducted in the area since the nineties revealed the followings: (1) hunters have an acute awareness of the coarse changes in prey abundance, even for the species for which population density is difficult to estimate with classic survey methods; (2) in southeast Cameroon and in forests regions with similar fauna, the bay duiker and the Peters duiker are clearly more abundant than the white-bellied and black fronted duiker; (3) the two sites investigated here are under different stages of prey depletion trajectory, and (4) the ranking of prey abundance by local hunters is likely to reflect more the faunal assemblages in anthropogenic forest mosaics, where hunting is more frequent and is consistent with village-based bushmeat records. **Discussion:** Hunters' interviews constitute a valuable means to rapidly assess the trends in animal populations. However, the discrepancies between the perceptions and the surveys in remote forest areas draws attention to the need of caution when using local knowledge to generalize trends in fauna assemblages over large scales.

Keywords: bushmeat, local-perception, snare-hunting, species-composition, wildlife-decline

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Taro diversity and conservation of agroforestry genetic resources in Vietnam

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Background: Vietnam is considered a center of diversity for Taro. Exceptionally high diversity for taro is found in Huu Lien Nature Reserve and it's buffer zone in Yen Thinh commune. **Methods:** We used plant inventories, UAV generated 3D models, plant regeneration experiments and ethobotany survey methods to study genetic diversity and use of plants. **Results:** Surveys and participatory appraisals revealed that 11 distinct taro types were grown and used by farmers from all five ethnic groups including a diversity of wild taro relatives. Nine cultivated varieties of true taro (*Colacasia esculenta*) are recognized, named and described as distinct land races. In addition, two types of a related species *Alocasia* are consumed, and *C. gigantea* grows wild in the commune. These are used for medicine and fed to pigs. Majority of taro was sold in market outside the commune. Other types are used for pig food and medicinal purpose. Seven taro types were found widely grown and were being safely conserved and used in situ. **Discussion:** Huu Lien Nature Reserve's buffer zone (Yen Thinh Commune, Lang Son Province has identified and met criteria of a Plant Genetic Resources Important Zone (PGR-IZ) and named as the PGR-IZ number 9 (Source: UNDP-GEF funded VIE/01/G35). The PGR-IZ number 9- limestone mountainous area of 6658 ha with rich diversity of taro mixed of other land races and their wild relatives (litchi and longan relatives, citrus); with an active groups of minority community participated in piloting were comprehensively discussed in this presentation.

Keywords: Taro, *Colocasia* spp., *Xanthosoma* spp., Huu Lien Nature Reserve, PGR-IZs, conservation

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The knowledge and use of trees are influented by their local availability in the ecosystems

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Background: Many etnobiological studies have tried to understand if the plant species ingress in the cultural practices of human groups are influented by their availability in the forest paths, and their differential uses by people are influented by their availability too. The logic rationales are that species more predictably found would be favored during human experimentation events, and because the human strategies of forest resources collect would be guided by a sense of energy economy. **Methods:** We performed two random effects meta-analysis on studies which correlated the local importance of tree species to human populations (estimated using the consensus informant technique) to their local availability (estimated using phytosociological parameters). The model A (nine studies meta-analysis, including tree species non cited as useful) is about the ingress and differential uses of tree species, whereas the model B (eighteen studies meta-analysis, just including tree species cited as useful) is just about the differential uses. Just to model B we tested the correlations abovemetioned in different kinds of uses such as construction, firewood, manmade objects and medicine. **Results:** We found positive and significative correlations between tree species availability and their ingress and differential uses by human groups. These correlations are more consistent in the model A. All the correlations are stronger to the phytosociological parameter of dominance. The tree species availability seems to explain their differential use mainly to firewood and construction use. **Discussion:** The ingress of plant species in human groups cultural practices indeed seems to be related to their availability because it would be illogical people to strive to experiment species little available or difficult to find because it would not ensure the continuity of their uses. The differential use of tree species are less related to their availability because, inside the repertoire of useful species, others factors may contribute to their importance. Indeed, the differential use of tree species to firewood and construction seems to be related to the availability because these kinds of uses requires a great wood volume, mainly firewood. Finally, we highlight that conservation strategies should consider our findings because even the most abundant species may be threatened, mainly if they are used to timber uses.

Keywords: Ethnobiology, forest management

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Characterizing the optimal conditions for the production of Darutoside in *Sigesbeckia orientalis*

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Background: *Sigesbeckia orientalis* (Asteraceae), a medicinal plant known for its wound-healing property, is highly demanded in cosmetic industries because of the presence of "Darutoside", an important active compound. This study aims in determining what factors influence the production of Darutoside in *S. orientalis* in the tropical ecosystems of Madagascar. **Method:** We extracted this compound from three different organs (leaves, seeds and whole plants) collected at different time periods during the rainy season (at the beginning, in the highest peak and at the end) and dried using three different methods (sun-, shade- and freeze-drying). We also analyzed how the chemical composition of the soil in the field where *S. orientalis* is naturally found, influence the production of Darutoside. **Results:** *Sigesbeckia* leaves, collected at the end of the rainy season and dried in the shade, have the highest content of Darutoside. This content is enhanced for individuals found on a strongly acid soil, with a very sandy silt texture, rich in Carbon, Nitrogen, Potassium and Phosphorus, and for those in close proximity to a river. **Conclusion:** This research highlights the importance of taking into account both environmental conditions and biological factors in the harvest of *Sigesbeckia orientalis* for an optimal production of Darutoside.

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Ecological engineering for the birds: Quantifying avian diversity in Hach Winik Maya agroforests

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Background: Agroforests can provide rural smallholders with provisioning ecosystem services while maintaining ecosystem structures and functions that support diverse biological communities. While agroforests tend to maintain the species richness observed for undisturbed forest ecosystems, they generally do not preserve community composition. However, few studies have evaluated diversity in indigenous agroforests, like those of the Lacandon Maya (hereinafter Hach Winik), whose traditional ecological knowledge is expressed in their swidden, sequential agroforestry system. We used birds as an indicator taxa to assess whether Hach Winik agroforests maintain diversity and how biological communities change along a successional gradient. **Methods:** We performed 25m radius 15min point counts for birds in the seven Hach Winik agroforestry successional stages, noting the time since disturbance and location of each sample site. We identified birds visually and visually in the field, recording species, time of observation, and distance to each observed bird. We modeled species richness and Simpson's diversity as a function of successional stage. Finally, we performed a principal component analysis and redundancy analysis to assess whether community composition changed along a successional gradient in Hach Winik agroforests. **Results:** Species richness and Simpson's diversity values for all Hach Winik agroforestry stages were similar to that observed in nearby undisturbed reference rainforest ecosystems. Community composition did not change along a successional gradient, but there was a distinction between communities supported by field and fallow stages. Earlier, intensely-managed stages supported more generalist species. Later, secondary forest stages tended to support more forest specialists. **Discussion:** These results demonstrate the potential of Hach Winik agroforestry management to conserve avian biodiversity, perhaps even more so than commercial coffee and cacao agroforests common in the Lacandon rainforest region. Furthermore, Hach Winik agroforestry provides farmers with a suite of ecosystem services. However, it is likely only sustainable if farmers do not reduce primary forest cover or shorten fallow cycles to increase production.

Keywords: agroforestry, biodiversity, conservation, community, succession

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Posters
Human development and tropical ecosystems

Cattle foraging behavior and impacts to tree community structure in Mexican tropical dry forest

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Background: An estimated 60% of Mexico's tropical dry forests (TDF) have been lost to clear-cutting. Remaining areas of old-growth TDF are mostly in private hands, and much is ranched for cattle. Cattle may negatively impact TDF; however, few studies to date have evaluated the role of cattle foraging and ranging decisions on impacts to tree diversity and community structure. I studied cattle behavior and TDF tree diversity to address the following questions: are cows reducing tree diversity and impacting tree community structure though browsing and trampling? Are cows preferentially eating particular species of woody plants? And are they selecting habitats in their home ranges, or ranging broadly? **Methods:** To study cow diets, I designed a novel custom animal-mounted time-lapse video and data logging systems ("CowPro"), which recorded 2,291 unique 10- and 20-second georeferenced videos of cattle feeding behavior. I quantified tree community structure with arrays of 5m x 5m plant census plots at two scales: [i] 165 plots on known cow foraging paths (foraging community) corresponding to coordinates of video documented feeding points, and [ii] 350 gridded plots across all available cattle habitat within ranches in the TDF (ranch community). I then compared tree species diversity in cow diet versus that in the foraging and ranch communities. **Results:** Cows are not impacting tree stem density or number of species, but are modifying the dominant tree species. Tree species frequency in cow diet and foraging community were similar, suggesting that cows are not selective in their foraging behavior. Preliminary analyses suggest that cow foraging behavior can differ between habitats in their home ranges. **Discussion:** This study shows that cattle may impact tree diversity in tropical dry forests by selecting their preferred habitat for foraging, rather than by preferentially seeking individual tree species to browse. A better understanding of cattle foraging and ranging behavior in tropical dry forests can help inform sustainable economic development practices and conservation in this threatened ecosystem.

Keywords: cattle, foraging, tropical dry forest

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Examining the effects of fragmentation and predators on ground-nesting bird nests in the Neotropics

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Tropical understory ground-nesting birds have been in decline as a result of habitat fragmentation due to urban sprawl and agricultural development. Here, we revisited a study conducted nearly three decades ago and reexamined the depredation of great tinamou (*Tinamus major*) nests in the San Juan-La Selva Biological corridor. We used artificial nests to test habitat and predator covariates as predictors of nest loss. Using camera trap data, we compared predator detection rates and assemblages at experimental nest sites in La Selva Biological Station and at sites in five fragments. Twenty-three out of 52 artificial nests were depredated. Mammalian and avian predators were common nest predators, but unknown snake predators were presumably responsible for over half of nests lost. Our results suggest that total nest predator abundance plays an important role in nest depredation probability. Nests within the La Selva forest core had a lower probability of nest depredation compared to fragments despite generally higher predator detection rates, yet other fragmentation covariates such as distance to forest edge or forest age did not explain variation in nest loss. Landscape and predator assemblages affect ground nesting birds, but the extent to which snakes depredate ground nests warrants further research in order to appropriately inform conservation priorities for vertebrates in the corridor.

Keywords: fragmentation, understory, ground-nesters, birds, nest-predators

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Saving Utila: a multi-disciplinary approach to conserving a Caribbean island

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Background: Utila, Honduras, is a Caribbean island almost half covered in mangrove forest. It forms part of the second-largest reef system in the world, and is home to various wildlife including the endemic Critically Endangered iguana *Ctenosaura bakeri* and the Near-Threatened bat *Vampyrum spectrum*. Utila is also an island under serious threat from uncontrolled development to serve a growing population and an expanding tourism industry. Kanahau Utila Research and Conservation Facility is a small organization working to protect the island's threatened habitats and species, through both research and education. **Methods:** Research projects include population ecology of *Ctenosaura bakeri*, bat species assemblage and habitat use, and mangrove health assessments. The environmental education program is run in 5 local schools, in conjunction with 2 other NGOs on the island. The students are taught about local wildlife and conservation issues, as well as more general environmental concepts. In 2017 the program will expand to include adult residents and tourists, and to address other important island issues, such as waste disposal and recycling, sustainable incomes, and nature as a resource. A new project for 2017 is a regular market for residents and tourists to purchase locally produced goods using local ingredients, to encourage sustainable incomes and an appreciation for what the island can provide. Local people will be taught to make environmentally friendly products (such as cosmetics and jewellery) to be sold at the market. **Results:** KURCF results so far include an improved awareness and understanding of the environment in the island's students, an IUCN status update for *Ctenosaura bakeri*, the facilitation of five university student projects, and the employment of a local field guide. **Conclusion:** This broad whole island approach to protecting the environment on Utila, and encouraging it's residents and visitors to do the same, is crucial to the success and longevity of any conservation actions.

Keywords: Honduras, Education, Species research, Community

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Crop management effects on Lepidoptera and other herbivore insects community in coffee plantations

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Background: Agroecosystems are complex systems where different management practices interact with biological components to regulate ecological features like soil fertility, crop productivity, biodiversity and pest outbreaks. The community of herbivore insects is a very important component of these systems because it is linked to productivity and pests outbreaks, but also with biodiversity of natural ecosystems. Therefore, understanding how herbivore insect community is modified by different management practices is important to provide strategies to reduce herbivory in crops, provide alternatives for pest control, but simultaneously maintain local biodiversity of this group. Coffee crops are a good model to study this because a broad range management practices are employed in coffee plantations, ranging from rustic polycultures with diversified shade to sun coffee monocultures. In coffee crops, Lepidoptera is an interesting group to assess how management intensity affects diversity because shade plantations can preserve a high diversity of lepidopteran. But also because the larvae and the adults have different roles in the agroecosystem, larvae are pests of coffee, while adults are potential pollinators of this crop. **Methods:** The study was conducted in six plantations of two productive areas of Veracruz, Naolinco (3 plantations) and Coatepec (3 plantations). The 6 plantations represent the span of management intensity types of the region. Insects were sampled in June, September and December of 2016. In each plantation, insects were collected by hand searching every plant along three transects of 30 x 2m. All insects except Lepidoptera individuals were collected in alcohol (70%). Caterpillars were captured alive and reared in lab for adult identification. **Results:** Cluster analysis show Lepidopteran communities of are more similar within the region regardless of the management practice, except from the monoculture plantation. Linear regression analysis show that caterpillars were less diverse and less abundant in plantations with more use of agrochemicals. The two plantations that used more agrochemicals showed differences in the relative abundance of Orthoptera that was more abundant than Coleoptera and Hemiptera in these plantations, while in the rest Orthoptera was the less abundant order. **Conclusion:** Overall, we found that coffee plantations preserve a high diversity of Lepidoptera and this group showed to be the better indicators of management intensity.

Keywords: Coffee, Lepidoptera, diversity, management, agrochemicals

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Bioacoustic niche dynamics of understory birds in varying conditions of anthropogenic noise

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Background: The interacting sounds in space and time characterize the state of the environment and may indicate the level of human intromission. The acoustic niche that bird species occupy has evolved to maximize their communication system. However, road noise may interfere with acoustic communication by making songs. We expected that bird singing at frequencies similar to that of the road noise would avoid proximity to the road, change their call rate and/or modify the temporal activity of song emissions. **Methods:** The study was conducted in Carara National Park, Costa Rica, adjacent to the national route 34. We used automatic recorders to collect vocalizations of the Chestnut-backed Antbird (CBAB), the Black-faced Antthrush (BFAT), and the Black-hooded Antshrike (BHAS) between 5 to 7 a.m. The recordings involved eight locations that were close and far from the road over a four day period. We quantified the number and rate of the vocalizations as well as the temporal emissions of the songs. **Results:** The total number of songs in locations close to the road was significantly lower than that in far locations for the CBAB and the BFAT, while no significant difference was found for the BHAS. Temporal variation in song emission showed a pronounced peak at 5:45 a.m. for the CBAB and the BFAT close to the road, whereas individuals of the same species far from the road maintained their song relatively constant from 5:30 a.m. through 6:15 a.m. Song rate of the CBAB and the BHAS did not differ in close and far locations. In contrast, song rate of the BFAT was significantly higher in close location compared to far locations. **Discussion:** The low number of vocalizations by the CBAB and the BFAT could indicate that there might be fewer individuals of these species close to the road. This is in agreement with previous findings. However, temporal overlapping peaks in song numbers in close and far locations indicate differential song emission through time. An increase in song rate close to the road by the BFAT may increase the probability of song detection by conspecifics **Conclusion:** Bird species could avoid proximity to road or adjust temporal song emission to maximize acoustic communication in noisy environments.

Keywords: Acoustic ecology, bird communication, Roads

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Means and ends: Operational tools and action points towards reconciling conservation and development

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In response to the recognition that sectorial approaches to land management are inadequately meeting persistent global challenges of poverty, food insecurity, and biodiversity loss, more holistic approaches to land management are increasingly being sought to reconcile conservation and development at the landscape scale. Such "integrated landscape approaches' have recently been embraced by researchers, donor communities, conservation and development agencies, as well as becoming ubiquitous in international conventions for climate, biodiversity, and development. Despite this, implementation efforts and evaluation of progress of landscape approaches remains challenging. We have reviewed the evidence to identify guiding principles and operational tools that have been determined to be of practical use for the implementation and evaluation of landscape approaches. We have used multi variate analysis to synthesize frameworks for integrated approaches to highlight where areas of congruence exist and consider how this compares with recent reviews of landscape approaches in practice. We then provide a summary of tools that we have documented within categories of: (i) incentivizing behavioral change, (ii) monitoring and evaluation, (iii) modeling and scenario building, (iv) stakeholder engagement, (v) advances in spatial mapping, and (vi) navigating complexity. This article provides a valuable resource for actors operating across the spectrum of research, policy and practice as we continue to develop the means by which we will fulfill such global commitments as the New York declaration on forests, the Aichi biodiversity targets, and the goals of the climate and development agendas. Our synthesis of the evidence provides a useful starting point for overcoming implementation and evaluation challenges, identifies where further research is required and serves to reduce duplication of future research efforts.

Keywords: Conservation and development trade-offs; SDGs

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Local coffee farm intensification impacts on ant community composition and biological control

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Background: Biodiversity in agroecosystems is key for maintaining ecosystem services that contribute to crop production, such as biological pest control. Farm intensification can alter habitat structure for natural enemies, which may reduce biocontrol services. Ants are important biocontrol agents of the coffee berry borer (CBB), where the alteration of ant communities could have implications for the control of CBB. Here we studied the impact of a local farm intensification on ant community composition in a coffee agroecosystem in Mexico. **Methods:** We collected data on a shaded coffee farm in Chiapas, Mexico. During 2016, the farm underwent management intensification, where workers clear-cut vegetation, tilled soil, and pruned shade trees. To assess the impacts of these changes, we surveyed a 48m2 plot with a grid of 169 points spaced every 4m. At each point, we measured the proportion of exposed soil, herbaceous cover, and leaf litter by sampling with a 45cm2 quadrant before and after intensification. To assess biodiversity impacts, we surveyed the ant community at each point with tuna baits placed on the ground and arboreally. Management changes were compared with ANOVA and Tukey's posthoc tests. Ant community composition comparisons were made with NMDS plots and statistical differences were determined with PerMANOVA tests. **Results:** While shade cover did not change, leaf litter, herbaceous cover, and soil exposure showed significant differences ($p < 0.001$). Herbaceous cover decreased by 25.4%, while soil exposure increased by 22.7%. While the arboreal community composition did not differ before and after ($p=0.997$), the ground ant community was marginally significantly different ($p=0.058$). Several ant species decreased in abundance after intensification, including a biocontrol agent *Wasmannia auropunctata* by 42%. **Discussion:** The difference in soil exposure, herbaceous cover and leaf litter from the surveys showed that intensification significantly altered the local environment. The change in ground ant community composition suggests that disturbances to these environmental factors may have significant impacts on ground foraging ant communities. The decrease in W. *auropunctata* after intensification has implications for coffee farm biocontrol. This study shows how the impact of local farm intensification through loss of structural complexity in agroecosystems can negatively impact ant community composition and important ecosystem services.

Keywords: Agroecosystems, Ant Communities, Biocontrol, Intensification

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Can Forest Conservation Increase Food Production?

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Background: A significant proportion of land use change occurs at the interface between cropland and forests, impacting carbon storage, biodiversity, livelihoods and food security. While problematic "edge effects" are widely appreciated in terms of their ecological impacts, the unique conditions at forest patch edges are less understood from an agricultural perspective. Forest edges produce localized micro-climatic conditions that potentially enhance yields of crops in the agricultural matrix surrounding forest patches. If the benefits of forest patches in agro-forest mosaics can be quantified and understood, an obvious synergy could be forged using forest restoration to aid landscape management for multiple purposes. **Methods:** Our study site is situated in the central Ethiopian highlands. The study region displays a severe forest-agricultural gradient, with increasing forest cover from west to the east. We aim to use high spatial resolution satellite imagery from the RapidEye satellite series for the years 2015 and 2016 (autumn) to estimate wheat production using established relationships between spectral vegetation indices and productivity. Additionally, soil characteristic data from EthioSIS (Ethiopia Soil Information Service) will be used to determine and correct for autocorrelation trends in the soil. **Results:** Preliminary results are mixed. The west (and less highly forested) portion of the landscape shows a slight positive relationship between VIs and distance from forest whereas trends in the eastern region are inverse. We also control for the impact of underlying soil trends from east to west and found patterns in pH, % sand/silt/clay, organic matter etc. Future work will incorporate factors obtained from prior household surveys to characterize the impact of agricultural inputs on productivity trend. **Discussion:** Our results will supplement and support forest restoration strategies to support multiple objectives that include livelihoods that depend on both forest resources and agricultural. Understanding the spatial arrangement of trees and forest patches throughout the agrarian matrix is an important element of enhancing food security and livelihoods while also supporting forest protection for wildlife and conservation planning.

Keywords: agriculture, food security, forests

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How pasture management can influence in the ecological functions performed by dung beetles?

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Background: The rapid expansion of livestock is a major threat to native ecosystems, mainly in Brazil, as this country has the largest commercial cattle population in the world. Different types of management practices used on pastures can cause impacts both on soil biodiversity, and on the ecological functions performed by the associated organisms. Dung beetles (Scarabaeidae: Scarabaeinae) perform various ecological functions important for the maintenance of native and managed ecosystems, including especially dung burial and soil bioturbation. In this study we addressed the following question: 1) Are the ecological functions performed by dung beetles (dung burial and soil bioturbation) influenced by different forms of pasture management? **Methods:** The study was carried out in 25 cattle pastures located in the Triangulo Mineiro region, in southeastern Brazil. These pastures represent a gradient of management intensities, which reflect in variations in the density of cows, in the frequency of use pesticides (Ivermectin) and herbicides, and in the structure of the vegetation (density of isolated trees). In each pasture, 10 experimental arena were installed, and inside each arena we put 500 g of cattle dung. After 24 h we determined the amount of dung removed by dung beetles. **Results:** Our results shown that pasture management affects the rate of dung burial and soil bioturbation. Pastures with a higher density of isolated trees, and where the use of pesticides and herbicides is relatively low, showed greater activity of dung beetles. Patures with a higher density of isolated trees and smaller cattle density influence only in the dung burial. Patures with a higher density of isolated trees and smaller cattle density showed an influence only dung burial. **Discussion:** Dung beetles perform primary ecological functions which have consequences on other functions considered secondary (i.e., soil fertility and soil compactation). Pastures that have high densities of cows appear to support a lower density of dung beetles, and consequently have a reduction in the primary and secondary ecological functions provided by these insects. Similarly, the widespread use of Ivermectin has found to have negative effects on dung beetle populations. The results of our study may assist local farmers to adopt more sustainable

Keywords: Scarabaeinae, dung burial, bioturbation

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Oases of biodiversity: birds and butterflies in Thai forest monasteries

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Background: Despite efforts by scientists, governments, and civil society, rates of tropical deforestation continue to be higher in Southeast Asia than in any other region. Widespread poverty and corruption hamper "top-down" efforts by governments and other organizations to curtail destructive actions such as illegal logging and hunting. By partnering with religious leaders, conservationists can appeal to the moral/ethical sensibilities of local people in a "bottom-up" approach to the conservation of biodiversity. **Methods:** In order to understand how religious sites can contribute to conservation efforts, we surveyed birds and butterflies inside and outside fifty Theravada Buddhist temples in Northeast Thailand. These focal taxa were chosen as indicators of vertebrate and invertebrate diversity, and both taxa can be reliably identified to species without killing the organism, which is forbidden within the temples. Birds were surveyed by point counts and butterflies were caught with a net, identified, photographed and then released. **Results:** Observed and estimated species richness of birds and butterflies was higher inside temples than outside. Butterflies and birds were assigned to categories of conservation concern (very rare, rare, uncommon and common for butterflies and critically endangered, endangered, vulnerable, near threatened and least concern for birds). Temples harbored more rare species than the surrounding area. Many species only occurred inside temples when compared with surrounding areas and most species that occurred outside temples also occurred inside temples. Using already available sequence data for the species sampled, we constructed phylogenies to determine if temples support entire clades that do not exist outside of the temples, thus enhancing regional genetic diversity. **Conclusion:** Our study indicates that Theravada Buddhist temples in Northeast Thailand support relatively high faunal diversity and provide a sanctuary for rare species. We argue that these temples are currently unappreciated areas for biodiversity conservation in this region.

Keywords: biodiversity, conservation, butterflies, birds, Buddhism

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The cultivation of coca leaf as an alternative development for the Andean communities

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Since pre-colonial times, Andean-Amazonian communities in Colombia, Brazil, Ecuador, Bolivia and Peru have used coca leaf (*Erythroxylum* spp.) for nutritional, ritual and medicinal purposes. During colonial times, the cultural practices around coca leaf grew, as its stimulant and nutritional uses were required to incentivize work in mining and public infrastructure projects. Landowner controlled coca plantations were thus developed to supply dried leaf and alkaline complement (llipta) for the regional workforce. This led to the establishment of territories where economic development was structured around coca leaf commerce. With the passage of time, commercial practices surrounding coca leaf evolved. Current coca leaf uses extend beyond ritual / religious practices to encompass every day and nutritional uses. There is a modern industry based on transforming coca leaves for non-psychoactive applications. The Cauca Office of SENA (National Learning Service) in Colombia has proposed studying the varied uses of the coca leaf. This has contributed to the development of a broad product portfolio, featuring products like solid and liquid fertilizers, processed foods such as chocolates, and baked goods such as pastries, bread and biscuits. This product development proposition aims to create opportunities for local communities to develop greater proximity to their traditions and to increase the value of a raw material as interesting and versatile as the coca leaf. Finally, the authors believe that inter-institutional research and collaboration is key to building a holistic and actionable development model that promotes the quality of life of coca leaf growing communities, which require special attention.

Keywords: Coca, Andes, Desarrollo comunitario, Colombia

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Influence of the structure of an old landscape on the occurrence of endemic bird species

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Background: Analysis of the landscape structure through specific metrics and indexes are important tools to better understand the relationship between fragmentation, habitat loss and the consequent reduction of connectivity for biodiversity conservation. The Brazilian Atlantic Forest has large percentages of forest losses and holds great biodiversity, such as bird species. Our objective was to evaluate the landscape structure, from the distribution of the remaining forest fragments occurrence, and the abundance and richness of species of birds' endemic to the Atlantic Forest. We also analyzed which scale of the landscape was most important to determine the occurrence of species by associating their occurrence with the sensitivity to fragmentation. **Methods:** Playback was used to detect the presence of 10 species of endemic forest birds in 13 fragments of different sizes in southeast Brazil. We divided the scale into three levels and through several variables: Local (height, CAP and canopy), regional (% forest, urban% and RENDVI), landscape (area, core, prox. And dIIC). The analysis was by means of GLM models associating each species with the variable of each scale. **Results:** Positive and significant relationship was found among the analyzed variables in 48 models, being 12 - local scale, 12 - regional scale and 24 - scale. By means of the AICc and w values of each model determined which variables were most influential for species occurrence, being significant height, area, core and dIIC for 6 species. The height of the trees was the highest weight model, followed by the area of the fragment. Studies that consider multiple landscape scales represent a more refined way of understanding how fragmentation influences biodiversity. Combining data on the landscape from the macro to the micro we have seen here how several variables can influence the occurrence of forest specialists birds, suggesting them as good indicators for the landscape. The influence on the occurrence of species dependent on some type of habitat associated with landscape multiscale provides robust responses in determining important variables. The development of studies in the Atlantic Forest are fundamental to plan actions to recover and / or connect forest patches by reducing the distance between fragments, increasing connectivity in the landscape.

Keywords: Fragment, Brazil, conservation, Atlantic Forest

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Effects of CO_2 elevation and temperature on the development in millet *Pennisetum glaucum* (L.) R. BR

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Background: It is estimated that the atmospheric CO_2 concentration will rise to over 800 µmol/mol-1 and the temperature will increase between 2 to 4 °C by 2100. Such effects will affect the plant metabolism and consequently, the food production. In general, elevated CO_2 can raise the growth while the high temperature tends to prejudice along development. The present work aimed to evaluate the effects of increasing atmospheric CO_2 and temperature on the development of millet *Pennisetum glaucum* (L.) R. BR. **Methods:** The study was carried out in 2013 in open top chambers where 4 treatments were tested: environmental CO_2/ambient temperature: Ctrl; increased CO_2 (~800 µmol mol-1)/ambient temperature: +C; environmental CO_2/high temperature (+3 °C over ambient temperature): +T; and increased CO_2/high temperature: +C+T at the Federal University of Minas Gerais, Brazil. Seeds were germinated and grown in the chambers during 65 days. Plant height, number of leaves, stage of development, shoot and root biomass were compared between treatments (N=30 per treatment). All statistical analysis were performed with ANOVA and post-hoc Tukey test. **Results:** plant height ($p<0,001$) and number leaves ($p=0,028$) differed among treatments. Increased temperature treatments (+T and +C+T) were about 20% higher than treatments with ambient temperature (Ctrl and +C). There was no differences of plant height between Crtl and +C, and between +T and +C+T. The number of leaves was 5% higher in the +C+T treatment than Crtl. After 21 days, we observed that plants in treatments with addition of CO_2 and/or temperature began to anticipate one stage of development compared to control, maintaining this pattern until day 65. The first grains of millet were found after 60 days only in +C treatment. There was no difference in the shoot root ratio biomass among treatments ($p=0,138$). **Discussion:** These results indicate that the high temperatures estimated to 2100 will not affect negatively the growth of the millet. Elevated CO_2 concentration will anticipate the grain production, although it is likely the grain quality will be affected. At the moment, we are analyzing the productivity and nutrient content of these grains. **Financial support:** CNPq, FAPEMIG, CAPES.
Keywords: climate change, global warming, growth

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Long-term ecological research

Landscape-scale controls on aboveground forest C stocks along environmental gradients

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Background: Albeit the fact that tropical forests store large amounts of carbon (C) in aboveground tree biomass, the mechanistic controls on forest C stocks remain poorly resolved. Here, we aim at unraveling the mechanistic links between environmental controls such as edaphic factors (i.e. geology, soil type, topographic position) and climatic drivers (i.e. temperature, precipitation), and demographic parameters (species composition and vegetation structure) and how they determine tropical aboveground C stocks at the landscape-scale. **Methods:** To account for spatial variability permanent plots have been established in four forest types i.e. (1) hilltop (crest) positions, (2) slope positions, and (3) valley bottom positions, and (4) in secondary forests of about 15-25 years age stocking on abandoned pasture or agricultural land. These forest types are represented in five regional clusters i.e. La Gamba, Riyito, Rancho Quemado, Agua Buena and Piro and thus estimates of aboveground biomass will be investigated along environmental gradients on the Osa peninsula, Costa Rica. **Results:** Based on identification of >10.000 tree individuals and high-resolution investigation of tropical vegetation structure (i.e. diameter at breast height, total tree height) derived from terrestrial laser scanning we found that species diversity was positively related to aboveground biomass and C stocks. However, whereas carbon stocks differed between forest type, tree species diversity differed by geographic region. We identified spatial patterns of tree species composition and vegetation structure associated to environmental gradients, such that the first NMDS axis was positively related to aboveground C stocks, while the second NMDS axis was negatively related to tree species diversity. **Conclusion:** Our results indicate that inclusion of species diversity and vegetation structure, both associated to environmental gradients and thus shaped by geographic region and forest type should reduce uncertainty in estimates of aboveground C stocks across the landscape-scale. We conclude that resolving spatial patterns of tree species composition and vegetation structure associated with landscape-scale gradients of environmental drivers will be crucial to create a mechanistic understanding of how these factors shape the distribution of aboveground C stocks and will be key to accurately predict future responses of tropical aboveground C storage in future scenarios.

Keywords: Carbon stocks, Costa Rica, environmental change, landscape, long-term ecological research

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Character Bioacoustics White-rumped Shama *Copsychus malabaricus* (Scopoli, 1788) as a Cage-Bird

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Indonesian people love to keep songbird in cage to be competed, such as White-rumped Shama (*Copsychus malabaricus*). Each individual White-rumped Shama will be pitted their song and try to imitate the rhythm of the enemy with its songs. This study was conducted to see the natural song characters of White-rumped Shama and song character from birds that had been trained and comparison in three different places in West Sumatra. Individuals were recorded totaling 30 individuals in three areas in West Sumatra namely Padang, Solok and Pariaman and sound recordings of White-rumped Shama in nature were taken in HBW and Xenocanto website. Research has done conducted from June to October 2016 at place group practice of birdsongs and recorded at 16:00 to 18:00 pm. These voices were analyzed by Avisoft SAS-Lab Lite inform of oscillogram and sonogram. Measured parameters included: the length of voice, repertoire size, and number of syllable type. The results showed that repertoire composition of White-rumped Shama in nature less than the sound which were trained and have repeat songs composed by the same type of repertoire composition. Comparison of song character White-rumped Shama in three different places in West Sumatra, those birds in Solok had the best quality of voice or song than Padang and Pariaman. It showed by higher repertoire composition in Solok.

Keywords: *Copsychus malabaricus*, Repertoire Composition, Song Characters, Songbird, White-rumped Shama.

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Long-term monitoring of honeybees (*Apis dorsata*) and impact of ban on harvest in Western Ghats India

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Background: Honeybees play an important role in the forest ecology of tropical forests, besides supporting livelihood of the people. *Apis dorsata* contributes more than 80% to the total honey production in India. Populations are known to migrate distances of 50 to 100 km and forages around 200 species. The indigenous Soliga community that resides in the research site harvests around 15 to 18 tons of honey per annum. **Methods:** To estimate the number of bee colonies seventeen one-kilometre transects were laid along streams in different habitat types, and thirteen rock cliffs were marked permanently. Bee colonies were counted before and after harvest from 1995 to 2016 (22 years) to determine the interannual variability in colony numbers. **Results:** The density of bee colonies in the forest landscape coincides with the flowering season. After the flowering season, honeybees migrate to the agricultural plains, where crop plants are flowering. Bee colonies distribution showed distinct spatial variability related to habitat types. The highest densities of bee colonies were recorded in evergreen forests, followed by dry deciduous forests. The level of extraction was high in dry deciduous forest, followed by evergreen, and least in cliffs depending on accessibility. Results showed gradual decrease in bee colony numbers from 1995 to 2016. Across the year, overall number of bee colonies decreased in evergreen forest (R^2 = 0.77) and dry deciduous forest (R^2 = 0.76), which was significant. Bee colonies number remains more or less constant on rock cliffs (R^2 = 0.24). **Conclusion:** There was no increase in bee colonies numbers after the ban on harvest, harvest of honey might not be influencing colony numbers and that use of pesticides in the agricultural area, distribution of invasive species like *Lantana camara* as well as the loss of nesting trees might have impacts on colony numbers.

Keywords: Monitoring, Honeybees, Soliga community

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Posters
Restoration of degraded tropical ecosystems

Ecological restoration of Brazilian Cerrado area degraded using branches transposition and seed bank

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Background: The Cerrado is the second largest Brazilian biome - behind only the Amazon - is considered one of the last open agricultural frontiers in South America and the areas transformed by these activities already exceed 65 million hectares, representing more than 49% of its original area. In Brazil, there are more than 200 million hectares of degraded areas, which have different characteristics due to the intensity and type of land use. The ecological restoration of degraded areas is a set of actions aimed at re-establishment of conditions and sustainability in natural ecosystems. In order to evaluate the effectiveness of nucleation techniques, the transposition of brushwood and seed bank in a degraded area by mining were tested. **Methods:** The density and richness of species of the seed bank and brushwood were evaluated for 24 months in an Ecological Park in the Federal District, Brasília, Brazil. The transposition of the branches was carried out in areas of 100m, connecting the degraded fragment to an adjacent Cerrado area. The seed bank was collected in a Cerrado *sensu stricto* preserved area and deposited in 25 random plots of 1 m^2 each, with a control treatment. A variance analysis was performed to evaluate the effectiveness of branches transposition techniques and soil seed bank and their relation to the number of established plant species. For the diversity, the Simpson and Shannon indices were calculated, as well as Equitability (J). To study the similarity between the techniques, we used the qualitative indexes of Sorensen and Jaccard, which consider the presence and absence of the species. **Results:** Fourty-four species of plants were identified in brushwood and thirty species in the soil bank seed. In both treatments, the herbaceous plants were dominant, with more than 50% of the individuals. The diversity values were H '= 2.246 and Ds = 0.7921 for the brushwood and H' = 2.43 and Ds = 0.8552 for the seed bank. The equability (J) was moderate for the two techniques, but J was slightly higher in the branches transposition, indicating that the latter had a more homogeneous distribution than the seed bank. Jaccard's similarity was 0.27 and Sorensen's was 0.43, respectively, corresponding to a low similarity between the two techniques used. **Conclusion:** The execution of techniques was satisfactorily efficient for the recovery of areas degraded by mining.

Keywords: mined area, Cerrado, tropical savanna

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Facilitation potential by Brazilian savanna species

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Background: Faced with the demand for strategies that make restoration of tropical ecosystems viable, discussions have highlighted the potential of using interactions among species as a way to facilitate the success of ecological restoration. Therefore, the aim of this study was to investigate whether some tree native species from Cerrado (Brazilian savanna) would be facilitating the regeneration of woody species, either directly (improving environmental conditions) or indirectly (removing competitors). **Method:** The study was carried out in an area under restoration process (5 years), on the municipality of Paracatu, Minas Gerais state, Brazil. Facilitation potential was studied in three native brazilian savanna species: *Lithraea molleoides*, *Terminalia argentea* and *Peltophorum dubium*, comparing biotic (soil cover by exotic grasses (%); and number of regenerating woody individuals) and abiotic parameters (Luminosity in % of total light, by luximeter; soil moisture by gravimetric method, and soil penetration resistance by an impact penetrometer in MPa) on underbrush and in open fields. Comparisons were made with parametric and non-parametric analysis, and influence of abiotic variables as predictors for biotic variables were tested with generalized linear mixed models. **Results:** All native tree species were capable to reduce the colonization by exotic grasses (<25%), when compared to the open fields sites (83,16%). The number of regenerating individuals underbrush from *P. dubium* and in the openings (6,1 and 4,1 respectively) was higher than the other two microhabitats studied (<1,7). The main factor that explains these differences was the subsurface compaction, which were lower in *P. dubium* and in open fields. The changing of the subsurface could be caused by the fast growing of that specie and also seems to be affected by the exotic vegetation, due the lower resistance found at these sites. However, the use of exotic grasses in restoration programs isn't an option because of their aggressive seed dispersal and colonization in detriment of other native species, plus the fact that those exotics grasses produces very susceptible to fire materials. **Conclusion:** *P. dubium* showed good potential to been an facilitate. Even do the exotics grasses are reducing the soil compaction it isn't recommended their use in restoration programs due the problems on long terms.

Keywords: Exotic grasses; facilitation; soil compaction

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Divergent successional trajectories in 10-year old restoration settings

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Livestock activities have simplified former rain forest landscapes in Mexico. Ecological restoration is a conservation strategy to accelerate the process of natural succession in the agricultural landscape. Restoration plantings represent maximum intervention whereas exclusion of disturbance is considered minimal intervention. In 10-year-old restoration settings under minimal intervention and two combinations of plantings, we evaluate the composition of trees > 30 cm diameter at breast height (DBH, potentially reproductive trees). We expected that plots under minimal intervention have a tree composition different from that of plantings. The experimental design was established in 2006 in Los Tuxtlas, Veracruz, Mexico in 24 30 X 30 m plots: eight plots were planted with animal dispersed tree species, eight plots were planted with wind dispersed species and the remaining eight plots were excluded from the disturbance. We recorded 834 trees from 45 species. The pioneer *Cecropia obtusifolia* (Urticaceae), was present at all the intervention levels and was the most abundant species (94 Individuals). In the plantings of trees dispersed by wind, the pioneer tree *Heliocarpus appendiculatus* (Malvaceae) was the most abundant species (61 indivuduals) whereas at the plantings of trees dispersed by animals *Cecropia obtusifolia* was the most abundant (Urticaceae). Finally at the plots with minimal intervention, the non-pioneer tree *Bursera simaruba* (Burseraceae) was the most abundant tree. According to a PERMANOVA analysis, the level of intervention had a significant effect on the composition of the tree community, explaining 58% of its variation ($F_{2, 24} = 14.959$, $P < 0.05$). After 10 years, the composition of the community of potentially reproductive trees was significantly different among the restoration intervention. These settings may provide different structure and food for different groups of animal in this permanent agricultural landscape.

Keywords: Restoration plantings, Ecological restoration

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Birds diversity present in a restored forest and an urban park in the city of Merida, Yucatan

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Background: Urbanization is one of the major threats to species diversity because it reduces habitat area and resource abundance. However, restoring forest cover on previously degraded land has the potential to increase the number of species found in the urban landscape. The objective of our work is to compare bird diversity between a restored forest and an urban park in the city of Merida, Yucatan, Mexico. We expect that restoration will be associated with higher plant productivity and bird species richness. **Methods:** We surveyed birds weekly between March and December, 2016 in a restored forest and urban park in Merida. We recorded the number of unique species in each site for each week. We used the normalized difference vegetation index from Landsat to measure the productivity of both sites. **Results:** Overall, we recorded 111 species, with 88 in the reforested site and 69 in the more urbanized park. The restored forest was also more productive. **Conclusion:** Restoring tropical dry forest in previously degraded urban areas has the potential to support a more diverse assemblage of birds than would otherwise be there. In particular, the restored forest we studied made an important contribution to the overall bird diversity of the city of Merida. Our results suggest that the restored forest supported more birds than a nearby park because it was a more productive habitat.

Keywords: Birds, species diversity, Mérida, Yucatán

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Physical properties of mine tailings can inhibit the establishment of native seedlings planted

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Background: Mineral extraction is one of the most degrading activities for the environment due the remove of the superficial soil that content the higher fertility and also the natural vegetation. In cases that the recovery process doesn't occurs naturally, anthropic actions are required to guarantee the establish of the new forest, as native seedlings plantations and all the mine spoil management necessary to the restoration process reach success. Therefore, the study aimed to evaluate mine spoil quality in a former mining area that was submitted to restoration process by seedling planting and a native Cerrado (Brazilian savanna) area nearby to verify if there is any limiting property to the seedling development. **Method:** The study was carried out in the Minas Gerais state, in Paracatu city on the central region of Brasil. Was evaluated two areas, one was a former mining area where a native seedlings plantation was made (five years before) and the other is a native cerrado area nearby the plantation. The plantation soil was only handled on the planting lines by revolving it until 60 cm of depth and fertilization applied. Was evaluated soil density and total porosity on 0-20 and 20-40cm depth, for this, seven random sample points was collected from the hole planting of the dead seedlings and also from the two most abundant species of the plantation. In the Cerrado nearby was collected more seven random points. The statistics analyses was made by non-parametric test. **Results:** The average soil density values vary from 0,93 in Cerrado to 1,19 Mg m^{-3} in the Seedlings for 0-20 depth and 20-40 varies from 1,00 to 1,24 Mg m^{-3} for cerrado and Seedlings respectively. None treatment showed differences between depths. Cerrado showed lightly lower values then the others, although, density on the plantation area doesn't showed any critical values that could limit the root system development. Total porosity followed the same pattern from density and showed values around 0,55 M3 m-3 being lightly lower on Cerrado. **Conclusion:** The analyses didn't showed critical soil physical levels and it wasn't associated to the seedling mortality. The soil preparation in the plantation area was efficient, getting close values to Cerrado. Others studies must be conducted to find others limiting factors to seedling development as chemical soil quality.

Keywords: soil, restoration, mining

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Selecting useful tropical tree species for ecological restoration of fields with bracken fern

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Background: Tropical forests have suffered a severe and rapid conversion to agriculture around the globe. For example, Marques de Comillas tropical rainforest region, southeastern Mexico, endured a loss of 70% of their old-growth forest cover, with an increase in cropland and cattle pastures, in just 40 years. Degraded agricultural lands are often infested by aggressive species that slow or impedes natural forest regeneration and drive deforestation to open new arable lands. Active restoration is needed to reforest these infested lands. This study aimed to identify native tree species useful to restore fields infested by bracken fern, and assesses whether transplanted tree's performance (survival and growth) relates with plasticity in functional traits. **Methods:** A experimental site (1.5 ha) was established in a pasture infested by bracken, where 1,200 seedlings of 6 native tree species were transplanted, distributed in equal numbers between two treatments: with bracken (WB) and without bracken (OB); in the last treatment, all above-ground fern tissues were eliminated every month by machete. During one year the survival and size (height, number of leaves, and average leaf area) of surviving transplants were monitored. Also the variation in specific leaf area (SLA) and specific stem density (SSD) of transplants between treatments was quantified for each species. Finally, a performance index (PI = annual relative growth rate x annual survival rate) was obtained for each species. **Results:** Four species showed higher PI in the OB treatment; only one species performed better in the WB treatment. SLA showed significant differences between treatments for all the species, and PI was highest in species with larger SLA variation. **Discussion:** The results indicate that species obtaining a high PI in both the WB and OB treatments are potentially useful for restoring fields infested by bracken. We identified three developing strategies among transplanted species: plastic (*Cojoba arborea*), light demanding (*Tabebuia* guayacan) and shade tolerant (*Brosimun alicastrum*) This diversity of strategies showed that leaf functional traits change in different environments maximizing the capture of resources. Careful selection of species with high performance and plasticity, and the recurrent fern removal, are critical for restoring fields infested by *P. aquilinum*.

Keywords: *Pteridium aquilinum*, Active restoration

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Natural regeneration in understory of *Eucalyptus* sp. in Cerrado biome, Federal District, Brazil

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Background: The fragmentation of the Brazilian Cerrado was especially associated with the expansion of agricultural boundaries. In this context, the creation of sustainable plantations of eucalyptus became an alternative. Natural regeneration in the understory of forests with exotic species can demonstrate the capacity of biodiversity redoubt spontaneously. This study aimed to evaluate the natural regeneration of the understory eucalyptus stand. **Methods:** The study was carried out in Brasília, Federal District. Three eucalyptus areas were selected with different characteristics: Area 1 (A1) reformed stand in the year of 2012, that occurred a superficial fire in the year of 2011; Area 2 (A2) implanted stand by means of seeding around 12 years ago, where a fire occurred in 2011, which caused significant damages to the eucalyptus health; Area 3 (A3) implanted stand in the year of 2009, with no record of fire occurrences. The three stands are on Oxisol, with clay texture, and are adjacent to fragments of native Cerrado. Ten 10 x 10 m plots were randomly allocated in each of the studied areas. The natural regeneration, the basal areas of the eucalyptus and chemical properties of soil were evaluated in the sampling units. Parametric and non-parametric analyses of variance were carried out. **Results:** The soils of the three areas were considered acid and dystrophic because of the low values of base saturation (< 50%). Averages higher than 5,0 dag kg-1 are considered high. As for the basal area occupied by eucalyptus stands, the distinction between the three areas was determined. A3 presented higher average in this variable, whereas A2 presented the lowest one. Regarding the results obtained by the forest inventory of the regenerating community, 317 individuals were recorded, among which, 40 occurred in A1, 247 in A2 and 32 in A3, distributed among the plots. A2 presented a greater number of individuals in relation to A2 and A3, while they do not statistically differ in this variable. In A2, it can be noted that some species were recorded with relatively high densities, especially *Miconia albicans*, *Miconia* sp. and *Baccharis tridentate*. **Conclusion:** We conclude that the underbrush formed by eucalyptus plantations studied reflected more clearly distinctions for the parameters of density and species richness of regenerating strata. This factor can be linked mainly to the input light in each area.

Keywords: Fire, chemical properties, native species

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Potential of seed dispersion by birds using fruits offered in feeders

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Background: Atlantic forest in Brazil is one of the most endangered habitats in the world, suffering from degradation and fragmentation. This situation requires human action, which includes ecological restoration activities that could improve structural complexity of vegetation. **Methods:** This study is being held to verify the possibility of using a new technique of seed dispersion induction by birds in State Park Alberto Löfgren, São Paulo, Brazil. Ten seeds of three different sizes are inserted in a slice of papaya fruit, which is placed above a feeder. We used seeds of species *Psidium cattleianum*, *Ipomoea purpurea* and *Solanum concinnum* (big, medium and small, presenting approximate average volumes 92.1 mm3, 37.2 mm3 and 1.8 mm3) to test if they would be ingested in these conditions. Data is being collected using focal observation of three feeders, three days per month for each feeder, between 07:00h and 12:00h, for one year, starting in September 2016 and yet to be concluded. Seeds were considered consumed when we couldn't find them inside the fruit, above feeders or above a plastic put under the feeders. **Results:** Until the end of February 2017, we observed 1866 feeding bouts, i.e. number of times an individual went to the feeder in order to eat, more frequent in November and January, between 08:00h and 09:00h. Nevertheless, possibly those months aren't the best to apply the technique, since most of feeding bouts included carrying pulp to feed young. Data collection of remaining months will help enlighten the best period to apply it. Most frequent birds' species were *Turdus rufiventris* and *Turdus leucomelas*, considered good dispersers because of its habit of swallowing large pieces of pulp, hence the seeds with it. Birds consumed 90% of small seeds, 54,4% of medium seeds and 36,6% of big seeds, showing seed size interfere in ingestion rates. **Discussion:** Purpose of restoration in this case is to enrich fragments with regional late successional stage species, like *Palicourea marcgravii* and *Psychotria suterella* and *Enlicheria paniculata*. Although bird species registered more frequently in this study hardly consume seeds as big as *E. paniculata*, *Penelope obscura*, a less frequently registered bird species, certainly could. Our results indicate this technique could introduce herbaceous and shrub species of late successional stage in restored areas, increasing structural diversity of the vegetation and consequently.

Keywords: Behavior; Conservation; Frugivory; Ecological Restoration.

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Considering species-specific interactions complexity to restore semiarid tropical forests.

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Background: Plant interactions in semiarid regions are known for their potential to be positive. However, despite positive net effects, most interactions are species-specific. The use of plant interactions in restoration programs has been increasing. Nurse plants have the capacity to improve abiotic conditions and resources. However, there is a poor understanding on how species-specificity might affect restoration success. Most studies in semiarid regions are conducted on herbaceous or bush communities; therefore, there is still a gap of knowledge on semiarid forest interactions. The semiarid tropical Caatinga forest is one of the most diverse semiarid forests of the world. More than 50% of its territory is degraded and 13% is facing desertification, which makes restoration an urgent matter. Here we aim to understand plant interactions specificity for a range of tree successional stages and apply this information to restore degraded areas. **Methods:** Our work was developed at the National Forest of Açu, northeast Brazil. We conducted a factorial field experiment using 20 potential nurse species and three target species. Each pair-wise combination was replicated five times in 100 blocks in which target plants were transplanted bellow and far from the nurse plant canopy. We monitored target performance as survival and growth for 275 days. The effect of plant interactions was calculated using Relative interaction intensity - RII. The outcome of species-specific interactions was calculated with a GLMM with RII values. We proposed the best plant species combinations to optimize Caatinga restoration. **Results:** All nurse successional stages potentially facilitate and inhibit target species. Plant interactions are very species-specific for growth but not for survival. The same plant species can positively affect one target species and negativelly affect others. Moreover, the same plant species can change its effect depending on the variable measured (survival or growth). **Conclusion:** These results highlight the importance of understanding species-specific interactions to restoration proposes. The positive average effect of one nurse species does not necessarily represent a positive effect in all target species. Thus, we suggest a table of species combinations to optimize restoration based on species-specific matches. We suggest that future studies should consider plant interactions in a species-specific scale to improve restoration programs.

Keywords: Tropical Semiarid; Caatinga; Species-specific; facilitation

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Direct seeding of tropical tree to restore agricultural fields invaded by *Pteridium aquilinum*

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Background: Processes of ecological succession can exist in abandoned agricultural fields that could restore the dynamics of the ecosystem. However, the formation of mono-dominant patches of *Pteridium aquilinum* limits the arrival of seed dispersed by animals and inhibits the reestablishment of native species. Therefore, active restoration through the use of seeds and other propagules, is outlined as a way for the recovery of the original vegetation. Hence, we assessed the yield of direct seeding of native tree species, with a persistent type of life history, as a means to create shade and prevent the development of the heliophile fern. **Methods:** The study was carried out in the Lacandon Jungle, Mexico. The selected species are *Amphitecna tuxtlensis*, *Cojoba arborea*, *Dialium* guianense, *Lonchocarpus rugosus*, *Sapindus saponaria*, *Licania platypus*, *Pachira aquatica* y *Vochysia guatemalensis*. All the seeds were buried and sown under the fronds of the fern *P. aquilinum*. Two experimental treatments were proposed: 1) Level without granivory: the seeds were excluded in plastic cups 2) level with granivory. This treatment served as an open control. The experiment has been monitored at 3, 8, 16, 20 y 32 days. The measured variables were germination, removal and growth. **Results:** Of total planted seeds only 2.19% were removed. The exclusion treatment showed less seed removal (40%) and higher percentage of germination (32.22%). For this treatment, the species with the highest germination was *L. platypus* (60.82%) followed by *C. arborea* (56.57%). At level with granivory *A. tuxtlensis* germinated 51.4%, while *S. saponaria* (1.02%, 1.98%) had the lowest yield in both treatments. P. *aquatica* had the highest mean height (28.20 cm and 26.74 cm) while *V. guatemalensis* had the lowest growth (2.67 cm, 1-4 and 3.33, 1-3) in both treatments. **Discussion:** The exclusion of seeds probably decreased their removal. The results showed for *L. platypus* y *P. aquatica* are similar to those obtained in other ecological restoration projects, while for *A. tuxtlensis* differs from these, where this species has had poor yield in restoration, with the transplant method.

Keywords: restoration, bracken fern, no-pioneers seeds

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Forest management, functional and ultrastructural adjustments in plant species from Atlantic forest

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Background: The Atlantic Forest (AF) is under severe anthropogenic pressure and important efforts are underway to preserve this biome, such as forest management. A management plan with the removal of eucalyptus individuals has been carried out in a reserve of the AF in Brazil. Our objectives were to evaluate whether the management and seasonality (rainy and dry season, and herbarium samples) influence the carbon (δ13C) and nitrogen (α15N) isotopic composition of the main regenerating species of the understory; and if these species underwent ultrastructural, biochemical, morphological, and physiological alterations due to the management. **Methods:** Three species (*Xylopia sericea*, *Siparuna guianensis*, and *Byrsonima sericea*) were evaluated at four sites:1) secondary forest, 2) understory before removal of eucalyptus (BRE) and 3) after removal of eucalyptus (ARE) in the dry and rainy season of 2013 and 2014, and 4) herbarium samples (collected between 9 and 16 years ago). Gas exchanges, chlorophyll a fluorescence, specific leaf area, δ13C, α15N, C and elemental N concentration, and C/N ratio were determined and transmission electron microscopy was carried out. **Results:** Higher values of carbon assimilation (A) were observed in the rainy season ARE for the three species. There were reductions in A and stomatal conductance (gS) ARE, reflecting higher values of δ13C ARE than BRE. The α15N also presented the same pattern of δ13C as a function of management. No photoinhibition was determined in the three species. Specific leaf area decrease and disorganization of thylakoids, production of phenolic compounds and plastoglobuli BRE were observed. **Discussion:** Forest management promoted functional and structural adjustments in the three species. Isotope values suggest that BRE microclimatic conditions are similar to those existing years ago when the native species understory was initiating regeneration in abandoned eucalyptus plantations and can be used as recorders of the management and regeneration process. We suggest that ultrastructural changes may be an acclimation attempt for the maintenance of the flow of electrons in conditions of high irradiance, ensuring its species success in the regeneration of the native forest. However, this could promote dominance by a few species in a hotspot of biodiversity that contains a species diversity higher than most of the Amazon forest.

Keywords: gas exchange, tropical rain forest

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Are Restored Riparian Forests Efficient for the Conservation of Biodiversity and Ecological Process?

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Background: Experiments suggest that biodiversity enhances the ability of ecosystems to maintain multiple functions, such as, productivity and buildup of nutrient pools (multifunctionality). In tropical forests, several reforestation programs have been created to recover biological diversity in deforested environments. However, the relationship between biodiversity and multifunctionality has been neglected in natural ecosystems. **Methods:** We assess how reforestation and the distance from the forest matrix could recover the following parameters: richness, composition, abundance of mammals, birds, amphibians and reptiles, soil invertebrates including ants, bees and wasps and plant species in five fragments of recovered riparian forest southern Brazilian Cerrado. We also search for fruit disperser (birds) syndromes of pollination, seed rain, and leaf litter deposition. We fit two different types of models, ecosystem function and biodiversity models. Ecosystem function models included measures of ecosystem function as the response variable and all other variables as predictor variables. Biodiversity models included vertebrate and invertebrate diversity as response variables and site- and landscape- level variables as explanatory variables. **Results:** Land use intensity had strong effects on tree and vertebrate diversity and on invertebrate diversity after accounting for significant. The greatest variation across sites occurs in invertebrate evenness and tree diversity, with the oldest sites having the highest index values. Tree evenness and vertebrate evenness is approximately the same across all sites, regardless of age and core area width. Moderate variation is present in invertebrate and vertebrate diversity, with the highest index values present in the older sites. Changes in the evenness of below ground invertebrates, vertebrates, and trees as well as the diversity of above ground invertebrates and trees are associated with declines in ecosystem multifunctionality, with the association between tree evenness and ecosystem multifunctionality highest in magnitude. **Conclusion:** Applying the concept of BEF will be valuable for example, for assessing functional consequences of species' extinctions for different types of ecosystem functions along the sampling sites. If we are to understand these consequences, we need to extend our understanding of biodiversity and ecosystem functioning to multispecies interactions.

Keywords: Biodiversity, ecosystem functionality, landscape ecology

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Tuesday, July 11th, 2017
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Posters
Social and economical drivers of tropical ecosystem change

Sea Turtle Monitoring During Seismic Survey by R/V Maurice Ewing off Northern Yucatan Peninsula, MX

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Background: The Yucatan peninsula harbors some of the largest sea turtle populations in the Atlantic Ocean. Those populations widely use marine habitats for migration, mating, development and foraging along their complex life cycles. There is an open research line on the influence that seismic studies have on marine life, particularly on sea turtles. Given the need of information in this theme and the conservation status of marine turtles around the world, any experience assessing interactions between seismic surveys and marine life is of the highest importance. **Methods:** Observations for sea turtles took place as part of a monitoring and mitigation program during a Lamont-Doherty Earth Observatory (L-DEO) seismic survey off the Yucatán Peninsula during January-February 2005. The sound source was a 20-airgun array, with a discharge volume of 6970 in3, and was towed behind the R/V Maurice Ewing. The monitoring and mitigation program was implemented to minimize potential impacts of seismic sounds on sea turtles and cetaceans. Mitigation measures included (1) ramp ups of the array, (2) shut downs of the array (or power downs to a single airgun) if a turtle or cetacean was sighted within the designated safety radius, (3) no seismic operations at night or in Beaufort Wind Force >4. Observers watched for turtles from the flying bridge of the Ewing for a total of 434 hours or 4281 km. **Results:** Twenty-nine turtles were observed, including 17 hawksbill (*Eretmochelys imbricata*), 2 loggerhead (*Caretta caretta*), and 10 unidentified turtles. Most were sighted within 200m of the vessel and its array. Seven turtles were seen during airgun operations. Although mitigation measures were implemented immediately, these turtles were likely exposed to sound levels >180 dB re 1 µ Parms if they had been diving recently. The majority of turtles sighted during seismic and no seismic showed no relative movement with respect to the vessel, but were seen logging at the surface. Only one turtle was seen swimming away from the vessel during airgun operations; no other overt behaviors in response to the seismic vessel were observed. **Discussion:** During this cruise, there were not any evident negative impacts on observed sea turtles while the airguns were operating; however, some temporary avoidance was likely. More research is needed on the potential negative impacts on sea turtles; meanwhile, implementing mitigation measures, as done during this cruise, is key for preventing negative impacts.

Keywords: Seismic-survey, mitigation-protocol, monitoring, sea turtles

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Analyses of environmental impact assessment resolutives at the coast of the Yucatan peninsula, MX

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Background: The Environmental Impact Assessments (EIA) are a tool for decision makers to protect environments. In these, studies the potential and actual negative modifications caused by the development project to the environment are evaluated; and then the project is authorized or denied for its execution. In Mexico, the coastal development is fast developing, particularly in the Yucatan peninsula, where frequently marine life and their habitats are threatened by distinct urban development activities. In this context, the aim of this study was to analyze the final resolutions of EIAs submitted for projects in the coastal and marine zones in the Yucatan peninsula, Mexico, in the period 2009-2013. It was also evaluated the portion of those resolutions which included the order of implementing mitigation actions for protecting marine turtles and their habitats. **Methods:** We examined and extracted technical data from the resolutives of EIAs at marine and coastal zones of the Yucatan peninsula, submitted to evaluation to the Environmental Minister in Mexico (SEMARNAT) from 2009 to 2013. All the resolutives were available through SEMARNAT's webpage. We evaluated all the data using descriptive statistics and thematic maps, and reported any spatial pattern found. **Results:** It was in Yucatan where the highest number of EIAs was submitted along the study period (59%). Most of the EIA projects was related to habitational infrastructure on the coast (49%), and 80% of all the EIAs evaluated for the Yucatan peninsula in this period was authorized. Only 31% of the EIAs included mandatory mitigation actions for protecting marine turtles and their habitats. **Discussion:** This is the first time that an evaluation of this nature is done in the southeastern Mexico. It shows the need of better communication and coordination among decision makers and with other key stakeholders in environmental conservation, as the flux of basic information for management is not fluxing as it should be, as well as the available information is not used at its maximum potential by decision makers.

Keywords: Environmental-Impact-Assessments, coastal-marine-zone, Marie-turtles, Threats

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Children's knowledge of local wildlife in Southeastern Mexico

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Background: Degradation of ecosystems is a process that has grown at an accelerated rate in recent decades causing loss of species. This loss can be mitigated by promoting local cooperations with landowning communities. Local communities that manage and use their land, may be long-term effective conservation processes associated with natural resource management. It is common that landowners do not know the animal diversity present in their communities. Evidence suggests that in Latin American countries in the loss of biodiversity knowledge usually begins at an early age, causing a process of loss of local knowledge in the communities. In Mexico there are few cases that document the extent of children's knowledge of local biodiversity. **Methods:** In this study we present a first effort achieved in the southeast of Mexico. Using draws we evaluated children's knowledge of local fauna. The study was performed in six communities associated to the Protected Areas "Laguna de Terminos" and "Pantanos de Centla". Each of the drawings was digitized and entered into the "Atlas ti" software for content analysis. **Results:** A total of 219 drawings were obtained, belonging to 119 boys and 100 girls. For the results, three categories of analysis were defined: i) Others (clouds, sun, cars, etc) ii) domestic animals iii) exotic animals and iv) local animals. The most mentioned elements were: Others with 126; Fish 36; Culebra 16; Vegetation 40 and Birds 18. **Discussion:** Children have a low knowledge of the native species living in their communities. Parallel to the development of the drawings, children are asked if they visit the mountain (as they call the conserved vegetation) and only those children who accompany their parents to their activities manifest knowing native species. The information obtained established the structure for developing a non-formal education program that promotes the knowledge and importance of the native species present in the communities. Also it represents a guideline to investigate the knowledge that parents have about conservation areas and their species.

Keywords: conservation, drawing, socio eological approach

ID:486
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Perspectives of conservation from multiple actors: the case of the ZPE-Chicamole, Mexico.

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While Statal Natural Protected Areas (ANP'e) are part of the Mexican system on Natural Protected Areas (ANP's), their role in conservation is frequently undervalued, mainly in ecosystems that are at risk. The objective of this work was to analyse the process of legal establishment and governance of the Chicamole Ecological Preservation Zone (ZPE-Chicamole), which protects a tropical montane forest in the Sierra Madre Oriental, Mexico. Semi structured Interviews were applied to both governmental institutions and local inhabitants. Despite of the obtained differences on perception of the parts involved, these coincide that there were mayor conservation derivate from the ANP. In addition, the presence of well-defined community norms with regard on the use of natural resources (especially firewood and water), has encouraged forest conservation. This study shows how a small area is important on the system context of the Mexicans ANP's, by allowing a greater operability, be an example to other sites and increases the interaction of the biological connectivity between fragments. The challenges of the ZPE-Chicamole include the increase the interaction between the sectors, achieve that locals recognize explicit the ZPE-Chicamole, and fortify the social organization and the sustainable use of the natural resources, while increasing the actors inclusion.

Keywords: ANP, CESMO, governance, decision-making.

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Education in tropical ecology: results from an undergraduate Plant Ecology course

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Now more than ever we need to consider how the results of our research are reaching a wider audience. How can we make science accessible, in order to help developers and citizens make informed decisions about conservation? In a Teaching as Research project at Michigan State University, I observed that many undergraduate students in STEM have issues reading and interpreting scientific figures. I ran an intervention that involved a three-pronged approach to getting students more comfortable and effective in interpreting scientific figures. First, students were required to collect data from a semester-long greenhouse study on plant diversity; we these data analyzed as a class using the RStudio interface. Second, students were required to give in-class presentations in which they had to present multiple figures from two peer-reviewed articles, and tie them into a larger narrative. Finally, student ability to interpret scientific figures was continually assessed throughout the semester, using class discussions, homework assignments, and on exams. The results from these three approaches are presented here, and are compared to a control year in which the instructor team was the same but the intervention was not given. Overall, the presentations were very effective in improving student ability to interpret and discuss figures from the scientific literature. Exam scores did not significantly change between the control and the intervention years. Data analysis in RStudio increased student awareness of the processes involved in presenting data; however, there did not seem to be a strong correlation between the RStudio activities and student performance on figure-related questions on exams. I conclude by inviting discussion on how these methods might be more broadly applied across STEM in university undergraduate courses, field courses, and workshops.

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Beyond economic imperialism: bush-meat and the importance of social relations, place and time

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Background: Commodification of nature is entrenched in conservation science. Understanding 'rational' economic decision-making is considered helpful for resolving problems such as consumption bush-meat consumption because market values enable price-comparisons against apparent alternatives. Yet, economic sociologists argue that the neoclassical economic assumption of market exchange in modern capitalist economies may not be met in transitioning economies. Indeed, efforts to assess which species are inferior or normal goods clash with evidence that many urban households harvest wildlife, plus sharing and exchanging. Hence, in high-biodiversity areas of the Global South economic decision-making is submerged in social relations (related to trust, norms and power), and reciprocity and redistribution may be more prevalent than market exchange **Methods:** In this study we assessed the economic, social and seasonal drivers of bush-meat consumption and harvest in four road-less cities in the central/western Brazilian Amazon, located hundreds of kilometres from each other. We randomly sampled 200 households per city, split between the peak high-water and low-water seasons. We utilized a structured question and analysed data using multi-model inference. **Results:** Determinants of consumption by non-hunters varied among cities but was there was consistently higher consumption in rural-urban migrant households. In the remotest town, bush-meat was mainly gifted and consumption linked to poor, socially marginalized households, and as a wet-season fish substitute. In a busy trading town, consumption was linked to higher-income in the dry season whereas social relations - not wealth - facilitated access in the wet season, showing social networks mediate economic actions. In a larger town bush-meat was mainly purchased yet consumption was linked to social capital. Hunting was associated with large families, chronic/acute poverty, limited education and rural origins. **Conclusion:** First, although economists assume generalizability we show that social relations, place and time matter for understanding the 'bush-meat crisis'. Second, hunting appears to be a livelihood of last resort poor rainforest cities and may enable marginalized people to live more dignified, healthy lives in in the Amazonian 'pre-frontier'. This is particularly significant because these cities are characterized by high social vulnerability to environmental, political and economic shocks.

Keywords: cities; wildlife; hunting; Amazon

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Landowners reveal different expectations about a forest certificate trading scheme

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Background: In tropical countries there are a variety of schemes to promote compensation for environmental damage and forest loss. For instance, tradable permits are now being applied to the context of forest and biodiversity conservation. Landowners who need to compensate for over deforestation (hereafter as buyers) may trade with landowners who had forgone their deforestation rights (hereafter as sellers). Significant research has focused on factors influencing participation (such as payment value, contract duration, access to information) of landowners acting as sellers. Less is known, however, if these factors are of the same importance for potential buyers. **Methods:** We used Q-methodology to identify views and perceptions of conservation sellers and buyers within the forest certificate trading scheme in Brazil, the Environmental Reserve Quota (Portuguese acronym, CRA). Q-methodology identifies and clusters individuals according to distinct perceptions of a topic. Using a data reduction technique (PCA or Centroid Factor Analysis), the analysis reveals clusters which represent groups of participants who presented a similar sorting pattern. From our findings we developed a trade compatibility index to examine what factors act as barriers for trade for both buyers and sellers. **Results:** A total of 35 sellers and 24 buyers were interviewed. The analysis revealed three distinct perceptions for both sellers and buyers. While two sellers' subgroups showed strong conservation values, each of them state different motivations to participate. Only one buyers' subgroup demonstrated a concern for conservation. Two subgroups did not consider participation within CRA as an appropriate forest loss compensation strategy for them. The compatibility index illustrated that expectations on contract duration and price are the main barriers avoiding trade between sellers and buyers. **Discussion:** Our results suggest that CRA evokes different responses from sellers and buyers. In particular, expectations around contract duration appear to be the most prominent barrier to effective trade. We relate these findings to other long-term compensation options available for buyers that act as strong competitors and, therefore, keep buyers and sellers apart. Finally, we propose some policy-relevant insights that could potentially reduce the scheme barriers and make it attain its conservation goals.

Keywords: Amazon, Cerrado, Private-land-conservation, Tradable-permits

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Timber, Carbon and Money Scenarios for Forest Communities on the Yucatan Peninsula

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Background: Management of multi-species tropical forests becomes complicated when considering the species' physiological differences, the complex environment and the multiple forest products taken out. Required by the REDD+ early actions in the tropical forests of Yucatan, Mexico, all these conditions must be taken into account when trying to predict the repercussions of management scenarios. Business as usual, reduced-impact logging or complete conservation scenarios result in different outcomes of harvested timber, carbon and revenue. Accurately predicting these outcomes supports the management decisions regarding the forests, even outside REDD+ programs. **Methods:** With this in mind, we created a simulation model that predicts potential timber, carbon and income from a set of management scenarios of the forests in the Yucatan peninsula. Different silvicultural techniques, such as minimum cutting diameters, directional logging, cable yarding, improved trail planning and gap enrichment have an effect in our final simulated volume, aboveground biomass and income. This is a stochastic individual-based model calibrated to regional growth, mortality, recruitment and population distributions of commercially important species as well as the potential local hurricane damage. **Results:** We found that RIL activities can reduce the amount of emitted carbon by 0.2 MgC per cubic meter. The simulation also highlights the importance of effective enrichment in the sustainability of the forest and the benefits of cable yarding for carbon retention. **Discussion:** We intend to continue the improvement of this simulation model, and it is open for anyone to use, modify and improve. The simulation also has a user-friendly interface that can be used as a tool for forest managers, government officials, technicians and scientists to generate discussions about management strategies and decisions taken in the Yucatan or other tropical forests.

Keywords: Simulation, opensource, R, communities, mahogany

ID:28
Tuesday, July 11th, 2017
Poster Board: 72

Posters
Invasive species

Effects of *Casuarina equisetifolia* invasion on understory plant cover, soil, and litter nutrients

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Background: *Casuarina equisetifolia* (Australian pine) is invasive throughout The Bahamas, where it dominates beaches, disturbed sites, and forest edges. Although *Casuarina* represses native plant growth through formation of a dense mat of litter on the forest floor and allelopathy, some studies have suggested that *Casuarina* litter could be used as an agricultural amendment. The objectives of our study were to: (1) investigate the effects of *Casuarina* litter removal on the understory plant community, (2) compare soil characteristics between invaded and non-invaded sites, and (3) analyze *Casuarina* litter nutrient concentrations. We hypothesized that: (1) removing *Casuarina* litter results in increased cover of understory plants, (2) soil properties differ between sites with and without *Casuarina*, and (3) the C:N ratio of *Casuarina* litter decreases with depth. **Methods:** We conducted our study in Eleuthera, The Bahamas. At sites with *Casuarina*, we established paired plots at individual trees, removed litter from one plot, and assessed understory plant cover before and one year after litter removal. We collected soil samples and *Casuarina* litter from five sites with *Casuarina* and collected soil samples from five sites without *Casuarina*. We measured soil organic matter, pH, and ammonium, and litter nitrogen (N) and carbon (C) concentrations. **Results:** There was no effect of litter removal on percent cover of understory plants. Soil organic matter (SOM), soil pH, and soil ammonium did not differ between sites with and without *Casuarina*. However, there was significant variation in SOM, soil pH, and soil ammonium among sites with *Casuarina*; the site with the highest pH had the lowest SOM and soil ammonium. Litter N increased with depth, resulting in a decrease in litter C:N with depth. **Discussion:** The physical presence of *Casuarina* litter does not appear to inhibit the growth of understory plants. Allelopathic effects of *Casuarina* or a deficient soil seed bank of native plants could limit understory plant growth or recruitment. Time since invasion, a factor that we did not account for, may explain the large variation in soil characteristics among sites with *Casuarina*. The lower C:N ratio of deeper litter suggests that it is more decomposed and has potential for use as an agricultural amendment. Further research should investigate the ecological and agricultural implications of *Casuarina* invasion in The Bahamas.

Keywords: allelopathy, Eleuthera, nitrogen, The Bahamas

ID:57
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Poster Board: 1

The impact of invasive fungus (*Puccinia psidii*) on the growth of Australian rainforest Myrtaceae

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Background: Since *Puccinia psidii* was first detected in Australia in 2010, the pathogen has spread rapidly, infecting up to 350 Myrtaceous species. A high number of susceptible species are found in the tropical and sub-tropical rainforests of Queensland, where the climate is ideal for disease development by *P. psidii* throughout most of the year. The aim of this study was to assess the impact of the disease on growth of a range of Queensland rainforest Myrtaceae. **Method:** In a shade-house pot trial, fifteen replicates of eight species of Myrtaceae previously described as having varying susceptibility/resistance to *P. psidii* were inoculated monthly with urediniospores. An equal number of control plants grown under the same conditions were protected against infection by the pathogen through regular applications of two systemic fungicides. These fungicides were shown to have no impact on plant growth in a separate experiment. After 12 months, plant height, stem diameter at the base, and above and below ground dry weight were measured and compared to measurements taken at the start of the experiment to determine differences in growth between control and inoculated plants. **Result:** Our results show that P. *psidii* had a varying impact upon growth of the Myrtaceous species investigated. Several species developed extensive visible disease symptoms, while no symptoms were observed on others. The growth parameters of inoculated plants from one susceptible genus (*Gossia*), was higher than control plants, while growth of a more resistant genus (*Syzygium*) was lower in the inoculated plants than the control plants. **Discussion:** This result may indicate that different defense mechanisms against infection from *P. psidii* are employed within the Myrtaceae family. Lower growth in inoculated plants may be attributed to physical or chemical induced defense where resources are reallocated away from growth. The increased growth in more susceptible species could be attributed to compensatory growth in response to pathogen attack. Changes in plant growth and structure are likely to influence competitive fitness in natural environments. This may lead to long-term impacts in rain-forest communities, as well as the food webs that they support. The long-term impact of *P. psidii* in the field requires further study, as does the flow on impact at a plant community level.

Keywords: *Puccinia psidii*, Myrtaceae, Rainforest pathogen

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Invasive biocontrol harlequin ladybird (*Harmonia axyridis*) foraging rate compared to local species'

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Background: Invasive species cause an array of ecological, economic and health impacts on invaded ecosystems. A common way of introduction and dispersal of invaders is the use of pests' biocontrol. The harlequin ladybird (*Harmonia axyridis*) is a well-known biocontrol agent originally from Asia that has established invasive populations in 60 countries around the globe. The aim of our study was to compare the foraging efficiency of invasive against native ladybirds' when preying on aphids. **Methods:** Native ladybirds *Hippodamia convergens* and *Cycloneda sanguinea*, and invasive *H. axyridis* were collected daily from cornfields in Morelia, México. Ladybirds were kept in individual insectaries without being fed for a day. To start the trials, each one was given a bean leaf with 10 aphids and its foraging behaviour was observed during 45 minutes. We recorded the time before the first aphid was captured, consumption time, search time to find the next prey and total number of aphids consumed. **Results:** Contrary to our expectations, the invasive ladybird was not the most efficient when foraging; the native *C. sanguinea* was the species with the highest consumption rate. There were no differences between *H. axyridis* and native *H. convergens*. **Discussion:** *H. axyridis* is a generalist voracious predator widely used as a biocontrol agent and is considered a threat to local species because it could outcompete and even predate on them. Our study provides evidence to consider it might not be the most efficient biocontrol agent when compared to other native ladybirds, which moreover left out the invasive species threats to biodiversity. When selecting a biocontrol agent site-specific research needs to be done on the accuracy of the species to be used. Native species might deliver the same and even better benefits than invasive species when used to control pests.

Keywords: behaviour, foraging, efficiency, biocontrol

ID:300
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Poster Board: 3

Ecological Restoration in a Biological Invasion, Approach from the Bogotá Botanical Garden.

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The Bogotá Botanical Garden José Celestino Mutis has advanced processes of ecological restoration since 1998 in places such as Usme, San Cristobal, Santa Fe, Chapinero, Usaquén, Suba, Engativá, Fontiban, Kennedy, Bosa and Rafael Uribe Uribe in the Capital District, with under different levels of disturbance, recovering and rehabilitating around 500 hectares and incorporation 210,000 plants of 113 native species (Solorza-Bejarano, 2015). Currently, activities are being carried out in six (6) pilot research areas in ecological restoration with the implementing strategies aimed at the recovery and rehabilitation of natural areas ecologically important. Around the management of biological invasions, has worked on the control species such as *Acacia decurrens*, *Acacia melanoxylon*, *Eucalyptus globulus*, *Genista monspessulana*, *Pennisetum clandestinum*, *Pinus patula*, *Pinus radiata* and Ulex europaeus, among others (Hernández-Pineda, 2015; -Zuleta, 2015 Rojas-Botero, 2015). Case study: *Ulex europaeus* L. Invasion in the Capital District. The locality of San Cristobal, located to the south of the capital of the country, is one of the areas more affected by the presence of this species. For this locality, the activities were conducted in three (3) areas: La Arboleda Metropolitan Park, Quebrada Morales and Las Brujas Park. In these areas we implemented mechanical handling techniques, with the process of cutting of the plant in standing, dissociating their roots, stacking and chopping of the plant structures; waste management techniques, its processing allows the product to be used for the production of compost. In addition, the technique of biocontrol used, certain plant species of different growth habits are incorporated into floristic arrangements that allow the adaptation of original characteristics of the ecosystem. The results show that in the case of La Arboleda, the strategy of re-introduction of native species was able to exert pressure on the exotic species in competition for light, space, and resources by which the process of the regrowth is slow. In the case of the Las Brujas Park, the continuity of work of mechanical type with the use of scythes manages to easily depletes the seed bank, although the flow of people and animals leads to the recolonization of the species. In terms of the Quebrada Morales, there is evidence of competition between the chusque (*Chusquea scandens*) and the gorse, tending to prevent its colonization.

Keywords: Ecological restoration, *Ulex europaeus*, invasive species and management techniques.

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Wednesday July 12th, 2017
Poster Board: 4

Posters
Structure, function, and dynamics of tropical ecosystems

Temporal dynamic of tree diversity in the context of forest management, Brazil.

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Background: Brazilian Amazon Forests have been used for the purpose of timber supply, through conventional logging (CL) and reduced impact logging (RIL) practices. Logging of commercial species and accidental death of other species may alter environmental conditions, leading to the increase of abundance of some species and reduction of others, thus modifying forest structure and diversity. The Species Abundance Distribution (SAD) is one of the best ways to express diversity, because it is a parametric approach, independent of sampling size and it is related to how species share resources. We have hypothesized that forest exploitation may alter the abundance of some species, which is reflected in SAD. **Methods:** Three permanent plots (24.5 ha) were established in 1993 at Paragominas, Pará, Brazil. All trees with DBH ~ 25 cm were registered. After this first survey forest management was conducted in two plots (RIL and CL), and the third plot was the Control. The plots were surveyed in 1994, 1998, 2000, 2006 and 2009. We used the correlation parameter from the bivariate Poisson Lognormal distribution in order to compare both species composition and abundance. We compared the plots in 1993 (before exploitation) to the ones in the years that followed. This correlation parameter varies from -1 to 1, if the value is 1, both communities contain the same species with similar relative abundance. **Results:** The correlation parameter was 1 for the Control treatment, comparing 1993 to the other years, indicating that species were the same, with similar relative abundance over this period. In RIL and CL, changes in composition and abundance were detected in 2009 (correlation was 0.98 and 0.96, respectively), which means that some common species are becoming rare while rare species are becoming common. **Discussion:** The main mortality cause in forest management is the accidental death of non-targeted trees. Because of the dominant role of random deaths of individuals of different species, management practices have not led to immediate differences in community structure. However, as time goes by, we notice the beginning of small changes. The relative abundance of some species have been altered in exploited forests, which is reflected in changes in the correlation parameter. Due to the long life cycle of the trees and their low growth rate, long-term studies are needed to understand the impacts of exploitation on tropical forests.

Keywords: species abundance distribution, parameter, Amazon

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Poster Board: 5

Functional Traits Variation of Tree Communities Along an Altitudinal Gradient in Southern Brazil

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Background: Understanding vegetation functional traits variation along altitudinal gradients is important for predicting the effects of climate change on forest ecosystems. Therefore, we aimed to study the functional traits variation of tree communities of the Atlantic Forest located along an altitudinal gradient in Southern Brazil. **Method:** We selected three forest remnants, in advanced stage of succession, located at different altitudinal levels (1,600 m, 900 m and 700 m), in Southern Brazil. In each area, the most abundant tree species were evaluated regarding their functional traits (wood density, leaf area, specific leaf area, potential maximum height, leaf renovation regime and dispersion syndrome). We analyzed the data through cluster dendrogram, community-weighted mean of trait values, and parametric and nonparametric tests. **Result:** Along the altitudinal gradient, we observed changes in leaf renovation regime, dispersion syndrome, leaf area, specific leaf area, wood density and potential maximum height). The highest site (1,600 m a.s.l.) showed shorter trees, with smaller leaves and harder woods, and a greater representation of evergreen animal-dispersed species, when compared to the lowest sites (900 m a.s.l. and 700 m a.s.l). **Conclusion:** We concluded the Atlantic Forest areas in Southern Brazil showed high functional traits variation along the studied altitudinal gradient. This result can be explained by historical events (e.g. tree species migration in response to past climate changes) and environmental conditions (e.g. abiotic filters).

Keywords: Deciduous forest; cloud forest; fragments

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Poster Board: 6

Abstinence in tropical trees: implications for pollination and the persistence of rare species

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Methods: We collected phenophase data for twenty-two tree species during the peak flowering season of 2016 in the 50 ha Korup Forest Dynamics Plot in Cameroon and asked how the occurrence and location of individual reproductive events were related to adult abundance patterns in the community, using nearest neighbor spatial statistics and linear regressions. **Results:** The number of co-flowering individuals was significantly negatively correlated with total adult abundance, with abundant species having a smaller proportion flowering individuals. Species nearest-neighbor spatial patterns were more aggregated than random for both total adults and flowering individuals, however nearest neighbor distances of flowering individuals were increased relative to nearest neighbor distances of total adults. **Discussion:** By functionally lowering the abundance of common species, intraspecific patterns of flowering may level the playing field somewhat between rare and abundant species. This could reduce fitness costs for rarer species due to interspecific competition for pollinators, while at the same time also reducing fitness costs for common species due to intraspecific competition for pollinators. In addition, if flowering ability is resource-dependent and rarer species benefit from low intraspecific competition for abiotic resources, this may explain the higher proportion of individuals of rare species flowering. Thus, the "rare species advantage" may in fact allow such species to maximize the size of their mate pool, and help them cope with pollination despite their low numbers.

Keywords: relative abundance, pollination, biodiversity, trees

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Poster Board: 7

Floristics and structure in a rocky outcrop cerrado

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Background: The rocky outcrop cerrado flora is composed of widely distributed species and by endemic species of high altitude rock outcrop areas. The vegetation on canga is distributed in restricted areas and associated to important deposits of iron. These areas are amongst the most threatened ecosystems and there are no studies in rocky outcrop cerrado in Minas Gerais State or in cerrado on canga for the entire Brazilian territory. The aim of this study was to characterize the floristic composition, structure and diversity of the rocky outcrop cerrado in the county of Rio Paranaíba-MG and to analyze the similarity of these cerrados with other rock outcrop cerrados in Brazil. **Methods:** Five fragments were evaluated through usual phytosociological methods; the floristic composition and structure were compared with other studies performed in brazilian cerrados. Phytosociological parameters, eveness and diversity were calculated using the FITOPAC software. The richness, structure, and diversity of this study were compared with the other studies by the Student's t-test. To evaluate the floristic similarity between the areas, the TWINSPAN divisive cluster analysis was used. **Results:** The Rio Paranaíba rocky outcrop cerrado exhibited 72 species, 45 genera, 30 families and greater floristic similarity with deep soils cerrado. There were no indicative species of the rocky outcrop cerrado, however there were typical species of this on other rocks. The basal area was significantly larger in the deep soil cerrado in relationship to the rock outcrops (t=3,17; p= 0,02); however, density (t= 1,24; p=0,26), richness (t= 1,33; p =0,24) and diversity (t=1,23; P=0,28) did not differ. Eveness was lower in the rocky outcrop cerrado of this study (J= 0,67) compared to others. **Discussion:** There are many dominant species and the diversity is lower than that found in other studies, which can be explained by the rocky outcrops high coverage that restricted places for plants establishment. The Rio Paranaíba rock outcrop cerrado woody flora is a wide distribution species mix of the cerrado sensu lato. The highest similarity between the Rio Paranaíba rock outcrop cerrado and deep soils cerrado can be explained by the canga ferruginous nature, which is more similar to the latosol than the quartzite or arenite rock outcrops, demonstrating the influence of substrate on the species distribution.

Keywords: rocky outcrop, canga, floristic similarity.

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Free living N2 fixation in the Imbalance-P experiment on French Guianese pristine rainforests.

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Background: Free living nitrogen fixation is thought to be an important contributor to high nitrogen availabilities in tropical ecosystems. However, our knowledge of controls over free living nitrogen fixation remains poor. **Methods:** We set up plots along a topographical gradient at two forest sites in French Guiana and measured free living nitrogen fixation in soil and leaf litter layer. We used two different techniques: the Acetylene Reduction Assay and 15N2 enrichment labelling. Along with fixation we measured available nitrogen, phosphorus and molybdenum to see how that correlates to the measured fixation rates. **Results:** We found very low N2 fixation rates which correlate with soil phosphorus availability. Activity was greatest in the wet season and higher in litter than in soil. Available nitrogen, phosphorus and molybdenum was low in both sites. **Discussion:** Compared to other tropical studies measuring free living nitrogen fixation, our rates were very low, likely attributable to the extremely low soil phosphorus availability on the Guiana Shield. This means N inputs coming from free living fixation are marginal and thus the N rich status of the forest is due to other processes.

Keywords: N-Fixation Phosphorus French-Guiana Stoichiometry

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Poster Board: 9

Spatial variation of photosynthesis in tropical pristine forests: saplings vs. adults

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Understanding what determines the spatial variation of photosynthesis is crucial for modeling canopy photosynthesis. Within canopy variation is often explained by leaf stoichiometry. Trees optimize their nitrogen allocation to maximize photosynthetic capacity under the different light conditions. The role of phosphorus in this relationship is still uncertain. Since the tropical forests of French Guiana are very poor in soil phosphorus availability, they represent ideal case studies to assess whether or not variation in leaf phosphorus contributes to the vertical variation in photosynthesis. We carried out 840 gas exchange measurements at different height levels in the canopy of 12 plots distributed over three topographic positions. We compared gas exchange of upper canopy, lower canopy, and ground vegetation. Here we will present how Amax (light-saturated photosynthesis at ambient CO_2) and the photosynthetic parameters Vcmax (maximum carboxylation rate) and Jmax (maximum electron transport rate) relate to soil nitrogen and phosphorus availability and to leaf stoichiometry.

Keywords: photosynthesis, spatial-variation, vertical-profile, stoichiometry, gas-exchange

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Poster Board: 10

Linking plant functional traits to demography in a fragmented landscape

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The objective of this study is to identify if there is a link between some functional traits and demography of three palm species (*Astrocaryum aculeatissimum*, *Euterpe edulis* and *Geonoma schottiana*) in response to habitat fragmentation. This study was carried out in five fragments (two big and three small fragments) of Atlantic forest located in southeastern Brazil. In each fragment, we censused palms in nine 30 m x 30 m plots. All individuals of the palms species were tagged in 2005. The survival of the plants was subsequently monitored in 2006 and 2007. All new plants were also tagged. Summary matrices describing the dynamics of the populations in each fragment type in each transition year (2005-2006 and 2006-2007) were constructed. For each matrix, we calculated the asymptotic population growth rate (α). In 2015, for each species and fragment we selected 15 individuals in the same plots of demography for functional trait measurements. Traits measured were height, stem basal diameter, nondestructively chlorophyll concentration in leaves, leaf-saturated weight, leaf thickness, specific leaf area, leaf dry matter content, quantum efficiency of photosynthesis, maximum electron transport rate and minimum saturating irradiance. *A. aculeatissimum* populations were stable in both years and in both type of fragments. *E. edulis* populations in the large fragment were projected to decline due to intense monkey predation and were stable in the smaller fragments along the years. *G. schottiana* populations were stable in the large fragments along the years but population located in the smaller fragments in the second year were projected to decline. Most of the traits measured were related with species characteristics, not with the fragment size. E. *edulis* individuals had bigger stem basal diameter at large fragments. E. *edulis* and *G. schottiana* had higher leaf area and thickness at large fragments. *G. schottiana* presented lower mean chlorophyll content at small fragments. On the contrary, *A. aculeatissimum* and *E. edulis* had lower values at large fragments. Quantum efficiency of photosynthesis for *A. aculeatissimum* increased significantly from small to large fragments. *G. schottiana* has morphological and physiological traits of a shadow species and is demographically affected by forest fragmentation. On the other hand, *A. aculeatissimum* and *E. edulis* are species that could lead with higher incidence of light and are not affected by the forest fragmentation.

Keywords: population ecology, palms, forest fragmentation

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Poster Board: 11

Synchrony between bird migration and fruit phenology during fall migration on the Yucatan Peninsula

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Background: To migrate successfully, birds must rest and refuel by consuming fruit in stopover habitats. In northern latitudes, fruit production coincides with fall bird migration. However, in the tropics, plants produce fruit throughout the year; it is unclear how much fruit is available for birds on stopover. Moreover, during migration there is turnover in the composition, quantity, and quality of fruit. Here, we describe the phenology of fruit production during fall migration at two sites of coastal dune habitat on the coast of the Yucatan Peninsula. Because birds make an all-night crossing of the Gulf of Mexico, coastal dune is where birds first land to refuel. We sought to understand the degree of synchrony between migratory bird abundances and fruit production and identify the plant species that provide fruit to birds during stopover. **Methods:** From Aug. 8 - Nov. 14, 2016, we caught birds daily and measured fruit abundances weekly at El Cuyo, Yucatán and Isla Contoy, Quintana Roo. We captured birds at 10 (El Cuyo) and 11 mist nets (Contoy). We counted fruit on both sides of each net. We also counted fruit on 50 (El Cuyo) and 15 (Contoy) randomly chosen individual plants. **Results:** At El Cuyo, bird abundances peaked in late August and early September, which coincides with peak production of *Metopium browneii*, the most abundant fruit at the site. Birds still arrived in large numbers until mid-October; *Chiococca alba* was the dominant fruit at this time. On Isla Contoy, bird abundances peaked in early September, which coincides with the peak fruiting of *Erithalis fruticosa*, the most abundant fruit at the site. Overall, fruit species richness was higher on El Cuyo than Isla Contoy (7 vs 3 species) though in El Cuyo, 11 species known to produce fleshy fruit did not do so during fall migration. **Conclusion:** Our study provides the first description of the phenology of fruit production of the Yucatan Peninsula's coastal dune habitats, which are critical stopover sites for birds crossing the Gulf of Mexico during fall migration. At El Cuyo, there is turnover among *Metopium browneii*, *Chiococca alba*, and *Thrinax radiata*. Meanwhile, at Isla Contoy, *Erithalis fruticosa* peaks early in migration but then stays relatively stable until the end. At both sites, bird migration coincides with peak production of the most abundant fruit, suggesting that these plant species may be an important resource for birds during their stopover.

Keywords: Phenology, migration, stopover, coastal dune

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Distribution of fruit-feeding butterflies: are ecotones a particular type of canopy?

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Methods: This study was carried out in the Rio Doce State Park, Atlantic rainforest, Brazil (19048'-19029'S e 42038'-42028'W), where forest surrounds a natural lake system. Butterflies were sampled over 12 months, from August 2015 to July 2016, in 9 transects in forest interior, forest-lake ecotone and anthropogenic edges. Each transect received 10 bait traps of a fermented mix of banana and sugar cane juice, left for 48 h and 25 m apart of each other, alternating in canopy and understory. **Results:** In total, 11598 individuals of 73 butterfly species belonging to subfamilies Charaxinae, Biblidinae, Satyrinae and Nymphalinae were collected. Although the understory has a greater abundance and an equivalent number of species (6698 individuals, 87 species), rarefaction reveals a richer canopy (4896 individuals, 88 species). Canopy and understory have distinct species assemblages in all areas, and the ecotone had a species distribution more similar to the forest interior than to the anthropogenic edge. The density distribution of the subfamilies/tribes per stratum shows that the ecotone has similarities with the forest interior, such as a greater abundance of *Brassolini*, *Morphini* and *Satyrini* in both understorey. However, there are idiosyncrasies, such as Biblidinae been found with greater abundance in the forest interior canopy and in the ecotone understory, or Charaxinae, a dominant group in the interior upper canopy, and equally abundant in the ecotone's understorey and canopy. **Discussion:** Our study showed that canopy is richer and has fewer individuals than understory, and that ecotones are more similar to the forest interior than to anthropogenic edges. In natural ecotones, the trees bent towards the ground level occupying the space in search for light, thus creating a particular habitat similar to canopy in surface and structure. The study was supported by CNPq, CAPES and FAPEMIG. AVLF thanks BIOTA-FAPESP, NSF, CNPq and USAID.

Keywords: Atlantic Forest, edges, Nymphalidae, stratification.

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Nitrogen dynamics in a groundwater dependent ecosystem of the Amacuzac basin

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Background: Conservation has recovered an integrative vision, where physical components such as hydrology and geology are considered as relevant as biological components. Understanding how nutrients and elements move within heterogeneous landscapes is of fundamental importance in understanding the functioning of riparian ecosystems. Factors that most influence nitrogen (N) dynamics in the riparian ecosystem are: the characterization of waters of different sources, the type and amount of dissolved organic compounds in those waters, the composition of microorganism communities, and the residence time of water in the riparian zone. We analyze whether temporal variations and anthropogenic activities have any significant effect on the N rates, in a groundwater dependent ecosystem, "El Salado" river, which is a tributary stream that flows into the Amacuzac River, in Morelos, Mexico. **Methods:** This tributary was bimonthly characterized hydrogeologically during 2016, by measuring the flow rate as well as, total ions and trace elements across six sections located along the stream. Basal respiration was evaluated at these sections as a measure of microorganism activity, in which the amount of nitrates, ammonium, carbon and total nitrogen were determined. In order to measure anthropogenic impact, ion exchange resins were located in one of these sections that coincided with agricultural activity point. Resins captured nitrates and other soluble salts leaching from pesticides products. **Results:** Groundwater baseflow discharge was around 700 l/s, while the inflow during rainfalls reached 2,700 l/s. Based on the geological properties of the basin and the flow data, we suggest the system has three groundwater flow types: a deep, a shallow and a disturbed shallow runoff system. The later probably related to anthropogenic activities. There were no significant differences of the physicochemical parameters among stream sections, but there were marked differences between the months sampled. Additionally, the mineralization rates vary in time and space, accordingly to the anthropogenic influence. **Conclusion:** Temporal and spatial variabilities in nitrogen dynamics help to explain the influence of transfer mechanisms in this groundwater dependent ecosystem. It can be assumed that the processes direction in nitrogen relation. Spatio-temporal analyses of physicochemical parameters helped to determine that the channel is homogeneous in terms of nutrient contribution.

Keywords: Nitrogen dynamic, GDE's, anthropogenic impact

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How Dung Beetle body condition is affected by environmental parameters in a fragmented landscape?

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Background: Environmental disturbance generates changes on the habitat of species, presumably affecting the physiological condition of the organisms. Through tools that evaluate the physiological condition, it is possible to predict how the species respond to environmental changes. In this study, we evaluated the effect of primate presence, canopy cover, connectivity, forest cover, landscape diversity (obtained through the exponential of Shannon index), and total edge on body condition of three tropical dung beetle species that live in a fragmented tropical landscape. We hypothesize that the conservation status of the remnants and the matrix configuration will influence the body condition of the dung beetles. **Methods:** The study was conducted in the Los Tuxtlas Biosphere Reserve in Mexico, in 15 tropical forest sites with varying landscape structure. Three species were selected for this study: *Onthophagus rhinolophus*, an exclusive forest species; *Onthophagus batesi* and *Canthon cyanellus*, which live in open areas. We used body size, body mass, lipid, and muscle mass as measurements of body condition of the beetles. The relationship of environmental parameters with the beetle condition was evaluated using general linear mixed models. Result For *C. cyanellus*, body mass, lipid, and muscle mass presented a negative relation with landscape diversity. Body size presented a positive relation with landscape diversity, and a negative relation with the amount of edge in the sites. In *O. rhinolophus*, body mass and muscle were lower in sites with primates, and there was a positive relation of body mass and muscle with the amount of edge. Body size presented a positive relation with landscape diversity and a negative relation to the total edge. For *O. batesi*, body mass and muscle presented a positive relation with landscape diversity. Muscle presented a negative relation to the total edge. Body size presented a positive relation with the connectivity of the sites. **Conclusion:** We can conclude that strong levels of fragment isolation and habitat disturbance can lead to a decrease in the body condition of dung beetles, and this may affect the maintenance of their populations through the time.

Keywords: eurytopic species; habitat preference; Scarabaeidae

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High heat tolerance in tropical alpine paramo plants

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Backround: One of the biggest uncertainties of this century is how climate change will affect tropical biota. It has been hypothesized that tropical species are thermally specialized because they evolved under low annual temperature variations, thus having a reduced thermal tolerance. Furthermore, tropical highland specialists might be particularly vulnerable to global warming due to their small geographic ranges. Here we evaluated thermal tolerance of tropical alpine paramo species with different altitudinal distribution ranges in order to understand whether species with restricted distribution (i.e. highland specialists) will be more vulnerable than those with widespread distribution. Method: We collected species with restricted altitudinal distribution (found above 2700 m.a.s.l., up to 2000 m more) such as *Espeletia grandiflora*, *Espeletia argentea*, *Espeletiopsis corymbosa*, *Berberis goudotii*, *Oreopanax mutisianus*, *Valeriana pilosa*, *Geranium multiceps*, *Puya goudotiana* and *Paepalanthus columbiensis*; species with a medium altitudinal range distribution (found above 1450 m.a.s.l up to 3000 m more): *Orthrosanthus chimboracensis*, *Bucquetia glutinosa* and *Pentacalia vacciniodes*; and species broadly distributed attitudinally (found above 600 m.a.s.l. up to more than 3000 m) like: *Macleania rupestris* and *Eryngium humboltii*. We measured heat tolerance using fluorescence, evaluating the decline of Fv/Fm after heating leaf disks at 7 temperatures, ranging from 34° C to 58° C. We found the T50 values for each species, or the temperature causing 50% reduction of Fv/Fm, and compared that value between the three-altitudinal categories. **Results:** The mean ± SD of T50 for the narrowed distributed species was 49.3° C ± 1.96, for the medium range of distribution 46.8° C ± 1.88 and for the broadly distributed species 51.5° C ± 4.81. The species with greater high heat tolerance was *E. humboltii* with 54.9° C ± 0.71 and the one with the lowest was *O. chimboracensis* with 46.8° C ± 3.03. **Conclusion:** The values for T50 are within the range for alpine and tropical plant species and they all exceed the highest temperatures measured in the study site by almost 20° C. Our results indicate that highland specialists are no different in their thermal tolerance than species with broader altitudinal distribution ranges, perhaps as a result of the high diurnal variation in paramo temperatures.

Keywords: Paramo, heat-tolerance, altitudinal-distribution, chlorophyll-a-fluorescence

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Root anatomical adaptations to soil moisture regimes in the high Colombian Andes

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Background: Páramos rise over 3000 meters high in the Andes as the fastest evolving biodiversity hotspot. It is surprising that only few plant anatomy studies have been made in these areas. This research consisted of exploring possible adaptations in root anatomy to differences in soil moisture. **Methods:** We measured soil gravimetric moisture and soil water potential in sloped and flat zones in páramos. Congeneric species were selected by making diversity plots in each zone. In order to visualize and analyze possible anatomical adaptations to changes in soil humidity, we made hand cross-sections of equal-order rootlets. Root anatomical characters associated with water impermeability, storage and transport were measured. We conducted a MANOVA test to find witch characters were significatively associated to changes in soil humidity. **Results:** Two humidity zones: "wet" and "dry" were distinguished by looking at soil moisture. Fifteen species congeneric in 6 genera (*Arcytophyllum*, *Eryngium*, *Espeletia*, *Hypericum*, *Lachemilla*, *Paepalanthus*) inhabiting wet and dry zones were selected. Root anatomy was characterized for each species. Vessel and fiber anatomic characters, amount of cortical parenchyma, epidermis length and, suberin and lignin quantity showed to be significatively associated with changes in soil humidity in every species group except for *Lachemilla nivalis* and *Lachemilla orbiculata*. Vessel number and cortical parenchyma amount appeared to be significatively higher in wet living species. In contrast, fiber number and lumen size were significatively higher in dry living species. **Conclusions:** Roots, as the main organ that have close contact with soil water constitute a good indicator of the kind of environment where a plant lives. Knowing which traits are associated to dry and wet environments allow us to make predictions about plant adaptations to microhabitats in the páramos.

Keywords: root anatomy, paramos, soil moisture

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A nonlinear dynamics perspective to agro-ecological transitions

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Background: Returning degraded tropical soils to a state capable of supporting sustainable agriculture is a fundamentally different process than the conversion of tropical forests into conventional agriculture. Soils are well-known to undergo hysteresis, a phenomenon where changing conditions in a forward direction cannot predict the state of the system when those same conditions are experienced in the reverse direction. Here we combine theoretical and empirical approaches to test whether changes to agricultural management can effect hysteresis. **Methods:** First we examine how correlations between parameters in simple nutrient-soil feedback models influence hysteresis. Then in a greenhouse experiment, we transition trays of corn seedlings from a completely organic fertilizer regimen to a completely inorganic fertilizer regimen and back, all while measuring effects on state variables including yield, biomass, water loss and nutrient leaching. We also test for the presence of unstable points within hysteretic curves by perturbing the system and monitoring the system for sudden changes to the state variable. **Results:** We find that increasing management intensity in simple theoretical models can result in a variety of hysteretic patterns including some with hidden stable states. We found several of these same patterns in our empirical results. When the system was perturbed at mid-intensive levels, many state variables experienced sudden shifts that were consistent with expectations for unstable points. **Discussion:** Management-driven hysteresis appears to be both common and complex, particularly when two or more driver variables are correlated. Our results imply that past management conditions can have long-term effects on agricultural outcomes. Thus, the ability for soils to retain water, support high crop yields and reduce nutrient leaching cannot be predicted solely from current management practices. For tropical agro-ecosystems, soil degradation from long-term conventional agriculture practices is anticipated to make transitions to viable, sustainable farms much more difficult than competing conventional farms that begin with better soil conditions.

Keywords: Agroecological transitions nonlinear dynamics

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Estimating tropical forest structure using a terrestrial lidar

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Background: Forest structure comprises numerous quantifiable biometric components and characteristics, which include tree geometry and stand architecture. These structural components are important in the understanding of the past and future trajectories of these biomes. Tropical forests are often considered the most structurally complex and yet least understood of forested ecosystems. New technologies have provided novel avenues for quantifying biometric properties of forested ecosystems, one of which is LIght Detection And Ranging (lidar). This sensor can be deployed on satellite, aircraft, unmanned aerial vehicles, and terrestrial platforms. **Methods:** In this study we examined the efficacy of a terrestrial lidar scanner (TLS) system in a tropical forest to estimate forest structure. Our study was conducted in January 2012 at La Selva, Costa Rica at twenty locations in a predominantly undisturbed forest. At these locations we collected field measured biometric attributes using a variable plot design. We also collected TLS data from the center of each plot. Using this data we developed relative vegetation profiles (RVPs) and calculated a series of parameters including entropy, Fast Fourier Transform (FFT), number of layers and plant area index to develop statistical relationships with field data. **Results:** We developed statistical models using a series of multiple linear regressions, all of which converged on significant relationships with the strongest relationship being for mean crown depth (r^2 = 0.88, $p < 0.001$, RMSE = 1.04 m). Tree density was found to have the poorest significant relationship (r^2 = 0.50, $p < 0.01$, RMSE = 153.28 n ha^{-1}). We found a significant relationship between basal area and lidar metrics (r^2 = 0.75, $p < 0.001$, RMSE = 3.76 number ha^{-1}). Parameters selected in our models varied, thus indicating the potential relevance of multiple features in canopy profiles and geometry that are related to field-measured structure. **Discussion:** Models for biomass estimation included structural canopy variables in addition to height metrics. Our work indicates that vegetation profiles from TLS data can provide useful information on forest structure.

Keywords: lidar, structure, Costa Rica

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Effect of tree diversity on yield in traditional cocoa agroforests in Brazil

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Background: Brazil is the world's 6th largest cocoa producer with 75% of cocoa grown in traditional wildlife-friendly agroforests in the state of Bahia. Cocoa trees are associated with large shading trees with high economic and conservation value. Cocoa agroforests are key elements for preserving Atlantic forest both through the native species they contain and through connecting undisturbed forest patches. However, numerous factors threaten these agroforests. Although productivity in Bahian agroforests is below the world average, most have produced cocoa for over decades without any chemical input. Shade trees are key elements in this long-term productivity. We studied the effect of shade trees and their litter cycle on cocoa yield in Bahian agroforests for nine months. **Methods:** In 10 traditional farms, we identified 6 plots consisting of 3 cocoa trees shaded by one native or one introduced shade tree species (*Artocarpus heterophyllus*, *Spondias mombin*, *Erythrina* spp, *Lecythis pisonis*, *Cariniana legalis*, *Plathymenia foliosa* and *Genipa americana*). Control plots had no shade trees. Litterfall was collected monthly for a year, dried and separated into three categories: cocoa, shade tree (by specific specie) and other. Cocoa pods (>10 cm long) on trees were marked and counted every two months. **Results:** During nine months, the biomass provided by the shade trees to the cocoa trees through litterfalls varied significantly between species varying from 125 $g.m^{-2}$ for *P. foliosa* to 331 $g.m^{-2}$ for *L. pisonis*. Most species follow seasonal patterns with a peak of leaf abscission in June (during the drier season). In non-shaded plots, cocoa produced more leaves (137 ± 3 $g.m^{-2}$) than in shaded plots (74 ± 7 $g.m^{-2}$). The N-fixing tree *Erythrina* was associated to the highest cocoa productivity (60 pods tree-1). Trees in non-shaded plots had higher productivity than non-*Erythrina* shaded plots (40 pods tree-1 in non-shaded plots). There was a significant positive correlation between the total litter biomass (per species and per farm) and the number of cocoa pods per tree (pseudo R^2=0.25). **Conclusion:** Shade trees provide nutrients through litterfall to cocoa trees in agroforests. Chemical analysis of the litterfall will identify the elemental contributions to the nutrient requirements of the cocoa trees. The various shade tree species will be evaluated to establish whether there are balances or trade-offs between maintaining biodiversity and cocoa yield.

Keywords: cocoa, agroforest, Atlantic forest, Brazil

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Poster Board: 20

In search of synergies for the knowledge and protection of Cerrado biodiversity

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Background: The Brazilian cerrado is the most diverse savannah in the world, also presenting high rates of endemism of fauna and flora and featuring a worldwide presence in food production and environmental services. Although it's considered a biodiversity hotspot, this biome is a target of major anthropic pressures. Given the great importance of Cerrado to the Brazilian ecological and economic scenario and the increasing process of environmental degradation, the ComCerrado Network - a group of researchers from eight institutions located in six Brazilian states - was created. **Metodology:** The study was performed between 2013 and 2016 using biodiversity surveys through standardized sampling protocols. The regional centers sampled a set of taxonomic groups extremely relevant to the studied physionomies. These works were published in academic texts, cientific papers and also a book that characterizes the Cerrado and propose measures of protection and recovery of this biome. **Results:** After 4 consecutive years of studies, it was possible to inventory more than 600 species of vascular plants, 4.000 specimens of birds, 60 species of mammals, 120 species of fishes and 1.257 bat specimens - highlighting the first record of *Dermanura glauca* in Brazil. Another result of the study is the high endemism of reptiles in the rupestrian grassland. Several functional groups of invertebrates were also inventoried, being 2.000 galls of insects (50 species), 8.000 individuals of dung beetles (60 species), at least 40 species of spiders distributed in 25 families, as well as studies concerning Lepidoptera, Hymenoptera (ants and bees) and mycorrhizal fungi. **Conclusion:** Given the megadiversity of Cerrado, its importance in the production of goods and commodities and the great anthropic impacts caused by agriculture and livestock, strategic plans need to be urgently established for this biome.

Keywords: Cerrado, Biodiversity, Endemism, Conservation

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Poster Board: 21

Evolutionary constraints on herbivore communities in Coffea agroecosystems - A global analysis

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Background: In a series of papers published in the 1970's Donald Strong challenged the "time"/"stability-time" hypothesizes which suggested that ecological communities typically are not saturated and thus older regions should be able to support more species. Strong and his collaborators convincingly showed arthropod herbivore species rapidly accumulate and saturate in cacao and sugarcane agroecosystems around the world as a function of the amount of area in production, not the amount of time the plant has been present. These results suggest native arthropods rapidly utilize introduced plants in ecological time. **Methods:** In this study I utilized records of the arthropod herbivores of Coffea and asked if Coffea's phytochemistry alters the dynamics of herbivore recruitment. If the long held assumption about the importance of plant phytochemistry in the mediation and evolution of insect-plant interactions is true, plants with strong phytochemical defenses (e.g., coffee) should accumulate fewer herbivores in introduced ranges on structures that are "well defended" (e.g., fruits) as opposed to less defended structures (eg., leaves). **Results:** I gathered 845 records of 272 species of arthropods herbivores feeding on Coffee around the world. Similar to Strong's work, an analysis of all herbivores shows a positive correlation between the amount of area in production within a country and the number of herbivores, with no signal from the native range of Coffea. Additionally, herbivore communities are quite distinct with very little overlap in species composition between regions. Separating herbivores by the structures they feed on, I found a strong positive correlation between the number of leaf herbivores and the amount of area in production. Interestingly, no correlation was found between area and herbivores of Coffea fruits, but the vast majority of herbivores that attack Coffea fruits being constrained to the native range of the genus. **Conclusion:** I suggest that high phytochemical concentrations in the fruits of Coffea prevent herbivore recruitment in its introduced ranges. Furthermore, I speculate that the presence of native plants with similar phytochemistry to Coffea in its introduced range may have allowed some herbivores to acquire adaptations to tolerate some levels of the phytochemicals thus facilitating herbivory.

Keywords: community assembly, agroecosystems, coffea, phytochemistry

ID:219
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Poster Board: 22

Niche overlapping and ratio between realized and potential niches of common atmospheric bromeliads

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Background: Atmospheric bromeliads are known as highly specialized epiphytes, due to their complete independence from the nutrition from the substrate, acquiring water and nutrients through absortive leaf trichomes. These plants can form massive populations and communities, reaching to thousands of individuals on some trees. In this study we try to respond I: How overlapped are the niches of close related and abundant atmospheric bromeliads environmentally and geographically?; II: How much the realized niche fills the potential niche of atmospheric bromeliad species with distinct levels of distribution?; III: How much species with distinct levels of distribution coexist in relation to the expected in potential niche? **Methods:** We raised in GBIF (Global Biodiversity Information Facility; gbif.org) and speciesLink (splink.org.br) databases all occurrence records of 9 species of abundant atmospheric bromeliads distributed over the New World, classified as broad, intermediate, and narrow distributed. With this records, what we called as 'realized niche', and the 4 first principal components of a PCA with the 19 bioclimatic variables of WorldClim (worldclim.org) we calculated the niche overlap among the species using two approaches. In an environmental approach we used the probabilistic method of 'NicheROVER' r-package, and for a geographical approach, we used different algorithm in an ecological niche modeling (ENM), for a geographical approach. The niche overlaps of the potential niches among each species were calculated with the output of ENM. For each approach we calculate the ratio between the overlapping of the species of the three classes of distribution in the realized and potential niches (i.e. the probability that a species fits in the niche of other, or the number of cells with the presence of a species). **Results:** The broad and narrow distributed species showed the greater and lower ratio between the realized/potential niche areas, respectively. The ratio of overlapping in realized/potential niches ranged on a gradient in the environmental approach from broadXbroad (mean of 0.933) to narrowXnarrow distribution species (mean of 0.281). The same was not observed in the geographical approach. **Conclusion:** The results indicate that, despite the species used are close related, the broad distributed could have special strategies to disperse in a more efficient way to overcome geographical barriers and fill more efficiently the potential niche.

Keywords: niche, ENM, species coexistence

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The phylogenetic structure of the Yucatan sand dune community: insights into assembly process

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Background: Community ecologists have tried to understand the importance of deterministic niche-assembly and stochastic processes to explain how the species are organized. Current evidence suggests that both, deterministic and stochastic processes act in concert. We evaluate the processes that govern the community assemblage in the dune plant communities and how invasive species and environmental condition affect those processes. Coastal communities are subject to strong ecological filters but also to strong stochastic processes. **Methods:** Study sites were located in the pioneer dune community of Yucatan, Mexico. We measured species presence and we used plastid matK and rbcL to reconstruct phylogenetic relationships. We estimate the Net Related Index (NRI; average phylogenetic relatedness in a community) and the Nearest Taxon Index (NTI; phylogenetic distance among closely related species), including and excluding invasive species, in order to identify the processes acting in coastal plant community assembly and to understand how invasive species affect the phylogenetic pattern. To determine whether NRI and NTI differed from the expected by chance, we used randomly generated null communities. To test the role of environmental conditions, linear regression analyses were realized between climatic variables and NRI. **Results:** Seventy-five species were recorded of which twenty were invasive species. Our results suggest that chance plays an important role in the structuring of communities. However, both NTI and NRI showed a trend to phylogenetic clustering. When invasive species were considered in the analysis, NTI and NRI also showed a clustering trend. The evenness was variable along the coast. The NRI tended to increase with precipitation, suggesting that species in dune communities of the Yucatan Peninsula were more phylogenetically related in communities with greater precipitation. **Conclusion:** Although chance seems to play a predominant role, abiotic conditions represents a strong filtering force that plays also an important role in community assembly in the pioneer dune communities. Our results suggest that in harsh environments clumping patterns are associated with habitat filtering and that evenness patterns are associated with biotic interactions. The anthropic activities along the coast have increased the susceptibility of invasiveness in these communities, but invasive species do not seem to change the way in which these communities are structured.

Keywords: Phylogenetic, Sand dune, Yucatan, Mexico

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Influence of multiple drivers that influence the structure of dry forests in BRT, India

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Background: In tropics, regional scale anthropogenic disturbances and land use patterns, climatic events and droughts are the major drivers that influence the forests dynamics. With a primary aim to understand the changes in diversity, structure, recruitment and mortality of tree species we conducted our study as a part of the overall goal to establish forest dynamics plots in the dry forests of Biligiri Rangaswamy Temple Tiger Reserve (BRT), in Southern India, extensively managed by indigenous community and forest department management. **Methods:** We established five one hectare permanent monitoring plots each in dry deciduous forest (DDF) and scrub forest (scrub) within BRT. All the trees (>10 cm DBH) and saplings (> 1 cm and < 10 cm DBH) were permanently tagged and monitored. Three censuses of 13,146 stems in ten 1-ha plots at BRT were conducted at five-year interval between 2002 and 2011. We estimated the stand and species level mortality rates of both sapling and adult trees at the each census intervals. The mortality rates were calculated using the statistical procedures described in CTFS protocols. We analysed our data using "CTFSRPackage" in R statistical software. **Results:** In DDF, sapling mortality was high in *Glochidion zeylanicum* (8.74 % yr-1), *Bauhinia racemosa* (7.68 % yr-1), *Ziziphus mauritiana* (4.82 % yr-1) and adult mortality was high in *Phyllanthus emblica* (19.87 % yr-1), *Bauhinia racemosa* (13.89 % yr-1), *Tectona grandis* (12.49 % yr-1). In scrub forests sapling mortality was high in *Phyllanthus emblica* (15.37 % yr-1), *Phyllanthus indofischerii* (7.95 % yr-1), *Grewia tillaefolia* (7.73 % yr-1) and adult mortality was high in *Bridellia retusa* (10.16 % yr-1), *Phyllanthus* indofisherii (8.99 % yr-1), *Anogeisus latifolia* (7.68 % yr-1). **Discussion:** In DDF and scrub forests during the first term (2002-07) mortality rates were high compared to second term (2007-11). This can be attributed to drought experienced by southern India during 2004-05. Set of species that experienced high mortality at sapling stage are different from adult tree species in both forest types. The saplings of NTFP yielding trees species such as P. *emblica* in DDF and *P. indofischerii* in scrub forests experienced high mortality. Multiple factors - past forest management practices in addition to drought have multiple interactions with the species leading to cascading impacts influencing species and population structure in dry forests.

Keywords: TropicalDryForests, LongTermMonitoringPlots, TreeMortality, SaplingMortality

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Wednesday July 12th, 2017
Poster Board: 25

Impacts of quality of leaf-litter on ant assemblages in shade-grown coffee in Chiapas, Mexico

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In Latin America, shade-grown coffee represents the livelihood of countless traditional and indigenous farmers and is a principal economic activity in the region. Therefore, it is vital to understand the ecological interactions underway in coffee agroecosystems as these may ultimately impact the farmer's lives and future conservation efforts. Planned biodiversity, understood as the specific shade trees planted in coffee farms, provides important economic benefits, by supporting productivity in coffee agroecosystems through processes such as biological nitrogen fixation. Less is known, however, about the benefits shade trees offer to diverse above- and belowground communities in coffee agroecosystems. A useful lens to evaluate the ecological benefits of shade trees is to assess how ground-dwelling ant and detritivore communities respond to the quality of leaf-litter from established nitrogen-fixing tree species, such as *Inga micheliana*, and non-nitrogen fixing species, such as *Alchornea latifolia*, commonly planted in coffee agroecosystems. We set out to answer the following questions: 1) how do C:N ratio and lignin content differ between I. *micheliana* and *A. latifolia*; 2) how do ground-dwelling ant communities and detritivore communities, specifically Collembola, differ from low quality leaf litter (i.e. high C:N ratio) and high quality leaf litter (i.e. low C:N ratio). Thirty sampling sites composed of three 1m2 quadrats within a 5m radius from base of randomly selected trees (15 *I. micheliana*; 15 *A. latifolia*) at a shaded-coffee farm in Chiapas, Mexico. Ant specimens were extracted from leaf litter collected from quadrats using the mini-Winkler method and identified to genus, species and morpho species level. Detritivore were also collected from the same leaf litter and identified to order and genus level. Results show: 1) I. *micheliana* has a lower C:N ratio than *A. latifolia* and 2) a higher abundance and richness of ants from the Pheidole, Solenopsis and Strumigenys genera and detritivores in *I. micheliana* sites than *A. latifolia*. An explanation for this is the higher abundance of food resources (e.g. Collembola) found under *I. micheliana* is influenced by higher decomposition rates of leaf litter from *I. micheliana* due to lower C:N ratio. This suggests that there may be significant feedbacks from nitrogen fixing vegetation to brown food webs by the creation of higher quality leaf litter, thus increasing detritivores and ground-dwelling ant communities.

Keywords: coffee, agroecosystems, ants, decomposition

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Relative importance of tree diversity, size and competition in growth in a primary tropical forest

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Background: Because tree growth determines forest structure, biomass and carbon storage, both for forestry and forest ecology it is essential to understand factors influencing tree growth processes. However, the relative importance of biotic factors influencing individual tree growth has been rarely studied, and such studies are practically missing from tropical forests despite their global significance. **Methods:** Using two 1-ha permanent plots in Brunei five times censused within 20-year interval, we applied individual-level neighbourhood analysis to explore the relative importance of tree diversity, size and competition in both short- and long-term growth in a primary species-rich tropical forest. **Results:** We found the tree size to be the strongest, positive, predictor of both short- and long-term growth, compared to competition for nutrients, asymmetric competition for light and other factors. Competition with all neighbours negatively affected individual growth in both plots both in 5 and 20 years period. Surprisingly, diversity had significant negative effect on 5-year tree growth in the plot 1 whereas neither 5-year growth in the plot 2 nor 20-year growth in both plots were affected by it. **Discussion:** While the effect of diversity on long-term growth was not detected most probably due to the lack of diversity gradient, our results highlighted the importance of large trees in undisturbed tropical forests. In the present study, large trees were the strongest competitors and grow fastest both over the short and long time interval. Our results thus underline the importance of conservation initiatives aimed at keeping the last fragments of primary Bornean forests untouched because removal of large trees by selective logging may significantly affect ecological functioning of tropical forests.

Keywords: growth, diversity, dbh, competition, Borneo

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Super typhoons offer an opportunity for Japanese mangrove forest to regain the ecological niche?

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Background: Japanese mangrove forests are not generally known because the forest area accounts only for 0.00005 % of the world's mangrove forests. Nearly 70 % of the all mangroves of Japan are distributed in Iriomote Island. The small island is located at westernmost and southernmost part of Japan in subtropical region that is well known not only as a biodiversity hotspot, but also as a place where strong typhoons frequently pass (Typhoon Ginza). In 2007, two super typhoons whose maximum instantaneous wind speeds were more than 60m/s directly hit the island. Consequently, several hectares of mangrove forests were blown down and destroyed completely. Immediately after such a natural disaster happens, usually new propagules are provided from survived mangrove trees and then the damaged forest can be restored. However, the area has still remained vacant and it is difficult to find enough number of seedlings to restore the mangrove forest at the present time. **Methods:** To reveal this phenomenon, we conducted several fright researches by drones since 2013. The UAVs used in the research were a fixed wing aircraft (UX5, Trimble) with a micro four-thirds camera (α6000, SONY) and quad-copters (Phantom3 Advanced and Professional, DJI). We also measured the ground level of the disaster area by traverse survey in 2017. **Results:** As the result of the traverse survey, it was found that the ground level of the devastated area was lower by 30 to 50 cm than the ground level covered by mangrove trees. It was also revealed by our flight researches that the devastated area has been growing year and year. **Discussion:** In conclusion, it was thought that the mangrove forest collapse in a fairly large area by typhoons induced soil erosion because the forest floor lost the forest crown to protect from rainfall. At the same time, the complex root system to keep mangrove peat stably from daily inundation was lost. And it was also suggested that the dynamics of large-scale soil degradation and inundation has caused continuous soil erosion, thus the continuous forest degradation has been also induced like domino effect. The changed ground level might not provide suitable ecological niche for the present mangrove species anymore. In our presentation in Mexico, we would like to talk about one more interesting hypothesis.

Keywords: mangrove, typhoon, UAV, ecological niche

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Soils and tree cover in rangelands in La Sepultura Biosphere Reserve, Chiapas, Mexico

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Background: Extensive cattle ranching, introduced in the late 1980s, is currently one of the main economic activities in the buffer area in La Sepultura Man and the Biosphere Reserve (ReBiSe). Therefore, tree cover in some ejidos of ReBiSe has evolved from a closed mixture of pines and oak trees to an open forest of the same species with an understorey of exotic grasses. Replacement of natural vegetation with exotic pastures could have promoted alterations in physical and chemical soil parameters. Soil degradation has already been identified as a threat to long-term cattle production. Here, we study the relationship between tree cover and soil parameters in 2 ejidos of ReBiSe: California and Ricardo Flores Magón. **Methods:** Seventy-two soil composite samples (0-15 cm depth) from 8 rangelands in each ejido (total=144) were collected and analysed for texture, bulk density, pH, SOM, total N, available P, and CEC. Soil sampling locations were chosen randomly using three tree cover categories: low, medium and high, which were defined based on a tree basal area assessment conducted previously. **Results:** Using the medium tree cover category as reference, we hypothesized that soils under high tree cover will present higher SOM, available P, total N, and lower bulk density than soils beneath medium and low tree cover. Other measured parameters (soil texture, soil pH and CEC) might not show significant difference between the three tree cover categories. However, soil texture might strongly correlate with soil pH and CEC. Tree species dominance might also influence soil parameters within the high tree cover category. We hypothesized that areas under oak trees might present higher SOM, available P and total N compared to areas under pine dominance. **Conclusion:** We found high overall heterogeneity of soil properties in rangelands in both ejidos. Beneath high tree cover, soil presented higher contents of organic matter and nutrients, suggesting strong relations between tree presence and some soil parameters related to nutrient provision. Trees in rangelands would seem to provide multiple benefits, but possible tradeoffs between tree litter quality and grass and forage production need to be investigated in ReBiSe.

Keywords: Soil, tree cover, rangelands, Mexico

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Soil carbon losses and erosion in riparian soils after land use change on Sumatra/Indoensia

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Background: Indonesia's forest is ranked among the Amazonian and the Kongo Basin as the largest tropical rainforest area worldwide. However, the country experiences a severe forest loss since the 1970s. Besides a growing population, the primary pressures are export-orientated timber production and a global commodity demand that lead to a permanent conversion from forest to agricultural areas. The roles of resulting transformation systems of tropical riparian rainforests for ecological functions have yet received little attention in scientific research. Especially C stocks in riparian zones are strongly affected by climate and land use changes that lead to changes in water regime and ground water level drops. **Methods:** We investigated the effects of land transformations in riparian ecosystems of Sumatra, on soil C content, stocks and decomposability. C losses in rubber and oil palm plantations and rainforests were compared and the contribution of soil erosion and organic matter mineralization was estimated. Based on δ13C values along soil depth, two processes decreasing C stocks were distinguished: erosion and mineralization of soil organic matter (SOM). Depending on the shift of the δ13C of SOC in the topsoil from the linear regression calculated by δ13C values with log(SOC) in the topsoil, modification of C turnover rate in the top soil was evaluated. Erosion was estimated by the shift of the δ13C value of SOC in the subsoil under plantations. **Results:** The Ah-horizons in non-riparian soils under oil palm and rubber plantations showed with 70% and 62 % a strong reduction in C content and a strong erosion: 35 ±8 cm in oil palm and 33 ±10 cm in rubber plantations. Within the riparian zones an inhomogenous spatial distribution of C content is expected, due to the trend of increasing C stocks from terrestrial through semi-terrestrial to wet conditions. By comparing decreasing δ13C values of SOC in the topsoil to those in subsoil, a lower erosion in all transformation systems in riparian zones could be detected. **Conclusion:** Higher clay content at riparian plantation sites leads to lower carbon losses due to increased aggregation protecting SOM from decomposition. In riparian zones soil carbon content is not only dependent on vegetation inputs, but also on the redistribution of suspended loads during flood events. Plantations on riparian soils are additionally influenced by flood-induced erosion enhanced by sparse or absent ground cover.

Keywords: deforestation, carbon sequestration, erosion, δ13C

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What drives diversity of frugivorous birds along environmental gradients?

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Background: Elevational gradients in species diversity are common and species richness generally declines towards higher altitudes. The underlying mechanisms behind these patterns are still being debated. Besides evidence of climatic variables, some authors suggest different patterns of niche occupancy as potential drivers. Niche occupancy is particularly relevant when investigating morphological and functional diversity, as species can divide and expand ecological niche space in different ways. Here we test what drives the functional diversity of frugivorous birds along elevational gradients and compare neo- to paleo-tropics. **Methods:** We sampled frugivorous birds and fleshy-fruited plants along elevational gradients of 2000 m, in the Andes of Ecuador and on Mt. Kilimanjaro, Tanzania. To estimate niche spaces, we measured functional traits of birds and plants and calculated indices of functional diversity (FD). Functional richness (FRic) calculates the volume of a trait space and estimates the size of a niche space, while functional dispersion (FDis) calculates the mean distance of species to the centroid of a trait space and estimates niche specialization. Climatic variables were measured at the sampling sites. **Results:** In total we sampled more species of birds and plants in the Andes than on Mt. Kilimanjaro. For birds, we found a linear decline of niche space volume with elevation in the Andes, while niche specialization increased. In turn, niche specialization of plants showed a unimodal distribution on Mt. Kilimanjaro. Climate was significantly correlated to niche space volume and niche specialization in the Andes, and to patterns of niche specialization on Mt. Kilimanjaro. We found no relationship between the niche spaces of birds and plants communities on both continents. **Conclusion:** Our results suggest that communities from both mountain systems differ strongly in their responses to changing environmental conditions. While the plant community of the Andes did not significantly change, the bird community reacted strongly to climatic variables. On Mt. Kilimanjaro, the plant community changes with climatic conditions, while the bird community remained similar. This finding suggests that communities in distinct mountain systems develop differently with changing climatic situations and may face different challenges with global change.

Keywords: Functional diversity, birds, climate

ID:331
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Bromeliad size predicts litter capture and influences community in a tropical forest fragment

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Background: Plant litter is an important resource for matter and energy flow in terrestrial ecosystems. Although most litter falls directly to the soil, some plants - such as bromeliads - have the ability to capture litter and typically exhibit an animal community associated to this resource. Because epiphytes are important components of tropical ecosystems, reaching up to 10% of all the vascular plant species, they might represent key components of ecosystem functioning. In this study we evaluated how differences in habitat structure and plant size predict litter accumulation in bromeliads (*Tillandsia* sp.) and how it influences the arthropod community associated to this resource. **Methods:** Fifty bromeliads were sampled in an Atlantic Forest reserve in southeastern Brazil, in two distinct habitats: a forest fragment (shady, close canopy habitat) and in a waterfall region (sunny, open canopy habitat). Plants were placed into plastic bags and taken to the laboratory for measurements and determination of fresh and dry biomass. Litter accumulated in the bromeliads was separated and weighed, and arthropods were separated and identified to the lowest taxonomic level possible. **Results:** Larger bromeliads, regardless of habitat, captured and accumulated more litter (R^2=0.38, P<0.001). Plants in open habitats were larger (size: 15±1.9 cm), exhibited greater dry biomass (4.13±0.67g) and accumulated 41% more litter than plants in shady habitats (2.26±0.32g) (P=0.03). We found 103 arthropod species associated to *Tillandsia* litter, and spiders, Hemiptera and mites were the most common invertebrates found. Arthropod richness, however, did not differ between habitats (t=0.57, P=0.28). **Conclusion:** Open and sunny habitats increased chlorophyll content in *Tillandsia*, promoting therefore plant growth and larger volume for litter accumulation. Higher wind incidence might help litter dispersion in open, sunny habitats promoting higher litter accumulation in bromeliads. These plants are very common in tropical areas and our results reinforce their role as refuges and nutrient source for arthropod communities.

Keywords: Bromeliads, Energy flow, Arthropods; Litter

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Liana diversity and composition track the tree community on the island of Dominica, West Indies

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Background: The extent to which tree and liana communities are assembled by similar processes is an open question in ecology. We investigated whether the community structure and composition of liana communities can be predicted by the tree community in hurricane-prone sub-montane rain forests on the island of Dominica in the Lesser Antilles of the eastern Caribbean. **Methods:** Across 17 permanent, 0.25-ha vegetation plots clustered in three regions of Dominica (northeast, northwest, and southwest), we censused all trees ≥1 cm diameter and lianas ≥0.5 cm diameter almost 30 years after Hurricane David caused substantial tree mortality primarily in the southern half of the island. **Results:** Based on tree species composition, we identified one vegetation association (Dacryodes–Sloanea) across the island that could be divided into two forest types depending on whether or not the near-endemic tree Amanoa caribaea was co-dominant. The liana community followed similar divisions, with certain species (*Heteropterys platyptera*, *Coccoloba ascendens*, and *Connarus grandifolius*) being found more often in forests with *A. caribaea*. As with the tree community, differences in species diversity of lianas was greater in the southwest than in the northeast or northwest. No differences in liana abundance were apparent among the regions or forest types. **Conclusion:** It appears that in sub-montane rain forests of Dominica, the liana community closely mirrors the tree community and appears to be driven by the processes that determine the presence or absence of the canopy tree species *A. caribaea.*

Keywords: Caribbean, community ecology, diversity, lianas

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Functional trait variation of stress-tolerant *Rhododendron* species along elevation gradients

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Background: Examination of plant functional traits along environmental gradients often reveal a shift in trait space, thus implying that ecological strategies may also change based on the environmental context. For instance, specific leaf area (SLA) generally declines with elevation, a pattern often attributed to increasing abiotic stress with elevation. However, abiotic conditions can also be stressful at lower elevations. Here, we address the question, what happens to patterns in trait space with elevation when considering plant species with a stress-tolerant ecological strategy? **Methods:** We addressed this question using the highly diverse genus *Rhododendron* (Ericaceae) as the model taxonomic group. Many *Rhododendron* species are associated with nutrient-limited soil conditions, thus suggesting a stress-tolerant ecological strategy. Within the tropics of South-East Asia, *Rhododendron* species can be found within many different habitats ranging from sea-level to mountain summits. We collected leaf functional trait data on 160 tropical *Rhododendron* species of known provenance grown in greenhouses of several botanical gardens. Habitat information (elevation, growth form, and edaphic specialization) was obtained from botanical monographs and herbarium records. Patterns of trait variation were examined with linear regression models accounting for differences in growth form and edaphic specialization. **Results:** Across all species, *Rhododendron* leaf area and seed tail length decreased with increasing elevation, yet many functional traits (SLA, thickness, toughness) changed little with elevation in terms of both trait means and variances. These patterns held when growth form was accounted for in that there was little difference in the traits of epiphytic versus terrestrial *Rhododendron* species. However, *Rhododendron* species that specialized in ultramafic (serpentine soil) habitat showed a decline in SLA with increasing elevation, and retained a distinct suite of traits compared even when grown under more resource rich conditions. **Conclusion:** Overall, *Rhododendron* species provide a unique perspective on how a stress-tolerant ecological strategy influences functional trait space across elevation gradients. These results reinforce the concept that adaptations that enable tolerance of low nutrient stressors may also help minimize the influence of other abiotic stressors.

Keywords: Functional traits; elevation gradient; *Rhododendron*

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Fire regime, vegetation and microclimate interactions in Brazilian Savanna: Process based model

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Background: The Brazilian Cerrado is the most biodiverse savanna in the world. Currently, it is highly threatened by both the increase of the fire frequency in some regions and by its suppression in others. In the absence of fire, vegetation homogenization and tree encroachment have been evidenced. However, positive or negative impacts on the vegetation and microclimate have been shown to depend on the fire regime. Thus, the definition of the most suitable fire regime is a key factor for successful management strategies in these ecosystems. **Methods:** We used Dynamic Systems (SD) models to demonstrate how the fire regime can change fire behavior and the effects on vegetation and atmospheric compartments over time in Typical Cerrado (tree cover ranging from 20- 50%). We built these models based on an extensive literature review about prescribed burnings for this type of vegetation. We consider as input variables: microclimate (temperature, humidity, and wind), biomass and post-fire recovery rates of the vegetal stocks (fine fuel load [litter, grass, herbs], shrubs, and trees). The outputs of the model were the fire behavior (fire spread and heat released) and fire effect (biomass increase and decrease). We designed different scenarios of burning regime, represented by annual, biennial and quadrennial burnings over four years. Result: Our simulations showed that the time interval of one or two years is sufficient for the recovery of the fine fuel load. However, the biomass of shrubs and trees declines linearly over time, producing burnings of greater extensions with greater release of heat, and causing negative balance between carbon emissions and stocks. The four-year time interval is sufficient for the recovery of the fuel load and trees, but it still does not allow the recovery of the biomass of shrubs. **Conclusion:** The burning interval shorter than four years is not indicated for the preservation of the structure of the Typical Cerrado plant community, causing a transition in vegetation structure, with greater dominance of grasses and greater impacts to carbon emissions.

Keywords: emission, management, burning, recovery

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Belowground carbon fluxes on Mount Kilimanjaro: effect of an elevational gradient on fine roots

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Tropical forest ecosystems are highly productive, storing 40-50% of the carbon in terrestrial ecosystems. Fine root production accounts for 30-50% of NPP in forest ecosystems. Therefore, due to its high contribution, it is crucial to include this kind of data in carbon fluxes research. Different studies on tropical montane forests have shown that elevation is positively correlated with fine root bio-and necromass (Hertel et al. 2010, Moser et al. 2011). At the same time, elevation is positively correlated with soil C/N and soil acidity, parameters that affect nutrient uptake and root longevity. In these studies, they conclude that soil C/N and soil acidity positively affect fine root biomass, fine root mortality, as well as fine root growth, as it will be fostered to compensate the amount of root lost. There is need of further research to confirm these patterns in other tropical montane ecosystems, especially in Africa where there is little information in this field. We want to test the following hypothesis: (1) Fine root bio-and necromass increases with elevation as a result of an increase on resource limitation, and (2) fine root production increases with elevation to compensate the higher mortality rates. Our study took place in the southern slope of Mt. Kilimanjaro, along an elevational gradient (871-3910 m) that includes savanna, montane forest, and subalpine forest. Savanna was included to study a wider elevational range. We realize a bio-necromass inventory and we study root production using the ingrowth core approach down to 40 cm depth in the soil. The higher fine root bio-and necromass values are found in the upper montane forest (446.86 g•m^{-2} and 773.25 g•m^{-2} respectively). The lowest values are found in savanna for fine root biomass (92.22 g•m^{-2}) and in lower montane forest for necromass (66.57 g•m-2). Both variables increase with elevation as well as with soil C/N and soil acidity. The fine root biomass/ aboveground biomass ratio follows the same trend. Preliminary results on root production along the elevational gradient will be presented. Our results on fine root biomass for an African tropical mountain confirm the pattern found in other elevational gradients in tropical mountains. The analysis on root production will show the trend for our studied ecosystem. Assessment of carbon pools and fluxes provided by this study could contribute to get information about how these parameters will change with the effects of climate change in the future.

Keywords: fine root production and biomass

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Effects of tree species diversity and genotypic on growth and aboveground biomass in a plantation

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Background: The effects of plant diversity on ecosystem function are well documented. Positive effects of plant intra- and inter-specific diversity on productivity have been attributed to niche partitioning among plant genotypes or species (complementarity effect) or due to a higher chance of including dominant genotypes or species with increasing diversity (selection effect). To date, most studies have not simultaneously tested for the effects of plant intra- and inter-specific diversity on plant growth, especially in arboreal communities. Here we tested for the effects of tree species diversity, SD (pool of six species) and genotypic diversity, GD (for one of the species) in a young (5 yr-old) plantation in Yucatan (Mexico). **Methods:** The tropical tree plantation experimental is composed of 74, 21 by 21 m plots classified as monocultures (one species) or polycultures (mixtures of four out of six species). For one of these species (big-leaf mahogany, *Swietenia macrophylla*), we planted a greater number of monocultures which were composed of either one genotype (all seeds from the same parental tree) or a mixture of four (out of six) genotypes. In February 2016, we measured diameter at breast height (DBH) and total height (H) for all trees (n ~ 4700). We also estimated the basal area, and aboveground biomass based on measurements of DBH, H and wood density. **Results:** We found positive effects of SD on plot-level means for growth-related variables. Specifically, DBH and basal area were 7% greater and 28% higher on average in polyculture than in monoculture. These increments were driven by selection effects (rather than complementarity), where a subset of dominant species exhibited strong positive responses to diversity, whereas the other species were unaffected. Likewise, biomass was on average 30% greater in mixtures than in monoculture. On the other hand, we found no effect of genotypic diversity on growth or biomass in mahogany. **Conclusion:** Our results indicate that the effects of plant species diversity on primary production may arise early after the establishment of experimental tree communities. Nonetheless, diversity effects appear to be initially more strongly driven by responses by dominant species, whereas effects of niche partitioning presumably become more important during later stages of development. This study also suggests that inter-specific diversity generally exerts stronger controls over primary productivity than genotypic diversity.

Keywords: Species diversity, genotypic diversity, productivity

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Functional trait variation in cacao agroecosystems: Influence of local conditions and cultivars

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Background: Intraspecific crop functional traits vary in response to a range of conditions, namely management, soil, and climate. Yet little work has disentangled the strength of genetic versus environmental influences on such variation. Economically important tree crops, such as cacao (*Theobroma cacao* L.), are ideal model species to determine dominant influences on intraspecific trait variation. We employ clonal gardens in Central America to determine the relative influence of environmental and genetic characteristics on leaf functional traits. **Methods:** We examine nine physiological (photosynthesis at saturating irradiance [Asat, umol m-2 s-1] transpiration [E, mmol H_2O m^{-2} s^{-1}], and water use efficiency [WUE, mmol CO_2 $mol^{-1}H_2O$]), morphological (leaf thickness [mm], leaf area [cm^2] and specific leaf area [SLA, mm^2 mg^{-1}]), and chemical (leaf nitrogen [LN, mg g^{-1}], leaf carbon [LC, mg g^{-1}], and C:N ratio) leaf traits among 172 cacao trees across two climatically and edaphically different sites in Central America. Six cacao cultivars, representing a range of disease-resistant clonal varieties which were bred in different stages, were studied at each site. Result: Physiological leaf traits (Asat, E, and WUE) showed a significant site by cultivar interaction effect. In particular, the two oldest local cultivars showed significant reductions in WUE at the more drought-prone site. Site-related factors were the main drivers of variation in chemical traits (LC, LN, and C:N ratio), with soil nutrient levels explaining 22.9-47.3% of the variation in these traits. Morphological traits (leaf area and thickness; SLA) varied significantly between cultivars, with little influence of site characteristics, suggesting a genetic basis for this trait variation. **Discussion:** We disentangle environmental and genetic drivers of cacao leaf trait variation. The strong site-based leaf trait variation, particularly for physiological and chemical traits, indicates significant response to climate and soil conditions, while leaf morphology is linked to cultivar status. Since the cultivars examined are part of a region-wide breeding program to provide farmers with disease-resistant, high-yielding varieties, information on the response of these cultivars to different climate and soil conditions will be important in assessing their feasibility in the region.

Keywords: *Theobroma* cacao, intraspecific trait variation

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Spatial and temporal distribution of reproductive resources in precipitation gradient in Dry Forest

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In xerophilous plants as in Caatinga, the water availability in the form of precipitation act on species development and reproduction, which takes advantage of the rainy season to perform their activities. Therefore, the study aims to analyze the reproductive phenological patterns of woody species submitted to a precipitation gradient in a Seasonally Dry Tropical Forest area. An increase on flowering and fruiting is expected in areas with higher precipitation and that the reproduction pattern of Caatinga woody species will be influenced by the rainy season. The study was carried out at Catimbau National Park, a semi-arid area in Northeast Brazil. 217 plants (56 species of 19 families) were monitored monthly between Aug/2014 and Jul/2016 regarding reproductive phenophases of flowering and fruiting. This was performed in 10 permanent plots (50 x 20m) along a precipitation gradient, with areas ranging from 510 mm to 940 mm precipitation. The synchrony index was calculated and classified the phenological pattern. The phenology was analyzed using circular statistics and the environmental effect on species distribution was tested with a CCA. Species presented irregular flowering and fruiting patterns, with records of two peaks (May/2015 and Feb/2016, in the rainy season and Aug/2015 and Mar/2016, dry and rainy season respectively). Individuals frequency in flowering and fruiting increased according to the precipitation gradient, both with seasonal patterns, being the seasonality in areas with lower precipitation most marked. In general, individuals synchrony was low for flowering and fruiting. However, there was a higher synchrony of flowering and fruiting in

Keywords: Flowering, Fruiting, Hydric availability, Perturbation

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Anthropogenic disturbance causes a proliferation of leaf-cutting ants in Brazilian Caatinga

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Background: Anthropogenic disturbance often results in predictable patterns of 'winner-loser' replacement that leads to biotic homogenization via direct effects on population size or indirect effects via habitat modifications. Leaf-cutting ants (LCA) are an example of winner organism in tropical rain forests because disturbance-induced shifts on vegetation strongly benefit them, but their response to disturbance in tropical dry forests is poorly known. In this study we investigated if *Atta* colony density in Caatinga ecosystems increases with both the proximity to roads and the vegetation cover surrounding the nests. **Methods:** *Atta* colonies were surveyed in 59 belt transects of 300 x 20 m, covering a total area of 35.4 ha. We classified each colony in active or inactive and extracted the geographical position of each colony and measured distance to the nearest road using a geographic information system. Based on satellite imagery (RapidEye 5m resolution), we also drew a map of vegetation and each colony were assigned to one of the four vegetation categories: exposed soil, low, medium, and high woody vegetation cover. We used regression analysis to access the effect of road distance, and chi-square tests to access the influence of vegetation cover on colony density. **Results:** We found 371 *Atta* colonies, 249 (67.12%) of which were active. Amongst active colonies 184 belonged to *Atta opaciceps* (5.19 ha-1), 54 to A. *sexdens* (1.52 ha-1) and 11 to A. *laevigata* (0.31 ha-1). The density of active colonies sharply decreased from 0.86 ± 0.18 ha-1 in a 50-m zone along roads to only 0.11 ± 0.05 ha-1 at distances up to 300 m. The reverse pattern was observed for inactive colonies. The frequency of occurrence of *Atta* colonies was higher than expected in high vegetation cover, while inactive colonies were more frequent in high vegetation cover. **Discussion:** Our results demonstrate for the first time that anthropogenic disturbances promote proliferation of leaf-cutting ants in a tropical dry forest. Additionally, LCA were preferentially found under higher vegetation cover, which indicates that remaining Caatinga patches in the future must face thigh pressure from both antropogenic activity and LCA herbivory.

Keywords: *Atta*, Seasonally Dry Tropical Forest, Chronic anthropogenic disturbance, Distance to roads, Vegetation cover

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Seed and saplings banks in a tropical montane forest of Mexico: Comparing oak and beech forests

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Tropical montane forest is one of the most biodiverse ecosystem of Mexico, with 10 % of total plant species of the country. *Quercus* with 46 species and *Fagus* with only one species are the boreal genera most important. However, tropical montane forest is threated for continuous human perturbation. The main aim of this research was evaluate the diversity of seed and saplings banks in two plant associations: i) an oak forest (with *Q. delgadoana* and *Q.* tritinatis) and ii) a beech forest (with *F. grandifolia* subsp. *mexicana*). Biodiversity parameters were used like forest regeneration indicators, considering null or low diversity as low regeneration capacity. The study was carried out in a fragment of tropical montane forest near to 555 ha, in the intertropical zone of the Sierra Madre Oriental, Mexico. Alpha diversity was estimated using Shannon index modificated by Jost (order 0 and 1). Previously, Chao and Shen completeness estimators were calculated. In order to compare forests, rarefaction and Jaccard similitude analysis were realized. Fourteen percent of tree species were shared in both forests. Saplings diversity was higher in beech forest than oak forest. Also, it had more successional late species. Similitude between forests was 35 %. Alpha diversity was higher in oak forest. However, not differences were registered using rarefaction curves. In both forest, seed bank had greater number of seeds of herbs (pioneers). However, oak forest had higher richness; while, if species abundance was considered then beech forest was more diverse. Seed and saplings banks were different between forests; regardless of whether they are adjoining. These results indicate that both forests maintain conditions for their natural regeneration. Saplings banks as a base for the gap dynamics and seed bank for the secondary succession. In the beech forest the higher diversity of late successional species, in the saplings bank, presupposes greater regeneration capacity in light or medium disturbances, including anthropic disturbance.

Keywords: Regeneration potential, ecology succession, biodiversity

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Effects of canopy tree species on seedlings in the understory

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Background: Both abiotic conditions and biotic interactions can act as ecological filters selecting the set of community-forming species. The aim of this study is to verify how the canopy species and their functional traits affect the environment and the development of seedlings in the understory. **Methods:** We addressed monospecific stands of 9 native species with contrasting functional traits (leaf phenology, growth rate and nitrogen fixation capability): *Balfourodendron riedelianum*, *Cariniana legalis*, *Cordia trichotoma*, *Enterolobium contortisiliquum*, *Gallesia integrifolia*, *Handroanthus heptaphyllus*, *H. vellosoi*, *Myracrodruon urundeuva*, *Peltophorum dubium*. The stands are more than 24-year-old, in São Paulo state, SE Brazil. We set up 27 plots, 3 under the canopy of each species. In each plot, we planted 45 seedlings of the same 9 species established in monospecific stands. To determine what variable best predict the development of seedlings, we performed 3 linear models for diameter increment of seedlings (10 months after planting). The predictive variable in each model are: i. canopy species, ii. abiotic variables (canopy opening, soil water content and litter input), iii. functional traits. All models included the initial diameter as predictive variable. Among the three models, we selected the best based on AIC. To investigate species-specific effects, we compared the diameter increment within the interaction of canopy and seedling species using ANOVA followed by Tukey test. **Results:** Canopy species ($p<0.01$, AIC 5988.5) and abiotic variables (canopy opening $p<0.01$, and soil water content $p<0.05$, AIC 6078.7) explained better the diameter increment than the functional traits of canopy species (growth rate $p<0.01$, leaf phenology $p<0.01$, AIC 6338.3). For differences among seedling species under each monospecific stand, the diameter increment of seedlings planted under co-specific canopy trees showed lower averages. For differences among the seedlings of the same species under different monospecific stands, 3 out 9 species did not vary their averages when planted beneath different canopy species and the other 6 showed the worse development beneath their co-specific canopy tree. **Conclusion:** Canopy species can indirectly affect the development of seedlings by altering the canopy opening and soil water content conditions of the environment or by interacting directly with other community organizations. Our results highlight the species-specific effects.

Keywords: Functional traits, Competition

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Intra- and interspecific variation in tropical tree phenology derived from Unmanned Aerial Vehicles

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Background: Phenology is a key functional trait that may respond to climate change. Unlike most other traits, tropical tree phenology is described through categories (e.g., evergreen, deciduous, brevideciuous), as quantitative metrics that can describe variation among and within species are lacking. Yet, intra- and interspecies variation in phenology, as it relates to variation in soil water, nutrients and light, may be a key to understanding how species phenology will change with climate. To quantify phenology over a large number of individuals and species, we collected bi-weekly images from unmanned aerial vehicles (UAVs) over Barro Colorado Island, Panama. The objective was to quantify inter- and intra-specific responses of tropical tree leaf phenology to environmental variation, and identify key environmental variables and physiological mechanisms underpinning phenological variation. **Methods:** Between October 2014 and May 2015, we collected 35 sets of UAV images, each with continuous coverage of the 50-ha forest inventory plot. UAV imagery was processed to extract spectral and texture information for individual tree crowns, which was then used as input for a machine learning algorithm that predicted branch and leaf cover. We obtained the species identities of 2000 crowns in the images by linking the crowns to stem tags in the field, thus producing, for 65 species, a time series of these phenological metrics: cumulative annual deciduousness; peak level and length of deciduousness; and dates of leaf drop and leaf flush. **Results:** Deciduousness showed continuous variation among species rather than clustering into distinct phenological categories (ie, evergreen, brevideciduous, deciduous). We found significant, positive relationships between species mean deciduousness and species' leaf phosphorous, photosynthetic capacity and growth rate, suggesting that higher deciduousness is associated with greater resource acquisition. Although for nearly all species, mean deciduousness was higher in a drought year versus the previous year with normal rainfall, there were large differences in the intraspecies variation in phenology in the drought year. **Conclusion:** There is strong evidence that deciduousness has continuous variation among species means that is related to resource acquisition strategies. Furthermore, intraspecies variation in leaf phenology is substantial and may have important consequences for how individual species respond to drought.

Keywords: phenology, climate change, functional traits

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Cotyledon type predicts tropical tree seedling growth survival tradeoff

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Background: Variation in plant resource allocation traits has been linked to the ubiquitous growth-survival trade-off and life history differences among species. Yet our understanding of the role of traits in community assembly comes from traits assessed on adults, and seed size and seed number usually are the only traits used to consider trade-offs in reproduction and recruitment of new individuals. However, ontogenetic changes in species' traits are to be expected because the understory environment faced by seedlings is quite different from that experienced by older life stages. In addition, much of the turnover in species composition of adult trees in the forest is driven by processes occurring at early life stages. Our objective was to understand whether seedling traits were successful predictors of trade-offs in seedling performance. **Methods:** Since 2002, we have conducted annual censuses that quantify and age- and species-specific rates of growth or mortality for young marked seedlings of more than 700 species of woody plants in Yasuní Ecuador. We quantified several key functional traits related to resource allocation for more than 100 species collected from the field at a standard developmental stage. These traits included cotyledon type, specific leaf area, stem density, and root-to-shoot ratio, among others. We used ordination techniques to reduce multivariate trait data to a single axis and compared this with an axis representing the growth-survival trade-off in seedlings. **Results:** We found variation in leaf and stem traits to be a significant predictor of growth-mortality trade-offs in seedlings. There was great variation in seedling functional traits, but much of it was associated with the species' cotyledon type: those with photosynthetic cotyledons and little to no storage reserves had high SLA and low stem density leading to higher growth but poor survival, whereas species with storage reserves in their cotyledons constructed denser leaves and stems that conferred lower growth rates but high survival rates. **Discussion:** Trait-based ecology aims to understand the assembly of ecological communities by investigating how species' functional traits may predict trade-offs in performance and variation among under different environmental conditions. Our results showing strong tradeoffs in growth and survival relate to cotyledon type contributes to our understanding of how seedling dynamics contribute to the maintenance of tropical forest diversity.

Keywords: seedlings, traits, diversity, ecology, rainforest

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Sex-specific patterns of phyllostomid bats in a human dominated landscape

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Background: Animal species exhibit sex-specific patterns for habitat adaptation, however adaptability to human-dominated landscapes is commonly explored at the species level, without concern of intraspecific differences. Several traits of bat communities, including: species diversity, social systems, segregation during the maternity season and sex-biased migration, make bats an ideal taxon in studies under the sexual habitat segregation context, nevertheless this subject is poorly explored. **Methods:** Using sex abundances of six bat species (*Artibeus jamaicensis*, *Artibeus lituratus*, *Sturnira lilium*, *Carollia perspicillata*, *Glossophaga soricina* and *Platyrrhinus helleri* we determine gender patterns associated to mature continuous forest and open pastures, with and without riparian vegetation in the Montes Azules Biosphere Reserve, Mexico. Also we performed a GLMM to determining the influence of vegetation traits on male and female abundance. **Results:** Overall, 43% of the sampled individuals from the six bat species considered were males, while 57% were females. We found that the sex ratio in disturbed habitat were predominately towards female for all species except *P. helleri*. Seasonality and habitat type were the best models describing the presence of females for *A. jamaicensis*, while for *S. lilium* vegetation structure and seasonality appeared as the most important factors explaining the presence of females. For *G. soricina* we found that the presence of females was positive related to total basal area and average tree height. **Discussion:** Our findings showed differences in the sensitivity of males and females to cope with habitat disturbance. Overall capture rates of females were greater than those of males; this pattern have been reported because females of some bat species may increase their activity (e. g., foraging and/or drinking) during lactation when energy and water requirements increase. Female responses to habitat quality is likely to reflect selective foraging in a resource rich environment and higher roost availability in forested habitats. These differences indicate important implications for our understanding of the adaptability of bats and mammals to habitat modification.

Keywords: agricultural lanscape, sex-patterns, reproductive costs

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Functional Properties of Early Successional Stages of Tropical Dry Forests.

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Background: Ecological succession is greatly influenced by the functional properties of the early successional stages. To characterize such functional properties would allow us to infer the different successional pathways that disturbed forests can follow in anthropogenically disturbed landscapes. In the Neotropics, one of the ecosystems most transformed by anthropogenic activities is the Tropical Dry Forest (TDF), which is currently constituted by a heterogeneous mosaic of agricultural fields, pastures, human settlements, preserved forests and secondary forests under different successional stages. In this study, we compared the vegetation and soil functional properties of TDF between early successional stages and preserved forests within an anthropogenic landscape. **Methods:** In ten plots of a Mexican TDF, five of early successional forests and five of preserved forests, we evaluated the plant water potential and leaf functional traits related to the use of light and nutrients in the most abundant woody species. We also evaluated the soil nutrient content and enzymatic activity. **Results:** The community weighed means of the functional traits evaluated did not differed between plots of preserved and disturbed forests, but instead they were related to the disturbance history of secondary forests as well as to the human activities performed in the landscape surrounding each secondary forest. The same pattern was observed in relation to soil biogeochemistry. We also found a greater variation in plant and soil functional traits among early succesional stages than among preserved forests. **Discussion:** The great heterogeneity on the functional performance of early successional forests can be explained by the highly stochastic nature of the processes influencing plant community assembly in TDF anthropogenic landscapes. Our data also indicates that past human activities influence functional properties of secondary forests and that present activities can influence such properties even at a landscape scale. In this sense, the secondary succession of TDF could follow different pathways under different natural and human contexts. This implies a great variability in the secondary forests recovery capacity, functioning and environmental services within anthropogenic landscapes.

Keywords: Functional attributes, Early successional forest

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Lianas reduce community-level canopy tree reproduction in a Panamanian forest

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Background: Lianas are a key component of tropical forests, where they compete intensely with trees, reducing tree recruitment, growth, and survival. One of the most important potential outcomes of liana competition is the reduction of tree reproduction; however, no previous study has experimentally determined the effects of lianas on tree reproduction beyond a single tree species. **Methods:** We used a large-scale liana removal experiment to quantify the effect of lianas on community-level canopy and understory tree and palm reproduction. In 2011, we removed lianas from eight 6400m2 plots (eight plots served as controls) and surveyed understory tree reproduction in 2012, canopy tree and palm reproduction in 2013, and a second census of all plants in 2016. **Result:** We found that lianas significantly reduced canopy tree community flowering and fruiting both two and five years after liana removal. Two years after liana removal, the number of canopy trees with fruits was 173% higher, fruiting individuals had 50% more of their canopy covered by fruits, and the number of tree species with fruits was 169% higher than in control plots where lianas were present. Five years after liana removal, the number of canopy trees with fruits was 150% higher, fruiting individuals had 31% more of their canopy covered by fruits, and the number of tree species with fruits was 109% higher than in control plots where lianas were present. Liana removal had only a slight positive effect on palms and on understory tree flower and fruit production, even though understory light-levels had increased 20% following liana cutting. **Discussion:** Our findings provide the first experimental demonstration that competition from lianas significantly reduces community-level canopy tree reproduction. Reduced reproduction increases canopy tree seed and dispersal limitations, and may interfere with deterministic mechanisms thought to maintain tropical canopy tree species diversity, as well as reduce food availability to many animal species. Because lianas are increasing in abundance in many neotropical forests, the effects of lianas on tree reproduction will likely increase, and, if the effects of lianas on tree reproduction vary with tree species identity, lianas ultimately could have a destabilizing effect on both tree and animal population dynamics.

Keywords: lianas, canopy, reproduction, understory, Panama

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Land cover change in a Natural Protect Area in the Yucatan peninsula, Mexico.

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Background: Natural Protected Areas (NPAs) are one of the main conservation strategies worldwide and their success depends of multiple factors, including the effectiveness for preventing land use/land cover change (LUCC), which can be part of different degradation processes. We evaluated LUCC in Otoch Ma'ax Yetel Kooh (OMYK) NPA, in the Northeastern Yucatan peninsula, Mexico. OMYK covers a total of 5369 ha and was created in 2002 by an initiative from the local community of Yucatec Maya. The predominant vegetation is medium semi-evergreen forest in different successional stages. Until recent years, the agricultural practice of milpa was the core activity, but more recently, tourism has been increasingly important. **Methods:** We used remote sensing data and ground truthing for characterizing land use and land cover in the NPA in 2003 and 2015. We distinguished five categories including milpa, secondary and old growth forest. Vegetation maps was generated using high resolution satellite imagery. We estimated the annual rate of change for each category and the LUCC by means of a transition matrix. **Results:** During the study period, milpa decreased in a 98%, allowing for the development of vegetation <15 years, which also increased due two wildfires in the northernmost portion of the NPA in 2009 and 2011. These wildfires, which probably resulted from a combination of anthropogenic activities and forest fuels generated by hurricane Wilma (2005), caused the loss of 658 ha, including at least 100 ha of old growth forest. The 16-29-year category also increased by 455 ha as a result of the maturation of vegetation previously <15. The most extensive vegetation in both 2003 and 2015 is the 30-50 year category, which occupied 50% of the NPA area in 2015 and is largely explained by forest recovering from a large fire that followed hurricane Beulah (1967). In 2015, old growth forest represented 3% of total NPA area, and showed a net gain of 73 ha. This category is limited to areas around the lakes. **Discussion:** Our results suggest that the creation of a NPA has driven the recovery of the medium semi-evergreen forest. The recovery of the forest in cover terms can be explained by the restriction of milpa and by increased relevance of tourism activities. However, the loss of forest due to wildfires highlights the need to reinforce the management policies with the participation of local people within the NPA.

Keywords: NPA, LUCC, forest, recovery

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Can owl pellets be an important input of nutrients and influence the vegetation dynamic?

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Background: The knowledge about the interaction of raptors with their preys in terrestrial ecosystems is one of the major topics when ecology research is focused on this group of birds; however their direct or indirect effect on the vegetation dynamic needs more attention since nutrient deposition throw carcasses, pellets and feces drops from theirs diets could provide an important nutrient input to the systems. Chemical analyses of owl pellets showed an average content of 6% of calcium, 5,9% of nitrogen, and 5,3% of phosphorus when organic material from pellets is analyzed. This study proposes that owls and their trophic interactions have and important effect on the growth, composition, survivorship, recruitment and mortality of plants via pellets deposition at roosting sites. **Methods:** To verify our proposal we are collecting information about nutrients soil, plant growth, plant recruitment and plant mortality in a simulation experiment established in the Serra do Mar State Park, Brazil. All these variables have been measured in the plants with less than 1m length. The experiment employs a block design with 20 blocks total containing two plots of 50x50 cm each, one treatment plot where owl pellets are deposited simulating a roosting site, and a control plot. **Results:** The growth rates (RGR) based on stem length and plant diameter has no significant difference. The tendency of the plant diameter in treatment plots, based on the average rate, is to increase along the time when compared with control plots. Mortality and recruitment both have no significant difference between treatment and control plots, but when compared along the time the fluctuations in both rates are bigger in control plots than in treatment plots. **Discussion:** These results correspond to one year of experiment, and we are expecting to continue for one year more. Our partial results have not demonstrate any expected effect on the vegetation dynamic, even that, in the next few months we will include in the analyses a taxonomic analyses based on morphotypes variation and herbivore effects.

Keywords: owls, pellets, nutrient pulses, vegetation

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Thermal safety of tropical terrestrial insects

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Background: Climate change in the form of global warming that currently occurs directly affects the organisms, which can have an impact on the interactions between the organisms themselves (biotic effects). In order to generate strategies for the conservation of all possible biodiversity, it is necessary to identify those species and, especially, those characteristics that make them particularly vulnerable to the biotic and abiotic effects of climate change. This study estimates the direct effect of global warming on tropical organisms by measuring their thermal sensitivity to elucidate whether any taxonomic group is especially vulnerable or if a trophic level or body length makes the organisms especially vulnerable. **Methods:** Thermal sensitivity can be calculated as thermal safety (TS): the difference between the critical thermal maximum (CTmax) and the body temperature of an organism. CTmax refers to the temperature at which the organism loses motor coordination. CTmax was obtained by an exhaustive online search and body temperature, assumed here as operative temperature, was calculated using a biophysical model. The biophysical model simulated that the organism was constantly exposed to solar radiation, constantly covered by shade or displaced between solar radiation and shade to maintain a proper body temperature. Body temperature was also simulated for the climatic conditions of the year 2000 and the year 2070. **Results:** It was found that the ants had the lowest TS, followed by the beetles, then the flies and finally the dragonflies. Currently, predatory insects are thermally more sensitive than those herbivores, but by 2070 the three trophic levels will be equally affected by temperature increases. Longer organisms had the highest TS. The organisms that covered themselves by shade presented higher TS that those that voluntarily or constantly exposed themselves to the solar radiation. The current TS is larger than it will be by 2070. **Conclusion:** Tropical organisms are at risk, as various studies prove. However, this research supports the pattern with even greater statistical power and decomposes the pattern between taxonomic groups and ecological characters. Within the ecology of conservation could deepened on predatory insects; on smaller insects; and those characters that cause that ants of equal length present completely opposite thermal sensitivities.

Keywords: CTmax insect prediction thermoregulation temperature

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Effects of environmental filters on oaks communities in a temperate forest in Jalisco, México

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Oaks are dominant trees and key species in many temperate and subtropical forests around the world. The genus *Quercus* is one of the most important components of temperate forest communities in México, which is considered the main diversification center for oaks in America. Ecological theory suggests that multiple environmental factors shape local species assemblages by progressively filtering species from the regional species pool to local communities. In this study, we studied community structure by examining the distribution of 24 oak species in a temperate forest in Jalisco across different scales of environmental filtering. This study was carried out in western Mexico in the state of Jalisco, at Serranias Meridionales de Jalisco, which is considered an important area for red oaks. We sampled the presence/absence and cover of trees in 33 plots (0.1 ha) distributed randomly between 800 and 2500 masl. on the study area. We also collected data on soil and litter fall per plot. Five environmental and terrain variables at 30m x 30m were used to model species richness and diversity metrics. We used canonical correspondence analysis (CCA) and linear models (LM) to test the relative influence of multiple environmental filters on species richness, diversity metrics and plant cover in the whole data set and the subsets (i.e. *Quercus*, red and white oaks). Species diversity indices were significantly influenced by environmental factors acting at both large and fine scales. Our results emphasize the hierarchical nature of ecological forces shaping local species assemblage: large-scale environmental filters having a primary effect. Our results shows a hierarchical effect, whereby large-scale environmental (precipitation of coldest quarter and mean diurnal temperature range) have an effect at family and genus level; while, fine-scale environmental filters (litter fall C:N ration and Cg/g in soils) act different between sections; where the proportion of white oaks species increasing with increasing elevation. These results provide insights into how oak diversity is maintained at the community level in a diversification center for red oaks in México. These communities are more likely to include members of both sections, suggesting that white oaks have high environmental tolerances, agreeing that the hypothesis that long-term competition between lineages could lead to evolutionary conservatism of traits that promote coexistence.

Keywords: *Quercus*, environmental variables, hierarchical effect, ecology

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The role of the Amacuzac River as a seed dispersal agent in the Topical Dry Forest

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Background: Rivers are important corridors for the movement, migration and dispersion of aquatic organisms, including the seeds of riparian plants. In Morelos, we can find tropical dry forest on the banks of the rivers. In this environment, a high number of seeds is dispersed during the dry season, but it is expected that in riparian corridors the number of seeds dispersed by rivers might be higher during the rainy than the dry season as a consequence of seasonality and the variability on the river flow. **Methods:** Here, we evaluated the relationships between the Amacuzac river flow regime, plant phenology and the number and species of seeds dispersed. We also evaluated differences among two seasons and four different sites located along the river. We collected the seeds transported by the Amacuzac River using nets hanging from four bridges crossing the river during 1day of 3 consecutive months per season (2015-2016); seeds were identified and species richness and the number of seeds transported determined. Seed diversity indices were estimated for each sampling site and the differences between sites and seasons were evaluated. We then estimated the Amacuzac mean flow for ten consecutive years (1997-2007), and seed community was associated with it. **Results:** Fifty-one plant species were identified and 909 seeds collected from the river. Species diversity flowing in the river was low (H = 1.52), and not significantly different among sites or season; however, the number of seeds was significantly higher in the rainy than in the dry season, and among sites. We found a significant positive relationship between flow rate and the number of seeds dispersed, but not for number of species. Although, the number of species did not vary between seasons, species composition was markedly different between them. **Conclusion:** Hydrochory is a significant process in tropical dry forests playing a fundamental role in the dynamic and composition of riparian vegetation.

Keywords: Hidrochory, seed banks

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Seasonal and successional patterns of litterfall production in a deciduous tropical dry forest

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Background: Land-use changes affect biological, chemical and physical factors, leading to a complexity and unpredictability of anthropogenic effects on ecosystem functions. One of the key challenges is to understand the patterns and processes involved in the nutrient and carbon dynamics in secondary tropical forests. Litterfall is one of the main nutrient cycling processes in forest ecosystems and an important pathway of carbon and energy transfer from the vegetation to the soil. This study aimed to estimate litterfall production to evaluate its temporal variation during a year and to determine the influence of forest stand age and climatic variables on this variation in a deciduous tropical dry forest. **Methods:** Fifteen forest stands in four categories of successional age (3-5, 10-17, 18-25 and >60 years after slash-and-burn agriculture) were selected for litterfall monitoring. Fifty two 400 m^2 circular plots (12-16 per successional-age category) were stablished, each containing three 0.5 m^2 litter traps. Litterfall was collected monthly during a year. One-way ANOVA was performed to assess effects of successional age on annual litterfall production. Seasonal variation in litterfall was analyzed using Repeated Measures ANOVA. Stepwise multiple regression analyses were performed to evaluate the effects of climatic variables on litterfall production. **Results:** Annual litterfall production was 6.089±0.226 Mg ha^{-1} $year^{-1}$. Litterfall production was significantly lower in the youngest forests than in other stand age categories, suggesting that litter production increases rapidly early in succession and remains relatively stable in subsequent stages. Litterfall production dynamic was markedly seasonal, with the highest values at the end of the dry season, which is primarily linked to a decrease in precipitation of the previous month and to wind speed, which acts as a mechanical factor in foliage loss. **Conclusion:** Litterfall production was lower early in succession likely reflecting incipient biomass accumulation. Litterfall production was markedly seasonal and is mainly determined by the leaf-shedding by plants as a strategy to cope with water stress. Results show the importance of multi temporal studies for a better understanding of the fundamental processes in tropical dry forests. In addition, the results obtained broadly outline the phenology of the forest studied; thus, they may be useful in developing conservation and management programs in these forests.

Keywords: chronosequence, climate-litterfall relationships, seasonality

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A simple simulation model of species succession on local and landscape scale

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Background: Successional patterns and dynamics of tropical forests are extensively studied using chronosequences and, more recently, longitudinal studies. These empirical studies generally focus on local factors and processes, even though landscape-scale processes may play an equally important role. Most theoretical models of succession are largely verbal and hypotheses derived from these models often are not very specific. As consequence, it is not always clear what patterns to expect under a given hypothesis. Here we describe a basic simulation model with simple assumptions and rules that operationalize specific hypotheses and explore how this model can generate predictions on how successional patterns differ within and across different landscapes. **Methods:** We developed a simple rule-based simulation model in which fixed numbers of trees are added and removed from a plot at each time step. Trees are randomly selected from a local species pool (recruitment) and from the plot (mortality), based on their species identity and the age-dependent recruitment and mortality probabilities per species (group). Simulations are run for 35 years and for 50 plots at the time, and a range of alpha and beta diversity indices are calculated for each time step based on the generated data. **Results:** We show how different (combinations of) assumptions and rules related to (1) size of and similarity among local species pools; and (2) variation in the age-dependent recruitment and mortality rates of species affect the sign, direction and shape of successional patterns in alpha and beta diversities as well as how and how fast the species composition of local communities and the metacommunity changes over time. **Discussion:** A crucial element of most models of succession is the variation in how species are adapted to the changing conditions along a successional gradient and how that drives successional species turnover. Dispersal limited is a key driver of succession but not always explicitly included in succession models. Our simple modelling exercise provides insight in how both can affect successional patterns, and highlights the need to study successional patterns on both local and landscape scale. To test prediction from the model - and explore the role and relative importance of different ecological processes along major environmental and land-use gradients - we need studies with replicated plots per age class, replicated along land use gradient.

Keywords: forest succession, simulation model

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Soil temperature influences soil CO_2 efflux only during an early dry season in a dry tropical forest

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Background: Soil temperature, soil moisture, and topography have a great influence on soil CO_2 efflux in tropical forests. Soil moisture would be responsible for the spatio-temporal variation of soil CO_2 efflux and soil temperature would cause its daily changes. Topography has an indirect influence: rainwater transports nutrients from high to low areas. **Methods:** In this study, soil CO_2 efflux was measured through year, besides its association with soil temperature and moisture, its difference between soils of borders of hills and soils in flat areas far from hills, and its variation during 24 h periods in a dry tropical forest of the Yucatan Peninsula. Within the forest, 24 measurement points were established, and soil CO_2 efflux, soil temperature and moisture were recorded during two days every month for a twelve-month period. **Results:** Mean soil CO_2 efflux was 4.0 ± 2.2 (SD) μmol m^{-2} s^{-1}; during the early dry season, similar to the annual mean and intermediate between the mean values for the dry and wet seasons (early dry: 4.1 ± 0.9; wet: 5.3 ± 1.2; dry: 1.5 ± 0.4 μmol m^{-2} s^{-1}, $p < 0.05$). The soil CO_2 efflux increased linearly when soil temperature increased only in the early dry season ($R^2 = 0.19$, $p < 0.05$). In all seasons, soil CO_2 efflux increased linearly when soil moisture increased, but soil moisture only explained 45% of the spatio-temporal variation of soil CO_2 efflux during the study period. Borders of hills had a greater soil CO_2 efflux than areas far from hills only in March, June, July, September and November ($p < 0.05$). **Conclusion:** The daily variation of soil CO_2 efflux was less important than its spatial variation. Thus, for this tropical dry forest soil CO_2 measurements should include these three seasons and contrasting topographic areas.

Keywords: Soil CO_2 efflux, soil temperature

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What frequently literature used estimators temporally change?

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Background: Insects 'are the little things that run the word' and it is even clearer in tropical regions. Assessing how insect communities and their interactions may temporally change becomes therefore crucial to understand the ecological stability of tropical environments. Most research uses community metrics (e.g. species richness) to assess ecological patterns in insect communities, while food web metrics are less frequently used to examine insect responses across time. As a result, our understanding of how insect communities and their interactions may vary temporally is limited due to the lack of researching assessing temporal changes in both community and food-web metrics. **Methods:** To address this knowledge gap, we assessed community (species richness, relative abundance and species composition) and food-web metrics (connectance, generality, vulnerability, linkage density, compartmentalization and mean chain length) from insect communities associated with a Leguminous plant species (*Senegalia tenuifolia*). Fruits and associated insects were sampled over four years (2011-2014) in three fragments of Brazilian native savanna (regionally known as cerrado). For community assessments, we considered the distinct trophic levels (e.g. herbivore, parasitoid and hyperparasitoid) as independent insect communities, while food-web assessments included the insect species from all the trophic levels and their interactions. Trophic level from each sampled species was determined according to its interactions within the food-web. **Results:** Across the four years, we sampled 1,399 fruits from which we extracted 12,651 seeds and 2,376 insects from 27 species distributed along four trophic levels. When investigating the temporal variation in community metrics, we found species richness, abundance and composition changing along time for insect communities from all trophic levels (all P-values < 0.01). Nevertheless, generality was the only food web metric that have significantly changed over the four years ($F_{3,8}= 5.12$, $p< 0.02$). **Discussion:** Our results have demonstrated that food-web metrics can maintain temporally stable even when community metrics such as species richness and abundance change across the time. Given the importance of insect communities for many ecosystem services, we stress the importance of applying both community and food-web approaches to better understand their temporal variation in both natural and human-modified ecosystems in tropical regions.

Keywords: food web, insects, temporal approach

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Patterns of vegetation recovery in secondary forests depend on the ecological measure and soil type

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Background: Understanding successional changes in secondary forests is crucial to the assisted recovery of their biological and functional diversity. Soil condition, among other biotic and abiotic factors, can be an important feature affecting forest recovery rates. Our aim was to analyse different ecological measures of secondary forest recovery. We compared such measures in two contrasting soil types in the Wet Tropics of Australia. **Methods:** We counted and identified woody vegetation (>2.5 cm diameter at breast height) in 50 m transects in 41 independent sites to model the response of nine vegetation variables (number of stems, basal area, alpha diversity, dominance, frequency of common species, number of rare species and two indices of functional diversity, functional dispersion and functional divergence). We used these measures as a function of soil types (basalt-derived=clayey, more fertile and granite-derived=sandier, less fertile) dominant in the region, time since land abandonment (determined by satellite and aerial imagery) and geographical distance from remnant forest patches. We used multiple linear regression models, unconstrained ordinations and indicator species methods to analyse the data. **Results:** Alpha diversity and dominance showed distinct patterns of recovery between basalt and granite soils. However, the inclusion of distance from forest remnant in the models of forest recovery reduced the effect of soil type. In terms of community composition, we found significant differences in the recovery patterns between basalt and granite soils, with several species being significantly associated with one or the other soil type. Contrary to our expectations, dominance by nitrogen-fixing legumes was not greater in nutrient-poor soils and higher dominance by legumes did not affect the vegetational change between soil types. **Discussion:** Although species and functional diversity tended to increasing with forest age, the recovery success may have different interpretations depending on the ecological measure analysed. Markedly, the community composition of woody plants may be influenced by the soil condition, indicating potential assemblages to be further investigated to improve restoration programs in the region. Moreover, the reestablishing vegetation community and the spatial distribution of surrounding mature forest also seemed to affect the rate of rainforest recovery.

Keywords: rainforest regeneration, parent material, chronosequence, successional pathways.

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"Dean" hurricane effect over the forestall species in the tropical forest of Quintana Roo, Mexico.

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Background: The management of the tropical forest in the Yucatan península, is more recognized as one important activity for conservation, generation of ecosystemic services and for income generation for local towns. But one of the several challenges that face the forest management is the recurrent presence of hurricanes. This challenge can be face and use favorably knowing the effect of hurricanes in the forest of Noh-Bec, Quintana Roo, affected by "Dean" hurricane (2007), with the objective of characterize the behavior of the population of *Swietenia macrophylla*, *Manilkara zapota*, *Simira salvadoresis*, y *Dendropanax arboreus*. **Methods:** Observational, longitudinal and comparative studies. Three measures were made (1998, 2010, 2014), 25 permanent sampling plots (PPM), for the evaluation of the population density, diameter, high, volume, basal area and hurricane damage. mid-point probes, inferential, and the importance index and structural diversity. **Results:** The analyzed species change in importance (IVI) and structural diversity (DE) since the affectation, with an abrupt descend of the high, diameter and volume values, and an increase of the basal area and population density among 1998 and 2010 (first period). For begin later the process of recuperation difference between 2010 and 2014(second period). **Discussion:** Its concluded that this species, even thought are initially affected by the hurricane on its values, they recover in mid term and are beneficed with the increase of its population densities.

Keywords: Management, forest, hurricanes, longitudinal, plots

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Macroecological patterns of leaf size, shape, and function in the cerrado

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Background: The wide variety of sizes and shapes of tropical tree leaves can be ultimately viewed as an adaptation to the complex problem of optimising photosynthesis as a function of the environment, physical constraints, and evolutionary history. For example, the abundance of drip-tips---long, acuminate leaf tips thought to aid removal of water from the leaf surface---in tropical wet forests has been identified as a key ecological pattern among plant communities. The evidence for this pattern comes from early comparative studies that identified high frequencies of drip-tips in tropical lowland rain forest and montane cloud forest sites, whereas temperate rain forest and drier forest sites lacked drip-tips. A recent macroecological approach comparing tree communities in 130 1-ha plots throughout lowland Amazonia found higher incidence of drip-tips in forests with heavy rainfall. Here, we ask whether a similar correlation with rainfall is found in the drier cerrado ecosystem with a different suite of species and evolutionary histories. **Methods:** We used data on the incidence of 849 tree or large shrub species at 367 cerrado and Amazonian savanna sites throughout Brazil, covering about 75% of the cerrado domain. Species richness varied from Amazonian savannas (1 species) to >100 in the cerrado core area. All taxa were identified to species-level. Leaf tip type was scored for each species from herbarium specimens. Climate data were obtained from WorldClim. We used a generalized linear modelling approach to test the correlation between the proportion of species with drip-tips at each site and six bioclimatic variables. **Results:** In contrast to Amazonia, drip-tips were present in only 11% of Cerrado species. Drip-tips varied from 0% (at 32 sites) to 22--25% of species at any one site. Incidence of drip-tips was weakly, but significantly, correlated with rainfall. Cerrado species with distributions that extended into Amazonia were much more likely to have drip-tips (72%) than species restricted to the Cerrado, and the correlation of drip-tip incidence was stronger in these species. **Conclusion:** The correlation of drip-tip incidence with rainfall supports the idea that they are an adaptation to increase water drainage from the leaf, even in dry savannas. Trait-based macroecological approaches can play an important role in the identification and assessment of adaptations.

Keywords: leaf, drip-tip, cerrado, rainfall

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Riparian Dry Forests for the diversity of dung beetles in a cattle landscape of Cordoba, Colombia

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Background: The widening of the agricultural frontier is considered one of the most important causes of loss of tropical forests. In transformed tropical landscapes, remnants of riparian vegetation are frequent elements that could have a function for biotic diversity at the landscape scale. In this study we estimate the diversity of dung beetles in riparian remnants of dry forest and it was compared with the diversity estimated from cattle pasture and forest fragments (control) to evaluate the role of riparian forests in a cattle landscape of Cordoba for the diversity of the dung beetles. **Methods:** This research was carried out in an agricultural landscape of Cordoba, a Colombian department where five riparian remnants, three dry forest remnants (used in this research as controls) and five pastures in livestock use were selected. Collection days were during the rainy season between October-December 2015 and July-August 2016. In each habitat the beetles were captured with traps that were active for 48 hours and were made with barley falls and human excrement. **Results:** During the research 22,021 individuals were recorded, distributed in 29 species and seven tribes. The most abundant species was *Canthon* 01H, followed by *Onthophagus marginicollis*. The highest abundance was registered in the controls, followed by the riparian remnants, which presented the highest wealth of the entire study. The analysis of diversity revealed that riparian remnants were more diverse in all orders of diversity compared to grasslands (between 1.8 and 3 times more diverse) and fragments of dry forests used as controls (between 1.2 and 2, 3 times more diverse). Beta diversity analysis showed that the assembly of coprophagous beetles from riparian remnants was more similar to the assembly of beetles from the control fragments compared to assembly of cattle ranches (Beta (riparian-control) between 1.2 and 1.8; Beta (control-pasture) between 1.4 and 1.9). **Conclusions:** In conclusion, it is important to keep riparian remnants in livestock landscapes, because they may present greater diversity compared to the dry forest fragments (control), and also because of their taxonomical similarity between the control.

Keywords: riparian, dung beetle, livestock landscapes

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Responses of Tropical Dry Forest trees to dry spells. An analysis between functional strategies.

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Background: Dry spells during the rainy season are a prevalent factor in the seasonal tropics that cause temporal heterogeneity; series of dry and wet pulses. The dry pulses might severely affect plant performance as drought takes place when plants experience accelerated metabolic processes, while wet pulses allow for physiological and growth recovery. Concerns have raised because the predicted increase in frequency and duration of dry-spells with global climatic change. In this study we investigated what are the effects of dry-wet pulses on plant performance and establishment, and how different functional groups of trees respond to different scenarios of dry-wet pulses. **Methods:** We selected 18 tree-species belonging to three different strategies to deal with drought: 6 drought-tolerators, 6 drought-avoiders, 6 water-exploiters, all dominant in Chamela, Jalisco, Mexico. Seedlings were subjected to four pulse scenarios by controlling watering in a common field experiment: a) no drought, b) frequent short-droughts (c) infrequent long-droughts, (d) progressive-drought. Survival and growth in diameter and height were monitored during 12 months. **Results:** Under no drought, tolerant, avoiders and exploiters survived equally. However, under dry-wet pulses, avoider species had the highest mortality rates while the tolerant group showed the lowest. Mortality rates of the three groups increased with the length of the dry pulse and this effect was stronger for avoiders, particularly in the longest dry pulses. Potential relative growth rate was higher for avoiders and exploiters, compared to tolerant species. However, this shifted under pulses; tolerant species performed faster than the other groups, especially towards longer droughts. **Discussion:** Our results suggest that in scenarios with no dry-spells tolerant species may be outcompeted against avoiders and exploiters, while in years with long or frequent dry spells tolerators may survive and growth better, suggesting a potential mechanism for temporal coexistance of different functional groups. The poor performance of avoiders under pulses suggest that these plants may get starved due to repeated dropping and production of new leaves. In contrast, an increased supremacy of tolerators in scenarios of longer droughts can be explained given both, resistant xylem to cavitation, and the development of deeper roots. Intriguingly exploiters were not clearly the most affected functional group under dry-wet pulses scenarios.

Keywords: funtional groups, dry spells, drougth

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Posters
Tropical ecosystem services

A comprehensive assessment of Hach Winik Maya milpa provisioning ecosystem services

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Method: We initiated Hach Winik management in five 600 m^2 experimental plots through a controlled burn of secondary forest in. Lacanja Chansayab, Chiapas, Mexico and planted with milpa crops and trees. We harvested and weighed crops during the first and second years of production. We used these data and the United States Department of Agriculture Food Composition Database to calculate the nutrition facts for all food harvested from our experimental plots. We compared these to the United States Food and Drug Administration's Dietary Reference Intakes (DRIs). **Results:** We found that yields from an average-sized 1 ha milpa meet most DRI requirements, including calories, fat, carbohydrates, fiber, sugar, protein, calcium, iron, zinc, and niacin. However, diets derived exclusively from milpa yields may be deficient in sodium and iodine. Milpa crop yields and nutritional content vary throughout the year. Milpa yields generally increase from the first to the second year of cultivation. **Discussion:** Milpas can provide Hach Winik farmers with enough food to meet most of the DRIs for them and their families. Hach Winik farmers supplement these harvests by foraging in fallows. This could serve as a means of acquiring provisioning ecosystem services necessary to supplement those obtained from milpas. Also, we observed that Hach Winik milpa management yielded 3090 kg/ha of maize more than most previous observations underscoring the potential of Hach Winik agroforestry management to provide rural smallholders in the Lacandon rainforest with provisioning ecosystem services while maintaining nearby forest cover to conserve biodiversity and other ecosystem services.

Keywords: traditional ecological knowledge ecological agriculture

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Ecological and socio-economic impacts of the dam breach in Mariana, Brazil

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Background: On November 5th, 2015, Brazil experienced its worst ecological disaster when an iron mine dam failed in the municipality of Mariana, State of Minas Gerais. Tailing management practices by Samarco mining company caused a dam breach that abruptly discharged 62 million m3 of tailings into the Doce River watershed and engulfed the small district of Bento Rodrigues, loading the Doce River and its estuary with toxic tailings along a 663.2 km trajectory, extending impacts to the Atlantic Ocean. The destruction of riparian, freshwater and marine ecosystems eliminated irreplaceable natural resources and ecological processes that support traditional livelihoods, disrupting fisheries, agriculture, tourism and provisioning of fresh water. The threats to riverine human communities are particularly critical for the disadvantaged populations from remote areas that rely on subsistence agriculture and fisheries, and are uniquely vulnerable to long-term heavy metal exposure. **Methodology:** Scientific papers, journals and technical reports were analysed for this article. **Results:** Analysis of surface reflectance data allowed measurements of the extension and intensity of the damage by the released tailings. Spatial analyses identified significant vegetation loss and deposition of tailings with extreme high concentration of iron along the Doce River. The devastation impacted approximately 1,469 ha of natural vegetation and 90% of the riparian habitats. Entire fish populations died immediately after the discharges when the slurry buried them or clogged their gills. Preliminary data estimates the loss of significant biomass of the original fish stock in the Doce River and marine ecosystems. **Discussion:** At the landscape scale, we predicted multiple negative impacts, ranging from alterations of the genetic diversity of fish populations to long-term vegetation loss and poor regeneration in contaminated areas. Consequently, compromised soil stability and run off control should increase the risk of further geomorphologic disturbance, including landslides, bank failure and mass movements. We propose spatially explicit long-term monitoring frameworks and priority mitigation measures to cope with acute and chronic risks. We posit that, from a national perspective, disastrous impacts like that of Doce River may become more frequent, given the recent regulatory changes that undermine both institutional governance structures and enforcement of environmental regulation in Brazil.

Keywords: Ecosystem services; Environmental contamination

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Litter decomposition rates in Tropical Alpine Paramos in response to experimental warming.

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Background: Paramos are tropical alpine ecosystems located in the northern Andean range above 3400 meters. In this ecosystem decomposition rates are typically slow as a result of the low temperatures and high humidity conditions, which have facilitated the accumulation of carbon and makes them major carbon reservoirs. Shifts in global temperatures due to climate change could accelerate decomposition rates and eventually turn paramos into carbon sources. Here we evaluate the effects of experimental warming on litter decomposition on two substrates, frailen (*Espeletia grandiflora*), a common and endemic paramo species and bay leaves (Laurus nobilis), a standard substrate that has been used worldwide on litter decomposition experiments. **Methods:** Litterbags were deployed in 20 experimentally warmed and 20 non-warmed plots as part of a long-term warming experiment set in two paramo sites on the eastern range of the Colombian Andes, Matarredonda and Sumapaz. Warming was achieved using open top chambers (OTCs). At each plot, we deployed paired subsets of coarse-mesh litterbags above ground with 1 gram of bay leaves or frailen leaves that were decomposed for 1, 3, 6 and 10 months. **Results:** After 300 days decomposing in the field, the remaining mass ranged from 56% to 85% with an average decay rate of 1.383 • year^{-1} for Matarredonda and 1.006• year^{-1} for Sumapaz, suggesting that 75% of the litter will be decomposed after one year. Leaf litter decay rates did not differ statistically among treatments, but had a partially significant difference among site and species. Substrate had the strongest effect on decay rates, where bay leaves had higher annual decay rates values than frailen leaves. As for the site effect, decay rates were higher in Matarredonda than in Sumapaz, and decay rates were slightly lower in warmed plots compared to control plots, although the difference was not statistically significant. **Discussion:** Compared to decay rates found in literature for tropical and neotropical ecosystems, our average values fall within the lower extreme of reported values, which supports that decomposition rates on paramos are slow, as we expected. Even though our data suggests slower decomposition rates on warmed plots the effect lacks statistical significance perhaps due to the recent establishment of the experiment.

Keywords: Decay rates, paramo, experimental warming

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Ecosystem services neglected by the biggest environmental disaster in Brazil

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Background: Brazil witnessed one of the worst environmental disasters in its history when a wave of 62 million m^3 of mud destroyed the Rio Doce river, the largest river in the Southeast Atlantic hidrogeographic region. The collapse of a dam of iron ore tailings belonging to a mining company called Samarco buried the entire village of Bento Rodrigues, destroying its historical and cultural patrimony. In addition to the losses caused by disruptions of tailings dams, mining involves conflicting demands - or trade-offs - between industry and biodiversity conservation, since it converts multifunctional landscapes, which provide a variety of ecosystem services, into monofunctional landscapes restricted to the mineral extraction. The objective of this work was to analyze these conflicts and propose mitigating measures. **Results:** Many scientists decreed the death of the Rio Doce river due to the loss of practically all its biodiversity. There was a failure in the environmental licensing process of the mining company due to the lack of resources and qualification of public environmental agencies employees. The Brazilian legislation does not require that companies compensate for mined areas in the same type of ecosystem. Thus, areas that are rich in valuable minerals are under-represented in the Brazilian system of protected areas. Besides, territorial planning is rarely done before the implementation of mining projects, and the value of environmental fines is now obsolete since they are old and are not comparable to the estimated value of lost services and the resources needed to recover degraded areas. Also, there is no obligation to reinvest the royalties of mining in environmental policies and the Brazilian production matrix is mainly based on the exportation of commodities. **Conclusion:** We propose measures to balance the trade-offs between mining and environmental preservation: 1) investments in more rigorous environmental licensing by government agencies; 2) protection of mineral-rich reference ecosystems 3) Investments in economic activities that promote the multifunctionality of landscapes; 4) adoption of prior planning for land management; 5) incorporate environmental services in the cost-benefit analysis of companies and add the cost of their loss in the calculation of fines;6) increase taxes on mining products; 7) invest the royalties of mining in the preservation of nature; 8) diversify the matrix of commodities produced in Brazilian territory.

Keywords: Ecosystem services; mining; biodiversity; restoration.

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Cattle and forests: Understanding social-ecological systems for the provision of ecosystem services

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Background: In the buffer zone of La Sepultura Biosphere Reserve, Sierra Madre of Chiapas in southern Mexico, pine-oak forests are usually found within extensive cattle enclosures. Alongside managed pastures for grazing, forests are used for oak firewood and pine resin extraction. The latter, considered a more suitable activity to the reserve's management goals, is a recently developed livelihood strategy that is being promoted by conservation-oriented actors in parallel to a land-sparing approach. However, cattle ranching remains the main source of income and also relies on forests. The importance of ecosystem services and the roles of different types of social and natural capital are therefore explored. **Methods:** A systematic horizontal point sampling was carried out in twelve cattle enclosures to estimate basal areas of oak, pine and broadleaf species, corresponding to tree-related provisioning services. The sampling grid was used to assess the relative occurrence of different vegetation cover types, and mapping of enclosures allowed to scale up to the landscape and the use of GIS tools. Concomitantly, through the use of semi-structure interviews supported by maps and photos of landscape features, farmers and other relevant actors were asked how they perceive and value different ecosystem services in the enclosures and throughout the territory. **Results:** There's a general pattern in these human-modified landscapes in which hillsides are forested and valleys have open grasslands with riparian tree remnants. Yet the supply and delivery of ecosystem services varies among enclosures, not only because the relative vegetation cover and composition of each is different, but also because the provision of these services depend on human livelihoods. Farmers value the environment for its contribution to their well-being, and conservation-oriented actors are additionally aware/interested in biodiversity. Both agree the delivery of ecosystem services could be enhanced, and propose different but not necessarily contradicting strategies. **Discussion:** An assessment of ecosystem services through a social-ecological systems approach reveals the links between actors and resources. This allows to focus research and eventual site-project objectives, e.g. of sustainable intensification and/or land use zoning, not just to safeguard biodiversity and improve agricultural production, but to support entire social-ecological systems for an adaptive provision of ecosystem services.

Keywords: ecosystem services, social-ecological systems, forests

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Influence of vegetation density on the transmission and infection severity of coffee leaf rust

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Coffee leaf rust is a common agricultural disease in the tropics, caused by the fungal pathogen *Hemileia vastatrix*. In 2013, epidemics throughout Latin America caused devastating economic loss and re-invigorated research into new disease management. Because *H. vastatrix* uses wind for transmission and humidity for germination, we propose that coffee leaf rust disease dynamics can be influenced by landscape structures that modify the abiotic environment. Specifically, we hypothesize that tree stands will disrupt wind transmission of fungal spores, but that increased canopy cover will reduce evaporation, increase local humidity, and increase rust germination. We explored the effect of trees on local disease dynamics on a highland coffee plantation in Chiapas, Mexico. At 128 sites, we measured evaporation rates, tree density, coffee plant density, and canopy cover, as well as the number of infected and uninfected leaves on five coffee plants. We predicted that increased tree density will reduce the probability of coffee plants contracting infection, but that once infected, coffee plants under higher canopy cover will experience less evaporation and suffer higher infection intensity. We modeled the influence of tree density, canopy cover, evaporation, and coffee plant density on the number of infected leaves per plant using a general linear mixed model for a negative binomial distribution with zero-inflation. Coffee plants were less likely to become infected at higher tree ($P=0.0230$) and coffee plant densities ($P=0.0249$). The number of infected leaves was influenced only by higher coffee densities ($P=0.0155$), and evaporation had no influence on infection. Our results suggest that vegetation structures - including both trees and coffee plants themselves - block wind-dispersal of rust spores and reduce the probability of plants contracting the coffee leaf rust. However, once infected, the infection intensity is controlled by higher coffee plant densities in the vicinity, not humidity. We suspect that areas with higher coffee densities are more likely to contain different varieties, some of which are more resistant than others, so that disease severity is managed through the dilution effect. These results suggest that tree stands can provide additional ecosystem services in controlling the coffee leaf rust disease, though they will need to be used in conjunction with other disease management strategies.

Keywords: microclimate, coffee agriculture, shade trees

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Divergent values of avian ecosystem services across forest-matrix interface in fragmented landscapes

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Background: Most contemporary Neotropical forests are highly fragmented, with nearly half of the remaining forest area dominated by edge and spillover effects with the adjacent matrix. Land use management strategies considering both biodiversity and forest ecosystem service provision at the interface between low- and high-quality habitats have received increasingly greater attention from ecologists and land managers. Here, we quantify the potential provision of ecosystem services (ES) by birds in two types of forest/matrix interfaces and examine differences in ES provisioning both within and between forest/matrix interfaces. **Methods:** In a large region of southeastern Brazil, bird communities were sampled using paired point counts at 32 forest-matrix interfaces (N=16 forest-pasture and N=16 forest-eucalyptus plantations). As proxy of ES provision by birds we calculated three metrics: pest control (PC), seed dispersal (SD) and pollination (PO). These three ES metrics were based on local species abundance and a data compilation on birds potentially consuming insects (for PC), fruits (for SD), or nectar (for PO). Differences between paired point counts within interfaces were assessed using paired t-test while differences between forest-forest and pasture-eucalyptus sites were assessed using t-test. **Results:** For all ES types, mean values were significantly different for forest-pasture, forest-eucalyptus and pasture-eucalyptus (all $p<0.01$), but not for forest-forest comparisons ($p=0,58$; 0,15 and 0,10 for PC, SD and PO respectively). Mean PO values were not significantly different ($p=0.21$) at forest/pastures interfaces. Both pastures and eucalyptus had lower mean values than adjacent forest edges for all three ES types evaluated ($p<0.01$). However, in all cases pastures had higher mean values than eucalyptus plantations ($p<0.01$). Forest-pasture interfaces had lower contrasts for all ES values than forest-eucalyptus interfaces. **Conclusion:** Our findings suggest that potential avian ES provision in matrices adjacent to forests edges differ according to matrix type, whereby bird assemblages in pastures tend to provide higher PE, SD and PO services than those in eucalyptus plantation. Furthermore, the higher contrast in vegetation structure across forest-pasture interfaces may reflect inverse patterns considering contrasting ecological functions provided by birds, compared to forest/eucalyptus boundaries.

Keywords: bird community, ecosystem function, Brazil

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Posters
Tropical biodiversity and ecosystem conservation

Gorillas ranging patterns are strongly influenced by their food plant distribution

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Gorillas ranging patterns are strongly influenced by their food plant distribution. From 2008, an increase of gorillas ranging outside the park in cultivated areas has been observed resulting in a rising conflict between gorilla and local people. This study aimed to determine gorilla food plants and their biomass distribution adjacent to the VNP which will help to determine whether there is a relationship between food availability and the frequency of gorilla visits outside park boundaries. We located about 93 transects perpendicular to the forest edge of 500m length, each separated by 250m.A total of 279 plots were established along transects in 250m intervals. The plot size depended on the dominant plant life form. We identified all plants eaten by gorillas in each plot and calculated the gorilla food plant biomass using standardized methods. Results showed that there are 25 gorilla food plant species near the VNP boundaries. Dominant species were *Eucalyptus* sp., Y. *alpina* and *Rubus* sp. Three gorilla food plant species were found outside but not inside the park (*Eucalyptus* sp., *C. lusitanica*, and *A. glutinosa*.) Among the top 10 consumed plants inside the park, only 3 of them were not found outside the park (*L. alatipes*, *P. kerstenii*, and *D. erici-rosenii*). For different life forms, *D. iners , C. nyassanus*, *Y. alpina*, and *Eucalyptus* sp. showed the highest biomass respectively. Gorilla food plant species diversity and biomass distribution outside the VNP were strongly influenced by both farming intensification and the distribution of *Eucalyptus* trees. This study shows that gorillas' ranging outside the park is due but not limited to the presence of their food outside the park. The failure to manage effectively the zones of interactions outside the park will result in continuous ranging outside the park and this will result in negative impacts for both gorillas and humans.

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Culturing of mountain gorilla fecal samples for identifying gastrointestinal helminths

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With the continued expansion of the global human population, interactions between humans and wild apes are increasing. As a consequence, ape habitats are reducing and the potential of exposure to zoonotic/anthroponotic pathogens are on the rise. This study aimed to 1) use microscopy and fecal culture (coproculture) for identifying gastrointestinal helminths in the endangered mountain gorillas; 2) to compare helminth larvae and egg diversity in fecal samples from Mountain Gorillas; 3) investigate sex, age and group effects on egg and larvae type prevalence. 104 fecal samples were analyzed (one fecal sample per individual gorilla) from 9 social groups (Gushimira, Isabukuru, Iyambere, Kuryama, Mafunzo, Musilikale, Ntambara, Pablo and Titus). Modified ethyl acetate sedimentation, sedimentation technique and microscopy were used to identify egg parasites. Culturing and Baermann technique were used to retrieve third stage larvae. 4 types of egg (*Trichostrongylus*, *Oesophagostomum*, *Necator* and *Anoplocephala*) and 5 types of larval (*Hyostrongylus*, *Trichostrongylus*, *Oesophagostomum*, *Ancylostoma* and *Probostmaryia*) were identified. Overall, larval diversity was higher than egg diversity. No significant differences were found in any larvae/egg prevalence in sex-classes. We found significant differences in the prevalence of *Oesophagostomum* egg type in age class, but no significant differences were detected in *Oesophagostomum* larvae type. The only significant difference between gorilla groups was found in prevalence of *Oesophagostomum* eggs, where the highest prevalence was in the Musilikale group. The prevalence of *Oesophagostomum* larvae in the Kuryama group was high, but there were no significant differences in the prevalence of *Oesophagostomum* larvae between the groups. There is a potential overlap of helminth parasites between people living around Volcanoes National Park and gorillas based on previous studies.

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Are Earth Mounds Local Biodiversity Coldspots or Sentinels of Degradation in the Caatinga, Brazil?

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Natural earth mounds in many ecosystems are local biodiversity hotspots because they provide a greater heterogeneity of habitat, soil and moisture conditions as well as refuge from periodic flooding and fire in the adjacent lowlands. However, in the semi-arid Caatinga ecosystem of NE Brazil, natural mounds have exposed soils with much less vegetation and leaf litter as compared to the surrounding areas, and appear to have lower floral and faunal diversity (coldspots). We formulate the following hypotheses: (i) the low vegetation cover on the mounds indicates very compacted and leached soils as compared to adjacent lowland and (ii) such conditions negatively affects the distribution and diversity of ant species due to shortage of foraging and nesting resources. This study was carried out in four mound fields in Contendas do Sincorá, Bahia, Brazil. Ants were collected using pitfall traps and the physico-chemical soil properties of mounds and adjacent lowlands were measured. The adjacent lowlands had, on average, twice as many ant individuals as the mounds along with a higher ant species richness and diversity. The high resistance of the soil on mounds to root penetration and the low pH explained partly the difference in diversity between mound and adjacent lowlands. Mounds are features which thus locally reduce ant diversity in Caatinga, a region with an otherwise high diversity of Formicidae. Further investigations are needed to infer whether this low diversity on mounds is a result of ongoing environmental degradation in the Caatinga, where vegetation removal may have changed the soil structure on mounds.

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Mountains: Refugia of Indigenous Plant Species in a Degraded Savanna Region

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Poorly accessible terrain of mountains and its ecosystems are characterized by diversity and less disturbance which provide refugia for several plant species. Ecosystems of north eastern Nigeria are highly degraded due to intensive anthropogenic activities and lack of conservation efforts. Given the background, Tula Mountains (TM) is one of the least disturbed areas in northeast Nigeria although currently unprotected. Due to its rocky terrain, farming activities have been minimal, a factor that has worked so far in favour of its conservation. However, no ecological study of its woody plant diversity and conservation status has ever been conducted. In this study, we investigated plant species diversity and vegetation structure of TM in guinea savannah region that has lost majority of plant cover to intensive anthropogenic activities. Point-Centred Quarter method was used. Series of line transects along which 190 random points 50 m apart were generated. A total of 135 plant species belonging to 39 families with 1716 tree stands were recorded in 1.9 ha giving an absolute density of 903 trees/ha. We identified 122 plants to species level and 13 to family level. Observed number of tree species was 112 (SD±5.1), Shannon-Weiner diversity index 3.61, 23 species were recorded only as saplings. About 76 % are rare species with relative site frequency <0.10. Species accumulation curve adjusted for bootstrap was 127 species (SD±5.1) and first order Jacknife 144.82 (SD±6.56). The common families recorded were Fabaceae and Combretaceae, while common species were *Detarium macrocarpum* and *Combretum glutinosum* comprising 13.3 % and 12.9 % respectively of total recorded trees. Species of conservation importance included *Vepris heterophylla* critically endangered (CR), *Afzelia africana* and *Khaya senegalensis* Vulnerable (VU), while 115 (94.3 %) of the identified species were not evaluated on the IUCN red list of threatened species (IUCN 2016). The results also show that more species are yet to be encountered with more efforts. On the whole, plants composed mainly of indigenous understory species typical of Guineo-Congolean dry savannah. Therefore, TM mirrors the original vegetation of north eastern Nigeria.

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Landscape Effects on the Angiosperm Phylogenetic Diversity of Ephemeral Freshwater Wetlands

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Wetlands are the most disturbed ecosystem on the world, although they are among the most productive ecosystems. Ephemeral wetlands are heterogeneous environments that harbor a high number of species. Landscape disturbance is an important driver of phylogenetic diversity. The goal of this study was to assess plant diversity at the community level in a phylogenetic framework and the influence of the landscape in ephemeral wetland phylogeny. We sampled 39 ephemeral wetlands on altitudes between 1,900 and 2,700 m a.s.l. between 2015 and 2016 in Central Mexico. We used a calibrated phylogeny of angiosperms to calculate the phylogenetic communities' index (PDss, MPD, MNTD, ses.PDss, ses.MPD, ses.MNTD). Maps of land use in scale 1:250,000 from 2011 to 2013 were used to measure the landscape features and disturbance on 10 km radius from the center of the wetland. Linear regressions were conducted to analyze the relationship between the landscape and its phylogenetic indices. 35 families, 76 genera, and 118 species were recorded, 27 of which are endangered species. The richest lineages were Cyperaceae (25 spp.), Asteraceae (17), and, Poaceae (16). Life forms found include emergent (50), amphibious (41), fixed floating (12), fixed submerged (11), free floating (3), and free submerged (1). The principal landscape features were: Agriculture/disturbed (43%), oak forest (24%) and, natural meadows (19%). The oldest lineage was represented by *Nymphaea gracilis* Zucc. (ca. 150 ma of divergence). Phylogenetic diversity sensu stricto (PD) pointed to a positive correlation with the disturbed landscape (p-value = 0.007), a negative correlation with altitude (p-value = 0.016), however we found no correlation to landscape heterogeneity. Our results suggest that landscape disturbance may contribute to increased phylogenetic richness in ephemeral wetlands. Vegetation communities of wetlands are susceptible to temporal changes in the environment, due to natural factors and to human interference. Hence, knowledge of local and global environmental characteristics is important to determine the causes of the phylogenetic diversity in ephemeral wetlands.

Keywords: Central Mexico, Heterogeneity, High altitude

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Variations in bark features of Melastomataceae species across different sites of Brazilian Cerrado

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Background: Bark, all the tissues outside of the vascular cambium, is anatomically diverse and functionally important part of the woody plant stem. Outer bark (periderm) has a protective function and inner bark (secondary phloem) is involved in the long-distance transport. In general, most developed periderm has been reported in dry sites while most developed secondary phloem in wet sites. Melastomataceae species have different habits and inhabit different sites in the Brazilian Cerrado (a savanna-like ecosystem), ranging from well-drained to temporarily or permanently waterlogged soils. Cerrado soils are dystrophic, acidic, and have high levels of aluminium. We performed a bark anatomical study of six species of Melastomataceae in order to explore the association among bark features, environment and habit. **Method:** Bark samples of *Miconia albicans* (treelet) and *M. fallax* (shrub) from strongly drained sites with deep water table and seasonal water deficit at topsoil level, *M. chamissois*, *M. ligustroides* and *Microlepis oleaefolia* (shrubs) from very wet alongside river course, and Rhynchanthera dichotoma (subshrub) from sites with successive periods of soil-water logging and strong water deficit were processed by usual histological techniques. **Results:** Typical periderm occurs in *Miconia chamissois* and *M. fallax*, rhytidome in *M. albicans*, polyderm in *M. ligustroides*, *Microlepis oleaefolia* and *Rhynchanthera dichotoma*, which, in the latter, is aerenchymatous. Lenticels occurred on *M. chamissois*. First phellogen location was variable among the species. *M. albicans* exhibited higher values for sieve tube diameter and sieve-tube element height. The sieve plates are simple varying in their inclination. Rays are uniseriate except in M. *oleaefolia* with 2-4 ray cells. Rays are heterocellular with height lower than 1mm, except in *M. albicans*. Dilated rays occurred in *M. chamissois*, *M. fallax*, *M. ligustroides* and *M. oleaefolia*. Septate fibers occurred in *M. chamissois* and *M. oleaefolia*. Sclereids with variable shape, calcium oxalate crystals and phenolic content are abundant in the bark. **Conclusion:** Our findings suggest the existence of some type of association between the characteristics of the periderm, quantitative features of sieve tube and rays with plant habit and water soil status, while the abundance of phenolic content seems to be associated to the little availability of nitrogen and phosphorus in the Cerrado soil favoring the formation of carbon-based compounds.

Keywords: habit, Melastomataceae, periderm, savanna, phloem

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Leaf types in the Brazilian cerrado according to bundle sheath extension (BSE)

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Background: Plant species are classified in heterobaric and homobaric leafed species according to the presence or absence of bundle sheath extensions (BSE), respectively. The leaf types differ on the physiological performance and are associated to the growth environment, being heterobaric leafed species predominant in temperate forests while homobaric leafed species are more common in tropical forests. Here, we aimed to characterize the leaf types and their photosynthetic performance in woody species growing in Cerrado, characterized by a strong seasonal climate. **Methods:** Using conventional anatomical methods, we investigated the presence/absence of BSE and their structural peculiarities in 48 woody species in 28 angiosperm families in an area of Cerrado (savanna-like vegetation) in São Paulo state, Brazil. From eight species, we measured physiological parameters using an infrared CO_2 and water vapor analyzer. **Results:** In addition to the typically homobaric (62.5%) and the heterobaric (20.8%) leafed species we found species with intermediary features, here named larger heterobaric (12.5%) and semi-heterobaric (4.2%) leafed species. The former presents BSE only around the large veins while the latter possesses BSE toward only the adaxial side of the leaf blade. The net CO_2 assimilation rates (Anet), the transpiration rate (E) and carboxylation efficiency (Anet/Ci) were higher in heterobaric than homobaric leafed species. In the larger heterobaric leafed species, such physiological indexes were similar to heterobaric leafed species while semi-heterobaric species presented physiological rates similar to homobaric leafed species. **Discussion:** Heterobaric leafed species can reach higher rates of phothosynthesis and transpiration because BSE act in the light capitation and water transport in environmental conditions with high light intensity and low humidity. The mesophyll segmentation, even in large compartments such in larger heterobaric leafed species, can improve the photosynthetic performance of the leaves through. In semi-heterobaric leaves, the incomplete mesophyll compartmentalization favors the larger lateral movement of gases as in homobaric leaves. In addition to the typically homobaric and heterobaric types, the anatomical distinctive features of BSE here described concerning the two additional leaf types, affecting the leaf gas exchange indexes, represent distinct adaptive strategies of the species to the Brazilian Cerrado environmental conditions.

Keywords: BSE; Cerrado; leaf anatomy; photosynthesis

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Stem structure indicates adaptation of tropical species to habitats with different rainfall regimes

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Background: Interpreting how plant stem varies phenotypically contributes to the understanding of the plant fitness in different habitats. In order to verify the adaptive stem morphological and anatomical features, we studied two distantly related species co-occurring in habitats with and without seasonal drought. **Methods:** We sampled xylem and bark (1.3 meters above the ground) of five individuals of *Zanthoxylum rhoifolium* (Melastomataceae) and *Moquiniastrum polymorphum* (Asteraceae) co-occurring in habitats with seasonal drought (cerrado *sensu stricto*, cerradão and semi-deciduous forest) and without seasonal drought (rainforest). We followed standard protocols for xylem and bark anatomy and compared anatomical traits across habitats using ANOVA. We carried out a PCA to examine similarity across habitats based on all quantitative xylem and phloem traits. **Results:** Stems did not vary in qualitative traits in *Z. rhoifolium* or *M. polymorphum* across habitats. However, we found narrower vessels and sieve tubes in *Z. rhoifolium*, higher and wider rays in xylem and phloem in M. *polymorphum*, and thicker fiber walls in the xylem of both species in habitats with seasonal drought. The first periderm arises from the subepidermal layers in *Z. rhoifolium*, whereas it arises from the secondary phloem in *M. polymorphum*. A thinner periderm was found in *Z. rhoifolium* from habitats with seasonal drought. All individuals of *M. polymorphum* had a rhytidome that did not vary in thickness across habitats. The PCA grouped individuals from seasonal habitats, separating them from individuals from the rainforest. **Conclusions:** The stem features indicate particular adaptations of these distantly related species to different habitats. In *Z. rhoifolium*, narrower vessels and thicker fiber walls contribute to safety of water transport in habitats with seasonal drought, and large conducting cells contribute to efficiency of water and food transport in rain forest. In *M. polymorphum*, larger water storing capacity by larger rays seem to contribute to vessel refilling during dry periods in habitats with seasonal drought. Similarity was found among habitats with seasonal drought. The first-formed periderm, superficial in *Z. rhoifolium* reflects in a uniform and smooth bark, and internal in *M. polymorphum* reflects in a furrowed and loose bark. Thinner periderm in *Z. rhoifolium* in habitats with seasonal drought facilitates the entrance of light and the occurrence of the stem photosynthesis.

Keywords: Cerrado, Forest, periderm, phloem, xylem

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Do either altitude or flowering suggest effects in the papillae development in *Chusquea* (Poaceae)?

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Methods: The studied collection includes plants from Argentina, Bolivia, Brazil, and Paraguay. Pieces of the middle portion of foliage leaf blades of each species were removed from fertile and sterile herbarium specimens. For epidermal description purposes, conventional methods of scanning electron microscopy were carried out. Altitudinal and reproductive data were obtained from the voucher information. **Results:** Intraspecific variation in the development of papillae was observed in all four species, in which papillae may vary from poorly to well developed (rarely completely absent). *Chusquea ramosissima* exhibits the most remarkable variation in the papillae development, and in all studied species poorly or well developed papillae occur independently of altitude. Papillae occur in fertile and sterile materials within a same species and show similar patterns of development. **Conclusion:** Our results show that, since all studied species grow at relatively low altitudes (500 up to 1,200 meters), and all fairly similar, there is no relationship of papillar development and altitude. It seems that, in this group, the development of papillae is due to other environmental effects (e.g., sun/shade) that will be explored in further studies. Also, papillar development did not correlate with reproductive state, and this is consistent with the fact that we also observed some variation among the specimens of *C. tenuiglumis* and *Chusquea* sp. nov., which only sterile material was examined. Lastly, considering that some species of *Chusquea* grow as high as 4,200 meters, further studies are worth doing to verify the papillar development over the entire range of altitude in the genus.

Keywords: Bambuseae, Bambusoideae, Chusqueinae, leaf, Poales.

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Marketing agroforestry products Carbon sequestration contribute livelihood improvement in Cameroon

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Background: *Tetracarpidium conophorum* is a vine of the Euphorbiaceae family producing edible fruits and presenting a wide distribution across West and Central Africa. This liana is classified among multipurpose agroforestry trees providing non timber forest products (NTFP's) with a lot of properties. Local population transforms their nuts into powder to obtain a proteinic food supply and hypocholesterolemian / hypotriglyceridemian vegetable oil. It is also commonly used in traditional medicine to cure several diseases. The vine is highly marketed in Cameroon and neighboring countries while the hole plant is used in cocoa-agroforestry based systems to improve shade; livelihoods and contribute to carbon sequestration. Despite all the functionalities of this species, the lack of knowledge on the socioeconomic and ecological potentialities of the wine is a hindrance for sustainable management and improvement of household income for local populations involved in the value chain. **Methods:** Therefore, the objective of the study is to assess the socio-economic and ecological potentialities as well as carbon sequestration potential in some selected agroforestry systems in the Mbam and Inoubou division in Cameroon. **Results:** Preliminary results demonstrate higher economic potentialities of the resource; seeds are sold; wholesale in 15kg buckets costs from US$15.43 to US$27.43 depending of the season of production. Amount generated per season, positive impact of this income had been observed on the livelihood of local population of the area. Regarding the carbon sequestration, the method of Chave et al. (2005) was used to calculate the carbon. So an aerial carbon biomass varying from 10.48 tC/ha, 18.52 tC/ha and 2.53 tC/ha, respectively in cocoa-agroforestry based systems. **Conclusion:** Surveys conducted revealed that wine associated with species in agroforests actively contribute to the sequestration of carbon thus mitigation of climate change effects. Considering these findings, urgent action should be taken for the management of this important vine and their integration in the different cropping systems.

Keywords: agroforestry trees

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Changes in bark traits along the plant body from Brazilian savanna

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Background: Bark is a structurally and functionally complex plant part, comprising the periderm, the outermost part of bark that provides protection, and the secondary phloem, the innermost part of bark that is important to a multitude of functions, including photosynthate conduction. Bark traits may change along the plant body according to the environment. In order to investigate the changes in bark traits along the plant body, we compared aerial and underground barks of 15 species from the Brazilian savanna (cerrado sensu stricto). **Methods:** We calculated the relative thickness (ratio of bark thickness to wood diameter) of total bark (periderm + secondary phloem), periderm, and secondary phloem, as well as density (ratio of oven-dry weight to green volume) and water content (percentage of ratio of weight of water lost to green weight) of the secondary phloem. We compared aerial and underground bark thickness, density and water content using a paired Student's t-test. Periderm thickness was also analyzed after embedding in polyethylene glycol (PEG 1500), cut in sliding microtome, and mounted in permanent slides. **Results:** Although relative bark thickness was similar in both aerial and underground organs ($p=0.07$), underground bark had a relatively thicker secondary phloem ($p<0.01$) and aerial bark had a relatively thicker periderm ($p<0.01$). More periderm layers were found in aerial bark, with more cell layers of either phellem or phelloderm. Density ($p=0.294$) and water content ($p=0.288$) were similar in both aerial and underground secondary phloem. **Conclusions:** Underground bark with relatively thicker secondary phloem, but similar density to aerial secondary phloem, suggests that underground secondary phloem has more living cells. This higher amount of living cells may indicate higher long-distance conduction of photosynthates, long-distance signaling, and storage of substances other than water, because water storage is similar in both aerial and underground secondary phloem. Aerial bark with thicker periderm (usually phellem) is associated with higher protection of inner tissues than underground bark. There is strong divergence in bark structure reflecting function according to its position along the plant body, which bark protected by soil has higher potential of photosynthate conduction and storage, whereas bark exposed to aboveground factors (e.g. fire, mechanical damage, sun irradiation) promotes higher protection of inner tissues.

Keywords: bark, savanna, cerrado

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Cacti species from the Brazilian Chaco: an illustrated field guide for conservation

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Background: Cactaceae is a key component of the arid and semiarid floras in the Neotropics. Nonetheless, nearly 1/3 of cacti species are under extinction risk as a consequence of human activities. In the Brazilian Chaco, which is restricted to the extreme western edge of Mato Grosso do Sul state, Cactaceae is represented by 16 species, including columnar (8), globose (3), coplanar (2), epiphyte (2) and shrub species (1). These species remain completely unknown regarding their ecological interactions, and are locally threatened by the advance of deforestation for pasture establishment. According with the National Plan of Conservation of Threatened Cacti, studies in this region are urgent and priority. **Methods:** From October 2014 to February 2017, we collected data on vegetative and reproductive traits, reproductive phenology, pollination and seed dispersal of cacti species. With the gathered information, we produced a bilingual field guide in order to motivate activities of environmental awareness and to arise interest of the local community about Cactaceae. **Results:** Most cacti species studied have extended or continuous flowering and fruiting phenophases, nocturnal white flowers, although we have also recorded diurnal flowers with yellow or red colors. Their fruits are berries, with attractive colors. Flowers and fruits are visited by different animals (ants, bees, beetles, birds, hummingbirds, moths), which potentially act as pollinators and seed dispersers. However, florivory events by deers and peccaries, which affected reproductive success of *Echinopsis rhodotricha* was also reported and quantified. **Conclusion:** The field guide is richly illustrated and presents all cacti species that occur in the Brazilian Chaco, their geographic distribution, conservation status, general characterization and ecological aspects, including potential mutualistic interactions. We highlight the major threats they suffer in the area and suggest conservation strategies, especially for species *Frailea schilinzkyana* and *F. cataphracta*, which are listed as vulnerable and near threatened, respectively (IUCN Red List). Additionally, lectures to the farmers and local community focusing on the importance of mutualistic interactions are scheduled as part of a strategy for enrolling local population in conservation activities. We believe this will facilitate the planning of basic guidelines to start an effective action plan for cacti conservation and management in this environment.

Keywords: Cactaceae, Dry forest, Pollination, Seed dispersal

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Effects of tree species diversity on insect herbivory and leaf defences in *Cordia dodecandra*

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We measured herbivory on four year-old plants allocated in six 21 x 21 m plots. Two plots were monocultures of *C. dodecandra* whereas the other four were mixtures of the focal species plus three other species (out of a pool of five). To quantify herbivory, we counted the leaves consumed by each group of herbivores and estimated the proportion of attacked leaves in each case. Two months later, we collected undamaged leaves to estimate specific leaf area (SLA, correlated with thoughness), trichome density, and chemical (total phenolics and condensed tannins) defences. We found a significant effect of diversity on beetle herbivory where the frequency of damaged leaves was 80% lower in mixtures than in monoculture. In contrast, we found no effect of diversity on caterpillar attack. In addition, we found a positive relationship between beetle (but not caterpillar) damage and chemical defenses, but there was no effect of diversity on chemical defences. Similarly, trichome density was lower and SLA was greater in mixtures relative to monocultures but neither trait was associated with herbivory and damage did not explain diversity effects in either case. Our results show contrasting effects of tree diversity on beetle and caterpillar herbivory on *C. dodecandra*, possibly due to differences in adult mobility and egg-laying patterns. As such these findings emphasizes the importance of testing for diversity effects on multiple guilds of insect herbivores and evaluating the underlying mechanisms for contrasting responses. Counter to expectations, treatment differences in beetle herbivory did not lead to concomitant differences (via induction) in either chemical or structural leaf defences in monoculture relative to mixtures, and differences in structural defences were likely mediated by other factors (abiotic conditions).

Keywords: defences; diversity; herbivory; phenolic compounds

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Temporal patterns of bird communities associated with habitat productivity in the Yucatán Peninsula.

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We used eBird data from the Yucatan Peninsula and from 2009 to 2016. We used land cover and satellite data to classify the habitat type and productivity (normalized difference vegetation index (NDVI)) of each eBird checklist, retaining only those in mangrove and tropical dry forest. We extracted the number of unique species observed across all checklists of each habitat type for each week of spring and fall migration. We used a generalized linear model to relate bird diversity to season, habitat and time while controlling for observer effort. We found that during spring, diversity decreased over time in both mangrove and tropical dry forests though the decrease was much stronger in mangrove. In fall, we found that diversity decreased over time in mangrove forest but increased over time in tropical dry forest. Because mangrove is on the coast of the Gulf of Mexico, we expected to see an increase in species diversity in spring. However, we observed a loss in both habitats suggesting that forest birds do not stop in mangrove before crossing the Gulf of Mexico. However, we did find that forest birds departed later than mangrove birds. In fall on the other hand, our results suggest that birds may arrive in mangrove after crossing the Gulf of Mexico and then move to the interior forest. Importantly, our study is the first to show that the changes in diversity over time due to migration differ among habitats with the effect of habitat differing between spring and fall migration.

Keywords: Bird, Communities, Migration, Yucatán

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Identifying trait-based correlates of disturbance response among tropical birds and dung beetles

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Background: Understanding the mechanistic basis of biotic homogenization - the increasing genetic, taxonomic or functional similarity of distinct geographic locations as a consequence of similarity species extinctions and invasions - is a priority in tropical landscapes undergoing ongoing anthropogenic disturbances. In highly modified regions such as the Brazilian Atlantic Forest, understanding the trait-based correlates of species that "win" or "lose" following forest decline will be critical to implementing effective land management and conservation strategies. While previous work has characterized variation in community level responses to habitat loss in this region, less research has investigated particular traits that render certain species more disturbance-sensitive or resilient than others. We examined the relationships between species' traits and species abundance response to declining forest cover, using both dung beetles and birds as model systems. **Methods:** We measured abundances of 42 dung beetle and 221 bird species across twelve independent 3km landscapes, spanning a 10-60% forest cover gradient in the Brazilian Atlantic Forest. We used generalized linear mixed (GLMM) models to quantify species-level abundance responses to natural habitat loss, analyzing birds and dung beetles separately. We subsequently examined which traits correlated with these responses using phylogenetic contrasts. **Results:** We found specific traits correlated strongly with dung beetle and bird species responses to declining forest cover. In particular, diel activity and diet were the most reliable trait-based predictors of disturbance response in dung beetles, whereas diet plasticity and nest-type best explained with birds' responses. These results suggest that land-use changes that result in natural habitat loss for dung beetle and bird species in the Brazilian Atlantic Forest drive patterns of biotic homogenization that are non-random with respect to species traits. **Discussion:** By identifying traits in dung beetle and birds which covary with species-level disturbance responses, we provide the basis for taxonomically explicit modeling approaches that can better predict biodiversity outcomes of land-use change. Coupled with robust knowledge of biodiversity-ecosystem functioning (BEF) relationships, such predictive techniques will be invaluable to informing land management strategies aimed at maintaining key ecosystem services within human modified landscapes.

Keywords: Biotic homogenization, biodiversity, traits, deforestation

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High intermediary mutualist density provides consistent biological control in a tripartite mutualism

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Background: Understanding the ecology of mutualisms becomes a particularly important task when considering agroecosystems, as many ecosystem services are associated with mutualistic interactions. Here we report on experiments associated with an indirect pest control mutualism between the arboreal nesting ant Azteca *sericeasur* and coffee. This system is particularly interesting because the indirect Azteca-Coffea mutualism emerges from an Azteca-scale insect (*Coccus viridis*) mutualism that takes place on the coffee plant which results in the protection of the coffee against herbivores and in particular against the Coffee Berry Borer (CBB) (*Hypothenemus Hampei*). Here we ask whether the benefit *A. sericeasur* provides to coffee increases with increasing density of the intermediary mutualist (*Coccus viridis*). **Methods:** In a 45 ha plot we located 30 plants with both *C. viridis* and *A. sericeasur*. In each plant we chose six branches with varying densities of *C. viridis*, and excluded A. *sericeasur* on three of them. We then added 20 adult CBBs and after 24 hours we returned to see the number of fruits damaged on the control and exclusion branches. **Results:** With high *C. viridis* density treatment consistently showing an effect from ants across both years, we suggest that this experiment provides what we understand as the first evidence of the reward of one mutualism to be dependent on the density of an intermediary mutualist. Furthermore, we also found that at low *Coccus* density Azteca only benefits Coffea in the beginning of the rainy season, and this effect is likely due to the fact that *Coccus* produces less sugars with higher precipitation thus altering the dynamics of the mutualism. The role of seasonality on the outcome of the Azteca-*Coccus*-Coffea complex is not so surprising, as the role of conditionality or context dependency in the outcomes of ecological interactions has become a prominent feature of ecology. **Conclusion:** and recommendations We suggest that management practices in agroecosystems may provide a useful mechanistic framework for unpacking contingency in these systems. Finally we caution against management recommendations, as our study suggests someone studying the dynamics of the Azteca-*Coccus*-Coffea interactions in the dry season may come to very different conclusions than someone studying it in the rainy season, and any management suggestions that may arise from either year individually could have unseen consequences for producers.

Keywords: Coffee, Biological Control, Conservation, Mutualism

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Diversity, phenology, and bird migration in urban green spaces of Merida, Mexico

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Background: In Mesoamerica, large tracts of tropical forest have been replaced by urban areas and the remaining green spaces are fragments with altered vegetation cover. There is overwhelming evidence that urbanization has reduced species diversity among a wide range of taxa, including birds. However, the effects of urbanization on the changes in bird diversity over short periods of time due to migration are less well known. We initiated a study in two urban green spaces in Merida, Yucatan, Mexico to test whether the level of urbanization in the surrounding landscape affects the temporal pattern of bird migration. **Methods:** We conducted weekly bird surveys for one year (Jan 2016 - Jan 2017) in two city parks that differ in the level of urbanization in the surrounding landscape and the presence of a water body in the park. We recorded the number of bird species in each site; here we focus on the transition between winter and summer, which includes spring migration. **Results:** Across both sites, we recorded 92 unique species: 22 aquatic and 70 terrestrial. The two sites shared 40 species. With respect to migration, we found that migration was later in the less urbanized site: species richness declined in May. In the more urbanized site, species richness declined in April. **Conclusions:** We have preliminary evidence that urbanization is associated with an earlier departure of migratory birds from their wintering grounds. It is also possible that birds using the sites for refueling during their northward migration are more likely to use the less urbanized site, which leads to an elevated species richness until the end of migration. We propose to examine whether similar trends are observed during fall migration.

Keywords: Phenologhy, migration, urban green spaces.

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Phylogenetic diversity of the Sierra Madre Oriental plant communities

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The Sierra Madre Oriental (SMOr) is the major mountain range located in northeastern Mexico, where plant communities have a rich and complex biodiversity. Tropical mountains act as allopatric barriers for plant populations, and create a mosaic of soil and climatic gradients on their surface that favor adaptive divergence, and promoting endemic lineages. Here we examine variation in the phylogenetic diversity (PD) for ten plant communities in the SMOr and its physiographic regions. We evaluated PD as the total phylogenetic branch length across species for each community and region (PDss), the mean pairwise phylogenetic distance between species (MPD), the mean nearest taxon distance (MNTD) and their equivalents standardized for species richness (ses.PDss, ses.MPD, ses.MNTD). We calculated the correlation of PD metrics with climatic variables. Also we examine the relationship between PD and singularity of lineages. PDss and MPD are strongly positively correlated with species richness (SR), whereas MNTD has a negative correlation. Temperate forests and cloud forests have the highest SR, PDss and MPD. We found that cloud forests, seasonally dry tropical forests and alpine grasslands have the highest ses.PDss, ses.MPD, and ses.MNTD. Temperate and cloud forests have the highest weighted singularity index. Huasteco Karst and the Great Folded Range are the physiographic regions with the highest PD metrics and weighted singularity index. PDss, MPD, ses.PD, ses.MPD, and ses.MNTD are strongly positively correlated with the weighted singularity index, whereas MNTD has a negative correlation. PD metrics are strongly positively correlated with mean annual precipitation and evapotranspiration, and the number of months that soil retain humidity. High ses.PDss and ses.MNTD reflect greater lineage diversity in communities. It is possible that high ses.PDss and ses.MNTD in Huasteco Karst and the Great Folded Range result from their complex geological history that yield the establishment of different lineages in multiple orogenesis stages. Western Ranges and Grasslands have low PD values with close relatives from fewer lineages, revealing ecophysiological constrains that promote in situ diversification in extreme environments. MPD results a good predictor of the weighted singularity index, however both are strongly correlated to SR, and a new singularity index that weighted for phylogenetic diversity is needed to assess best conservation strategies in the SMOr.

Keywords: Dated phylogenies, conservation, endemism, vegetation.

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Are the protected populations of the two globular cacti species facing a demographic explosion?

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Background: Our understanding of the demography of cacti species is severely limited compared to other aspects of their biology. In order to assess if successful conservation may be achieved in areas that were protected after been disturbed, the population growth rate and elasticity, is useful. In this study we address the following questions: What is the growth rate of the both species when in simpatry and sintopy? What are the relative contributions of survival, growth, and fecundity to the population growth of both species? Which life cycle stages have the highest mortality? **Methods:** We studied three sub-populations of two simpatric and co-generic species of globular cactus *Discocactus placentiformis* and *D. pseudoinsignis* in the Espinhaço Mountain Range, Brazil. We censuses individuals in 15 plots of 100 m2. Projection matrices were used to obtain the growth rate and elasticity of population of. We construct life cycle graphs for the cacti species, which we then constructed the Lefkovitch matrices based on these four ontogenetic stages for each area. **Results:** Based on *D. placentiformis* sympatry matrices, asymptotic population growth rate was significantly greater than one, the populations is projected to grow at rate of 84%. But when the populations were in syntopy with *D. pseudoinsignis*, the asymptotic population growth rate was greater but not significantly different from one. The *D. pseudoinsignis* asymptotic population growth rates are greater than one. The population in sympatry is projected to explode: grow at a rate of 159%. When this species is in syntopy with *D. placentiformis* the populations is projected to grow at rate of 98% and 75%. **Conclusion:** The three studied populations are growing. Process of colonization after the establishment of a Conservation Area, when the density dependence will act. This type of population structure reflects massive but infrequent recruitment events, apparently associated with benign periods of abundant rainfall.

Keywords: Cactaceae, elasticity, conservation

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The underestimated risk in little-known species, large-spotted civets *Viverra megaspila*

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Background: There is concern over unrecognized extinction of little-known species, particularly species with specific habitat requirements under increased anthropogenic pressure. An example of such species is large-spotted civet *Viverra megaspila* that occurs in continental Southeast Asia. Their potential association with water sources has been suggested from camera trap records, mostly by-catch data. If large-spotted civets associate with water sources, it would be critical to ensure the availability in the landscape where local people also depends on these water sources for their livelihoods. This study aims to explore the possibility and risk of co-use of water sources between large-spotted civets and local people. **Methods:** We conducted camera trap survey in the Chheab Wildlife Sanctuary, northern Cambodia, in the 2013/2014 dry season to examine the activity and occupancy patterns of large-spotted civets. Interview survey was also conducted at three villages surrounding the Wildlife Sanctuary, in order to understand how local people use NTFPs resources in the area, and the possibility and risk of temporal and spatial overlap between the species and people. Result: The distance from water sources including various size of rivers and waterholes was an important predictor of the occupancy of large-spotted civets. The species exhibited a nocturnal pattern of activity, and often used small water bodies. Based on interview survey, it was found that local villagers used rivers and waterholes in the Wildlife Sanctuary for fishing, and relatively large water bodies for camping during resin collection trip. Illegal activities around water sources were not mentioned in the interview, but snaring and poisoning were observed during camera trap survey with an incident that the civet was killed by poison near a small seasonal waterhole. **Discussion:** Large-spotted civets may be able to avoid great overlap with local people temporally and spatially when civets use people's fishing sites in night time, and/or smaller water bodies at where people does not camp; however, given observed illegal activities targeted to water sources, the accessibility of water sources to this ground-dwelling civet appears to be limited. The threat to this species is likely to be much greater than simply whether the area of habitat is shrinking across their range or not. This implies the possibility of underestimation of the risk in little-known species with specific habitat requirements.

Keywords: Small carnivore, water sources, Cambodia

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Changes in epiphytic bryophyte communities in Brazilian cacao agroforestry

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Background: Studies on shaded cacao (*Theobroma cacao* L.) plantations (= cabrucas) show that species richness of bryophytes in these agroforests is similar to that found in native forests. However, in cabrucas the species composition is characterized by substitution of the most sensitive species for those more generalist. Despite these trends, there are still knowledge gaps in our understanding about of reproductive responses of species in cabrucas and about the effects of forest proximity and the forest amount around the cabruca on the bryophytes. **Methods:** We selected nine plots with 500m2 in the southern of Bahia, Brazil, the main cacao producing area in the country: three native forests (NF), three cabrucas in Una (CBU) and three cabrucas in Ilhéus (CBI). The plots are in a gradient of forest amount (%) around the sample sites (in a 2 km's buffer) and CBU is connected to NF and distant at least 50 km from CBI. In each plot, bryophytes were collected from 20 trees ~ 5 cm DBH until 0-2 m in stem and the following variables were estimated: Understory density, Canopy cover (%), Temperature (°C) and Air relative humidity (%). Species were classified in: 1) Taxonomic group; 2) Reproductive system, with registration of reproductive structures; 3) Tolerance to luminosity, and; 4) Abundance. Result: We found a significant reduction of species in CBU in relation to NF (62 and 76 spp., respectively) with low similarity between these communities. The total and typical shade species richness were influenced by the forest amount around the sample plots, but not by geographic distance. The six plots of cabrucas were similar in environmental and microclimatic conditions, leading to greater similarity between their communities. Ten out of 11 spp. more abundant in CBI were equally abundant in CBU, of which ca. 50% were dioecious and regularly carrying asexual structures. In NF, ca. 80% of spp. more abundant were dioecious and regularly carrying sporophyte. **Conclusion:** Unlike other studies, cabrucas in southern Bahia maintain significantly fewer bryophyte species in relation to native forest and this is related to the forest amount in the surroundings. The cabrucas tend to maintain more similar communities and dioecious assemblages with greater dependence of vegetative propagation, which may compromise the genetic variability in the populations making them more vulnerable in these environments.

Keywords: cabrucas, species richness, asexual reproduction, sporophyte

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Why are some marine fish species more vulnerable than others?

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Background: Many worldwide fish species are under sharp decline, due overexploitation and increasing threats. Consequently, entire communities and the future resilience of their ecosystems will be compromised. Usually, is expected that the species enter in collapse to define management and conservation measures. However, if factors that more related with collapse are known, is possible to take precautionary measures. **Methods:** Here, we adopted a multi-steps approach to explore which factors influence the risk of collapse for 132 marine fish species in Brazil for the period 1950-2010: (1) definition of a status of exploitation (collapsed, overexploited, fully exploited, in development) using the catch-based method of stock classification; (2) general additive models (GAMs) to evaluate the influences of fishery type (artisanal/industrial), climate variability (sea surface temperatures - SST) and ex-vessel prices on the exploitation status; (3) multivariate analysis to identify which ecological (trophic level, maximum body size, resilience category, type of habitat) and external traits (ex-vessel price and fishery type) are more recurrent in overexploited and collapsed stocks. Ecological traits data were extracted from FishBase, climatology variables from the NEMO model, and fishery catches data and economic variables were provided by the Sea Around Us project. **Results:** Overall, 19 species were classified as collapsed, 39 as overexploited, 51 as fully exploited and 23 as in development. The GAMs indicated that the most important factors explaining the overexploited or collapsed status of a species were SST variability, the type of fisheries and the ex-vessel price of the species. **Discussion:** In particular, overexploited and/or collapsed species are negatively affected by SST variation, highlighting the concern about tropical fisheries facing future climate changes. Industrial fishery is more negatively affecting fish stocks, even though in Brazil almost a half of catch is provided by artisanal fisheries. In addition, species with higher ex-vessel price are the ones with an overexploited or collapsed status, probably because are more sought by fishers. Finally, the multivariate analyses suggest that it is likely that differences in species exploitation are due to a mixture of ecological and external induced effects. With these results, we will be able to indicate which species that are already harvested present higher probability to collapse in the future.

Keywords: West Atlantic, Brazil, industrial fishery

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Social dimensions of conservation conflicts in Calakmul Biosphere Reserve, Mexico

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Background: Biosphere reserves can generate conservation conflicts (sensu Redpath et al. 2013) despite explicitly considering conservation and development objectives. Parties involved in these conflicts (i.e., local populations, reserve managers) do not share their views on the conservation and use of biodiversity. It has been recognized the need to study the management of conservation conflicts to improve conservation outcomes and mitigate social impacts of protected areas. **Methods:** Located in Southeastern Mexico, the Calakmul Biosphere Reserve (CBR) has originated numerous conservation conflicts since its creation. We documented the cases of two communities located within the CBR. During the stays in the study communities, non-participant observation was carried out and semi-structured interviews were applied to heads of households (N=66), allowing to obtain the local perspective about the study conflicts. Likewise, the official perspective on the conflicts studied was collected through in-depth interview with the Manager of CBR. **Results:** The first study community (communal land tenure) won a lawsuit which exempts the community from CBR regulations. Despite that, local population still must deal with reserve's restrictions on natural resources use. The second study community (private land tenure), despite having been relocated by the federal government, remained inside the CBR. This has implied the restriction in the use of natural resources, as well as the impossibility of titling peasant's lands. We found that conflict parties hold different views on the conflicts, and observed a general distrust from local populations towards CBR. These two findings (i.e., lack of shared understanding and distrust) hinder the resolution of the conflicts. Likewise, the federal conservation policy aiming at increasing the coverage of natural protected areas, might hamper the search of solutions to the studied conflicts (e.g., reducing CBR area by disincorporation of a community). **Conclusion:** The feasibility of effectively managing the study conflicts mainly rests on building a shared understanding between the parties, and overcoming the constraints faced by CBR in proposing conflict management alternatives that are not aligned with the federal conservation policy. It is imperative to address the social and political dimensions of conservation conflicts' management, to find alternatives that can be locally adopted and offer insights for similar cases in tropical contexts.

Keywords: biosphere reserves, conflict, shared understanding

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Integrated conservation of threatened tree species: *Quercus brandegeei* in S. Baja California, Mexico

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Background: *Quercus brandegeei* is a rare and highly restricted Mexican oak species found at the southern tip of the Baja California peninsula in Mexico. The species faces major ecological barriers to regeneration across its range, undermining the long-term viability of the species. While about one-third of the range of *Q. brandegeei* is within a protected area, this is an example of how simply protecting habitat does not necessarily address the underlying ecological factors threatening individual species. In recent years, this species was included in habitat restoration efforts within the protected area, but those plantings failed to survive due to lack of consideration for the species' specific ecological needs. Given this history, *Q. brandegeei* serves as a case study of an endangered species that cannot be conserved through standard, one-size-fits-all conservation methods, but that instead requires context-specific information gained from scientifically robust research. **Methods:** In order to uncover the mechanism that is preventing wild regeneration of *Q. brandegeei*, this project integrates in situ and ex situ methods, including a population demographic study, greenhouse germination experiments, microsatellite analysis of population genetics, and ecological niche modeling. **Results:** Throughout the range of *Q. brandegeei*, population density is low and only large, mature trees can be found. As a result of long term climate change, this habitat is experiencing increasing drought and shifts in precipitation patterns that are limiting seedling recruitment. Ecological niche modeling shows that in the face of climate change, assisted migration may be necessary for species survival. Microsatellite analysis provides evidence that the species still maintains high levels of genetic variation but has likely incurred recent demographic bottlenecks. **Conclusion:** The case of *Quercus brandegeei* demonstrates how protecting ecosystems and habitat does not automatically protect all biodiversity within those systems. For certain endangered species, like *Q. brandegeei*, conservation efforts will require more focused consideration of the species-specific impacts of ecological constraints.

Keywords: threatened, species, conservation, *Quercus*, regeneration

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Subtle determinism of second-growth forest heterogeneity: implications for vertebrate conservation

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Background: Large-scale, passive forest regeneration offers a potent tool for achieving conservation goals across the tropics. However, even under ideal socio-political and eco-evolutionary settings, such as those found in dry forest sectors of the Área de Conservación Guanacaste (ACG) in Costa Rica, second-growth forest habitat is highly heterogeneous in terms of forest structure and composition, with potential conservation implications for plants and wildlife. This talk will address two key questions to unpack this heterogeneity to better understand the potential role of second growth tropical dry forest for achieving conservation goals. First, what factors shape forest structure and composition in this system? Second, how do variations in forest structure and composition affect habitat usage and occupancy of wildlife? **Methods:** Over 3,000 trees (>10cm DBH) and saplings (<10cm DBH) were surveyed in twenty-eight 50 m X 20 m plots within dry forest sectors ACG. The plots varied in their proximity to 'nuclear trees' (large trees present in actively managed cattle pasture that was subsequently incorporated in the ACG), old-growth forest fragments, and time since most recent fire. Camera traps were installed in each plot along with twelve additional plots established by collaborators, collectively accounting for over 10,000 trap*nights. Occupancy or abundance modelling was conducted for ten key species of terrestrial vertebrates. **Results:** Variation in forest structure was explained primarily by time since most recent fire, and proximity to old growth forest, while species composition was shaped by time since fire and proximity to nuclear trees. Forest structure, landscape composition, and to a limited extent, forest composition explained variation in modeled occupancy of several species of terrestrial vertebrates, while several others did not have significant variation explained by any variables considered. **Discussion:** An important but often overlooked feature of second-growth tropical forests is their high degree of heterogeneity. Here we've identified multiple drivers of heterogeneity in forest structure and composition, and traced through their impacts onto multiple wildlife species, including multiple IUCN Red List species.

Keywords: restoration; secondary forest; camera trap

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Floristic composition and structure of natural regeneration one year after logging in Western Amazon

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Background: The logging can provide several short and long-term effects including changes in forest understory micro-climate, soil compaction and erosion, nutrient cycle disruption, and changes in species composition. To understand better how the forest responds this study aims to determine the natural regeneration of tree species in an open tropical forest in Western Amazon after logging. To achieve this goal we analyzed the structure and floristic composition of the natural regeneration one year after logging in the Antimary State Forest (ASF) in the State of Acre, Brazil. **Methods:** Plots were established in different disturbance levels localized in habitats as skid trails, log landings, bole gaps, secondary roads and unlogged forest. In each habitat were established 10 plots. The natural regeneration of trees, with <10 cm DBH and >50 cm tall, were measured and identified. The number of individuals, species and families were compared between disturbed areas and unlogged forest, and the floristic diversity was assessed using the Alpha Fisher diversity index (α). **Results:** A total of 2493 individuals were recorded, belonging to 142 species and 40 families. The most abundant families were Euphorbiaceae, *Cecropia*ceae and *Rubiaceae*. Species richness differ among disturbed sites and unlogged forest (P = 0.00004) and was higher on skid trails (N = 68) showing an increase of 6.25% comparing with unlogged forest (N = 64) and the lower richness was found on bole gaps (N = 33) that showed a decrease of 48.43% of total number. The high diversity values were found on unlogged forest (α = 26.93) followed by the skid trails (α = 20.39) and lowest values on secondary roads (α = 9.28). The commercial species with higher abundance in different environments were *Calycophyllum spruceanum*, *Tabebuia chrysotricha*, and *Swietenia macrophylla*. The density was greater on unlogged forest than the felling gaps and then secondary roads. The density of individuals by size class differ between habitats (P< 0.001) and tree seedlings (0.5 - 1 m tall) and small saplings (>1 m and < 3 m) were most abundant. **Conclusion:** In general, disturbed areas demonstrated favor the natural regeneration of trees mainly intermediate and low disturbance level as skid trails and felling gaps.

Keywords: Amazon; Sustainable Forest Management; Reduced Impact Logging; Disturbance level; trees

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Biodiversity and ecosystem function along the process of tropical forest conversion to agriculture

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Background: Lacking of large natural areas to conserve, human modified landscapes (HML) emerge as possible scenarios where food production for human-wellbeing and conservation of biodiversity (B) and functions (EF) of forest ecosystems can be balanced. However, conservation in HML is challenging because the agricultural frontier is still advancing. Hence, the analysis of trajectories of change of B and EF as forest is converted to agriculture can help to identify HML compositions where agriculture and conservation can be conciliated. The aim of this study is to explore possible landscape compositions (relative cover of old-growth forest, agricultural fields and second-growth forests) enabling high B and EF values relative to those found in continuous old-growth forest. For this, we analyse trajectories of change in B (tree species richness) and EF (above ground biomass of tree assemblages) along a gradient of landscapes encompassing the whole process of forest conversion to agriculture. **Methods:** In Marqués de Comillas (South-eastern Mexico), a tropical rainforest region opened to agriculture in the 70's of the past century, we established 20 landscapes (1 km^2 each and encompassing from 100% to 7% of rainforest cover). In each landscape, 30 circular plots (706.8 m^2 each) were randomly established to quantify species diversity (species richness, SR) and AGB of all trees with DBH of 10 cm or larger. Data were adjusted to non-linear regression models to describe trajectories of change of SD and AFB as a function of the percentage of old-growth remaining in the landscape (OGF). **Results:** SR followed a convex declining as OGF reduced in the landscape, showing a tipping-point around 75% of deforestation. In contrast, biomass was reduced in a concave way with reduction in forest cover. **Discussion:** The convex SR trajectory indicates that landscape elements other than OFG (e.g. second-growth forest) may maintain diversity in HMLs. This is supported by the fact that SR collapsed at 60% deforestation when cover of second-growth forests added to OGF. The concave biomass trajectory suggests that as OGF reduces tree species with high wood density are lost. This result concurs with a previous study showing that wood density community-weight decrease with forest cover reduction in the landscape. Our study shows that high levels of OGF and second-growth forests are necessary to conserve high value of B and EF, especially for the last one.

Keywords: tree biodiversity, human modified landscapes,

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A global analysis of multiple dimensions of bird diversity

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Background: Elevational gradients are good models for exploring patterns of biodiversity and the variables structuring them. For instance, both rainfall and temperature are needed to predict elevational diversity patterns of birds. It remains unclear, however, whether the relative importance of these variables is associated with abiotic filtering (physiological constraints) or mediated through the availability of resources (biological interactions and niche partitioning). Here, we examine multiple dimensions of diversity (taxonomic, functional and phylogenetic diversity) of bird assemblages along elevational gradients worldwide, and compare the potential forces that drive differences between tropical and temperate mountains. **Methods:** We gathered an extensive dataset of bird species co-occurring at different elevations from published studies on montane bird communities. Phylogenetic information and functional traits for each species were extracted from global datasets. Species richness, functional and phylogenetic diversity metrics were calculated for bird assemblages across elevations for each of these gradients. First, we describe elevational gradients for each of the three dimensions of biodiversity at a global scale. Then, we compare each of these diversity patterns between tropical and temperate mountains. Finally, we test for potential mechanisms driving diversity patterns and compare their relative importance between tropical and temperate systems. **Results:** We found low correlations between different dimensions of biodiversity in montane systems. The relative importance of potential deterministic processes (habitat filtering, biological interactions) shaping mountain biotas varied across elevations. However, we found little evidence of these processes to vary consistently across latitudes. Our results suggest that local factors and region-specific historical processes are more important than latitudinal gradients to drive diversity patterns in montane ecosystems. **Discussion:** Based on our findings we discuss the relative importance of global scale patterns (i.e. latitudinal) and local scale changes in shaping biodiversity in montane systems. By examining and comparing these gradients, we further examine the generality of deterministic processes hypothesized to shape biological diversity and their relative importance across elevations. Further, we discuss the potential consequences of climate change on tropical and temperate montane biotas.

Keywords: Altitude, Latitude, Gradients

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Relative impacts of mammal and habitat loss on dung beetle community structure

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Methods: We selected twelve independent 3km landscapes in the Atlantic Forest of São Paulo, Brazil, where all landscapes were constrained to similar soil types, elevational ranges and slopes, but spanned a 10-60% forest cover gradient. We distributed eight sampling points within each landscape using a stratified, random proportional selection process based on largest fragment size. At each point, we simultaneously collected data on dung beetle and medium and large-bodied mammal community structure in 2015, using well-replicated and standardized methods (i.e. baited pitfall traps and camera traps). We used generalized multilevel path analysis (GMPA) to quantify dung beetle abundance responses to both native habitat loss and mammal occurence. GMPA is a generalization of Shipley's d-sep test, wherein a generalized linear mixed model (GLMM) can be used to test a series of related claims of independence in a path diagram. **Results:** We captured 2,598 beetle individuals in 35 species across 11 genera, and registered 19 mammal species across the 12 focal landscapes. Preliminary analysis suggests that dung beetle community structure is more strongly influenced by changes in landscape-scale forest cover, than by altered mammal occurrence, and that these influences work independently to influence beetle community structure. These results were likely influenced by the extensive degree of biotic homogenization in the relatively depauperate mammal community across the 12 landscapes. **Discussion:** Our study advances an understanding of the relative mechanisms that impact dung beetle species in rapidly changing tropical forest landscapes, and suggest that conservation of dung beetles in working tropical landscapes will require both forest and mammal conservation efforts.

Keywords: Biodiversity, path-analysis, land-use change, landscapes

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In vitro propagation of the giant bamboo *Guadua* Kunth in the southwestern Amazon, Brazil

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Background: The Amazonian bamboo forests are located in an important region of high biodiversity in the countries of Brazil, Peru and Bolivia. This is the largest area of native bamboo in the world. The genus *Guadua* consists of tropical bamboos with unique characteristics such as renewability, durability, versatility and sustainability. Therefore, there is an increasing demand for industrial seedling production in the State of Acre, Brazil. **Methods:** This research was conducted in the Laboratory of Plant Tissue Culture at the Brazilian Agricultural Research Corporation in Acre, Brazil. The establishment was realized with nodal segments collected from plants stored at the laboratory greenhouse. The nodal segments were disinfected with a systemic fungicide, bactericide, alcohol and sodium hypochlorite. Plant Preservative Mixture was used as a synthetic biocide in concentration of both 2 and 3 mL L^{-1} in glass tubes with the semisolid Murashige and Skoog (MS) culture medium and 2 mg L^{-1} of benzylaminopurine (BA) to stimulate the axillary bud break at 15 days of incubation. The variables analyzed were shoot number, and degrees of bacterial and fungal contamination. In vitro multiplication was performed with BA plant growth hormone in concentrations of 0, 2, 4, 6, 8 mg L^{-1} in glass tubes with MS liquid at 38 days of incubation. The variables analyzed were shoot number, shoot length, multiplication rate, callus and root growth in two consecutive subcultures. Rooting was induced with the naphthaleneacetic (NAA) and indolebutyric (IBA) acids in concentrations of 0, 0.5, 1, 2 mg L^{-1}. The variables analyzed were root number, root length, rooting rate at 30 days of incubation. **Results:** The establishment using 3 mL L^{-1} of PPM was more efficient than 2 mL L^{-1} against bacterial and fungal attack, and shoot regeneration was not concentration dependent. The use of BA was effective in increasing the shoot number and the shoot length during the first subculture as compared with the control treatment. The second subculture results showed increased shoot number in all BA concentrations tested, except for the control. Shoot length showed no statistical increase in any of the concentrations used. In vitro rooting using the auxin NAA demonstrated good root response while IBA demonstrated no root response. **Conclusion:** Micropropagation of the *Guadua* sp. is best accomplished using 3 mL L^{-1} of PPM for establishment, 2 mg L^{-1} of BA for multiplication, and 2 mg L^{-1} of NAA for rooting.

Keywords: Micropropagation. Cytokinin. Auxin. Biotechnology. Phytohormones

ID:456
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Poster Board: 30

Agriculture matrices impacts on ant species richness in Atlantic Forest

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Background: Habitat loss and forest fragmentation are processes that threaten the forest biodiversity all over the world. This study aimed to measure the impacts of agricultural crops (matrices) on ant communities, and on its adjacent forest fragments (fragments) at Alfenas city micro-region, (south of Minas Gerais state, Brazil) in a transitional area between Semidecidual Atlantic Forest and Savanna. Ant's community were used to test the following hypotheses: (1) does the type of matrix influence the ants community?; (2) the community present in edges of forest fragments are influenced by the type of matrix? **Methods:** It was sampled nine fragments surrounded by different agricultural matrices: three replicate to each agricultural matrices (coffee, sugar cane and pasture). It was used 180 pitfall traps, 90 in the forest fragment and 90 in the agricultural matrices. We use NMDS (Non-Metric Dimensional Scaling) to the communities' composition, and measured the centroid distance among the communities (using the dissimilarity distance of Jaccard). **Results:** It was found that richness was different among fragments and matrices (pMCMC < 0.05). Pasture matrices and fragments adjacent to pasture and coffee, had the lower ant species richness (pMCMC<0.05). On the other hand, coffee and sugar cane matrices, together with forest fragments surrounded by sugar cane had the higher richness (pMCMC < 0.05). The species composition from coffee agricultural matrix had a higher similarity with their forest fragments (Jaccard=0.20). The centroid distance from forest fragments surrounded by sugar cane to sugar cane matrices (Centroid Distance = 0.74) was major compared with forest fragments surrounded by pasture (Centroid Distance = 0.605) and coffee (Centroid Distance = 0.475) with their agricultural matrices. **Discussion:** These results suggest that the agricultural matrices that surrounded forest fragments affect ant communities' composition into the forest fragment. Habitats, such sugar cane, affect negatively the ants community and cause a massive degradation in forest fragments, while matrices with higher vegetation complex tend to support more ant species and biodiversity.

Keywords: Ants Biodiversity, Agricultural matrix, conservation

ID:492
D-Thursday, July 13th, 2017
Poster Board: 32

Areas of endemism from the cloud forests of Mexico and identification of areas for conservation

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Cloud forests have been through different geological and climatic phenomena that have produced a complex evolutionary and biogeographical history, where events such as vicariance and dispersal have shaped both a huge biodiversity and biogeographic patterns that should be preserved. Areas of endemism represent patterns of distribution that can help determine regions for conservation. The aim of this work was to identify areas of endemism of terrestrial vertebrates (amphibians, reptiles, birds and mammals) from Mexican cloud forests and to use those areas in Systematic Conservation Planning (SCP) to propose priority areas for biodiversity conservation. Endemism areas were identified with endemicity analysis and different spatial scales 1°x 1°, 0.5° x 0.5 ° and 0.25° x 0.25° (lat/long) through the main country's cloud forest patches. Areas of endemism were used like surrogates of biodiversity and defined priority areas in medium, high and very high importance areas were prioritized according to five cumulative parameters. Each area of endemism was supported by shared species with a single biogeographic history with different times of divergence and are located in one or multiple temporal strata (Oligocene, Miocene, Pliocene and Pleistocene). Through the steps in SCP, the areas of endemism located in Sierra Norte de Oaxaca, cloud forest in Guerrero and Hidalgo, Puebla and Veracruz, proved to be highest priorities for conservation in Mexico.

Keywords: vertebrates, biogeographic patterns, highest priorities

ID:499
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Poster Board: 33

An interdisciplinary approach to gaining insights on rare species: Bush dogs in the Rupununi, Guyana

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The bush dog (*Speothos venaticus*) is naturally rare, extremely elusive, and notoriously difficult to study in the wild. Guyana contains a wealth of intact Neotropical forest and savanna habitat, but is one of only two countries with no information on the status of this species. Camera trap studies in the Rupununi Region resulted in the first photos of this species in the wild in Guyana, but nine photographs from three locations generated from tens of thousands of trap nights at >300 sites provides few insights into the status of this species. Capitalizing on the interested generated by sharing camera trap photos with Rupununi communities, we conducted a systematic survey of subsistence hunters, fishers, and farmers that resulted in 84 reports of opportunistic encounters with bush dogs. While camera trap photos provide indisputable confirmation on the presence of this species, reports from key informants resulted new understandings of the biology, ecology, and behavior of this species, as well as unique insights into threats facing bush dogs in the Rupununi and their place in Makushi and Wapichan culture. This interdisciplinary approach allowed access to data outside of the scope and scale of conventional research, represents an inclusive method that engages communities in the research process, and generates information that is directly applicable to the conservation and management of wildlife and wild lands.

Keywords: Guyana, indigenous knowledge, *Speothos venaticus*

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Poster Board: 34

How does landscape and fragment metrics shapes dung beetle diversity in Los Tuxtlas, Mexico?

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Background: Deforestation is one of the major drivers of biodiversity loss in the Neotropics. Loss of forest cover can have effects on animals at different scales. In agricultural landscapes, dung beetles are a key component in nutrient cycling. The aim of this work is to test diversity of dung beetles, both at landscape and fragment scale, to answer the following questions: 1) do fragment and landscape metrics have an influence on dung beetle diversity?; 2) does it change between ensamblages and dung beetle specialists?; 3) does it change with different rates of deforestation in an already deforested region? **Methods:** At Los Tuxtlas Biosphere Reserve, in Veracruz, Mexico, a sampling was conducted in two areas. Those areas differed in forest cover: 24% for Low Deforestation (BD) and 11% for High Deforestation (AD). We sampled dung beetles in 14 forest fragments in BD and 17 in AD. In those fragments, we placed pitfall traps 50 meters apart from each other, baited with dung and carrion. To test the fragment and landscape effect on typical diversity (1D) we check single models for ensamblage and for the subset of species that were "forest and dung specialists", using generalized lineal models. The fragment metrics used were area, shape and distance to the closest fragments; landscape metrics used were forest cover, fragment density, edge density and fragment isolation. Landscape metrics were calculated from a 550 m radius from the focal fragment centroid. **Results:** In general, landscape and fragment metrics didn't have an effect on diversity of ensamblages and specialists, except that distance to the nearest fragment related to diversity of specialists in AD. **Discussion:** The lack of effect of landscape and fragment measures means the diversity is diluted in the whole region and all fragments matters for its conservation. The main resource used by dung beetles comes from monkeys, which uses live fences and moves across the region. Dung beetles ensamblages are made of species with different geographic affinities and dispersal abilities. As we found most of historic richness in this sampling (63%), these species could have been subject to a big selection process, and the extinction debt in this area could have already been paid. **Conclusion:** We recommend to preserve the existent forest cover with sylviculture.

Keywords: landscape metrics, tropical rainforests

ID:514
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Diversity and species turnover in tree species along an altitudinal gradient in Morelos, Mexico

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Background: Vegetation structure and composition are influenced by several landscape characteristics. Altitudinal gradients are particularly relevant, since they have a strong effect on environmental variables that control species establishment. In an altitudinal gradient, variations in species composition and diversity may be smooth or rather abrupt, and these are reflected in species turnover, which can be an important component of regional plant species diversity. We analyzed species composition, structure and distribution of tree species in four vegetation types along an altitudinal gradient of 1100 m (1250 - 2350 m) in a small area (2 610 ha) in the Eastern part of Sierra de Chichinautzin (Morelos, Mexico). We estimated α± diversity in each vegetation type and analyzed species turnover. **Methods:** We analyzed satellite images and made field trips to make a supervised classification of vegetation types. These were delimitated and sampling sites defined (N=12). Size of each sampling site was 1000 m2 (10 × 100 m2) and in each we registered height and basal diameter of all woody individuals with DBH ≥ 2.5 cm, as well as some environmental variables. We analyzed structure, composition and diversity of each community. This information was integrated in a SIG to obtain a map of vegetation types. **Results & Discussion:** We identified four vegetation types, from low to high altitudes: tropical dry forest (TDF, 1250-1800 m), oak forest (OF, 1500-2050 m), mixed pine-oak forest (POF, 1650-2150 m) and pine forest (PF, 1700-2350 m). Average basal area was higher, and density lower, in POF, while TDF showed the opposite pattern. In TDF four species had the highest IVI, while in OF and PF one species dominated (*Quercus magnoliifolia* and *Pinus teocote* respectively). This pine dominated also in POF; however, in POF five out of ten species with high IVI values were oaks. TDF had the highest values in richness (S = 53) and diversity (H'= 3.44 and eH = 31.65), while PF had the lowest (S = 8, H' = 0.8 and eH = 2.22). In OF and POF richness was similar (S =20), but diversity was higher in the second (H' = 1.81 and 2.53 respectively). IVI were more homogeneous in vegetation types having high diversity (TDF and POF). Various indices showed a high similarity between TDF and OF, and all indicated low similitude between TDF and PF. TDF is most affected by land use change, thus it is advisable to increase connectivity and center conservation efforts in larger, more preserved patches.

Keywords: *Pinus*, *Quercus*, Tropical Dry Forest

ID:542
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Understanding roads and their buffer areas as integral parts of wildlife corridors

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Background: Wildlife corridors are a key conservation strategy because they can increase effective population sizes by facilitating animal dispersal between different conservation units. Frequently, the establishment of wildlife corridors needs to include landscape features that can hinder animal dispersal such as roads and their surrounding areas where natural land cover has disappeared. We explored the effects that roads and their surrounding areas may have on the connectivity of terrestrial vertebrates, particularly medium and large body-sized mammals, between three protected areas located in the eastern slope of Ecuador's Andes: Cayambe-Coca National Park, Sumaco-Napo-Galeras National Park, and Antisana Ecological Reserve. **Methods:** Our study objectives included: 1) to explore landscape composition and configuration associated with higher mortality on roads, and 2) to identify best corridor routes. Our methods included: 1) a systematic survey of road kills to detect road areas with higher risk of mortality, 2) camera-trap surveys to evaluate wildlife occurrence in potential areas for the establishment of corridors, and 3) the development of circuit models to identify potential wildlife corridors based on landscape attributes and expert opinion. **Results:** We surveyed 7128 km of roads in 72 days where we found 452 road kills. Distance to remnant vegetation was the most important variable to predict mortality of birds, reptiles and mammals, while distance to rivers and ravines was important in predicting amphibian mortality. Among the species detected by camera traps were little red brocket *Mazama rufina*, mountain tapir *Tapirus pinchaque*, oncilla *Leopardus tigrinus* and Andean bear *Tremarctos ornatus*. The occurrence of these species was associated with the proportion of natural cover surrounding camera traps and distance to ravines and to rivers. Circuit models identified 5 main routes for the establishment of wildlife corridors, which were associated with the presence of natural vegetation cover and vicinity to protected areas. **Conclusion:** Small remnants of natural vegetation and ravines that maintain natural cover were important in determining possible wildlife corridors. When roads are present, small habitat patches and ravines can be among the few places used by wildlife to move between protected areas, therefore, it is important for managers to develop strategies to promote the maintenance of these landscape features whose function might be undervalued.

Keywords: Ecuador, connectivity, conservation, Andes, mammals

ID:548
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Incidence of Morphological abnormalities in the engangered Salamander *Bystoma ordinarium*

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Background: Identification of early warning signals previous the occurrence of population decline or extinction is a major challenge for the conservation of animal species. Prevalence of morphological abnormalities in a population can be one of these signals. We registered morphological abnormalities in the salamander *Ambystoma ordinarium*. **Methods:** To collect field data on morphological abnormalities surveys were carried out during the dry season of 2014. A 100 m long transect was laid at the middle section of each of the 16 streams where A. *ordinarium* populations were existent. Within each transect, salamanders were visually detected and captured with hand-held nets. Once captured, salamanders were photographed. Photographs were used to identify morphological abnormalities. **Results:** Of 502 sampled individuals, 44.62% had at least one body abnormality. Of the 224 individuals with body abnormalities, 37.5% presented more than one abnormality. Of a total of 5,522 evaluated morphological characters, 6.74 % were abnormal. Partial loss of gills and missing digits were the most frequent abnormalities. **Discussion:** Morphological abnormalities in amphibians have been frequently associated to a reduction in survival and fitness. The 44.6% of individuals of A. *ordinarium* with morphological abnormalities recorded in this study is markedly higher than the background incidence of 0 to 5.0 % reported in wild populations in natural habitats. Studies evaluating body abnormalities can provide important information to determine the causal elements, and can be a sign of the health status of the ecosystem, since the proliferation of body abnormalities not only can cause death to individuals but may be a warning signal of environmental degradation.

Keywords: Stream salamander habitat quality abnormalities

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Improved management through collaborative partnership in the South Sumatran landscape

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Background: Sembilang-Dangku landscape in South Sumatera Indonesia is an important area for biodiversity including areas with HCV (high Conservation Value) such as the Berbak Sembilang National Park and Dangku Wildlife Reserve. These protected areas are home to many endangered species including the iconic Sumateran tiger (*Panthera Tigris*). The landscape has extensive peatland areas, which are threatened with drainage by the logging and oil palm industries. The goals and objectives of environmental and forestry sectors highlight the importance of balancing the utilization of natural resources for development, with conservation. **Methods:** By using 2015 satellite images, agricultural land covers 51.29% of the total landscape area, or 468,753.22 ha. This consists of dry land agriculture, mixed plantations, acacia plantations, rubber plantations, mixed rubber and palm oil plantations, palm oil plantations, and paddy fields. Using testing pilot models on the ground provides valuable information to inform better natural resource management policies. **Results:** Forests cover 29.45% of the total landscape area or 269,132.90 ha. This forest area consists of secondary forest, peat swamp forest and mangrove forest. Non-forested areas cover 14.17% of the land area or 129,534.73 ha, and include swamp areas, scrubby swamp areas and shrubs. Wetlands cover about 1.65% of the total landscape area or 15,068.62 ha, and consist of muddy coastal area, coastal fish ponds, and water bodies or river/streams. Improved policy and governance is essential to successful sustainable landscape management to synchronize the Sembilang-Dangku landscape management master plan with national, provincial and district government land management policy. **Discussion:** The Sembilang-Dangku landscape faces challenges due to the complexity of land and natural resource use in this area. The major problems are illegal logging, peatland degradation and forest fires, as well as competing land use among development sectors. The lack of coherence and connection among the parties contributes to unsustainable natural resource management practices. Pressure on forest and peatland has increased due to the expansion of land and forest-based industries such as oil palm, timber and mining. This project for sustainable landscape management in Sembilang-Dangku represents a strategic effort toward balancing production and conservation goals and thus promoting the Green Growth Vision of South Sumatera.

Keywords: Biodiversity, landscape approaches, South Sumatera

ID:558
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In vitro orchids germplasm bank, a strategy for ex situ conservation in the Bogotá Botanical Garden

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Colombia is ranked first as the country with the highest biodiversity of Orchids in the world, with over 4000 species which thrive in almost all the thermal floors. However, day by day its populations are under threat from different factors as overexploitation for marketing. Coping this panorama, the Bogotá Botanical Garden José Celestino Mutis associated with CORPOICA, La Pontificia Universidad Javeriana, Instituto Alexander Von Humboldt and Gobernación de Cundinamarca developed a project with the aim to study and rescue threatened Orchid species. The in vitro orchids germoplasm bank of the Bogotá Botanical Garden José Celestino has over 15 years of experience of conservation and propagation of Orchids. The research starts with the characterization of relic Andean zones which own Orchids; afterwards the excursions are made to take capsules of several species (particularly high Andean and moor zones) found in the capital district and its influence area; subsequently in the laboratory the precedence of the species is registered as well as its threat level and other related information about the specimen. The monitoring and evaluation is made from the plantation to the collecting of the seeding that will be taken to the greenhouse and which in the posteriors phases will be reintroduced into its natural habitat. Furthermore, it will be delivered to the growers in the region with the purpose of promoting breeding and legal marketing of this species. Results The actual agreement has identified priority areas of orchids natural distribution. On those areas over 25 species have been identified and a list of growers with around 70 nurserymen, who market with orchids, has been consolidated. Additionally, in the in vitro laboratory of the Botanical Garden are over 50 species including the ones managed by the institution as well as the ones which take part in the agreement. Nowadays, the in vitro orchids germoplasm bank of the Bogotá Botanical Garden José Celestino is the most important in Colombia related with orchids conservation. Discussion and Conclusions The inclusion of the in vitro technology will achieved a greater quantity of higher phytosanitary standards plants with relatively lower cost, every so often the marketing is taken to the masses among the nurserymen. As a result of this, an improve in the conservation of natural species as a base of posterior process of propagation, repopulation and plant breeding will be noticed.

Keywords: Germoplasm Bank, invitro propagation, phytogenetic

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Comparison between *Phyllophaga* (Coleoptera: Melolonthidae) assemblages in Western Cuba

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Background: The Cuban archipelago has 79 *Phyllophaga* species with a 98.6 % of endemism, which makes the group ecologically and economically important, as some species are classified as crop pests. The aim of this study was to determine the relationship between the composition and structure of the *Phyllophaga* assemblages with their habitat type, considering plant structure and level of human habitat disturbance. **Methods:** A total of 17 locations were sampled in Western Cuba during the rainy seasons of the period from 2011 to 2015; these differed in habitat types (forests and agroecosystems). Samplings followed standard methods and were made once with a light trap screen in each locality. **Results:** A total of 1 153 individuals of 24 *Phyllophaga* species were collected. The total abundance of collected individuals varied between 10 and 306, and species richness between two and nine species. The most abundant species was *Phyllophaga dissimilis* (Chevrolat) which also had the highest frequency of occurrence. Generally, less anthropized sites reflected richer and equitative communities; although these characteristics appeared in two sites that showed intermediate degree of disturbance. The non-metric multidimensional scaling showed that the most similar samples were those of the very anthropized sites; this similarity was given mainly by the abundance of *Phyllophaga dissimilis*, *P. insualepinorum* and *P. puberula*. Besides, the geographical distance was not related to the similarity of these assemblages. Additionally, fourth new species of *Phyllophaga* were recorded for science

Keywords: *Phyllophaga*, Cuba, western zone, assamblage

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Poster Board: 41

Composition and functional diversity of terrestrial mammals at the Greater Lacandona Ecosystem

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The Greater Lacandona Ecosystem represents one of the last remains of tropical rainforest in Mexico. However, most of its original forest cover has been reduced in the last 40 years due to anthropogenic activities, and most of the remaining forest cover of this region is preserved by seven Natural Protected Areas. Also, there are crucial relicts of forest outside these protected areas which are maintained by the landowners that receive Payment of Environmental Services (PES). Mammals are an important component in tropical rainforest, with diverse ecological roles among species and function in the ecosystem processes. We examined different aspects of the terrestrial mammal's community (richness, diversity, and relative abundance). In addition, we examined the functional diversity by using functional traits (i.e. body mass, trophic guild, sociability, and population density) in order to define functional groups and determine the functional diversity. We implemented camera-traps surveys in three Natural Protected Areas (Montes Azules, Yaxchilán, and Chan-Kin) and in forest remnants maintained by PES at the Marques de Comillas Region during one year. All these sites have different protection management, forest cover, landscape configuration and anthropogenic pressure. We obtained 2,567 independent records of 19 different species of terrestrial mammals with a sampling effort of 13,956 trap-days. The sites with the highest richness, diversity and functional diversity were Montes Azules, Yaxchilán, and the Marques de Comillas Region. Chan-Kin had the lowest values of diversity and functional diversity showing a high dominance of rodents. We defined five functional groups which were represented at the four sites. This is the first large scale study focused on the community of mammals at the Greater Lacandona Ecosystem region. Our results highlight the importance of the PES conservation tool to maintain the diversity and functional diversity of the mammal community outside the Natural Protected Areas. Although Chan-Kin is a Natural Protected Area, it lacks of a management plan. Probably the low diversity and functional diversity of Chan Kin contrasts to the other three surveyed areas because of the high anthropogenic pressure by hunting and logging.

Keywords: mammals, diversity functional, composition, rainforest

ID:569
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Association of *Ocimum basilicum* in the rose bush: Implications for conservation biological control

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Background: The rose is the most produced and commercialized cut flower in the world. The rose bush is susceptible to attack from pests and farmers have difficulties to control it through the use of insecticides. Nowadays, alternative practices have been used for sustainable crop production. The habitat management through diversification is a tool used to regulate pest populations in diverse agroecosystems. There is little information about the association of basil (*Ocimum basilicum* L.) with ornamental plants, especially rose bushes. This attractive plant can shelter natural enemies that will regulate pests. The objective of this study was to apply the conservation biological control in rose bushes in greenhouse, using basil as attractive plant for natural enemies. **Methods:** The experiment was conducted in rose bush cv. 'Carolla' in greenhouse at Epamig in São João Del Rei-MG, Brazil. The greenhouse was divided internally into four compartments, where treatments were randomly placed. The treatments were: a) diversified, where it was planted rose with basil, in two compartments, and b) simplified, containing only roses in the two compartments. Samples were collected for sixteen weeks on the rose plants and on basil. Data the arthropods were submitted to faunistic analysis and compared by analysis of variance. The production and quality of flowers were also analyzed. **Results:** The main phytophagous arthropods found were mites (*Tetranychus urticae*), aphids (*Macrosiphum rosae*, *Macrosiphum euphorbiae*, *Rhodobium porosum*) and whiteflies (*Bemisia* spp.). The natural enemies found were parasitoids (*Praon volucre*) and predators (*Allograpta* sp., *Chrysoperla externa*, *Cycloneda sanguinea*, *Hippodamia convergens*, *Pseudodorus clavatus*, *Toxomerus* sp.). The treatments were similar with respect to species richness, but the number of individuals was higher in monoculture (3255) compared to the diversified (2711). The rose-associated basil showed lower number of aphids and whiteflies compared to rose bushes without of the attractive plant. The basil as an attractive plant provided an increase in the number of natural enemies in the rose bush. The production and flower quality were not affected. **Conclusions:** The vegetable diversification provided by the use of basil influences the occurrence of pests. The basil flowers (pollen/nectar) as a supplementary food provide valuable supplementary resources for natural enemies.

Keywords: Arthropods, Biological control, Pest, Rose

ID:579
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Climate change, aguadas and herpetofaunal community structure in the Calakmul Biosphere Reserve

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Background: Neotropical herpetofauna are rapidly declining, and understudied, despite them containing a large global assemblage. Tropical dry forest, such as that in the Calakmul Biosphere Reserve (CBR) in Campeche acts as a cline between the dryer North of the Yucatán and the more humid Central America, and consequentially contains a large herpetofaunal community. Due to limestone karst, water in CBR is a limiting resource, only existing in the form of temporary lakes, locally known as aguadas. These aguadas are sustained by rainfall (which has been decreasing over the years due to climate change), and constitute the only source of water to both the fauna and the human communities of the region. **Methods:** Annual biodiversity surveys have been conducted in the CBR by Operation Wallacea, a UK based non-governmental organization, in collaboration with Pronatura Peninsula de Yucatan (PPY) and the Comisión Nacional de Áreas Naturales Protegidas (CONANP) aimed at monitoring the impact of climate change on biodiversity in CBR. Herpetofaunal species richness and abundance in aguadas were studied by opportunistic, timed searches and pitfall trap surveys between June and August of 2013-2016 in four different sampling localities in both the core and buffer zone of the reserve. **Results:** We report a reduction in the availability of water in all aguadas over time, followed by the complete disappearance of multiple aguadas in 2016. Corresponding herpetofauna records for each aguada indicate a decline in abundance and diversity of both reptiles and amphibian as aguadas reduce in surface area and permanence. Dry aguada locations tended to exhibit no record of herpetofauna, or presented significant lower numbers, usually of species less dependent on water (e.g. *Ameiva undulata*; *Incilius valliceps*). **Discussion:** Our results suggest that herpetofaunal species in CBR are being affected by climate change, but it is not yet clear if the change in water distribution is result in the decline if herpetofauna or simply altering habitat preferences and ranging. Consequently, further study is needed, preferably identifying functional differences in herpetofauna community assemblage associated with habitat types, which in CBR represents comparing aguadas with different vegetation types (even if dry). This information is urgently required to determine if and when the reserve management should restore aguada habitats to conserve herpetofauna populations.

Keywords: Herpetofauna, Climate Change, Calakmul

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Amphibian diversity in two forests inside a Biosphere Reserve of Mountain Cloud Forest in Mexico

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At worldwide, the mountain cloud forest (MCF) is considered the ecosystem with the greatest number of endemic species, but, at the same time is the ecosystem with the highest number of threatened species. In México, the MCF presents a naturally fragmented distribution maintaining great beta diversity between them, even if they are relatively close. For that reason the principal aim of this study is to evaluate the amphibian community structure in two MCF with a high degree of conservation. We realized six samples in two forests from the Biosphere Reserve of El Triunfo, Chiapas. Every sample we put four plots in every forest and in every plot we realized surveys in the ground and in the canopy. We evaluated the current situation of amphibian diversity in the cloud forest of this reserve to analyze the species richness and abundance and comparing the assemblage structure between the two forest. During the six samples we surveyed 24 different plots in every forest, with a 768 person-hours of sampling effort. A total of 306 amphibians belonging to 14 species were recorded between the two forests (11 and 9 species respectively). We did not found significant differences in the richness between the two forests; however we founded differences in the abundances between them (113 and 193). With respect to the beta diversity, we founded a dissimilarity in the composition of the 0.57%. With these results we founded that every forest play a different role in the conservation of the regional diversity, while one forest maintain a major species number, the other maintain a main abundance, being complementary between them. Despite the minimum richness differences, we could see a great species replacement, because only six species were presents in the two forests. Finally we can conclude that the MCF has a great importance in the amphibian conservation, they protect a high number of threaten species and presents a high species replacement between them no matter if the forests are close to each other.

Keywords: Amphibians, diversity, dissimilarity, Chiapas, conservation

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Forest biodiversity in Sorocaba's Metropolitan Region

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Sorocaba is located in the southeast region of the State of São Paulo, Brazil, and it's historically industrial, being surrounded by smaller cities which economy are based on agriculture activity, livestock or forestry. Recently the region was converted to RMS (Sorocaba metropolitan region) having its center in Sorocaba. Metropolization implies in urban sprawl, increase of industrial and highway areas, which can be a threat to biodiversity. The remaining forests that are already fragmented can be totally destroyed. The original coverage of the region is the Semidecidual Seasonal Forest, in Atlantic Forest domain. This study aims to diagnose regional forest biodiversity in the RMS, in order to evidence endangered species, and sites with great diversity that need legal protection. The survey was carried out in 9 areas (within 5 cities). The plot method was used, with 12 samples in each area, totaling 108 plots or 1.08 ha. All woody individuals with DBH (diameter at breast height) of 5 cm or more were collected. The phytosociological parameters (absolute and relative density, dominance and frequency, coverage value index - IVC) were calculated for families and species, and the diversity index of Shannon H' was calculated, which in this case represents gamma diversity because the study was done on a landscape scale. We sampled 1,750 individuals, 57 families and 247 species. The families with the greatest species richness were Fabaceae, Myrtaceae and Lauraceae, and those with the highest IVC were Fabaceae, Anacardiaceae and Lauraceae. Among the species with the highest IVC there are several pioneer species, common in degraded areas such as *Lithrea molleoides*, *Moquiniastrum polymorphum*, and *Piptadenia gonoacantha*. But there are also late species such as *Copaifera langsdorfii*, *Machaerium villosum* and *Cryptocaria aschersoniana*. The diversity index of Shannon, 4.72 was quite high. Richness in the area was relatively high when compared to other studies in the region, which registered from 80 to 120 species. Work done in the region showed H ranging from 3.3 to 4.01, which shows that the region still maintains a great diversity, which needs to be protected. The studied areas of the cities of Boituva and Itu, which are north of Sorocaba, presented the greatest richness and diversity index. These areas are extremely threatened since the Sorocaba-Itu axis is an area of industrial and road expansion, demonstrating that these areas require effective legal protection.

Keywords: protected areas, forest diversity, conservation.

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Geographic biases in the distribution of scientific knowledge and biodiversity in the Amazon

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Background: The enormous biodiversity of the Amazon makes it one of the key targets for the global conservation movement. However, its vast size poses enormous challenges to researchers and has caused abundant geographic gaps in scientific knowledge about Amazon biodiversity and conservation. These gaps have potentially important consequences: due to an absence of baseline data it is uncertain how much biodiversity and ecosystem services may have been lost, or may be lost, in regions not yet studied. Our objective was therefore to map Amazonian knowledge production to identify geographic deficits in biodiversity and conservation knowledge. **Methods:** We sampled the Scopus platform for scientific publications on conservation and biodiversity in the Amazon region using the following search terms: (amazon OR amazonia OR amazonas OR amazonian) AND (conservation OR biodiversity). Of 2,383 articles returned, we recovered 2094 PDF files. We then performed content filtering to extract the georeferenced locations where the research was carried out. We then compared the geographic distribution of published research sites in scientific articles with the distribution of Amazonian biodiversity downloaded from the GBIF. Specifically, we retrieved occurrence data for Chordata, Arthropoda and Pteridophyta groups. QGIS was used to plot the data. **Results:** We were able to extract geographic information from 857 PDFs for a total of 4,019 geographic co-ordinates. Scientific research sites and occurrence records for Chordata, Arthropoda and Pteridophyta groups were highly concordant, clustering along the great rivers and around major urban centers. Research deficits occurred throughout the region, including heavily deforested areas and those at most risk of climate-induced ecosystem transformations. **Discussion:** The vast size of the Amazon region combined with limited funds/capacity for biodiversity and conservation research mean that knowledge deficits are inevitable. Nevertheless, it is essential that we are able to identify research 'coldspots' and integrate this information into policy and planning. Our study clearly demonstrates that more isolated locations, away from major rivers and urban centers, are characterized by scientific knowledge deficits. We argue that research efforts in these regions should receive incentives to sample biodiversity and reduce bias related to the distribution of species in the forest.

Keywords: research efffort knowledge deficits conservation

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Soil biodiversity footprints in human-modified landscapes: The case of the Amazonian Dark Earths

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Background: During the Holocene, humans have greatly altered global patterns of biodiversity and ecosystem dynamics. Numerous examples exist of ancient land-use systems in human-transformed landscapes, supporting vast numbers of people, and greatly modifying the forest cover. One of these are the Amazonian Dark Earths (ADEs): highly nutrient-enriched soils with an outstanding capacity for carbon sequestering, agricultural production and resilience to desertification. Surprisingly, the contribution of soil biota has been severely ignored in these soils, and little is known of their biodiversity. **Methods:** Nine sites (ADE & adjacent reference) were sampled for soil fauna, including the assessment of the main ecosystem engineer populations (earthworms, ants, and termites) using standard method (n= five 25 x 25 x 30 cm deep soil monoliths per site). Soil chemical parameters and macromorphology were assessed on samples from the 0-30 cm layer. Study sites included three old-growth forests, three young forests, and three agricultural systems in the regions of Belterra, Iranduba, and Porto Velho. **Results:** ADE soil species composition was staggeringly different when compared to adjacent soils with a large number of exclusive representatives in ADE, with some newly discovered species. A higher proportion of ecosystem engineers was found in ADEs, closely associated to the presence of bio-aggregates, potsherds and to the soil's unique physical and chemical properties. Species richness was also lower in agricultural sites and higher in old-growth forest. **Discussion:** Results suggest that the unique enriched environment of ADEs became so conspicuously different from adjacent land that it developed its own characteristic fauna. We argued that the human impact in this ecosystem is broader than ever before estimated. This is true for the ecosystem engineers which seem to be a main component of ADEs, representing more than half of the total macrofauna and >80% of total biomass. They therefore contribute significantly to the functioning and engineering of these human-modified ecosystems. It is accepted that the ancient human societies that occupied the region adopted sedentary habits and the presence of exclusive representative ADEs species across the sites may reflect these ancient human dynamics, in particular, exchange of crops. This process of human-mediated transport would explain the distributions that are observed in some of the widely-distributed soil fauna in Brazil.

Keywords: Soil_fauna, Biodiversity, Anthropic_Ecosystems, Amazonian_Dark_Earth, Ecosystem_Engineers

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Habitat preference of two Ecuadorian primate species

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Background: Agricultural expansion has left only 2-5% of pristine Pacific Equatorial Forest intact, making it one of the most fragmented biodiversity hotspots in the world. Two of its inhabitants, the critically endangered Ecuadorian white-fronted capuchin (*Cebus aequatorialis*) and the threatened Ecuadorian howler monkey (*Alouatta palliata aequatorialis*) are prolific seed dispersers that are critical to forest health. We sought to understand the specific habitat preferences of these monkeys and their current demographics within a 487 hectare private reserve in order to inform future land acquisition and conservation strategies. Home range sizes are often used to estimate the amount of contiguous forest required to support a given population size, however landscape heterogeneity could render the actual amount of suitable habitat to be much less than the amount of contiguous forest. **Methods:** 800+ hours were spent surveying A. *palliata aequatorialis* and C. *aequatorialis* in the Jama-Coaque Reserve (Manabí– , Ecuador) from 2011-2015. We used an Ecological Niche Factor Analysis to estimate habitat preference to factors including elevation, distance to river, distance to deforested sites, and distance to ridges. **Results:** A. *palliata aequatorialis* prefered intact moist forest at lower elevations (300 - 400 m asl) and greater distances from deforestation. Our results suggest C. *aequatorialis* prefers higher elevations, but they were not statistically significant. **Discussion:** Efforts to restore connectivity in the Pacific Equatorial Forest are underway and primate habitat is priority for restoration and conservation. Our results suggest that undegraded moist forest from 300 - 400m asl should be prioritized to facilitate increases in the population of A. *palliata aequatorialis* which are in risk of extinction. In this reserve, C. *aequatorialis* numbers are dwindling on the brink of extirpation with only one or two troops left. Creating ridgeline corridors to other intact forest and reserves is critical to ensuring the survival of this monkey species. Continued surveying should take place to assess how recent changes in yearly precipitation patterns will affect monkey habitat preference and demographics.

Keywords: habitat preference; corridors; GIS; howler; capuchin

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Evaluating biodiversity and ecosystem services in a mosaic of agricultural land and forest patches

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Background: Estimates indicate that tree cover is disappearing at an average rate of 139,000 ha yr-1 in the tropical forests of Peru, mainly due to human migration from coastal and Andeans regions towards the Amazon. The dynamic of this process, likely to have existed since pre-Inca times is pursuing exponential trends, challenging forest biodiversity and biomass resilience. I hypothesised the following: - Above and below-ground values of species diversity and biomass accumulation of secondary forests during succession from abandoned agricultural activities is eroded by the agricultural use intensity. - Forest remnants and agricultural fields patch size and distribution in the landscape has a significant impact on biomass and diversity resilience to human-induced disturbance. - Young forest patches hold low biomass and biodiversity values, but are no less suitable for agriculture than fragments abandoned earlier although their value for biological conservation is lower. **Methods:** I tested these hypotheses in the Alto Mayo valley, on the eastern slopes of the Andes in Northern Peru, region counting among the highest concentrations of diversity on earth. I used remotely sensed images to determine successional stages and size evolution of forest patches within several study sites spanning an area of 500 Km^2. This sequence of images represented aerial photographs from the year 1961 to 2013, and I obtained additional information about land-use after interviewing local farmers. **Results:** Analysing those images allowed me identifying forest fragments ranging from1 ha to continuous forest and aged from potentially five years since abandonment to more than 55 years of age. Environmental variables were monitored in those fragments by establishing randomly 25X8m transects, in each fragment to obtain metrics on biomass, biodiversity and ecosystem functions related to woody plants regeneration capacity. The work isn't finished yet and will continue until I achieve a representative sampling size of 80 transects. **Conclusion:**The aim of this work besides publishing the finding in peer-reviewed journals, is to encourage agricultural practices that will engage the local community to conserve highly valuable species pools while improving their livelihood. I am already working with local partners governmental and non-governmental agencies, to determine the level of farmers' ecological knowledge and their capacity in changing their farming practices.

Keywords: Regeneration Biomass Biodiversity Chronosequence Tropical

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Sudden flooding vulnerability and conservation prioritization in the Pacific Islands

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Background: Earthquake-generated tsunamis threaten coastal areas and low-lying islands. Human hazards and infrastructure damage have been well documented for tsunamis in recent decades, however the effects of sudden flooding on wildlife populations are rarely quantified. On 11 March 2011 a moment magnitude (Mw) 9.0 earthquake occurred off the Tohoku coast of Japan, generating a tsunami. This study describes the earthquake-generated wave event on Pacific Islands more than 3,800 km from the epicenter, and uses a spatially explicit approach to estimate habitat inundation and predict short-term impacts to bird populations across four Pacific Islands. **Methods:** We used GPS, satellite imagery, distribution and abundance data to quantify inundation extent and probable effects to 23 breeding bird species in the Hawaiian Archipelago. We describe variation in species exposure and sensitivity to sudden flooding events as a tool for conservation prioritization with additional utility in the face of climate change driven sea level rise. **Results:** Sudden flooding at Midway Atoll and Laysan Island inundated 21-100% of island areas. We estimated Procellariform's (albatrosses and petrels) chick and egg losses from the tsunami exceeded 260,500 at Midway Atoll and albatross chick losses at Laysan Island exceeded 21,400. The tsunami flooded during the peak of nesting for 14 species, caused extensive mortality of adult breeders and chicks of at least eight species, and endangered species populations declined approximately 40% on both atolls. **Discussion:** Our results highlight the extent and variation in impacts to wildlife communities from catastrophic sudden flooding events that likely to increase in frequency with global sea level rise. With limited global ranges of Pacific Island species, sensitivity to invasive mammalian predators, and high population densities, the biodiversity of insular bird communities on low-lying atolls is vulnerable to catastrophic population declines from Pacific tsunamis and storm driven flooding. Albatrosses and burrow nesters were among species at greatest risk and non-migratory land birds were sensitive to secondary effects of sudden flooding. With low-lying islands vulnerable to future sudden flooding, and lack of sufficient invasive predator refugia for island bird communities on higher elevation Islands, additional conservation strategies are warranted for some species.

Keywords: Tsunami, tropical seabirds, Hawaii

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Posters
Tropical forests and global change

Effect of chemical pollution and parasitism on heat tolerance in dung beetles

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Background: Many insects are threatened by recent increasing global temperatures, particularly in the tropics, where they live close to their thermal limits. Given that tolerance to high temperatures (critical thermal maximum, CTmax) depends on individual metabolism and physiological stress response, it may also be sensitive to other stressors that are common in natural and human-modified environments, such as pollution and parasite pressure. Here we tested the effects of parasitism and exposure to a contaminant on thermal tolerance of dung beetles, which provide key ecosystem services in cattle pastures. **Methods:** We measured CTmax in dung beetles exposed to ivermectin, a toxic parasiticide with known negative effects on coprophagous fauna, and in beetles exposed to an immune challenge simulating parasitism. We also exposed a group of beetles to a combination of both ivermectin and immune challenge to test for potential additive or synergistic effects of both stressors. **Results:** Contrary to our predictions, CTmax did not change with ivermectin exposure, but increased in immune-challenged beetles. As found in other insects, CTmax was higher in larger beetles, highlighting the importance of body size on thermal tolerance in insects. **Conclusion:** Natural and human-induced environmental pressures now interact with global warming and threaten wild animals and ecosystem function.

Keywords: immune challenge, ivermectin, Scarabaeidae

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Effects of disturbance and climate change on extrafloral nectaries' features at the Caatinga

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Methods: The survey was carried out at the Catimbau National Park (Pernambuco, Brazil), where three adult individuals of P. *moniliformis* were marked in each of the 14 0.1 ha-plots distributed along two independent gradients CAD (i.e. distance from the plot to the closest road and farms, and length of goats trails) and rainfall (940-510 mm/year). For each individual we measured collect information for the EFN size (width of secretory tissue, lengths and widths of glands) and nectar volume and concentration. **Results:** The width of secretory tissue, lengths and widths of glands were negatively affected by increasing aridity, but were not influenced by CAD. On the other hand, CAD promoted a decrease in nectar volume but not in concentration. Finally, neither nectar volume nor concentration were influenced by rainfall. **Discussion:** These findings indicate that drier and more disturbed sites are more stressful for EFN-bearing plants with physiological stress resulting in lower EFN size and nectar secretion. These changes in EFN features may result in a decline of attraction for ants, and consequently in a reduction of antiherbivore services provided by them.

Keywords: Extrafloral nectaries; chronic disturbance; precipitation

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Impact of climate change on altitudinal distribution on rodent species in southwest Mexico

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Background: Many tropical species are strongly associated with specific habitats. As such, we can consider their vulnerability to climate change to be a function of the risk those habitats may experience. In this study, we assess risk with a technique called exposure analysis that uses downscaled global circulation models to make spatially explicit predictions about future climatic conditions for a given vegetation type. Vulnerability is then based on the degree of change between current and predicted future conditions for that vegetation type. In this study, we estimated rodent diversity and future vulnerability across an elevation gradient in Oaxaca, Mexico, by characterizing present day habitat and modeling future vegetation exposure. **Methods:** We used live traps to sample small rodent species and estimate altitudinal range in forest habitats across an elevational gradient from 300 to 2550 masl. We characterized vegetation and site physical parameters at each trapping locale to relate species presence with habitat. The putative altitudinal range of each rodent species was related to vegetation characteristics across that range and compared to an exposure analysis for vegetation in the study area. We then assessed rodent species vulnerability based on how tightly linked a species was to a given vegetation type and that type's vulnerability. We also used these results to predict changes in rodent community structure. **Results:** Rodent communities responded differently to climate change depending on elevation and habitat type. The altitudinal range from 300 to 900 masl-mainly dry tropical forest-was most vulnerable to modeled changes in climate variables. Comparing these results to our sampling of rodent diversity, we predict that ~30% of species in the study site will be in areas of high vulnerability to climate change. No major shifts in the altitudinal distribution dynamics of rodent community composition were predicted. **Conclusion:**: Those species most tightly linked to tropical dry forests may be at the greatest risk. Several of the species found in this vegetation type may also experience higher local extinction rates given their low relative abundances. Diversity sampling combined with exposure analysis provides a promising way to anticipate potential vulnerabilities of plant-animal species associations, indicating not only which species may be at risk, but also where in their range that risk may be most acute.

Keywords: exposure analysis, range, vegetation, vulnerability

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Estimates of the equivalent CO_2 stock in the native vegetation of the South-Western Amazon

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Background: In tropical forests, most of the biomass is found in trees, especially living in aboveground biomass. Tropical rainforests, mainly the Amazon rainforest, represent nowadays the largest terrestrial sink of anthropogenic emissions of carbon dioxide (CO_2). The study aimed to estimate stock of CO_2 in the vegetation of the riparian forest in the Rio Acre, Acre, state Brazil, to further subsidize studies that value the standing forest. **Method:** The inventory was performed using sample units with more than one stage (conglomerates), using random sampling techniques stratified in marginal line at the Rio Acre. The collected variables were: scientific name of the species, habit and Diameter High Brest- DHB (individuals ≥ 20 cm). Six Primary Plots (PP) were allocated to the riparian forest of Rio Acre. The PP has the following dimensions: 190m x 1000m, totaling 19 hectares. In each PP were allocated systematically and measured four Secondary Plots (SP) following dimensions: 10m x 250m, 0.25 ha each, totaling 1 ha. To calculate the bole biomass it was used the equation: Ln Bvf = 0.12264 + 2.069532 * Ln (d) + 0.811727 * Ln (h). In order to estimate the carbon stocks, 50% of the dry biomass was considered and this value was multiplied by the constant of 3.67 t CO_2 equivalent (CO_2 eq). **Results:** The total number of individuals with DBH ≥ 20 cm inventoried in six PP was 716. This represents 119.34 individuals per hectare, being 112 (15.64%) non-arboreous and 604 (84.36%) arboreal, distributed in 38 families and 131 species. The total carbon stock was estimated at 86.92 t ha-1. The potential of atmospheric carbon removal by riparian forest in Rio Acre was 318.99 t ha-1. Families found three represent 34.11% of CO_2eq Euphorbiaceae (10.65%), Mimosaceae (11.89%) and Moraceae (11.57%). Regarding forest species: *Dipteryx odorata* (Aubl.) Willd, *Hevea brasiliensis* Muell. Arg. and *Inga* sp. had the highest representativity regarding the amount of CO_2eq with 4.46, 6.61 and 6.99%, respectively. **Discussion:** The riparian forests, although protected by law, have also not escaped destruction, on the contrary, they have become the target of all kinds of degradation. This category of the forest, besides the already recognized environmental services of soil and water conservation, is also attributed to the function of fixing the atmospheric carbon, thus contributing to the reduction of the greenhouse effect.

Keywords: forest, biodiversity, carbon sequestration

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Landscape level spatial patterns in forest drought response in eastern Puerto Rico

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Background: Second-growth tropical forests account for 40% of the aboveground global carbon sink and provide myriad ecosystem services. Climate models predict an increase in frequency and duration of drought in the tropics with potential feedbacks to the carbon cycle. The effects of drought at the landscape scale, however, and the factors that modulate landscape heterogeneity in the magnitude of drought impacts remain understudied. Here, we examine the impacts of a severe drought in 2015 on a Neotropical forested landscape in eastern Puerto Rico using anomalies in two vegetative indices derived from 30m Landsat 7 ETM+ images: the Normalized Difference Water Index (NDWI) and the proportion of Non-Photosynthetic Vegetation (NPV). **Methods:** A cumulative anomaly of NDWI was calculated in Google Earth Engine, using a baseline of 204-2012, which did not experience severe drought. The study landscape is fragmented and topographically complex and includes both old- and second-growth forest. We consider how topography (slope), fragmentation (distance to forest edge), and forest characteristics (old- vs second-growth) modulate landscape heterogeneity of drought impacts. Remotely sensed products, a map of forest age, slope, elevation, and distance to forest edge were all sampled and analyzed using linear regression models. **Results:** The effects of drought across the landscape were evident in the remote sensing products with a significant decrease in NDWI and a significant increase in NPV in 2015 relative to 2013, an average precipitation year. Drought impacts were most marked in second-growth forests, steeper slopes, and closer to forest edges. **Discussion:** The effects of drought across the landscape were clear in the remote sensing products with a significant decrease in NDWI anomaly from 2013 (an average precipitation year) compared to 2015. Drought impacts were most marked in second-growth forests, on steep slopes, and nearer the forest edge. Given predictions of more intense and frequent drought, understanding differential drought response related to forest age and other landscape scale factors will become increasingly important for management. Together these results demonstrate the need for a multi-scalar approach to the study of drought impacts on tropical forests.

Keywords: drought, remote sensing, landscape fragmentation, Puerto Rico

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A comparison of phenological patterns of cloud forest plant species over 36 years of climate change

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Background: Climate change has led to marked changes in the flowering phenology of many plant species in temperate communities, but much less is known about recent phenological changes in tropical plants. In the montane forests of Costa Rica, the number of sequential precipitation-free days has been increasing over the past thirty years. In order to determine whether flowering phenology patterns of hummingbird-pollinated plants have shifted in response to precipitation shifts we compared current flowering patterns of 7 plant species to the flowering patterns of the same species in the 1980's based on data collected for 37 species in the Monteverde Cloud Forest Reserve in an earlier study. Our study questions were 1) how do phenological patterns of flowering correlate with concurrent temperature and precipitation patterns; and 2) have phenological patterns shifted over the past 36 years. **Methods:** Initial estimates of flowering phenology were based on censuses of the number of open flowers of 7 species of hummingbird pollinated plants at monthly or half-monthly intervals between 1981 and 1983 and between 1986 and 1991. The flowers were counted within study plots located in the upper montane forest community of the reserve. Recent estimates of flowering phenology of the same species were based on half-monthly counts of open flowers along transects in the reserve between January 2017 and June 2017. Measures of daily precipitation, maximum and minimum air temperature over the initial and recent census time periods were used to assess climate patterns within and between years and seasons as well as to establish correlates with flowering. **Results:** Despite long-term drying trends in precipitation we did not observe dramatic shifts in flowering initiation time, peak flowering and cessation of flowering of study species over time. In contrast, there was greater variance in flowering patterns between initial study years than between initial and recent study years. **Conclusion:** We conclude that general phenological patterns of the focal species in this study have remained consistently variable over the past thirty years. Two possible explanations for these patterns are that any climate shifts over that time period have not included changes to key determinants of the timing of flowering or that the focal species lag in their ability to respond to shifts in environmental characteristics associated with climate change.

Keywords: phenology, flowering, climate-change, cloud forest

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Beyond deforestation: Mexican land cover transitions

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Background: Land use change has been identified as a major cause of global change. Most tropical land use studies have focused on deforestation; however, the "no-forest" class is diverse. In addition, the drivers of change are likely different and dependent on the local environmental context, as well as temporal and spatial scales. In the last decade, Mexico has undergone rapid and considerable changes in land use. Identifying the main long time land trends, and the regions where these are occurring can have important implications for land use and conservation activities. **Methods:** We analyzed land use changes over 14 years at the ecoregion scale for Mexico. Ecoregions are a useful study scale as they capture the variability of environmental and socio-economic context. We focused on the three major cover classes, woody vegetation, pasturelands, and croplands. Using MODIS data, we evaluated the main land use transitions at each ecoregion from 2001 to 2014, and identify the areas where changes have been significant (i.e., increased or decreased trends of land use change for the period of study). **Results:** Results show spatial segregation of areas where important trends are ocurring. In general, the increase in woody vegetation occurred in areas of dry and coniferous forest, due to the reduction of both croplands and pasturelands. The decrease of woody cover was mainly recorded in tropical forests, mostly due to an increase of pasturelands; while the decrease of shrublands in arid regions due to the expansion of croplands. The region that experienced the greatest loss in croplands was the Tamaulipan mezquital. A significant expansion of pasturelands was recorded in center and south of the country, most notably in tropical forest areas, at the expense of woody vegetation. Land use trends varied during the evaluated period, and were more conspicuous from 2008-2014, particularly the loss of croplands. **Discussion:** Temporal and spatially, cropland and pastureland expansion is happening aggregated within each cover, but segregated between them, indicating different causes influencing the presence of each system that vary in time. Despite the overall increase in woody vegetation and the overall decrease of pasturelands, specific ecoregions showed a reduction or increase of each cover. These results show that patterns of land use in recent years in Mexico, have been dynamic. A next step will be to identify the distant factors that have influenced these trends.

Keywords: Cropland, Ecoregion, Land use, Pastureland

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Including seed dispersers in individual-based forest models

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Background: Forests play a major role in the global carbon cycle. Our understanding of net carbon fluxes and of how carbon stocks change over time is increasingly aided by models that incorporate theoretical and empirical knowledge from a range of organizational scales (from single leaves to entire forests. Individual-based models are useful tools when local interactions, individual variability and/or adaptive behavior are relevant. That is the case for many questions in ecology and conservation of tropical forests, where patterns emerge from the complex interactions among many adaptive agents. These models have been successfully used to investigate the impacts of several anthropogenic disturbances on carbon sequestration and stocks. However, they do not explicitly include seed dispersers, which can greatly influence the dynamics of tree communities. **Methods:** We developed an individual-based forest model that includes seed dispersers as adaptive agents. The model follows an object-oriented approach in which each tree, primary and secondary disperser is represented as an object. Multiple species (or functional groups) are supported and can differ in their attributes (e.g: wood density) or behaviors (e.g: foraging strategy). A variety of data can be collected and stored in an HDF5 database, including carbon stocks in soils, dead wood and living trees, population sizes for trees and dispersers, movement patterns and dispersal kernels, in addition to individual level information. As an example of disturbance we included a selective logging routine. **Results:** The software is freely available under an open-source license. The code is mostly written in the Python 3 programming language and therefore can run on Windows, Linux and Mac OS. Several visualization and calibration functions are included. The resulting tool is capable of simulating the population dynamics of trees and dispersers, which allows the investigation of cascading effects linking disturbances, effects on the tree community, the consequences for dispersers and finally the long-term impacts on the dynamics of trees and how these affect carbon stocks and sequestration. Documentation and examples of use are available online. **Conclusion:** The tool here presented aims to serve as a framework for models that will improve our understanding of the complex network of feedback mechanisms involved in the maintenance of carbon stocks in tropical forests.

Keywords: Carbon stocks, individual-based model

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Prevalence and seasonality of avian haemosporidian parasites in Brazilian Tropical Dry Forest

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The transmission rate of vector borne diseases fluctuates in response to annual seasonal cycles because of the sensitivity of vectors to climatic conditions. Alteration in temperature, rainfall and available resources can strongly influence the host, the parasite and their relationship. However very little is known about the diversity and the effect of seasonality on avian haemosporidian parasite and their host in the Neotropics. The aim of this study was to determine the lineages of avian haemosporidian and how prevalence is affect by seasonality (genera *Plasmodium* and *Haemoproteus*). A total of 946 wild birds blood samples representing 55 species were collected in a Seasonally Dry Tropical Forest (SDTF) in Estação Ecológica do Seridó (ESEC) Brazil, using mist nets in two dry and two rainy seasons. SDTFs are characterized by pronounced seasonality in rainfall distribution, where precipitation is less than 1600mm/yr, and by several months of drought (at least five or six months receiving less than 100 mm). PCR methods were used for the detection of parasites. We found a very high prevalence of avian haemosporidian parasite (52.21%) in the study area. A total of 109 positive samples were sequenced and the parasites community was composed of 110 lineages: 39 *Plasmodium*, 50 *Haemoproteus*, 13 *Parahaemoproteus* and 8 new lineages. The highest prevalence of infection was observed in the second rainy season (60.7%). This is due to large sample size of Columbina *minuta* in that season. As Columbiformes birds are preferably infected by parasites from genera *Haemoproteus* (the genera most abundant and diverse found in ESEC). When C. *minuta* was excluded from the analysis, there was no significant difference in prevalence between the dry and rainy seasons. So, the prevalence of avian haemosporidian was unaffected by the seasonality. Despite the avifauna of Brazilian SDTF harbors a high prevalence and diversity of avian haemosporidian parasites, we did not find seasonality effects on avian haemosporidian prevalence.

Keywords: Caatinga; Haemosporidian infection; Avian malaria; *Haemoproteus*; *Plasmodium*

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Spatiotemporal variability of soil respiration in a seasonal tropical forest

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Background: Tropical forests contribute to the global carbon cycle through storing 40% of global terrestrial carbon stocks (Jobbágy & Jackson, 2000; Beer et al., 2010), 56% of which, is found in aboveground biomass and 32% in soils (Pan et al., 2011; Ngo et al., 2013). Carbon assimilated by the biosphere, is released through autotrophic and heterotrophic respiration, (Malhi et al., 1998) of which respiration from soils is the major component, and second in magnitude only to gross primary productivity (Raich & Schlesinger, 1992). However, the spatial distribution of this carbon source and its sensitivity to global climate change are still uncertain (Pendall et al., 2004). In order to quantify regional carbon losses from tropical soils, factors that induce spatial and temporal variability on soil respiration should be examined across a range of tropical forests. Lowland seasonal tropical forests are particular important because they allow us to investigate a larger spectrum of moisture regimes, including long dry spells and near saturated conditions. **Methods:** We monitored soil CO2 effluxes for over three years in a seasonally wet tropical forest in Central Panama using automated and manual measurements from 2013 to 2016, to analyze their spatial and temporal variability. Soil temperature and soil moisture were measured in proximity of the sampling points. Additionally, forest structure and indirect size fraction (zenith weighted gap fraction) were measured over the canopy in each point. Correlation analysis, robust nonlinear least-squares method, coefficient of variation, semivariogram, autocorrelation function, ANOVA and Artificial Neural Network were used to analyze the data. **Discussion:** Temporal variability could be largely explained by surface soil water dynamics over several orders of scale. Soil moisture was responsible for seasonal cycles, diurnal cycles, intraseasonal variability such as rain induced pulses following dry spells, as well as suppression during near saturated conditions, and ultimately, interannual variability. Spatial variability, which remains largely unexplained, revealed an emergent role of forest structure in conjunction with physical drivers such as soil temperature and topography. This study shows how a combination of automated and manual measurements provides accurate estimation of landscape soil carbon losses at annual scale.

Keywords: Soil respiration, tropical forest, variability

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Quantification of Carbon and Nitrogen Litterfall in Semidecidual easonal Forest

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Background: Litter production for any type of forest represents the first stage of nutrient and energy transfer from vegetation to soil and is extremely important in nutrient cycling, thus improving soil fertility and facilitating the uptake of nutrients by the roots, besides serving as protection against erosion caused by rain drops. The aim of this study was to quantify the total organic carbon (TOC) and total nitrogen (TN) of litterfall accumulated in a remnant Atlantic Forest. **Method:** The study was carried out in a fragment of the Semidecidual Seasonal Forest, in the southwestern region of Minas Gerais state, Brazil. For the litterlayer sampling, 12 plots (20 x 50 m) were systematically distributed in the field. In each of the 12 plots, 15 samples of accumulated litter were collected randomly. The litterlayer collection was carried out with a square steel template with dimensions of 48 cm on internal side. The collected material was taken to the Laboratório de Análises de Solos do Instituto Federal de Minas Gerais - Câmpus São João Evangelista for chemical analysis. The litterlayer samples were placed in paper bags and then dried in a circulating oven and renewal of air at 65 °C to constant dry weight and measured on a precision scale (0.01 g) for the determination of the dry weight. The characterization of litterlayer involved the quantification of the concentrations of easily oxidizable organic carbon (COeo) and total N (NT). The organic carbon was determined by oxidation solution with potassium dichromate in acid solution, while the total nitrogen content was obtained after digestion of the sample with sulfuric acid. **Results:** The analyzed Semideciduous Seasonal Forest accumulated an average of 8.97 $Mg.ha^{-1}$ of litter. At the collection points at the edge of the area, TOC values ranged from 24.26 to 45.61 $dag.Kg^{-1}$, these values being statistically higher than the TOC values found within the area. The NT content of the edge and inside litter from the area did not differ. The average C/N ratio of the interior litter was higher than the average C/N ratio found for the edge collection points. **Conclusion:** A larger accumulation of dry litter mass was found inside the field. Greater C/N ratio of the interior of the area contributed to a greater accumulation of organic matter from the soil of this site.

Keywords: Nutrient cycling; Soil; Tropical forest

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An extreme weather event triggers rapid structural changes in a tropical dry forest

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Background: Extreme climatic and weather events such as severe droughts, heat and cold waves are predicted to increase in frequency and/or intensity. Extensive tree mortality related to these events has been reported worldwide. Tree mortality can lead to forest structural changes with consequences for ecosystem functioning and the provision of services such as carbon storage. We studied the effects of a short but severe frost from February 2011 on the structure of a tropical dry forest (TDF) in its northern range limit in America (Sonora, Mexico). This region has a long history of cattle ranching and agriculture. Therefore, the landscape is a complex mosaic of annual crops, old-growth and secondary forests up to 40 years old. **Methods:** In 2015, we established 12 study sites, each containing 10 plots of 50 x 2 m (for a total of 120 plots) using a systematic field sampling designed to include mature and secondary forest fragments as we did back in 2008 in this same area. In each plot, we identified and measured DBH and height of all live and dead trees and shrub stems (DBH > 2 cm) and calculated average individual density, basal area and height. We used ANOVA to compare the structure of the old-growth and secondary forests in 2008 (before the extreme frost) and old-growth and secondary forests in 2015 (after the extreme frost). **Results:** In 2008, there was only 3% of dead individuals in the old-growth forest and 5% in the secondary forest. By 2015, dead individuals accounted for 4-9% of the total individual density in the old-growth forest and 13-23% in the secondary forest. This rise in tree mortality led to an increase in the proportion of dead biomass, which was higher in the secondary forest. In 2008, the average height of the woody vegetation was 4.8 and 4.9 m in the old-growth and secondary forests, respectively. By 2015, these numbers decreased to 4.7 and 4.2 m, reflecting the higher tree mortality in the secondary forest. **Discussion:** Our results show the effects of an extreme weather event that lasted only three days. Secondary forests, the main legacy of land-use change in TDF landscapes, seem highly vulnerable to extreme climatic and weather events. However, the consequences of widespread tree mortality for the regional carbon cycle and the successional pathway of these forests are largely unknown. Therefore, the effects of extreme climatic events on the structure and functioning of tropical dry forests deserve more scientific attention.

Keywords: tree mortality, tropical dry forests

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Representing the role of tree recruitment in tropical forest change in Earth system models

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Background: Tropical forest responses to global change have consequences for Earth's carbon cycle and climate system. Recent advances in large-scale models of forest responses include demographic processes and greater biodiversity, capturing important time lags and forest resilience. However, it is unclear if changes in tree recruitment and forest regeneration resulting from land-use and climate change are critical to long-term tropical forest change. At present, even advanced land surface models use diverse and fairly simple formulations for recruitment, but the consequences of these formulations for forest response have not been examined, and benchmarks for evaluating formulations have not been developed. **Methods:** We review current approaches to representing tree recruitment in advanced land surface models. We identify model requirements for representing forest gap-phase dynamics, shifts in forest functional composition in response to environmental change, secondary forest succession, and shifts in the geographic distribution of functional types, as well as data benchmarks for evaluating model representations of recruitment. Result Models vary in how they capture stages of regeneration: 1) allocation for reproduction, 2) seed banks, 3) germination, 4) seedling establishment, and 5) recruitment into the adult population. Two advanced land surface models, LPJ-GUESS and CLM(FATES), both allocate a fixed fraction of NPP to reproduction annually. Yet, while LPJ-GUESS uses bioclimatic limits to determine which plant functional type (PFT) will establish in a given climate, FATES assumes that fixed fractions of individuals will germinate from PFT-specific seed banks and survive to 1.25 m in height. Neither model explicitly simulates the dynamics of the seedling stage, which limits their abilities to predict responses to environmental change at this early life stage. Initial benchmarks for modeled recruitment include variation in abundance of saplings and recruitment rates to >1cm size classes across PFTs and environmental gradients, and temporal variation in allocation to reproduction and recruitment rates. **Conclusion:** Alternate approaches to representing tree recruitment yield differences in ability to represent gap-phase recruitment, compositional shifts, secondary succession and range shifts. For global models to make credible projections of tropical forest change, further refinements in tree recruitment and forest regeneration formulations are required.

Keywords: tree recruitment, model, climate changeID:516

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Flowering in Amazonian Forest: evaluating long-term changes in responses to climatic variations

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Background: Understanding how the reproductive patterns of tropical tree species are related to climatic factors may be crucial for predicting future changes in tropical forests, considering that flowering in tropical forests varies with species, location and climate variables. However, no previous study has quantified long-term effects on flowering in multiple tropical species between different sites. This study quantified the relative contribution of location and climatic variables in explaining 30 years of flowering in nine neotropical tree species. **Methods:** The flowering of *Aniba canelilla*; *Cariniana micrantha*; *Dinizia excelsa*; *Dipteryx odorata*; *Goupia glabra*; *Hevea guianensis*; *Jacaranda copaia*; *Minquartia guianensis* and *Parkia pendula* was recorded monthly in two sites (5 individuals per site) during the years 1982-2011. The determinants of flowering patterns were examined in two scales - annual (month of first flowering and duration) and monthly. Cross-correlations were used to understand the associations between timing of annual and monthly flowering and seven climatic variables (temperature, rainfall, humidity, Southern Oscillation Index (SOI), SOI anomaly, North Atlantic Tropical and Sea Surface Temperature). Generalized additive models were used to describe and explain patterns in flowering in response to location and climatic variables. Result: The flowering peak occurred between the months of June to October (dry season), with an average of 3 months. Monthly flowering was correlated with at least one of the climatic variables in all species, except for *D.excelsa*. Significant intraspecific variation occurred between sites in 8 species. The additive effects of location and climate had no influence on annual or monthly flowering in *J. copaia*, *D. excelsa*, *A. canelilla* and *M. guianensis*. *Hevea guianensis* tended start blooming later and increase the duration of flowering, in D. *odorata* first flowering tended to occur sooner and the duration of P. *pendula* increased. **Conclusion:** There was variation in first flowering, frequency and duration in different species. Each species showed different patterns of association with local and global climatic variables. Rainfall was the most important climatic factor for explaining flowering in most species. The set of climatic variables only weakly influenced the flowering of *D. excelsa* and *D. odorata*. The difference between the two sites had the most significant effect on all the phenological parameters studied.

Keywords: Climate change, Central Amazon, Flowering phenology, Tropical tree

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Ant canopy diversity and their parasitoids in coffee agroecosystems

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Background: The composition of shade trees in coffee landscapes has drastically changed over the past 40 years. It can be characterized by a significant increase in the proportion of commercial shade trees (*Inga* spp.), which subsequently negatively impacts biodiversity and ecosystem function. We studied ant diversity and parasitism rates across three different coffee farms, with varying proportions of *Inga* spp. in a coffee agricultural landscape in Chiapas, Mexico, to see if this trend negatively affects pest control services. Our goals included a) understanding the ant diversity and abundance in three habitats; b) describing the social structure of ants nesting in the canopy; and c) measuring the parasitism rates of the ants nesting in the canopy. **Methods:** We placed bamboo trap-nests at sites in three different coffee farms across a gradient of agricultural intensification: Finca Santa Anita (Traditional polyculture), Finca Irlanda (Commercial polyculture) and Finca Hamburgo (Shade Monoculture). Ants colonize these trap nests and we can then collect them and measure the rates of parasitism of the ants that colonize them. In August 2014, we created 48 experimental sites (16 in each habitat) and we tied 30 bamboo traps per site, in three different strata: 10 traps in native shade trees; 10 traps in *Inga* trees, and 10 traps on coffee bushes. Bamboo traps were then harvested for the first eight sites in each habitat in March 2015 (720 bamboos harvested, dry season) and the last eight sites in September 2015 (rainy season, 720 bamboos harvested). **Results:** We found five subfamilies corresponding to 15 genera and 28 species. The most abundant species were *Dolichoderus lutosus* (74 bamboos), *Crematogaster carinata* (28) and *Neoponera crenata* (18). We found the highest rates of ant parasitism in Finca Santa Anita, but there were no significance differences between habitats (df= 1,22, P>0.05) or strata (df=2,19, P>0.05). **Discussion:** Our data do not support decreases in pest control services due to differences in agricultural intensification. However, other studies have identified the importance of conserving shade to support ecosyste services like parasitism.

Keywords: ants, parasitoid wasps, ecosystem services

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