2010 International Year of Biodiversity

Frugivores and Seed Dispersal:
Mechanisms and Consequences of a Key Interaction for Biodiversity

Organized in partnership with
the **Association for Tropical Biology and Conservation** (ATBC),
the **Society for Tropical Ecology** (GTÖ),
the **British Ecological Society-Tropical Ecology Group** (BESTEG) and
the **Société Française d'Ecologie** (SFE)

PROGRAM – ABSTRACTS

The Venue – Le Corum

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More information at http://www.fsd2010.org

Welcome by the organizers

Welcome to the Region of Languedoc-Roussillon and the city of Montpellier Both the region and the city itself have enjoyed a remarkable history as well as recent growth. The city's name – Montpellier – first appears in the early Middle Ages (AD 985); today, Montpellier is the fastest growing urban area in the country and France's 8th largest city. Being 750 km distant from Paris, Montpellier is a bridge between northern and southern Europe. Moreover, it is at the brink of multiple habitats of keen interest to researchers of seed dispersal systems: lagunes and marine habitats 10 km away in the South, Mediterranean bush habitat (garrigue) 20 km North, and mountain habitats 70 km North. It is thus not by chance that this great city was nominated and elected by FSD2005 participants in Brisbane to host the 5th International Symposium on Frugivores and Seed Dispersal.

Part of the dynamic flair of Montpellier can be attributed to its Academy with 93,000 students today. Known as an important historical center of knowledge, the Schools of Medecines and Law of Montpellier were officially recognized as University in 1289. After being sold to the Crown of France in 1349, the city of Montpellier was considered the second country of the Kingdom, and had great potential to become a major city in France, henceforth the capital. But, the Plague, religious conflicts, and settlement of the Bourbon branch crown elsewhere (Paris, and then Versailles) changed the city's destiny.

Throughout the history of this great city, Montpellier has become one of the most important centers for ecological research in the world. Indeed, the city hosts two major research institutions devoted to the discipline: Centre d'Ecologie Fonctionnelle et Evolutive (CEFE) and the Institut des Sciences de l'Evolution Montpellier (ISEM). Montpellier is also home to the Botanical Garden and Arboretum of Montpellier classified in 1992 as a historical monument. Founded in 1593 by King Henri IV and established under the leadership of the botanist Pierre Richer de Belleval, it served as model for the Jardin des Plantes de Paris in 1626. Originally implemented to cultivate medicinal plants, it rapidly developed as a tool to teach botany for students, and remains so. Today the garden contains more than two thousands of plant species, including 500 native to the Mediterranean region. More recently, the city of Montpellier created and opened in 2007 the Serre Amazonienne as part of the Zoo of Lunaret which is a tropical greenhouse representing the Amazon environment. With its seven climatic zones and habitats, the greenhouse hosts myriad tropical plant and animal species, including pacu fishes, iguanas, bats, guans, toucans, tamarins, agoutis, squirrel monkeys, howler monkeys – all well known frugivores and seed dispersers!

We thus view Montpellier as an ideal location to welcome participants to the FSD2010, and hope that you will enjoy all that the city has to offer.

Pierre-Michel Forget (UMR 7179 CNRS-MNHN), Martine Hossaert-McKey (CEFE-CNRS) and Isabelle Olivieri (ISEM-UM2)

The host institutions:

Montpellier concentrates one of the largest communities of Ecologists, population geneticists and evolutionary biologists in Europe (e.g., CEFE, ISEM). Several institutes with expertise on biological control are also in town (CSIRO, USDA). Furthermore, all main national research organisations are represented (INRA, CIRAD, IRD, CEMAGREF, IFREMER, BRGM, CEA, INRIA, INRAP), which are associated to Universities (3) or SupAgro or various Higher Education organisations. A large part of the research at CEFE and ISEM focuses on mediterranean and tropical ecosystems. CEFE and ISEM at University of Montpellier II furnishes a rich scientific environment for the themes of this Symposium-Workshop.

Centre d'Ecologie Fonctionnelle et Evolutive (CEFE). The Centre d'Ecologie Fonctionnelle et Evolutive » unites scientists from CNRS (National Centre for Scientific Research), universities of Montpellier, CIRAD (Centre for Agronomic Research Applied to Development), EPHE (Ecole Pratique des Hautes Etudes), and SupAgro (Ecole Nationale Supérieure Agronomique de Montpellier). The CEFE also hosts researchers from IRD (Institute for Research and Developement). The activities of the CEFE focus on important societal concerns: biodiversity, global change and sustainable development. The overall objective is to establish scenarios for changes in the structure, functioning and evolution of ecological systems and of strategies for their conservation, restoration and rehabilitation. Research at CEFE is coordinated around four transversal themes: (1) human actions, human-influenced systems and conservation biology; (2) the adaptive significance of life history traits in relation to environmental constraints ; (3) the role of biodiversity in ecosystem functioning; and (4) global change and ecosystem functioning.

Director: Jean-Dominique Lebreton (member of the French Academy of Sciences)

Website: http://www.cefe.cnrs.fr/

Institut des Sciences et de l'Evolution Montpellier (ISEM). The Institut des Sciences de l'Evolution Montpellier units scientists from the University of Montpellier II, the CNRS and IRD. Research at ISE-M focuses on the patterns and mechanisms of evolution in the living world. It aims to better understand the processes involved in the origins and dynamics of biodiversity. A specific approach taken by scientists at the ISE-M is to work on both extant and fossil material and to study plants, animals, and micro-organisms. The main research areas are paleontology and paleobiology, paleoenvironment and paleoclimate, molecular phylogeny, evolutionary biology, Human evolutionary biology, and integrative biology.

Director: Jean-Christophe Auffray

Website: http://www.isem.cnrs.fr/

About the FSD2010 logo

The FSD2010 logo was prepared by Erin Kuprewicz, Ph. D candidate at University of Miami, Florida (http://www.bio.miami.edu/kuprewicz/).

After being held in the tropics (Veracruz, Mexico) and sub tropics (Rio Grande do sul, Brazil; Southern Queensland, Australia), FSD2010 is in the temperates, in a mediterrranean environment, Southern Europe. Because frugivory and seed dispersal are not constrained by latitude, a logo was designed to put emphasis on plants and animals that occur within and outside the tropics. Erin Kuprewicz's logo presents an oak (*Quercus* sp.) tree, Florida Scrub Jay (*Aphelocoma coerulescens*), Eurasian Jay (*Garrulus glandarius*), Agouti (*Dasyprocta punctata*), *Apodemus* sp., and *Sus scrofa*. Note that the light green foliage of the tree matches the Herault Department map, the dark green being the Mediterranean Sea. Erin Kuprewicz also designed the ATBC2008.org logo.

Illustrations at FSD2010.org website are by Erin Kuprewicz and François Feer. Many thanks to Ellen Andresen, Steve Blake, Jedediah Brodie, Rhett A. Buttler, Tomás A. Carlo, Hazel Chapman, Benoit de Thoisy (Association Kwata), René Dumoulin (Oiseaux.net), Nico Eisenbauer, Jakob Fahr, Guillaume Feuillet (Association Kwata), Jules Fouarges (Oiseaux.net), Sean Mc Cann, Benoit Guenard, Nicole Gross-Camp and Simon Camp, Arndt Hampe, Kent Harrison, Dennis Hansen, Alain Houle, Kae Kawanishi, Britta Kunz, Diego Lizcano, Antonio J. Manzaneda, Patrica Medici, Phil Myers, Paulo Oliveira, Marco Aurelio Pizo, Soumya Prasad, Emilie Regnier, Carolina Santos, Joël N. Strong, Kevina Vulinek, Diego Zárate and Pierre-Michel Forget for sharing pictures of frugivores and plants to illustrate the website, and for helping us to prepare and edit the pages of the frugivores of the month.Thanks to all participants for sharing photos at the website Galleries.

Meeting organization

Chairpersons

Pierre-Michel Forget. UMR 7179 CNRS-Muséum National d'Histoire Naturelle (MNHN)
Martine Hossaert-Mckey. CNRS-Centre d'Ecologie Fonctionnelle et Evolutive (CEFE)
Isabelle Olivieri. Université de Montpellier II-Institut des Sciences de l'Evolution Montpellier (ISEM)

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Katrin Böhning-Gaese, Johannes Gutenberg-Universität
Pedro Jordano, Estacion Biol. Donana, CSIC
Pierre-Michel Forget, UMR 7179 CNRS-MNHN
Joanna Lambert, The University of Texas at San Antonio
Anna Traveset, Institut Mediterrani d'Estudis Avançats
Joe Wright, Smithsonian Tropical Research Institute

Organizing committee
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Tomás A. Carlo, Penn State University
Pierre-Olivier Cheptou, CEFE-CNRS
François Feer, UMR 7179 CNRS-MNHN
Pierre-Michel Forget, UMR 7179 CNRS-MNHN
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Jacques Tassin, CIRAD
Josh Tewksbury, University of Washington
Anna Traveset, Institut Mediterrani d'Estudis Avançats
Joe Wright, Smithsonian Tropical Research Institute

Logistic and conference management, secretariat, public relation and communication
Association ATBC2008. The non-profit association called "Association ATBC2008" (Loi du 1er Juillet 1901-Art. 5; Law 1st July 1901-Art. 5) has been created to manage the organization of the Annual ATBC meeting in June 2008. Association ATBC2008 was officially registered on 28/12/07 and published on 19/01/08 by the French Official Journal – Announcement N°1575). SIRET: 503 378 366 00010

Organizers/chairpersons of symposia
Alastair Robertson, Institute of Natural Resources, Massey University
Anna Traveset, Spanish Research Council, Mediterranean Institut of Advanced Studies
Arndt Hampe, Consejo Superior de Investigaciones Científicas (CSIC)
Britta Kunz, Goethe-University Frankfurt
Daniel Garcia, Universidad de Oviedo
Dave Kelly, School of Biological Sciences, University of Canterbury
Delphine Grivet, CIFOR-INIA
Dennis Hansen, Stanford University
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Martine Hossaert-McKey, CEFE-CNRS
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Patrick Jansen, Wageningen University & University of Groningen
Pia Parolin, INRA, Agrobiotech
Steve Vander Wall, University of Nevada

Plenary speakers
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Andy Jones, Imperial College London
Arndt Hampe, Consejo Superior de Investigaciones Científicas (CSIC)
Britta Denise Hardesty, CSIRO
Carlos Peres, University of East Anglia
Colleen Downs, University of KwaZulu-Natal
Cristina Garcia Perez, Georgia University
Daniel García, Universidad de Oviedo
David Westcott, CSIRO
Dennis Hansen, Stanford University
Doug Levey, University of Florida
Elisabeth Kalko, University of Ulm
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Roger Cousens, University of Melbourne
Shumpei Kitamura, The Museum of Nature and Human Activities
Theodore Fleming, University of Miami
Tomás A. Carlo, Penn State University

Sponsoring institutions and financial support

We are grateful for all institutions and partners that offered financial support, donations or contributed to the organization of the symposium.

The MEEDDM granted the ATBC2008 Association

The Région Languedoc Roussillon granted the ATBC2008 Association for the organization of the symposium

The Agglomération de Montpellier granted the ATBC2008 Association for the organization of the symposium

Enjoy Montpellier sponsored the organization of the symposium

The Mairie of Montpellier sponsored the public conference at Salon Belvédère, Le Corum on 18 June.

CNRS INEE granted the UMR 7179 CNRS-MNHN for the organization of the symposium

The University of Montpellier II and INRA sponsored the organization of the symposium “Evolution of dispersal” by Pierre-Olivier Cheptou (CEFE-CNRS), Hélène Fréville (CEFE-MNHN) and Isabelle Olivieri (ISEM-UM2)

Wiley-Blackwell offered free advertizing space for FSD2010 in appropriated journals published by Wiley. Wiley-Blackwell also donated two books as well as a free one-year online subscription to Biotropica to the winner (first prize) of the David W. Snow Award for the best oral presentation by students.

CABI donated two books to the winner (first prize) of the David W. Snow Award best poster presentation by student

Oxford University Press donated two books to the winner (second prize) of the David W. Snow Award best oral and poster presentations by students

CSIRO sponsored the David W. Snow Award with 100 € prize for each of the six winners of best oral and poster presentations by students

DICAP at MNHN edited the FSD2010 brochure and poster

Disweb designed the website and offered online assistance

Bayceer prepared with the registration website and offered online assistance

Mongabay.com promoted FSD2010 with interviews of plenary speakers and scientists at **www.fsd2010.org/Interviews/Mongabay.htm**

Dominique Boudet organized special evenings at the Restaurant Les Caves de Trinque Fougasse, and warmly welcomed participants who discovered winegrowers and their vintage

The Association Les écologistes de l'Euzière organized field trip and tours before and after the symposium

The airlines of SKYTEAM, Official Alliance Network offer attractive airfares for participants

FSD 2010 has been organized in partnership with the Association for Tropical Biology and Conservation (ATBC), the Society for Tropical Ecology (GTÖ), the British Ecological Society-Tropical Ecology Group (BESTEG) and the Société Française d'Ecologie (SFE)

Information for participants

Program overview

The FSD2010 Symposium is scheduled to take place on 13-17 June 2008 at Le Corum in Montpellier (France). Montpellier is easily accessible from Paris via airplane and very rapid train (TGV or Train à Grande Vitesse; 3h15 from Paris), and from the rest of the world. The FSD2010 Symposium is scheduled before the holiday period in Europe. Le Corum offers a perfect venue for international conventions, congresses, seminars, business meetings or cocktail parties. Plenary talks and symposia will be presented on Monday 14, Tuesday 15, Wednesday 16 and Thursday 17 June at the Einstein Auditorium (318 pers.). Three concurrent sessions will be organized at the Einstein Auditorium, and at Joffre A/B and C/D, each with 110 and 130 seats, respectively. All are equipped with air conditioning, sound technology, video and LCD projectors. Soft drinks, tea and coffee will be served during break in Joffre Hall, where will also be presented Posters during late-afternoon session. Lunches will be prepared by the partner CABIRON traiteur and served at Salon Sully Centre. A cyber space (Internet café), wifi and a mobile bar will be available during the four days of the symposium at Joffre Hall.

Meals

Lunch buffet will be served (12:30-14:00) at Salon Sully Centre at Le Corum, and meals will be prepared by CABIRON Traiteur with local fresh food.

For dinner, there are many restaurants in the center of Montpellier. We have also organized two special evenings at the Restaurant Les Caves de Trinque Fougasse to meet with winegrowers and discover the vintage of the Region on Tuesday 15 and Wednesday 16 June, as well as organized an evening with Jazz music at the same location on 18 June.

FSD2010 Award

Committee: **Denise Hardesty**, Coordinator of David W. Snow Award, and **Pierre-Michel Forget**, Chair.

David W. Snow Award for best student papers

In 2005, the committee chose the ***David W. Snow Award*** in recognition of the immensely important contribution the late David Snow has made to the field of Frugivores and Seed Dispersal, especially among Manakins and Melastom plants. In the first Updates after the FSD2005 symposium, Ronda Green wrote "I sent a book of abstracts to Dr David Snow, who happily agreed last year to our request to use his name for the first prize for an oral student presentation. He seemed delighted to receive the abstracts, and responded in part: "I am amazed at how the subject has been so enthusiastically carried forward since our early and one might say primitive days' ".

Eligibility.-All individuals who have been students within the last three years (2008, 2009 & 2010) are eligible, including those who have completed the Ph.D. within that period. The work must have been done by the student as the senior author on the paper. Two or more students may present a joint paper and would then split the award

Award Criteria.-originality of study-contribution of the study to science-breadth of the study-quality of the research design and execution of the data analysis-quality of the presentation including audio-visual materials. The Committee reserves the right to make no award if it deems that no deserving paper has been presented or if fewer than five eligible papers are presented. All students who wish to be considered for the David W. Snow Award must indicate so on their registration forms.

If you want to be considered for the 2010 David W. Snow Award, complete the registration form, and email your scanned student ID and/or certificate of Dissertation (Master and/or Doctorate) defense to fsd2010 -at- yahoo.fr

Information for authors

Plenary talk

Participants are advised to prepare PowerPoint presentation with a time slot of 30 minutes with a couple of minutes for questions.

Oral presentation

Participants are advised to prepare PowerPoint presentation with a time slot of 15 minutes, which includes approximately a couple of minutes for question and discussion.

Poster presentation

The size of Poster Board is 120 x 110 cm in size maximum including 6 cm margin on both side. Poster should then be 117 x 96 cm (Height x Width) max. Presentations will be by topic within session.

Program schedule

Overview

Sunday 13 June

Joffre 2/3, 14:00-17:00-Registration

Welcome Cocktail – Wine and Cheese

Salon Sully Centre, 18:00-21:00-Introduction by **Pierre-Michel Forget** (Chair)-Welcome by the Président de l'Agglomération de Montpellier, Welcome by the Organizers Martine Hossaert-McKey, Isabelle Olivieri and Pierre-Michel Forget

Monday 14 -Tuesday 15-Wednesday 16
08:30-10:00: Plenary
10:30-11:00: Break at Joffre Hall-Poster
10:30-12:30: Plenary
12:00-13:30: Lunches (Salon Sullly Centre)
14:00-16:00: Invited Symposia
16:00-16:30: Break at Joffre Hall-Poster
16:30-18:30: Proposed Symposia
18:30-20:00: Joffre Hall-Poster sessions and mobile bar

Tuesday 15-Wednesday 16
20:00: Les Caves de Trinque Fougasse-Wine tasting (both dates)-Book your table

Thursday 17 June
08:30-10:00: Plenary
10:30-11:00: Break at Joffre Hall-Poster
10:30-12:30: Plenary
12:00-13:30: Lunches (Salon Sullly Centre)
14:00-15:45: 3 Concurrent sessions with 7 talks each
15:45-16:15: break at Joffre Hall
16:15-18:00: 3 Concurrent sessions with 7 talks each
18:00-18:00: Synthesis at Einstein Auditorium, with Academic and Organizing Committees.

Thursday 17 June (evening)
20:00-24:00: Salon Sully Centre, Banquet and music.

Friday 18 June
18:00-20:00: Salon du Belvédère, Le Corum. Public conference.
« Pourquoi les frugivores sont-ils si importants pour la dispersion des graines dans une forêt amazonienne –
Why are frugivores so important for seed dispersal in an Amazonian forest »
by Pierre-Michel Forget – UMR 7179 CNRS-MNHN
Debate with Vincent Tardieu, Journalist

20:00-Les Caves de Trinque Fougasse-Wine tasting, Dinner and Jazz

Scientific program

The 5th International Symposium-Workshop on Frugivores and Seed Dispersal (1985-2010) in Montpellier will celebrate 40 years of studies on seed dispersal. The main thema in 2010 is **Frugivores and Seed Dispersal**: *Mechanisms and Consequences of a Key Interaction for Biodiversity*

In 1985, Ted Fleming and Alejandro Estrada called an international meeting in Mexico of about 50 scientists studying the interactions between frugivores (fruit-eaters) and the seeds they disperse. The book published in 1986 resulting from this 1st International Symposium-Workshop on Frugivores and Seed Dispersal soon became a key reference for students and researchers around the world. The 2nd and 3rd Symposium-Workshop, in Mexico (1991) and Brazil (2000), respectively, demonstrated the growth in research on this important topic. The books published in 1993 and 2002 from these conferences have also been highly important texts for scientists, students and environmental managers.

At the close of the 3rd Symposium the out-going committee decided to hold the next meeting in Australia. This provides an important opportunity for academics and managers west of the Pacific (e.g. Australia, Southeast Asia) to meet with leaders in the field and new researchers from around the world, and also to demonstrate progress within this region. The 4th International Symposium-Workshop on Frugivores and Seed Dispersal was held in July 2005 at the Nathan campus of Griffith University, Brisbane, Australia, and the proceedings were published in 2007.

During the last day of FSD2005, a vote of participants decided that FSD2010 will be held in Montpellier France, to celebrate 25 years of the Symposium-Workshop (1985-2010) and Pierre-Michel Forget accepted to chair it, invited a number of participants to help him as Academic committee as early as July 2005, and later, invited other colleagues in France to compose the Organizing Committee.

The persistence and distribution of any plant species is affected by many factors, but no wild plant could be where it is now without its seed or spore (or an ancestral seed or spore of plants that sometimes spread non-sexually) having traveled to a spot where it could germinate and grow. Many plants appear unlikely to grow or persist if their seeds remain too close to their parents, whether because they compete with parent and siblings for resources (light, nutrients, water, space) or because the seeds or seedlings are more likely to be found there by seed-eating or herbivorous animals or pathogens. Seeds of plants can be carried by wind or water, or simply drop by gravity, or they can travel by clinging to fur or feathers. They may also be attached to or enclosed in a fleshy pulp which is eaten by animals, carried from the parent plant, and discarded, some hopefully landing in places suitable for survival and growth. This has led to some intriguing adaptations by both plants and animals.

In tropical and subtropical rainforests throughout the world, fleshy-fruited plant species are the rule rather than the exception, their proportion decreasing towards cooler and drier regions.

This mutualism (mutually-beneficial relationship, where each species enhances the survival or reproduction chances of the other) of frugivores and seed dispersal is far

from simple, and brings many challenges in ecological and evolutionary theory. There have so far been four international gatherings of scientists interested in this field (for published proceedings see Estrada & Fleming 1986, Fleming & Estrada 1993, Levey et al. 2001, Dennis et al. 2007).

Biodiversity involves not just the preservation of species, genetic code and habitat types but also a range of natural ecological processes, and it is important to keep frugivores and seed dispersal systems functioning for this reason alone. In addition, many plant species may fail to keep reproducing themselves without their dispersers, and many frugivores will be disadvantaged if they cannot find sufficient fruits in lean seasons. This needs to be remembered for instances when managing habitat fragments and providing resources for both sedentary and migratory birds. Some frugivores can be encouraged to assist in restoring habitat in mining areas, degraded slopes and abandoned agricultural land, if we can decide which dispersers we should try to attract and how to best do so.

Human-designed landscapes can benefit also from a study of frugivores and seed dispersal. Nature-loving gardeners and managers of public parks can choose to plant trees, shrubs, vines and herbs to attract a variety of frugivorous birds, and perhaps a few other creatures as well. Colorful fruits can be attractive garden features and many are edible by humans, albeit with a wide range of palatability. However, birds and bats unfortunately do not just disperse the seeds of native fruits but also those of fleshy-fruited weeds, and an ever-increasing body of researchers in all biomes is looking at ways of predicting and solving problems.

* Based on an original text by Ronda Green, slightly adapted by Pierre-Michel Forget

http://www.fsd2010.org/history/1985-2010.htm

List of symposia

Plenary (Einstein Auditorium)

1 Organismal and Natural History Oriented Research (14.06.2010 08:30-10:30, Einstein Auditorium)
2 Organismal and Natural History Oriented Research (continued) (14.06.2010 11:00-12:30, Einstein Auditorium)
3 Oaks and Acorns (14.06.2010 14:00-16:00, Einstein Auditorium)
4 Chemical Ecology of Seed Dispersal : Odors, Taste and Nutritional Ecology (14.06.2010 16:30-18:30, Einstein Auditorium)
5 Movement Ecology, Dispersal Kernels, and Genetic Effects (15.06.2010 08:30-10:30, Einstein Auditorium)
6 Movement Ecology, Dispersal Kernels, and Genetic Effects (continued) (15.06.2010 11:00-12:30, Einstein Auditorium)
7 The Seed Dispersal Kernel (15.06.2010 14:00-16:00, Einstein Auditorium)
8 Seed Dispersal on Islands (15.06.2010 16:30-18:30, Einstein Auditorium)
9 Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal Systems (16.06.2010 08:30-10:30, Einstein Auditorium)
10 Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal Systems (continued) (16.06.2010 11:00-12:30, Einstein Auditorium)
11 Anthropogenic Impacts on Frugivory and Seed Dispersal: Mechanisms, Scales and Consequences (16.06.2010 14:00-16:00, Einstein Auditorium)
12 Evolution of Dispersal (16.06.2010 16:30-18:30, Einstein Auditorium)
13 Ecology and Evolution of Frugivory and Seed Dispersal (17.06.2010 08:30-10:30, Einstein Auditorium)
14 Ecology and Evolution of Frugivory and Seed Dispersal (continued) (17.06.2010 11:00-12:30, Einstein Auditorium)

Concurrent sessions

15 Anthropogenic Impacts on Frugivory and seed Dispersal (part II) (17.06.2010 14:00-15:45, Einstein)
16 Consequence of the Loss of Large Frugivores (17.06.2010 16:15-18:00, Einstein)
17 Organismal and Natural History Oriented Research (Part II) (17.06.2010 14:00-15:45, Joffre A/B)
18 Movement Ecology, Dispersal Kernels, and Genetic Effects (Part II) (17.06.2010 16:15-18:00, Joffre A/B)
19 Ecology and Evolution of Frugivory and Seed Dispersal (Part II) (17.06.2010 14:00-15:45, Joffre C/D)
20 Animal-Plant Interactive Networks and Seed Dispersal Services (17.06.2010 16:15-18:00, Joffre C/D)

Poster sessions

21 Organismal and Natural History Oriented Research
22 Movement Ecology, Dispersal Kernels, and Genetic Effects
23 Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal Systems

Conference schedule at a glance

Monday, 14.06.2010: Day 1		
08	15	Foreword
	30	Plenary 1.1: Ahimsa Campos-Arceiz et al.: Mega-gardeners of the forest – the role of elephants in seed dispersal
	45	
09	00	Plenary 1.2: Nicole Gross-Camp et al.: Differential seed handling by two African primates affects seed fate and establishment of large-seeded trees
	15	
	30	Plenary 1.3: Shumpei Kitamura: Frugivory and seed dispersal by hornbills (Bucerotidae) in tropical forests
10	00	Plenary 1.4: Michael Horn et al.: Seed dispersal by fishes in tropical and temperate fresh waters: the growing evidence
	30	Break
11	00	Plenary 2.1: Nico Eisenhauer et al.: Importance of earthworm – seed interactions for the composition of plant communities: a review
	30	Plenary 2.3: Tomás A. Carlo: Are generalist consumers the ecological rock stars of plant-frugivore mutualistic networks?
12	00	Plenary 2.4: Jin Chen et al.: Geographic mosaic of selection on cone and seed traits of *Pinus armandii* by nutcrackers and scatter-hoarding rodents
	30	Lunch
14	00	Plenary 3.1: Mike Steele et al.: The importance of multidisciplinary approaches for understanding the seed dispersal process: an example from the North American oaks
	30	Oral 3.2: Emily Moran et al.: Contrasting patterns of seed dispersal in two red oak populations revealed by hierarchical Bayesian model integrating genetic and ecological data
	45	Oral 3.3: Douglas Scofield et al.: Using animal foraging models to understand patterns of seed movement in oaks
15	00	Oral 3.4: Fernando Pulido et al.: Recruitment of *Quercus robur* at its southern range limit: lessons for the conservation of marginal populations
	15	Oral 3.5: Carolina Puerta-Piñero et al.: Exploring the mechanisms that determine oak regeneration at regional scale: the interplay between interacting organisms and landscape structure
	30	Oral 3.6: Akiko Takahashi et al.: Effects of seed characteristics on the individual seed fate of a deciduous oak species *Quercus serrata*
	45	Oral 3.7: Zhishu Xiao et al.: Evolutionary interactions between rodents and nuts：a review in China
16	00	Break
	30	Plenary 4.1: Renee M. Borges et al.: When should fig fruit produce volatiles? Pattern in a ripening process
17	00	Oral 4.2: Larissa Albrecht et al.: Nutritional importance of *Ficus* for the common fruit-eating bat *Artibeus jamaicensis*
	15	Oral 4.3: Catherine Soler et al.: Scent as a component of dispersal syndromes: a comparative analysis in the genus *Ficus*
	30	Oral 4.4: Robert Hodgkison et al.: Bat fruits and fruit bats: chemical adaptations for seed dispersal by bats within the genus *Ficus* (Moraceae)
	45	Oral 4.5: Joanna Lambert et al.: Frugivory and digestive physiology in arboreal, tropical Carnivora (*Arctictis binturong, Potos flavus*)
18	00	Oral 4.6: Kerstin Reifenrath et al.: A temperate diplochorous seed dispersal system? Interactions between herbs, slugs and ants
	15	Oral 4.7: Pia Parolin et al.: Fruit and seed chemistry and dispersal modes in Amazonian floodplain forests
	30	**Poster 21: Organismal and Natural History Oriented Research**
20	00	

Tuesday, 15.06.2010: Day 2		
08	15	Foreword
	30	Plenary 5.1: Cristina Garcia et al.: Propagule and frugivore movements inferred with molecular markers: analytical approaches and evolutionary consequences
09	00	Plenary 5.2: James Hamrick: Using population genetic analyses to understand patterns of seed dispersal
	30	Plenary 5.3: Daniel García: The landscape ecology of frugivory and seed dispersal: concepts and applications
10	00	Plenary 5.4: Andy Jones et al.: Confronting ecological observations of seed dispersal with population genetic data: examples from wind and water dispersed Neotropical trees
	30	Break
11	00	Plenary 6.1: Helene Muller-Landau et al.: The tolerance-fecundity tradeoff and the maintenance of seed size diversity: theory and tests in a tropical forest
	30	Plenary 6.2: Ran Nathan: A movement ecology approach for studying seed dispersal by frugivorous animals
12	00	Plenary 6.3: James Bullock: Complex and simple models of plant spatial dynamics using real dispersal data
	30	Lunch
14	00	Plenary 7.1: Roger Cousens: What on earth is a dispersal kernel? Why loose terminology confuses everyone and proliferates mistakes
	30	Oral 7.2: Erin Kuprewicz: Estimating seed dispersal kernels by tracking seeds: the effects of large terrestrial mammals on the fates of seeds with various defense strategies in a Costa Rican rain forest
	45	Oral 7.3: Juan J. Robledo-Arnuncio: Genetic estimation of the seed dispersal kernel
15	00	Oral 7.4: Marco D. Visser et al.: Measuring dispersal kernels through inverse modeling: density dependence of seed dispersal in a Neotropical palm
	15	0Oral 7.5: Roland W. Kays et al.: Estimating seed dispersal kernels from fine-resolution animal movement data: better to be breakfast or dinner?
	30	Oral 7.6: Merel Soons: Estimating dispersal kernels through mechanistic modelling
	45	Oral 7.7: John Terborgh et al.: Saplings arise from dispersed seeds
16	00	Break
	30	Plenary 8.1: Dennis Hansen et al.: Seed dispersal on islands: a global overview of insular frugivores
17	00	Oral 8.2: Annabelle Vidal et al.: The time is ripe for the study of seed dispersal by bats in the greatest of the Antilles: identification of the species involved and a preliminary characterization of the interaction
	15	Oral 8.3: Daniel Bennett: Giant frugivorous lizards and *Pandanus*: seed dispersal and seed fate in lowland dipterocarp forests of the Philippine Islands
	30	Oral 8.4: María Calviño-Cancela: Estimating the effectiveness of seed dispersers: the seed dispersal system of *Corema album* in the Canary Island
	45	Oral 8.5: Manuel Nogales et al.: Pigeons as frugivores on insular environments: the case of two sympatric species in the Canary Islands
18	00	Oral 8.6: Erica Spotswood et al.: Novel dispersal relationships on remote oceanic islands affect native communities and species invasions in French Polynesia
	15	Oral 8.7: Christine Griffiths: Restoring seed dispersal functions using taxon substitutes
	30	
20	00	**Poster 22: Movement Ecology, Dispersal Kernels, and Genetic Effects**

Wednesday, 16.06.2010: Day 3		
08	15	Foreword
	30	Plenary 9.1: José Manuel V. Fragoso et al.: The abundance and diversity of vertebrate frugivores at lanscape levels in Amazonia
09	00	Plenary 9.2: Patrick A. Jansen et al.: Hunting impacts on recruitment of large-seeded palm species: Are Neotropical forests getting palm-dominated?
	30	Plenary 9.3: Kimberly M Holbrook et al.: Human impacts on tropical forest dispersal systems: implications for large frugivorous birds and long-distance dispersal
10	00	Plenary 9.4: Katrin Böhning-Gaese et al.: Movement patterns and seed dispersal by frugivorous birds in fragmented landscapes
	30	Break
11	00	Plenary 10.1: Elisabeth Kalko: Frugivory and seed dispersal by bats: effects of habitat degradation and fragmentation on plant diversity and distribution
	30	Plenary 10.2: Arndt Hampe: Plants on the move: dispersal and colonization in a rapidly changing climate
12	00	Plenary 10.3: David Westcott et al.: Modelling dispersal in the context of plant invasions: interactions between dispersal, landscape structure and management determine the most effective management strategy
	30	Lunch
14	00	Plenary 11.1: Carlos A. Peres et al.: Pervasive consequences of overhunting in Amazonian forests: a basin-wide meta-analysis of kill profiles and implications to ecosystem structure
	30	Oral 11.2: José M. Herrera et al.: Bird-mediated seed dispersal across fragmented landscapes: interactions between habitat cover and quality
	45	Oral 11.3: Nina Farwig et al.: Pollination and seed dispersal in human-shaped landscapes
15	00	Oral 11.4: Catherine Moran et al.: Changes in the frugivore assemblage reduce seed dispersal potential in fragmented Australian rainforest
	15	Oral 11.5: Valérie Lehouck et al.: Altered frugivore communities in changing landscapes – consequences for plant recruitment
	30	Oral 11.6: Georgina O'Farrill et al.: Megafaunal losses: when does a forest become empty?
	45	Oral 11.7: Mauro Galetti et al.: Defaunation drives rapid evolutionary shrinkage of seeds
16	00	Break
	30	Plenary 12.1: Isabelle Olivieri: An overview of evolutionary models for the evolution of dispersal
17	00	Oral 12.2: Frank M. Schurr: Can long-distance seed dispersal respond to natural selection?
	15	Oral 12.3: Bodil Kirstine Ehlers: Geographic varation in seed dispersal; islands vs. mainland and central vs. marginal populations
	30	Oral 12.4: Miquel Riba et al.: Evolution of dispersal and fragmentation: testing some model predictions using natural experiments
	45	Oral 12.5: Pierre-Olivier Cheptou: Rapid evolution of seed dispersal in urban environment in the weed *Crepis sancta*
18	00	Oral 12.6: Danny Rojas et al.: When did fruits become important to leaf-nosed bats? The evolution of frugivory in phyllostomids
	15	Oral 12.7: Orr Spiegel et al.: Incorporating density-dependence into the directed dispersal hypothesis
	30	**Poster 23: Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal**
20	00	**Systems**

Thursday, 17.06.2010: Day 4		
08	15	Foreword
	30	Plenary 13.1: H. Martin Schaefer: Visual communication between fruits and frugivores
09	00	Plenary 13.2: Britta Denise Hardesty et al.: In a new landscape: dispersal ecology and genetics of *Miconia* invasion in Australia
	30	Plenary 13.3: Colleen T. Downs: Effect of sugar type and concentration on diet choice and digestion in a range of South African avian frugivores
10	00	Plenary 13.4: Doug Levey et al.: Rethinking the benefits of vertebrate seed dispersal – escape, camouflage or pathogen removal?
	30	Break
11	00	Plenary 14.1: Pedro Jordano: The functional value of plant-frugivore mutualistic networks
	30	Plenary 14.2: Theodore Fleming: A brief history of fruits and frugivores in time and space
12	00	Plenary 14.3: Richard Corlett: Frugivory in tropical forests: what don't we know and why do we need to know it?
	30	Lunch

		Einstein	Joffre A/B	Joffre C/D
14	00	"Anthropogenic Impacts on Frugivory and seed Dispersal (part II)" Chair: Andresen, Ellen ; Wright, S. Joseph Oral 15.1: Tarek Milleron et al.: Human frugivory and seed dispersal in Neotropical forests	"Organismal and Natural History Oriented Research (Part II)" Chair: Robertson, Alastair ; Chapman, Hazel Oral 17.1: Anuttara Nathalang et al.: Interannual variability in fruiting affects the diet of frugivores	"Ecology and Evolution of Frugivory and Seed Dispersal (Part II)" Chair: Vander Wall, Stephen B.; Kunz, Britta Oral 19.1: Stephen Vander Wall et al.: Black bears (*Ursus americanus*) are effective seed dispersers, with a little help from their friends
	15	Oral 15.2: Jean-Yves Meyer et al.: Vanishing endemic frugivorous birds and endangered plants in the islands of Eastern Polynesia (South Pacific): an extinction cascade?	Oral 17.2: Chanpen Wongsriphuek et al.: Liana seed dispersal by white-handed gibbons (*Hylobates lar*) in the seasonal evergreen forest, Thailand: dispersal distance, germination rates, and dispersal quality	Oral 19.2: Mari Terakawa et al.: Microsatellite analysis of seed dispersal of *Myrica rubra* by the Yakushima macaque (*Macaca fuscata yakui*) on Yakushima Island, Japan.
	30	Oral 15.3: Beatriz Rumeu et al.: Different ecological patterns in the seed dispersal systems of two endemic junipers (*Juniperus cedrus* and J. *brevifolia*) in the Macaronesian archipelagos	Oral 17.3: Hazel Chapman et al.: Post-dispersal seed removal and seed germination of *Cercopithecus nictitans* dispersed seed in a West African montane forest	Oral 19.3: José María Fedriani et al.: "Liaisons dangereuses" in the Mediterranean dwarf palm: the defensive role of fresh pulp against seed predators
	45	Oral 15.4: Josep Rost et al.: The importance of piling wood debris on bird-dependent seed dispersal in Mediterranean burned forests	Oral 17.4: Laurence Culot et al.: Linking tamarins' behaviour with spatiotemporal pattern of seed dispersal and seedling recruitment	Oral 19.4: Clare Aslan: Establishment of novel dispersal mutualisms between introduced plants and resident birds in California, USA
15	00	Oral 15.5: Ellen Andresen et al.: Seed dispersal by animals in a shaded coffee agroecosystem in Mexico: How prevalent is it, and how is it perceived by people?	Oral 17.5: Norbert Cordeiro et al.: Giant African rats and an endemic tree: dispersal and harvesting pressures	Oral 19.5: Britta Kunz: Fruit choice and seed size selection in an eclectic primate omnivore and implications for plant community dynamics in West Africa
	15	Oral 15.6: Jerry Jacka et al.: Impact of gold mining on seed dispersal and extractive resources in a Papua New Guinea rainforest	Oral 17.6: Laura D'Arcy et al.: High levels of seed predation for three important primate food species, within the tropical peat swamp forests of Central Kalimantan. A gap in the loop?	Oral 19.6: Kim Valenta et al.: A spatial test of the ultimate null hypothesis: White-faced capuchin dispersal of *Genipa americana*
	30	Oral 15.7: S. Joseph Wright: The consequences of hunting for frugivores, seed dispersal and plant species composition in tropical forests	Oral 17.7: Alastair Robertson et al.: Germination consequences of non-dispersal in fleshy fruited plants	Oral 19.7: C. E. Timothy Paine et al.: Testing the Janzen-Connell hypothesis at the community level with functional traits
	45	Break		

16	00	Break		
	15	"Consequence of the Loss of Large Frugivores" Chair: McConkey, Kim ; Kelly, Dave Oral 16.1: Dave Kelly et al.: Large fruits without large frugivores: can variance save dispersal?	"Movement Ecology, Dispersal Kernels, and Genetic Effects (Part II)" Chair: Heymann, Eckhard W. ; Choo, Juanita Oral 18.1: Eckhard W. Heymann et al.: Spatial patterns of seed dispersal by Neotropical tamarin monkeys, *Saguinus mystax* and *S. fuscicollis*	"Animal-Plant Interactive Networks and Seed Dispersal Services" Chair: Mello, Marco ; Kalko, Elisabeth Oral 20.1: Marco Mello et al.: The backbone of seed dispersal: within- and among-network variation in the importance of different dispersers
	30	Oral 16.2: Debra M. Wotton et al.: Seed dispersal with the wreckage of an avifauna: consequences for large-seeded trees in New Zealand	Oral 18.2: Torbjørn Haugaasen et al.: Seed dispersal of the Brazil nut tree (*Bertholletia excelsa*) by scatter-hoarding rodents in a central Amazonian forest	Oral 20.2: Jessica Lavabre et al.: Disentangling seed dispersal of an endangered conifer
	45	Oral 16.3: Kim McConkey: Ecological significance of seed secondary metabolites in a rodent-dispersed tree: adaptation to seed-eating dispersers?	Oral 18.3: Kazuhiko Hoshizaki et al.: Ecological significance of seed secondary metabolites in a rodent-dispersed tree: adaptation to seed-eating dispersers?	Oral 20.3: Matthias Schleuning et al.: Specialization of seed-dispersal networks decreases at edges and disturbed sites of an African rain forest
17	00	Oral 16.4: Felipe Melo et al.: Successional trajectories of defaunted tropical forests: effects of vanishing large frugivores and the role of remaining seed dispersers	Oral 18.4: Youbing Zhou: Effectiveness of seed dispersal by five frugivorous carnivores: implication for their differential role in forest recruitment and regeneration	Oral 20.4: Suann Yang et al.: Network theory and the seed dispersal loop
	15	Oral 16.5: Edu Effiom et al.: Bush meat hunting disrupts forest regeneration in African rainforest	Oral 18.4: Juanita Choo: Dispersal and recruitment patterns of palms inferred through parentage analysis	Oral 20.5: Rebecca Snell et al.: Can we scale up seed dispersal? Incorporating dispersal into vegetation-climate models
	30	Oral 16.6: Varun Swamy et al.: A basin-wide study of seed rain patterns in lowland western Amazonia	Oral 18.6: Manfred Türke et al.: Gastropodochory in myrmecochores: when slugs do the job of ants	Oral 20.6: Juan M. Morales et al.: Linking frugivore behaviour to plant population dynamics: thrushes and fleshy-fruited trees in the Cantabrian range
	45	Oral 16.7: Haldre Rogers et al.: What is the fate of a silent forest? The impact of the complete loss of frugivorous forest birds from the island of Guam	Oral 18.7: Marina Côrtes et al.: How does pollen and seed movement influence local spatial genetic structure of a tropical understory plant?	Oral 20.7: Oliver Tackenberg: The role of animals for Dandelion seed dispersal
18	00	**Synthesis**		
	30	**Break**		
20	00	**Banquet-David W. Snow Award Ceremony-Welfare Party-until 24:00**		

Abstracts

Plenary 1.1 in *Organismal and Natural History Oriented Research*: Einstein Auditorium, 14.06.2010, 08:30-09:00

Mega-gardeners of the forest -- the role of elephants in seed dispersal

Ahimsa Campos-Arceiz[1], *Stephen Blake*[2]

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[2] Max Planck Institute of Ornithology

As the largest frugivores on earth, elephants have unique ecological properties. Found in deserts, savannahs, and forests, they are the last remnants of a diverse lineage. Among the three currently recognized forms, African forest elephants are the most frugivorous, followed by Asian and then African savannah elephants, although their role as seed dispersers is very variable and context-dependent. Forest elephants may consume more seeds from more species than any other taxon, defaecating them in viable conditions into nutrient-rich and protective dung over long distances, in a unique spatial pattern. In short, elephants are forest gardeners. The signature of elephant dispersal is evident in the spatial distribution of trees suggesting that elephants maintain tree diversity and retain low redundancy in seed dispersal systems. Large numbers of forest elephants ranging over large areas may be essential for ecosystem function. However, forest elephants, both in Africa and Asia, are rapidly declining due to hunting and other conflicts with people. The loss of elephants will have important negative consequences for the ecological trajectories of some plant species and whole ecological communities, yet the conservation status of forest elephants is catastrophic in Asia and rapidly becoming so in Africa. In this paper we review the current knowledge of elephants as seed dispersers, discuss the ecological consequences of their decline, and suggest priority areas for research and conservation action.

Plenary 1.2 in *Organismal and Natural History Oriented Research*: Einstein Auditorium, 14.06.2010, 09:00-09:30

Differential seed handling by two African primates affects seed fate and establishment of large-seeded trees

Nicole Gross-Camp[1], Beth Kaplin[2]

[1] University of East Anglia, Overseas Development Group
[2] Antioch New England University

We examined the influence of seed handling of two African primates, chimpanzees and mountain monkeys, on the fate of large seeded tree species in an afromontane forest in Rwanda. Primates exhibited different oral processing techniques with chimpanzees discarding large quantities of seeds in wadges and mountain monkeys spitting single seeds cleaned of fruit pulp. The first two components of a PCA of eight microhabitat characteristics describing the site where primates deposited seeds explained 46.7 % of the variance. When plotted, microhabitat characteristics of defecations and spit seeds have little overlap suggesting that seed handling influences the deposition site. We monitored a total of 552 primate seed dispersal samples through time at their site of deposition for seed persistence, germination, and establishment. Defecations were deposited significantly farther from an adult conspecific where they experienced the greatest persistence but poorest establishment. In contrast, spit seeds were deposited closest to an adult conspecific but experienced the highest seed establishment rates. Experimental plot results revealed a significant difference in seed handling and fate, with undispersed seeds in whole fruits experiencing the lowest establishment rates. Our results highlight the importance of primate seed handling on the deposition site and seed fate, and may be helpful in the development of models to predict seed shadows and recruitment patterns of large seeded trees.

Plenary 1.3 in *Organismal and Natural History Oriented Research*: Einstein Auditorium, 14.06.2010, 09:30-10:00

Frugivory and seed dispersal by hornbills (Bucerotidae) in tropical forests

SHUMPEI KITAMURA[1]

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Hornbills are known to be largely frugivorous and are believed to be important seed dispersal agents in their habitats. I review the recent studies on the following three questions about hornbills as seed dispersers: (1) Do they eat fruits? (2) Do they defecate, regurgitate, spit or drop potentially viable seeds away from the parent plant? (3) Are they significant dispersal agent? Some degree of frugivory has been reported for almost all hornbill species, especially for Asian hornbills. Despite their high frugivory, most hornbill studies could not answer the question (2). A few studies examined the viability of seeds that were defecated or regurgitated by hornbills. Hornbill visit lengths, visit frequencies, and seed passage times indicated that few seeds were deposited beneath parent plants. To answer the third question is more difficult, because it is hard to determine a seed disperser's significance for a plant. Several fruit species are considered as being exclusively consumed by hornbills. It has been asserted that large hornbills are the major consumers of the fruits from many primary forest plants with one large-seeded fruits. Although the seed dispersal by hornbills at nest trees during the breeding season and roosting trees are inefficient from the point of view of the plant, the extent of hornbill seed shadows suggests that their influence in determining forest structure will likely increase as other larger mammalian dispersers are exterminated.

Plenary 1.4 in *Organismal and Natural History Oriented Research*: Einstein Auditorium, 14.06.2010, 10:00-10:30

Seed dispersal by fishes in tropical and temperate fresh waters: the growing evidence

MICHAEL HORN[1], SANDRA CORREA[2], PIA PAROLIN[3], BART POLLUX[4], JILL ANDERSON[5], CHRISTINE LUCAS[6], PETER WIDMANN[7], ALBERTUS TIJU[8], MAURO GALETTI[9], MICHAEL GOULDING[10]

[1] Department of Biological Science, California State University; [2] Department of Wildlife and Fisheries Sciences, Texas A&M University ; [3] Department of Biology, University of Hamburg ; [4] Department of Biology, University of California ; [5] Department of Biology, Duke University ; [6] Department of Wildlife Ecology and Conservation, University of Florida [7] Fakultas Kehutanan, University of Tanjungpura ; [8] World Wildlife Fund Indonesia ; [9] Departamento de Ecologia, Universidade Estadual Paulista ; [10] Amazon Conservation Association

Fruit-eating by fishes represents an ancient interaction increasingly regarded as important for seed dispersal (ichthyochory) in tropical and temperate ecosystems. Most of the nearly 200 known frugivorous species belong to the mainly tropical Characiformes (pacus, piranhas) and Siluriformes (catfishes), but cypriniforms (carps, minnows) are more important in the Holarctic and Indomalayan realms. Frugivores are among the most abundant fishes in Neotropical floodplains where they eat the fruits of a wide variety of trees and shrubs. By consuming fruits, fishes gain access to rich sources of carbohydrates, lipids and proteins and act as either seed predators or dispersers. With their often high mobility, large size, and great longevity, fruit-eating fishes can play important roles as seed dispersers and exert strong influences on local plant-recruitment dynamics and regional biodiversity. Recent feeding experiments focused on seed traits after gut passage support the idea that fishes are major seed dispersers in floodplain and riparian forests. Overfishing, damming and deforestation potentially diminish ichthyochory and require immediate attention to ameliorate their effects. Much exciting work remains in terms of fish and plant adaptations to ichthyochory, dispersal regimes involving fishes in different ecosystems, and increased use of nondestructive methods such as stomach lavage, stable isotopes, genetic analyses and radio transmitters to determine fish diets and movements.

Plenary 2.1 in *Organismal and Natural History Oriented Research (continued)*: Einstein Auditorium, 14.06.2010, 11:00-11:30

Importance of earthworm – seed interactions for the composition of plant communities: a review

ESTELLE FOREY, THIBAUD DECAENS, STEFAN SCHEU, SEBASTIEN BAROT, ESTELLE LANGLOIS, PIERRE MARGERIE, KAM-RIGNE LAOSSI, *NICO EISENHAUER*[1]

[1] J.F. Blumenbach Institute of Zoology and Anthropology, Georg-August-University Göttingen

Soil seed banks are crucial elements for the understanding of plant population and community ecology. Among animal species, earthworms are increasingly recognised as important dispersers and predators of seeds. Through direct and indirect effects, they might affect either positively or negatively the distribution, survival and establishment of seeds in plant communities. Thereby, earthworms may affect seedling establishment by a variety of mechanisms such as selective ingestion and digestion of seeds, acceleration or delaying of seed germination, and downward or upward seed transport. Seed displacements might for instance reduce exposure to harsh environmental constrains and to aboveground seed predators. Surface earthworm casts and middens often contain many viable seeds and might be important regeneration niches for plant seedlings and therefore likely favour specific plant strategies. Nevertheless, the role of earthworm as seed dispersers and mediators of seed bank dynamics has seldom been considered in past studies, especially in case of natural plant communities. Many aspects of the processes induced by earthworm activity remain obscure. Thus, we propose in this review to discuss the potential consequences of earthworm-mediated impacts on soil seed banks, plant community dynamics and potential outlooks in plant evolution, restoration, and conservation ecology.

Plenary 2.3 in *Organismal and Natural History Oriented Research (continued)*: Einstein Auditorium, 14.06.2010, 11:30-12:00

Are generalist consumers the ecological rock stars of plant-frugivore mutualistic networks?

TOMÁS A. CARLO[1]

[1] Biology, Penn State University

Plant-frugivore relationships at community levels are now modeled as bipartite networks of interactions. In this context, it is well documented that the overall architecture of the distribution of frugivory and seed dispersal relationships is cuasi constant across a wide range of communities worldwide. One of such predictions is that generalist frugivores are the "backbone" of communities because they create connectivity patterns both between plants and animals in direct and indirect ways. However, this and other general predictions stemming from the architectural patterns of bipartite network models are fundamentally untested. Here I test some of the main predictions by confronting bipartite models with field data on frugivore behavior and seed dispersal across gradients of environmental heterogeneity. I conclude that bipartite network approaches often fail to identify the key frugivores that hold communities together, especially in the face of strong environmental heterogeneities such as forest destruction-regeneration dynamics.

Plenary 2.4 in *Organismal and Natural History Oriented Research (continued)*: Einstein Auditorium, 14.06.2010, 12:00-12:30

Geographic mosaic of selection on cone and seed traits of *Pinus armandii* by nutcrackers and scatter-hoarding rodents

JIN CHEN[1], FAN CHEN[1], FANGFANG XU[1]

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The strength and outcome of interspecific interactions often vary across the landscape because of differences in community context. Geographic variations in the composition of the seed disperser and seed predator assemblages may result in variations in selective pressures on the fruit and seed traits of plants. *Pinus armandii* is a species of pine with large (about 300 mg) and wingless seeds that native to western China. Nutcrackers (*Nucifraga caryocatactes*) are the primary seed dispersers and scatter-hoarding rodents are the secondary seed dispersers. To determine whether and how the pine has evolved in response to selection by nutcrackers and scatter-hoarding rodents, we conducted studies in five sites located in Diqing prefecture, northwest Yunnan province where the mountains and rivers divided the pine forest into isolated or partly-isolated populations. The study demonstrated that cone and seed traits evolution were divergent among the five study sites with different seed disperser community compositions, consistent with variation in selection by nutcrackers and scatter-hoarding rodents. In order to examine the gene flow among the five sites, we use SSR technology to present the scale of gene flow among the sites, which will be presented in the talk. As a whole, the study help us to understand how geographic mosaic of selection facilitating the formation of biodiversity in this worldwide well-known biodiversity hotspot.

Plenary 3.1 in *Oaks and Acorns*: Einstein Auditorium, 14.06.2010, 14:00-14:30

The importance of multidisciplinary approaches for understanding the seed dispersal process: an example from the North American oaks

MIKE STEELE[1], NATHAN LICHTI[1], SHEALYN MARINO[1], ROBERT ROBERT SWIHART[1]

[1] Dept. of Biology, Wilkes University

Although a unified theory of seed dispersal has been slow to emerge, recent studies employing an integrative approach have greatly improved our understanding of this complicated but important ecological process. Here we review (1) a series of ecological, behavioral, and genetic approaches that have been used to understand oak dispersal in temperate forests of North America, (2) the consistencies and inconsistencies that result from these varied approaches, and (3) the additional approaches needed to resolve these inconsistencies. We report on a series of recent studies that show how secondary dispersal, cache memory, predator-prey interactions, and a retriever's advantage can all influence the seed dispersal process. By simulating predation of scatter-hoarding tree squirrels immediately after caching, we demonstrate that cache owners have a retrieval advantage over conspecifics even in a high-density population. We also show how habitat structure influences the placement of various seed types and how this influences spatial variation in cache pilferage. Our recent findings suggest that scatter hoarding is a dynamic process often controlled by the cache owner but also influenced by other ecological factors. We suggest that the close integration of genetic studies with behavioral and ecological experiments is vital for reconstructing the various mechanisms that contribute to the process of seed dispersal.

Oral 3.2 in *Oaks and Acorns*: Einstein Auditorium, 14.06.2010, 14:30-14:45

Contrasting patterns of seed dispersal in two red oak populations revealed by hierarchical Bayesian model integrating genetic and ecological data

EMILY MORAN[1], JAMES S CLARK

[1] Biology, Duke University

Scale of seed and pollen movement has a critical influence on plant population dynamics and their response to environmental change through migration or adaptation. Oaks (*Quercus* spp.), an ecologically and economically important component of many temperate forests, are usually considered to be relatively dispersal limited, but seed trap data does not capture secondary dispersal by animals. Genetic parentage analyses, combined with ecological information, can help to overcome some of these challenges. We apply a hierarchical Bayesian parentage model to two red oak stands in North Carolina. We ask whether the scale of effective seed and pollen movement differs between these populations and, if so, this difference can be explained by site history and plant-animal interactions. Effective pollen dispersal distances were long at both sites (mean > 60 m); average mother-seedling distances were significantly higher than previous seed-trap-based estimates at the Piedmont site, but at the Appalachian site conformed more closely to the initial gravity-created seed dispersal kernel, although disperser activity levels are similar. Patterns of spatial genetic structure are consistent with the history of each site. The relatively long dispersal distances observed at the Piedmont vs. Appalachian site suggests that in some areas dispersal may not strongly limit oaks' abilities to reach suitable recruitment sites, whereas at other sites dispersal could interact with reduced disturbance frequencies to reduce oak seedling recruitment.

Oral 3.3 in *Oaks and Acorns*: Einstein Auditorium, 14.06.2010, 14:45-15:00

Using animal foraging models to understand patterns of seed movement in oaks

Douglas Scofield[1], Victoria Sork[1], Peter Smouse[2], Pamela Thompson[1], Delphine Grivet[3]

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Many plant species depend upon animals for seed dispersal, yet animals disperse seeds while pursuing their own social and behavioral agendas. Models for estimating seed dispersal patterns in plant populations typically follow various forms of more or less diffusive dispersal kernels, and through the use of such techniques broad patterns of seed dispersal have been successfully described in a variety of systems. However, in some animal-mediated systems this approach appears to be inadequate for understanding seed dispersal patterns that nonetheless arise from well-known and repetitive aspects of animal behavior. Here we describe a novel approach in which we draw upon well-established animal foraging models to incorporate important details of animal behavior into analyses of seed dispersal. We demonstrate our approach by analyzing the movement of acorns (*Quercus* spp.) by the cooperative-breeding acorn woodpecker (*Melanerpes formicivorous*) in an oak savannah in southern California, USA.

Oral 3.4 in *Oaks and Acorns*: Einstein Auditorium, 14.06.2010, 15:00-15:15

Recruitment of *Quercus robur* at its southern range limit: lessons for the conservation of marginal populations

Gerardo Moreno[1], *Fernando Pulido*[1], Arndt Hampe[2]

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A better understanding of how relict populations perform under environmental conditions close to their tolerance limits would allow developing efficient strategies for their conservation and management in a changing climate. Here, we evaluate whether tree fecundity and recruitment success show consistent relationships with population size and degree of spatial isolation in a set of 19 *Quercus robur* relict stands located in central Spain, the southern range margin. We showed that flower production occurred in all trees studied regardless of stand size, internal fragmentation, and degree of isolation. Acorn production also occurred in all stand studied (but not in all trees), and it was positively related to stand size and tree density. Seedling emergence was low and mostly concentrated beneath tree canopies. However, seedling survival after summer drought was relatively high (above 50 % and 20 % after first and second summer). Survival was higher in canopy gaps, where emergence was very low because of limited acorn dispersal. Overall, sapling recruitment was very low, and again independent of stand size and isolation. Our results suggest that past and recent limitations for *Q. robur* regeneration seem to be more associated to anthropogenic disturbance than to climatic constraints or population structure.

Oral 3.5 in *Oaks and Acorns*: Einstein Auditorium, 14.06.2010, 15:15-15:30

Exploring the mechanisms that determine oak regeneration at regional scale: the interplay between interacting organisms and landscape structure

CAROLINA PUERTA-PIÑERO[1], JOSE MARÍA GOMEZ[2]

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We used several models to examine the direct and indirect effects of landscape traits and plant-animal interactions on three life-cycle stages of the Mediterranean oak tree, *Quercus ilex*. Models were built combining field and GIS-based information on habitat patches and considering the connectivity of each patch, as the potentiality of an acorn of reaching each patch, realistically computed using observed dispersal patterns of the main acorn dispersers. Biotic interactions as well as landscape traits controlled *Q. ilex* regeneration. Jay seed dispersal was highly positive for *Q. ilex* establishment being relevant for all stages and connectivity values while wild boars negatively affected, by seed and seedling predation, the establishment. The connectivity of each patch entailed direct and indirect effects on biotic interactions. Our results advocate that regeneration at a regional scale strongly depends on a complex relationship between landscape and the interacting organisms that move throughout it. Submitted as: Oral in Symposium01 Oaks and Acorns

Oral 3.6 in *Oaks and Acorns*: Einstein Auditorium, 14.06.2010, 15:30-15:45

Effects of seed characteristics on the individual seed fates of a deciduous oak species *Quercus serrata*

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To examine effects of seed characteristics, including tannin content and size, on their seed fates in the individual seed scale, extent of intraspecific variations in seed characteristics was examined in *Q. serrata*. Then we conducted the field experiment, analyzing the relationships between seed traits (size and tannin content) of individual acorns and their seed fates (seed dispersal and survival) using a nondestructive method of estimating the chemical contents of individual seeds. This method was developed by near infrared spectroscopy (NIRS) to solve a problem: a conflict between obtaining the information of seed chemical traits and pursuing seed fate.In the field experiment, I obtained the following results: tannin content (0.1-31.5 %, n = 8988) and seed size (0.1-5.0g, n = 8940) varied largely among individual acorns of *Q. serrata*; on one hand, large and low-tannin seeds tended to be dispersed well; and on the other hand, small and high-tannin ones tended to survive well. These results have indicated that individual seeds may not survive in even probability due to selective consumption by seed consumers according to tannin content and seed size. It was also revealed that advantageous seed traits to dispersal and survival were opposite to each other. Studies examining the effects of seed traits on seed fates in the field were quite limited (e. g. Sork, 1984; Gómez, 2004; Xiao *et al*., 2004). None of the studies focused on variation in chemical traits among individual seeds.

Oral 3.7 in *Oaks and Acorns*: Einstein Auditorium, 14.06.2010, 15:45-16:00

Evolutionary interactions between rodents and nuts：a review in China

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We will review our recent advances in seed-rodent interactions performed at several field sites across China. Our long-term research on seed-rodent interactions is aimed to fully understand how scatter-hoarding rodents as both seed predators and seed dispersers select plant seeds based on seed traits (e.g. seed size, seed chemistry, seed germination/dormancy and hull hardness), and how such behavioral preferences by these animals in turn influence dispersal and establishment of related plants, including the evolution of seed traits under selection. In this talk, we will focus on feeding and hoarding preferences among different rodent species and its impacts on seed dispersal and seedling establishment. In particular, we will also show some new findings about the squirrel-oak interactions in China. According to these recent advances, we suggest that behavioral preferences of scatter-hoarding animals can have a substantial impact on plant demography and vegetation diversity, including the evolution of related seed traits.

Plenary 4.1 in *Chemical Ecology of Seed Dispersal: Odors, Taste and Nutritional Ecology*: Einstein Auditorium, 14.06.2010, 16:30-17:00

When should fig fruit produce volatiles? Pattern in a ripening process

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The domesticated fig *Ficus carica* as well as some others, e.g. *Ficus religiosa*, are considered to have climacteric fruit wherein there is very rapid ripening following a burst of ethylene production. Such fruit may have very short retention time on the plant after ripening. However, not all fig species show such a ripening phenomenon. In this paper, we examine the differences in ripening, fruit presentation and fruit availability in some Asian fig species and also investigate whether these patterns relate to their dispersal agents, and when in the diel cycle the figs are dispersed. We examine variation in diel production of volatile organic compounds by ripe figs and attempt to relate these patterns to disperser identity and activity. We erect and test the hypothesis that volatile production for figs which attract their dispersers by olfactory processes should be most pronounced when dispersers are most active during the diel cycle.

Oral 4.2 in *Chemical Ecology of Seed Dispersal: Odors, Taste and Nutritional Ecology*: Einstein Auditorium, 14.06.2010, 17:00-17:15

Nutritional importance of *Ficus* for the common fruit-eating bat *Artibeus jamaicensis*

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Figs (*Ficus sp.*) are frequently considered as keystone resources for many frugivorous mammals due to their abundance and year-round fruiting phenology. In addition, nutritional values and mineral composition may contribute to the importance of figs for frugivores. Particularly the very high calcium concentration found in many fig species has been proposed to be crucial for successful reproduction in frugivorous mammals, as calcium is the most important and often limited mineral for the development of the offspring. We will present and compare data about the mineral and nutritional composition of fruits from about 170 trees of 18 *Ficus* species present in the Gatún Lake area in Panama and of several non-fig fruit species eaten by the common fruit-eating bat *Artibeus jamaicensis* (Chiroptera, Phyllostomidae). Figs have a significantly higher calcium concentration (2,8 – 19,8 mg/g dry matter) than the other fruits analyzed (0,13 – 7,6 mg/g dry matter). To further elucidate the importance of figs as calcium source we also performed assimilation experiments with wild-caught *A. jamaicensis* at different reproductive stages. The bats were fed for several nights with one fruit type (either fig or non-fig fruits).We subsequently collected faeces and fruit pellets and analyzed these samples for their mineral composition. Based on these data we determined the calcium balance of the bats. Finally we discuss the importance of figs as keystone resource for calcium in frugivores.

Oral 4.3 in *Chemical Ecology of Seed Dispersal: Odors, Taste and Nutritional Ecology*: Einstein Auditorium, 14.06.2010, 17:30-17:45

Scent as a component of dispersal syndromes: a comparative analysis in the genus *Ficus*

CATHERINE SOLER[1], JEAN-MARIE BESSIERE[1], BERTRAND SCHATZ[1], MARTINE HOSSAERT-MCKEY[1]

[1] Interactions Biotiques, CEFE-CNRS

Many studies of plant/frugivore interactions have focused on identifying traits adapting plants to different seed-dispersing animals. Almost no work has examined the role of fruit scents in differential attraction. We focus on this neglected element of dispersal syndromes. The unique phenology of figs (*Ficus* spp.), with year-round fruiting, sometimes makes them keystone resources for frugivores. Figs of some species are eaten primarily by bats, others by birds, and others (in Madagascar) by lemurs. Little is known about how these frugivores are differentially attracted. Recent work has shown that mutualisms between figs and their specialized pollinating wasps are chemically mediated: emission of specific volatile signals by figs and their perception by the pollinator ensure encounter of the mutualists. To explore whether fig/frugivore interactions are also chemically mediated, we used adsorption/desorption methods to study scents emitted by mature fruits of several fig species from different tropical regions. We examined whether the identity of the main seed disperser (bats/birds/lemurs) was associated with the quality and quantity of the bouquet of scents emitted by figs at the seed-dispersal stage. We found consistent differences between scents emitted by mammal- and bird-dispersed fig species. Based on our results, we discuss the importance of scent in adaptations of figs to seed-dispersing vertebrates.

Oral 4.4 in *Chemical Ecology of Seed Dispersal: Odors, Taste and Nutritional Ecology*: Einstein Auditorium, 14.06.2010, 17:15-17:30

Bat fruits and fruit bats: chemical adaptations for seed dispersal by bats within the genus *Ficus* (Moraceae)

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Using the genus *Ficus* as a model, this study explored the fruit scents of nine species of fig, from the New and Old World tropics, in relation to the foraging behaviour of New and Old World fruit-eating bats, to test the following hypotheses: 1) variation in the chemical composition of fruit scent in the genus *Ficus* is adaptive, rather than phylogenetic in origin, 2) the composition of fruit scent, among bat-dispersed fig species, is convergent within geographically isolated and phylogenetically separate lineages. The fruit scents of bat and bird-dispersed figs were sampled in the field, using dynamic headspace adsorption techniques. Chemical analyses, using gas chromatography (GC) and GC/mass spectrometry (MS), revealed a broad overlap in scent class between bat-dispersed species from both biogeographic regions. The bouquets of these species were dominated by monoterpenes, which, contrary to phylogenetic predictions, were almost completely absent from bird-dispersed species from both regions. The scents of bird-dispersed figs were also unattractive to bats. Thus, variation in fruit scent, between bat and bird-dispersed figs, is almost certainly adaptive rather than phylogenetic in origin. However, a strong phylogenetic component to fruit scent variation was revealed among fig species dispersed by bats. Behavioural experiments, on naïve bats, from the New and Old World tropics, suggest that interactions between bats and figs could be more specialized in the Neotropics.

Oral 4.5 in *Chemical Ecology of Seed Dispersal: Odors, Taste and Nutritional Ecology*: Einstein Auditorium, 14.06.2010, 17:45-18:00

Frugivory and digestive physiology in arboreal, tropical Carnivora (*Arctictis binturong, Potos flavus*)

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[3] Animal Science, North Carolina State University

While most Carnivora species consume animal diets, *Arctictis binturong* (binturong) and *Potos flavus* (kinkajou) are – like many primates-flexible omnivores and frugivores. Our aim was to evaluate whether these species also exhibit convergence with primates in their digestive physiology. Data on digestive retention (MRT), carbohydrate fermentation, short-chain fatty acid (SCFA) production, and fiber digestion were collected at the Carnivore Preservation Trust, NC. Carbohydrate fermentation, SCFAs, and fiber digestibility data were measured on fecal samples assayed in the laboratory. Carbohydrate fermentation samples were incubated anaerobically and analyzed for methane, pH, and SCFA. Digestibility and fiber were assayed using standard NDF and ADF methods. Preliminary results indicate that both species digest food several orders of magnitude faster than comparably-sized frugivorous/omnivorous primates (binturong: 13-27kg; MRT = 38mins; kinkajou: 2–5kg; MRT: 27mins). Data on carbohydrate fermentation and fiber digestion are consistent with this pattern. NDF assays indicate fiber digestion at only 14.22 % and ADF at 28.82 %; only trace SCFAs were found. All data suggest that these species concentrate on extraction of simple sugars/disaccharides in the small intestine rather than fermentation of polysaccharides in the large intestine. Implications for interpreting adaptations to a fruit diet, seed dispersal, and competition with primates will be discussed.

Oral 4.6 in *Chemical Ecology of Seed Dispersal: Odors, Taste and Nutritional Ecology*: Einstein Auditorium, 14.06.2010, 18:00-18:15

A temperate diplochorous seed dispersal system? Interactions between herbs, slugs and ants

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Ants are the best-known dispersers of elaiosome-bearing seeds of early spring flowering plants in temperate ecosystems. In order to identify those seed properties that trigger the ants' choice for certain seeds, we correlated seed preferences in field experiments with structural and chemical analyses. We expected that certain fatty acids play a major role as cues for seed removal behaviour. However, bioassay-guided analyses of the chemical profile of preferred seeds revealed that the amount and composition of amino acids in elaiosome-bearing seeds is a better predictor of the ants' seed choice. In further field experiments, we identified slugs as a second important and highly effective group of seed dispersers with a strong preference for elaiosome-bearing seeds. Slugs swallow seeds and defecate them after several hours of ingestion. Surprisingly, seeds with their attached elaiosomes remain intact after the gut passage. Therefore one can expect that such defecated seeds attract secondary dispersers. We tested if these defecated elaiosome-bearings seeds attract ants, but observed a diminished attraction. Analyses revealed strong differences in the amino acid profile between these slug-treated seeds and intact seeds. In conclusion, ants may act as secondary dispersers of seeds primarily transported by slugs, but since amino acids are key substances that render seeds attractive to ants, the altered chemical composition may be responsible for low transport rates.

Oral 4.7 in *Chemical Ecology of Seed Dispersal: Odors, Taste and Nutritional Ecology*: Einstein Auditorium, 14.06.2010, 18:15-18:30

Fruit and seed chemistry and dispersal modes in Amazonian floodplain forests

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[1] Plant Systematics, University of Hamburg
[2] Max-Planck-Institute for Limnology

In Amazonian floodplain trees, there is a large variety of morphological, nutritional and chemical traits of fruits and seeds. With a flooded period of up to 7 months, fruits and seeds are released into the water and may be submerged or floating for several days to months – a situation which normally makes most seeds unviable. Trees are adapted and seeds remain visually sound for >2 months when continuously submerged. This stands in contrast to the majority of land plants, whose seeds quickly lose viability if submerged for prolonged periods. On the contrary, seeds of floodplain species kept in air dry or decompose within few days or weeks. Many species have high nutrient contents as a function of the relation to fish dispersal, just as in upland forests diaspores of species dispersed by mammals are rich in fat and proteins. However, in Amazonian floodplain trees dispersal syndromes are closely linked to water, with all necessary adaptations enhancing floatation and attractiveness for fish. High nutrient contents are also advantageous for the seedling, because a high investment of the parent tree into seed reserves guarantees fast initial growth. This can be crucial in an environment with a flood amplitude exceeding 10m. Time for seedling establishment in the non flooded terrestrial period is reduced to few months or weeks. For a fast and well timed establishment, seeds must germinate fast and they need adequate nutrient reserves, especially in nutrient poor environments like black water floodplains.

Plenary 5.1 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*: Einstein Auditorium, 15.06.2010, 08:30-09:00

Propagule and frugivore movements inferred with molecular markers: analytical approaches and evolutionary consequences

DELPHINE GRIVET[1], *CRISTINA GARCIA*[2]

[1] CIFOR-INIA
[2] Plant Biology, Georgia University

By mobilizing a large amount of propagules and the genes they harbour, frugivorous vertebrates have pervasive spatial, demographic and genetic consequences for plant populations. Yet integrative approaches examining how frugivorous' movement patterns determine the demographic and genetic features of plant populations are scarce. Here we first review molecular approaches and analytical methods to the study of propagules and gene flow with neutral markers and then illustrate two specific cases of animal-mediated seed dispersal. On one hand, we examine individual acorn dispersal events in terms of distance and direction in an open valley oak (*Quercus lobata*) and inferred dispersers' movement patterns at the landscape level. On the other hand, we quantify the maternal genetic correlations set in a frugivore-generated seed rain in a heterogeneous population of St Lucie cherry (*Prunus mahaleb*). We show highly non-random dispersal patterns by frugivorous vertebrates that result in a strong aggregation of maternal progenies both at the population and the landscape level. Data available on pollen flow complement our observations to discuss the potential evolutionary consequences of plant-frugivore interactions in determining recruitment and genetic patterns of plant populations in heterogeneous landscapes.

Plenary 5.2 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*: Einstein Auditorium, 15.06.2010, 09:00-09:30

Using population genetic analyses to understand patterns of seed dispersal

JAMES HAMRICK[1]

[1] Plant Biology, University of Georgia

The use of biparentally and maternally inherited molecular genetic markers to estimate levels of genetic differentiation among spatially separated populations allows the determination of the relative effectiveness of historical pollen and seed flow. Direct estimates of contemporary seed dispersal rates and distances from parentage analyses can identify the parents of dispersed fruits, seeds, or seedlings. With parent-pair analyses on seeds or seedlings, problems arise in distinguishing maternal and paternal parents. Use of maternally derived DNA from dispersed fruits or seed coats allows the direct identification of maternal individuals and, as a consequence, the distance and patterns of seed dispersal can be described. From such studies, we can better understand the role of seed dispersal in the maintenance of genetic connectivity between populations in natural and highly disturbed landscapes. Finally, studies that estimate genetic relatedness among plants in relatively recently colonized populations can provide insights into the role of seed dispersal in population colonization and growth. High levels of genetic relatedness within such populations would indicate that the site was originally colonized by few individuals and that increases in population size are largely due to the establishment of progeny of original colonists. In contrast, low relatedness would result if population growth resulted from continuous long-distance seed dispersal from multiple sources.

Plenary 5.3 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*: Einstein Auditorium, 15.06.2010, 09:30-10:00

The landscape ecology of frugivory and seed dispersal: concepts and applications

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Understanding how the spatial topology of organisms and the environment determines the functioning of ecosystems is a major challenge today. Landscape ecology aims to evaluate how the spatial patterns of the landscape affect the distribution of ecological objects and the functioning of ecological processes. In addressing this goal we may predict that both the spatial configuration and the spatial scale matter. Here, I seek to answer how the functioning of plant-frugivore interactions, and the concomitant seed dispersal, depend both on the spatial configuration of the environment and on the spatial scale. This requires to consider that, firstly, from the animal's perspective, plants are resources whose spatial heterogeneity is hierarchically nested along a gradient of spatial scales. Secondly, from the plant's perspective, interactions are sequential demographic sieves through the regeneration cycle, whose spatial structure depends on the scale at which animals perceive the environment. Animals respond to the spatial heterogeneity in plant populations by matching their activity to the abundance of plant resources. Such a spatial tracking may ultimately determine the spatial scale of seed dispersal and hence of plant populations. By understanding the spatial performance of frugivory and seed dispersal we may assess how these ecological processes respond to human-induced landscape alterations.

Plenary 5.4 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*: Einstein Auditorium, 15.06.2010, 10:00-10:30

Confronting ecological observations of seed dispersal with population genetic data: examples from wind and water dispersed Neotropical trees

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[1] Silwood Park Campus, Imperial College London
[2] Smithsonian Tropical Research Institute

Population genetic theory predicts that populations connected through gene flow will show less genetic differentiation than those with less frequent dispersal. Abiotically dispersed seeds offer a tractable system to examine the relationship between the behavior of the dispersal vector, species traits, and gene flow patterns across large and small spatial scales as dispersal is be expected to be down wind or down stream. I present results from comparative analyses of population genetic structure in wind and water dispersed tropical trees. By examining local genetic structure in three wind dispersed tree species whose seeds are released at different times of the year when wind speeds vary in strength and directionality, I demonstrate directional patterns of genetic structure, but the direction differs from observed wind direction. By comparing population genetic patterns of two dominant water-dispersed mangrove species in the Pacific and Carribean estuaries of Panama and ecological observations of seed dispersal ability in these species, I show how and explain why short term observations differ from observed genetic patterns. We predict that with the advent of increasingly powerful and available genetic techniques and the ability to accurately monitor and predict the movement and behavior of dispersal vectors, the gap between ecological observation and population genetic structure will continue to narrow.

Plenary 6.1 in *Movement Ecology, Dispersal Kernels, and Genetic Effects (continued)*: Einstein Auditorium, 15.06.2010, 11:00-11:30

The tolerance-fecundity tradeoff and the maintenance of seed size diversity: theory and tests in a tropical forest

HELENE MULLER-LANDAU[1], S. JOSEPH WRIGHT[1], OSVALDO CALDERON[1], ANDRES HERNANDEZ[1]

[1] Smithsonian Tropical Research Institute

Seed size commonly varies by five to six orders of magnitude among coexisting plant species, a pattern ecologists have long sought to explain. Higher competitive ability combined with strong competitive asymmetry can in theory allow coexistence through a competition-colonization tradeoff, but empirical evidence is inconsistent with this mechanism. I hypothesize that seed size diversity is maintained by a tradeoff between stress-tolerance (ability to recruit in hazardous sites) and fecundity. I present a simple, new model of this tolerance-fecundity tradeoff. Analyses of this model show that the tolerance-fecundity tradeoff enables stable coexistence of large numbers of species in heterogeneous habitats. Under this mechanism, the more tolerant species win all regeneration sites that are highly stressful and some of those that are less stressful, while the more fecund species win most but not all of the less stressful sites. I test the assumptions and predictions of the tolerance-fecundity and competition-colonization models using empirical data from a moist tropical forest on Barro Colorado Island Panama. The results show that the tolerance-fecundity model provides a far better fit than the competition-colonization model. Altogether, theory and empirical evidence suggest that the tolerance-fecundity tradeoff is the best explanation for the maintenance of diversity of seed size within plant communities.

Plenary 6.2 in *Movement Ecology, Dispersal Kernels, and Genetic Effects (continued)*: Einstein Auditorium, 15.06.2010, 11:30-12:00

A movement ecology approach for studying seed dispersal by frugivorous animals

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The movement ecology framework asserts that the movements of an organism, of any kind, can be described by only four basic components. Three components are properties of the focal individual: The internal state affecting its motivation to move, and the motion and navigation capacities accounting for its ability to move in various ways and directing its moves by sensing and responding to the environment, respectively. A fourth component lumps all external factors associated with the abiotic and biotic environment influencing movement. The generality assertion implies that the movement of seeds dispersed by a frugivore, and the movement of the frugivore itself, can be described mechanistically by identifying the parameters that make for the same four components in each of the two entities. More specifically, the case of animal-mediated seed dispersal constitutes an inner movement ecology scheme (of the dispersed seed) nested within an outer movement ecology scheme (of the frugivore). This view advocates a vector-based rather than a seed-based approach to studying seed dispersal by frugivores (or any other vector). Applying the movement ecology approach to seed dispersal by frugivorous birds and bats points at the importance of spatial scale, and helps to identify the key morphological, behavioral and ecological features that underlie the formation of complex seed shadows.

Plenary 6.3 in *Movement Ecology, Dispersal Kernels, and Genetic Effects (continued)*: Einstein Auditorium, 15.06.2010, 12:00-12:30

Complex and simple models of plant spatial dynamics using real dispersal data

JAMES BULLOCK[1]

[1] Centre for Ecology and Hydrology

Dispersal is simply part of the life cycle and models are being developed to use dispersal data alongside standard demographic measures of birth, growth, fecundity and death. Models vary in complexity and generality from simple, general mathematical models to complex but specific individual-based simulations. These models are useful for different questions, but all require accurate measures of dispersal and other aspects of the life cycle. I present our studies which have implemented this philosophy in modelling the spatial dynamics of plants. These studies include modelling invasions, species re-introductions and metapopulation dynamics. I show how even simple models can be effective for answering complex questions. Conversely, complex models which include many real-life conditions such as stochasticity and realistic long-distance dispersal question the validity of metapopulation theory derived from simple models. The importance of the form and distance of the dispersal kernel is central to these studies, showing that intricate models can never replace detailed fieldwork to quantify dispersal. However, the whole life-cycle measures required for these models emphasise the importance of less fashionable parts of the life cycle, such as survival of the seedbank.

Plenary 7.1 in *The Seed Dispersal Kernel*: Einstein Auditorium, 15.06.2010, 14:00-14:30

What on earth is a dispersal kernel? Why loose terminology confuses everyone and proliferates mistakes.

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Modellers coined the term "kernel". It sounds scientific, is embedded in theoretical work, so now everyone is using it. But the one word is being used to mean two very different things. Many papers confuse the frequency of seeds dispersing a given distance with the density of seeds arriving at a particular point. These are quite different, and have very different shapes, but both are being called kernels. Modellers usually model "in one dimension" but parameterise their models with data from two dimensions. The result is that mistakes are being made, interpretations of results are inappropriate, and in many papers it is unclear what the authors have done. In this paper, I will yet again plead for a consistent use of nomenclature. I will explain the difference between the two types of dispersal "curve", review the use of the term "kernel" by modellers, give examples of where nomenclature is ambiguous and examples of where errors have been made in predicting dispersal patterns.

Oral 7.2 in *The Seed Dispersal Kernel*: Einstein Auditorium, 15.06.2010, 14:30-14:45

Estimating seed dispersal kernels by tracking seeds: the effects of large terrestrial mammals on the fates of seeds with various defense strategies in a Costa Rican rain forest

ERIN KUPREWICZ[1]

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In neotropical rain forests, large terrestrial mammals are major seed dispersers and predators. The positive and negative effects that mammals have on seeds influence tree propagation yet little is known about how the interplay between frugivore handling strategies and seed defenses affect seed fates. Central American agoutis (*Dasyprocta punctata*) scatter-hoard seeds and collared peccaries (*Pecari tajacu*) consume and kill most of the seeds they encounter. The main goal of this study was to assess how agoutis and peccaries affect the dispersal and survival of diaspores with no defenses, physical defenses, or chemical defenses against predation at Estación Biológica La Selva, Costa Rica. I tracked thread-marked diaspores of five large-seeded plant species either exposed only to agoutis or exposed to agoutis and peccaries. Non-defended and chemically-defended seeds suffered high levels of predation by peccaries whereas agoutis consumed many physically-defended seeds. All chemically-defended seeds were consumed by peccaries *in situ*. Peccaries and agoutis exhibited significantly different patterns of seed removal, but when taking into account seed fates, these mammals exhibited similar patterns of seed dispersal. Peccaries and agoutis did not differ in median dispersal distances of seeds from sources. In peccary-rich forests, seeds protected by hard endocarps are more likely to survive, be hoarded by agoutis, and potentially germinate than unprotected or toxic seeds.

Oral 7.3 in *The Seed Dispersal Kernel*: Einstein Auditorium, 15.06.2010, 14:45-15:00

Genetic estimation of the seed dispersal kernel

JUAN J. ROBLEDO-ARNUNCIO[1]

[1] CIFOR-INIA

Unlike seed-tagging and non-genetic inverse modelling approaches, genetic parentage analysis allows making inferences on the individual origin of dispersed seeds for large seed samples originating from many potential maternal plants; it thus provides a powerful mean for dispersal kernel fitting based on mother-seed dispersal distances. This is especially true since the genetic analysis of maternally inherited diploid seed tissue has solved the longstanding two-parent dilemma inherent in parentage analysis of cosexual species, which burdened kernel estimation models with usually arbitrary assumptions on the relative location of parent pairs. Several methodological and sampling issues must still be considered, however, in order to estimate accurately the dispersal kernel using exact maternity assignment based on maternal-origin seed tissue. Using simulated and empirical data, I describe here the logic behind available methods, highlighting the importance of (i) properly accounting for the spatial arrangement of seed collection sites relative to source plants, (ii) sampling scale and intensity, and (iii) kernel function selection. I further provide some practical sampling recommendations and discuss ways of using immigrant seeds from outside the study area in order to incorporate long-distance dispersal events into kernel estimates.

Oral 7.3 in *The Seed Dispersal Kernel*: Einstein Auditorium, 15.06.2010, 15:45-16:00

Measuring dispersal kernels through inverse modeling: density dependence of seed dispersal in a Neotropical palm

MARCO D. VISSER[1], PATRICK A. JANSEN[1], S. JOSEPH WRIGHT[2], HELENE MULLER-LANDAU[2]

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Understanding the mechanisms that allow species coexistence in complex systems like tropical forest is a fundamental challenge facing scientists today. One leading hypothesis, dispersal limitation, states that the distribution of species depends on their ability to disperse to suitable habitats. Here we tested the previously unexplored hypothesis that seed dispersal by animals can be negatively density-dependent. Specifically, we expected that clumping of conspecific adults would increase intra-specfic cometition for seed dispersers, resulting in reduced seed dispersal compare to isolated trees. We measured effects of adult density on seed dispersal distances in the palm *Attalea butyracea* on Barro Colorado Island, Panama. We sampled dispersed seeds from the soil at varying distances from adult trees at sites that ranged widely in *Attalea* density. Then we used inverse modeling (IM) to estimate dispersal kernels and compared those across sites. We found that IM-estimated dispersal distances, obtained from fitted dispersal kernels, were indeed negatively related to the density of adults. This provides evidence that animal-mediated seed dispersal can decline with increasing fruiting tree density likely due to satiation. This reduction in seed dispersal effectiveness should increase dispersal limitation, causing less seeds to reach sites suitable for germination and growth. Density-dependent dispersal may therefore facilitate tree species coexistence.

Oral 7.4 in *The Seed Dispersal Kernel*: Einstein Auditorium, 15.06.2010, 15:30-15:45

Estimating seed dispersal kernels from fine-resolution animal movement data: better to be breakfast or dinner?

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Our understanding of seed movement is restricted by the difficulty of tracking individual seeds. New GPS tags allow high resolution movement data for animals. This opens the possibility of combining animal movement data with seed retention times to estimate a dispersal kernel. However, animals do not move evenly throughout the day but follow daily rhythms. For example, typical birds are most active in the morning, less active in the afternoon, and have no nocturnal movement. We used GPS tags with accelerometer activity sensors to track toucan (4 *Ramphastos sulfuratus* and 2 *R. swainsonii*) movement at 15 min intervals in Gamboa, Panama. We used their pattern of movement and activity to distinguish bouts of feeding and generated trajectories of seeds eaten in each of these implied feeding bouts. We use these to estimate the probability that toucan would move a particular distance over a particular time interval. We also estimated regurgitation times for toucans by feeding ripe fruits (*Virola nobilis*) to captive toucans. Finally, we calculated the dispersal kernel by combining these probabilities of regurgitation and movement over time to estimate the proportion of seeds that would move various distances away from the mother tree. We will present this seed dispersal kernel for *Virola* and toucans and show the effect of time of day on seed movement. We will also illustrate a variety of real bird and mammal movement kernels using tracking data from www.movebank.org.

Oral 7.6 in *The Seed Dispersal Kernel*: Einstein Auditorium, 15.06.2010, 15:00-15:15

Estimating dispersal kernels through mechanistic modelling

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Seed dispersal kernels describe the distribution of dispersed seeds in space. They are very useful to ecologists because they inform us where the majority of dispersing seeds will end up, how far seeds can disperse, and with what probabilities. However, seed dispersal kernels are very difficult to quantify. This is mostly because the seeds that travel over the longest distances are extremely difficult to track, resulting in a lack of data on the long-distance end of the dispersal kernel. One way to address this problem and quantify complete dispersal kernels is mechanistic modeling. In this approach, models are built that describe the mechanisms underlying the dispersal process. These models are then tested against trapping and tracking data at short to medium distances, and (when found accurate) used to extrapolate to cover the full dispersal kernel. A great benefit of this approach is that it allows us to assess which processes determine the dispersal kernels. Also, through model sensitivity analysis, it allows us to assess which seed, plant and environmental variables are most important in determining dispersal distances. In this way mechanistic modeling does not only help us quantify dispersal kernels, but also helps us understand which variables and processes contribute to shaping the kernels – and to what degree.

Oral 7.7 in *The Seed Dispersal Kernel*: Einstein Auditorium, 15.06.2010, 15:15-15:30

Saplings arise from dispersed seeds

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For nearly 8 years we have monitored a grid of 289-0.5 m^2 seed traps in hyperdiverse floodplain forest at the Cocha Cashu Biological Station in Perú. Approximately 900 trees ≥ 10 cm dbh have crowns that overhang the 1.44-ha grid. With traps every 7.5 m, few fruiting events escape detection. By knowing the locations and crown dimensions of fruiting individuals, the seed rain can be partitioned into dispersed vs. undispersed fractions. Species differ greatly in the fraction of seed crops that are dispersed, with values ranging from < 10 % to nearly 100 %. The rain of dispersed seeds is extremely sparse. For example, the rain of “intact” (presumptively dispersed) seeds of the two most abundant non-palm tree species at Cocha Cashu is 0.11 and 0.10 seed per m^2-y. Concurrent monitoring of sapling recruitment in the same area has shown, a) that sapling recruitment is very low in the vicinity of fruiting adults, and b) that dispersed seeds carry probabilities of producing saplings that are many times greater than those of undispersed seeds. Calculated seed dispersal kernels that treat undispersed and dispersed seeds as equal are therefore biologically invalid. Studies of disperser ranging behavior indicate that the rain of dispersed seeds is widely mixed on scales much larger than the nearest-neighbor distances between adult trees. These findings imply that a loss of disperser function will lead to a sharp reduction in the diversity of species that can persist over time.

Plenary 8.1 in *Seed Dispersal on Islands*: Einstein Auditorium, 15.06.2010, 16:30-17:00

Seed dispersal on islands: a global overview of insular frugivores

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Island ecosystems are famous as natural laboratories for studies in ecology and evolution because of their isolated and relative simple ecosystems. However, compared to continental ecosystems, seed dispersal interactions on islands have only been little studied. And yet, among the 'noise' of all the quirky, endemic evolutionary ecology that makes island biology so fascinating, there may be general patterns. For example, while plant diversity on islands is highly idiosyncratic, insular frugivore communities are, or were, often assembled from a fairly low number of taxonomical groups, e.g. lizards, tortoises, pigeons, and fruitbats. We here present a global overview of island frugivores, focusing on broad-scale taxonomical and geographical patterns. Using a subset of the world's tropical and subtropical islands, both continental and oceanic, we investigate effects of island size, age and isolation on frugivore assemblages, and highlight global patterns. We further explore how recent extinctions have likely influenced seed dispersal interactions on islands.

Oral 8.2 in *Seed Dispersal on Islands*: Einstein Auditorium, 15.06.2010, 17:00-17:15

The time is ripe for the study of seed dispersal by bats in the greatest of the Antilles: identification of the species involved and a preliminary characterization of the interaction

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The abilities of bats as seed dispersers and its contribution to forest regeneration have been highlighted. In the Caribbean islands a small group of phyllostomid bats play the role of its continental counterparts. The characteristics of this interaction in the Antillean region have been poorly described and the impact of bats to forest regeneration has received little attention. In our work we identify native and introduced plants that are dispersed by bats in the Cuban archipelago. Morphometry of fruits is described and related to skull and jaw characteristics. Distances of dispersion of fruits from the parental trees are related to locomotion indexes of bats. The composition of the diet of fruit-eating bats is also examined, and the ecological contributions of bats are assessed for the main plant formations of Cuba. Finally it is presented a list of plants that are dispersed by Cuban bats, which includes about 90 species of 35 families and its location in the Cuban archipelago. This list can become a baseline for the study of this interaction in fragile and unique insular ecosystems as inland mogotes and coastal vegetation.

Oral 8.3 in *Seed Dispersal on Islands*: Einstein Auditorium, 15.06.2010, 17:15-17:30

Giant frugivorous lizards and *Pandanus*: seed dispersal and seed fate in lowland dipterocarp forests of the Philippine Islands

DANIEL BENNETT[1]

[1] Polillo Butaan Poject

Pandanus are an important component of the subcanopy of some lowland dipterocarp forests in the Philippines, and provide unique microhabitats for many fungi and vertebrate and invertebrate fauna. At least three species of large (> 7kg), frugivorous monitor lizards occur in the Philippines, all of which appear to be dependant on *Pandanus* species. On Polillo Island, Quezon Province, *Varanus olivaceus* feeds on *P. radicans* (present in 39.1 % of fecal samples) and *P. simplex* (present in 8.4 % of samples), and appear to be the only animals that ingest these drupes. Whilst virtually all fruiting *P. simplex* trees in forests were visited by lizards, less than 50 % of fruiting *P. radicans* were visited. Lizards deposited feces containing an average of 8 or 9 *Pandanus* drupes a mean of 46 m (*P. radicans*) and 93 m (*P. simplex*) from the nearest potential parent plant. Germination of *P. radicans* and *P. simplex* seeds was observed in 62 % and 33 % of feces left *in situ* and revisited after 1-3 years, with mean germination rates per fecal clump of 25.4 % and 23.7 %, respectively. Germination for *Pandanus* was slower than for most other seed species in fecal clumps, and many drupes which had not germinated were still viable two years or more after deposition. The results indicate that the lizards are important dispersers of *Pandanus*. However, anecdotal evidence suggests that *P. simplex* might not be a natural component of the forest flora, but introduced by lizards from plants introduced to the island by people and planted near forest edges.

Oral 8.4 in *Seed Dispersal on Islands*: Einstein Auditorium, 15.06.2010, 17:30-17:45

Estimating the effectiveness of seed dispersers: the seed dispersal system of *Corema album* in the Canary Island

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Effectiveness is the best parameter to express the benefit that a plant obtains from a disperser. It is crucial to understand the ecological and evolutionary consequences of seed dispersal but remains largely uninvestigated as it is very complex to measure. We measured the effectiveness of seed dispersers (gulls, *Larus michahellis*, blackbirds, *Turdus merula*, and rabbits, *Oryctolagus cuniculus*) of the shrub *Corema album* (Empetraceae) in the Canary Islands (NW Spain) with a stochastic simulation model of the recruitment process parameterized with field data of seed dispersal, predation, and seedling emergence, and validated with independent data on seedling density. This model presents several advantages compared to previous models of plant recruitment and allows estimating, for the first time, disperser effectiveness as seedlings/m^2 contributed by each disperser. Gulls were 3-125 times more effective than the other species. Plant dependence on each disperser differed between the 3 habitats studied. Quantity and quality of dispersal were not correlated. Quality was a better predictor of effectiveness. A sensitivity analysis showed marked differences in the impact of frugivores depending on fruit avalilability: poor-quality dispersers had positive effects on recruitment with high fruit availability, but negative when fruits were limited. Thus, the same species may play a positive or negative role depending on the circumstances, which may vary at both spatial and temporal scales.

Oral 8.5 in *Seed Dispersal on Islands*: Einstein Auditorium, 15.06.2010, 17:45-18:00

Pigeons as frugivores on insular environments: the case of two sympatric species in the Canary Islands

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The frugivory is the predominant trophic strategy adopted by many insular species of pigeons, playing an important role on the structure and composition of plant communities. In a recent review carried out by our research group, we suggested that more detailed and systematic studies on diet should be performed to understand the ecological and evolutionary effects of pigeons on their ecosystems. Probably this lack of information is due to the methodological complexity of these trophic studies. Therefore, we decided to develop some complementary techniques which were applied on the two endemic pigeons of the Canary Islands (*Columba bollii* and *C. junoniae*). Due to the fact that in the Canaries inhabits two species of endangered pigeons, it was convenient to study the diet by the development of non-invasive methods, based in droppings. Therefore, firs table, it was necessary to develop protocols of extraction and amplification of DNA in order to identify both pigeons from a genetic point of view. Once identified the droppings, we proceeded to the microhistological study of the diet and trophic ecology of both endemic pigeons. As general patterns, we have confirmed that both species have a vegetarian diet and that they share a high number of diet components. However, the quantitative component is clearly different.

Oral 8.6 in *Seed Dispersal on Islands*: Einstein Auditorium, 15.06.2010, 18:00-18:15

Novel dispersal relationships on remote oceanic islands affect native communities and species invasions in French Polynesia

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The arrival of introduced organisms on remote oceanic islands can disrupt mutualisms between frugivores and plants. These changes can trigger cascading consequences for native communities and can facilitate the spread of invasive plants. In the tropical high islands of French Polynesia, three frugivores disperse the seeds of many plants, both native and exotic. We investigated the network of relationships between frugivores and fruit bearing plants on the islands of Tahiti and Moorea. Bird diet was determined through analysis of fecal samples. Seed viability was assessed with germination tests with seeds extracted from intact fruits and fecal samples. Our results show a high level of integration between native and exotic organisms. Birds consumed the fruits of 21 species, 13 of which are introduced and naturalized. Exotic seeds remain viable after digestion, while the seeds of two native plants show enhanced germination after digestion by native frugivores highlighting the important role of dispersal. Native frugivores consume many exotic species which provide a highly abundant and continuously available resource. These indirect impacts of species invasions are likely to be detrimental to the regeneration of native forests.

Oral 8.7 in *Seed Dispersal on Islands*: Einstein Auditorium, 15.06.2010, 18:15-18:30

Restoring seed dispersal functions using taxon substitutes

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[1] Biological Sciences, University of Bristol

Restoring ecosystem functions, such as endozoochorous seed dispersal, on oceanic islands using native fauna may be impossible. Large seeds often require suitably large dispersers. The disproportionate extinction of large vertebrates and oceanic islands' lower functional diversity means that plant species with large seeds are often anachronistic. On the offshore island, Ile aux Aigrettes (Mauritius), I investigated whether the fruits of the native ebony, *Diospyros egrettarum*, were seed dispersal limited. Historically, these fruits were dispersed primarily by the extinct Mauritian giant tortoises, *Cylindraspis triserrata* and *C. inepta*, that occurred in large densities. In 2000, a small population of Aldabran giant tortoise, *Aldabrachelys gigantea*, were introduced with the aim of reinstating the lost seed dispersal function once performed by the extinct Mauritian tortoises. Here, I provide the first empirical data indicating that these taxon substitutes are capable of restoring ecosystem functions. In addition, I found that dispersal improved fitness and survival supporting the Janzen-Connell model, and that gut passage enhanced the germination rate and percentage of seeds that germinated. When suitable native species are unavailable, carefully selected exotic species, taxon substitutes, can be used to restore missing ecosystem functions and aid ecological restoration.

Plenary 9.1 in *Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal Systems*: Einstein Auditorium, 16.06.2010, 08:30-09:00

The abundance and diversity of vertebrate frugivores at lanscape levels in Amazonia

José Manuel V. Fragoso[1], L. Flamarion Oliviera[2], Kirsten Silvius[3], Jane Read[4]

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[3] Gordon and Betty Moore Foundation
[4] Syracuse University

Frugivorous animal distribution should be patchy in response to the aggregated distribution of fruiting trees. We test this hypothesis with data collected from a little disturbed 30,000 km square region of Amazonia, and control for the effects of hunting. We selected natural vegetated areas around 13 villages and 3 unhunted areas for study. At each site, transect arrays (for counting animals) were divided into two concentric zones, heavily hunted (0 – 6 km) and moderately hunted (6 – 12 km), with four 4-km transects within each zone. This sampling protocol was also applied at the three unhunted areas. We recorded all observations of the 21 animal species most frequently killed by humans. A total of 6,608 km were walked on all transects over 2 years. Animal abundances varied within unhunted areas, within human hunted areas, and between hunted and unhunted areas. Surprisingly the abundance of some of the most hunted species, occurred around villages rather than in unhunted regions. We conclude that contiguous areas in undisturbed regions can support very different diversities and levels of frugivorous vertebrate species, and that human occupied areas, even when they experience hunting may support vertebrate abundance and diversity levels greater than what occurs in areas undisturbed by humans. We discuss the implications of these patterns for understanding animal influence on tree distribution patterns.

Plenary 9.2 in *Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal Systems*: Einstein Auditorium, 16.06.2010, 09:00-09:30

Hunting impacts on recruitment of large-seeded palm species: are Neotropical forests getting palm-dominated?

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[1] Wageningen University & University of Groningen

Poaching lowers the abundances of large-bodied animals, including many important seed dispersers and seed predators of particularly large-seeded plant species. The resulting simultaneous reduction of seed dispersal and seed predation by vertebrates likely affects the recruitment success of large-seeded species, but it is unclear and hard to predict how. We studied how poaching affected patterns of seed dispersal, seed predation and seedling recruitment in large-seeded palms in the tropical moist forest of Central Panama. These palms are primarily dispersed by agoutis, which scatter-hoard seeds as food supplies throughout the forest understory. We found that poaching negatively affected seed dispersal due to satiation of the few remaining dispersers, resulting in increased seed exposure to seed-predatory insects. However, poaching reduced predation of cached seeds by vertebrates so much that seedling recruitment nevertheless increased dramatically. Seedlings were more clumped under poaching yet density-dependent seedling mortality did not compensate for the recruitment advantage. It appears that palms benefit from poaching as long as agoutis do not go extinct, because it affects predation more than dispersal. Studies on other palm species suggest that this phenomenon is common in Neotropical forests. Palms tend to attain dominance in disturbed forests, which usually have high levels of hunting, at the cost of other tree species and hence biodiversity.

Plenary 9.3 in *Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal Systems*: Einstein Auditorium, 16.06.2010, 09:30-10:00

Human impacts on tropical forest dispersal systems: implications for large frugivorous birds and long-distance dispersal

KIMBERLY M HOLBROOK[1], BETTE A LOISELLE[2], THOMAS V DIETSCH[3], TONY CHASER[3], MARTIN WIKELSKI[4], THOMAS B SMITH[3]

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[3] University of California-Los Angeles
[4] Max Planck Institute

Anthropogenic influences have major and lasting effects on tropical forest ecosystems and processes. Seed dispersal, a key process that drives forest diversity and genetic structure, has been shown to be negatively impacted by human activities. Long-distance dispersal (LDD) is particularly important in population spread, colonization, and gene flow among populations. Large frugivores, such as hornbills and toucans that are more likely to contribute to LDD, are especially vulnerable to hunting and habitat fragmentation. We discuss the implications of alteration of seed dispersal at local and regional scales for these two large frugivores based upon animal movement tracking and genetic insights on effective dispersal in plants. Previous research showed hornbills to move up to 290 km from tagging sites and to regularly move seeds more than 500 m from fruiting trees. Recent work with hornbills (14 individuals tagged with satellite GPS units) in Cameroon confirms long-distance movements of > 100 km. In Ecuador, toucans were shown to regularly disperse seeds up to 450 m with longest recorded movements of 3.7 km. Finally, a study using molecular methods to compare dispersal distances in hunted and non-hunted sites demonstrated a 50 % reduction of dispersal distance by toucans at the hunted site. Frugivore movements likely have a profound effect on forest regeneration and structure and should be considered an important aspect of conservation in tropical forests.

Plenary 9.4 in *Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal Systems*: Einstein Auditorium, 16.06.2010, 10:00-10:30

Movement patterns and seed dispersal by frugivorous birds in fragmented landscapes

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Long-distance movements of birds are necessary to disperse seeds of trees among forests, forest fragments and other semi-natural patches of habitat. Whereas we have a first understanding of movement patterns of birds and resulting seed shadows within homogenous habitats, little is known about movement and seed dispersal in heterogeneous landscapes. We quantify movement patterns and seed dispersal of large frugivorous birds, in particular Trumpeter Hornbills (*Ceratogymna bucinator*) and blackbirds (*Turdus merula*) in fragmented landscapes in South Africa and Germany. To track movement patterns we use (among others) telemetry devices that store data on the location of the bird on the bird; the data can later be downloaded. This technique allows to collect data on movement patterns of large birds at the landscape scale with hitherto unreached quality. We use these data together with data on habitat distribution, fruit availability and gut passage times to calculate seed dispersal kernels and spatially explicit seed rain at the landscape scale. These data are essential to evaluate the ability of tropical and temperate trees to disperse in fragmented landscapes, especially under climate change.

Plenary 10.1 in *Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal Systems (continued)*: Einstein Auditorium, 16.06.2010, 11:00-11:30

Frugivory and seed dispersal by bats: effects of habitat degradation and fragmentation on plant diversity and distribution

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[1] Experimental Ecology, University of Ulm

Bats (Chiroptera) are highly mobile links that promote plant recruitment and diversity through transportation, processing and handling of seeds as well as through selection of (micro)habitats and feeding sites. Quality and quantity of dispersal services depend strongly on species composition and abundance and associated behavioral and physiological characteristics of the main disperser(s). Human impact, in particular changes in land use, (over)hunting and global (climate) change increasingly affect these intricate interactions. Combining results from published work and our own studies, I am providing a synthesis on current knowledge, how habitat degradation and fragmentation affect community composition and structure of bats and how these changes are likely to translate into changes in plant distribution and diversity. Here, ecological and behavioral flexibility of the dispersers and differential reactions towards disturbance, as well as landscape attributes (i.e., connectivity), and other dispersers (i.e., birds, primates) lead to a highly complex picture. Inclusion of physiological parameters is of the essence. As an example, changes in (micro)climate may alter the distribution of scent, one of the main attractants of chiropterous fruits. The overview ranges from case studies on behavior, mobility and resource use of individual species on the local scale to comparisons contrasting composition and structure of frugivorous bat assemblages in the Old and New World (sub)tropics on a global scale. Future research needs to be targeted explicitly towards interdisciplinary work with well-founded predictions that provide the scientific basis for improvement of management strategies to slow down or stop further loss of this important ecological service.

Plenary 10.2 in *Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal Systems (continued)*: Einstein Auditorium, 16.06.2010, 11:30-12:00

Plants on the move: dispersal and colonization in a rapidly changing climate

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Modern global climate is warmer than that recorded throughout most of the Quaternary and temperatures are predicted to rise at an unprecedented rate. As a consequence, plant species worldwide are expanding their ranges towards higher latitudes and altitudes through the establishment of new populations at range limits. Seed dispersal is the principal means for plant populations to colonize newly available areas. A great uncertainty exists to which extent dispersal limitation is constraining the ability of species to reach such areas under rapid climatic change, and how differences in the colonization ability of species are contributing to reshuffle communities. Recent advances in dispersal ecology have been largely ignored by attempts to model the impact of climate change on species distributions. Here I explore potential effects of climate change on the successive demographic processes involved in plant dispersal and population spread. Except for altitudinal treelines, few dispersal studies have to date examined actively expanding pioneer populations at the forefront of advancing range margins. Therefore little is known about how processes such as propagule production and movement, pre- and postdispersal seed predation or seedling establishment are affected by the particular ecological situation of pioneer populations. I review the existing evidence and discuss how these processes could be influenced by climatic changes such as increases in mean temperature, CO2 concentrations or the frequency of extreme climatic events. Finally, I highlight potential implications of emerging patterns in attempts to model future species distributions under rapid climate change.

Plenary 10.3 in *Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal Systems (continued)*: Einstein Auditorium, 16.06.2010, 12:00-12:30

Modelling dispersal in the context of plant invasions: interactions between dispersal, landscape structure and management determine the most effective management strategy

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[1] Sustainable Ecosystems, CSIRO

Plant invasions are increasingly recognised as a major threat to tropical forests. Because plant invasions are fundamentally about the movement of plant propagules through landscapes, an understanding of dispersal holds the promise of informing both our understanding of invasion processes and improving their management. Despite the effort invested into describing dispersal in tropical forests, there has been little investment in the application of this knowledge to the management of rainforest invasives. Here we use descriptions of dispersal kernels to predict the pattern of spread of rainforest invasives at a landscape scale and to identify options for improved management of invasive plants in tropical forest systems. We do this using an empirically derived, mechanistic model of vertebrate dispersal kernels, integrated into an individual-based, spatially-explicit simulation model of a plant population and parameterised with the life-history parameters of a major invasive species of rainforest, *Miconia calvescens*. Using this model we explore the effect of environmental heterogeneity and mortality factors on the rate and pattern of invasive spread. We use the model to examine the interaction between management and invasive spread to identify 'rules of thumb' for the design and conduct of management programs. The model and field results provide a clear example of the major contribution that dispersal ecology has to make to the management to a major environmental threat.

Plenary 11.1 in *Anthropogenic Impacts on Frugivory and Seed Dispersal: Mechanisms, Scales and Consequences*: Einstein Auditorium, 16.06.2010, 14:00-14:30

Pervasive consequences of overhunting in Amazonian forests: a basin-wide meta-analysis of kill profiles and implications to ecosystem structure

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We investigate nearly continental scale patterns of game vertebrate biomass across a large network of sampling sites surveyed over two decades throughout lowland Amazonia and the Guianan Shields. Macroecological patterns at different spatial scales are examined in terms of the historical and environmental determinants of habitat patch occupancy and species turnover. We first examine the extent and scale of the game vertebrate harvest across Amazonia. Patterns of frugivore abundance in structurally undisturbed forest sites are then explained in terms of key determinants of population densities, including forest type, floristic diversity, forest hydrology, rainfall seasonality, soil fertility and degree of hunting pressure. Regional scale estimates of aggregate frugivore biomass are highly variable and crucially dependent on the interaction between baseline habitat productivity and levels of offtake. On the basis of a large number of tree plots, we then estimate the consequences of persistent defaunation to forest structure and composition, and ultimately the magnitude of ecosystem services foregone by the chronic depletion of vertebrate frugivores.

Oral 11.2 in *Anthropogenic Impacts on Frugivory and Seed Dispersal: Mechanisms, Scales and Consequences*: Einstein Auditorium, 16.06.2010, 14:30-14:45

Bird-mediated seed dispersal across fragmented landscapes: interactions between habitat cover and quality

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The ability of individuals to disperse through matrix habitats is a major factor behind extinction risk of species in human-impacted landscapes. For animal-dispersed plant species, dispersal success simultaneously depends on how habitat fragmentation drives both quantitative and qualitative changes in landscape structure and how these changes affect foraging behaviour of their seed-dispersal vectors. By using inverse models, we integrate these effects to explore the mechanisms by which habitat fragmentation shapes the seed dispersal kernels of *Crataegus monogyna*, in a fragmented forest of northern Spain. Our approach combined changes in both cover and fruit abundance at the immediate surround of parent plants (i.e., source effects) as well as through all environments that seeds potentially encountered along its dispersal (i.e., path effects). We found that fruit-resource was the main factor in explaining both source and path effects on seed dispersal kernels both years. Our findings imply that temporal and spatial variations in fruit availability critically condition the effects from habitat spatial configuration on frugivore decisions and therefore plant dispersal resilience in human-modified landscapes. Therefore, no consideration of the underlying resource distribution might obscure the relationship between landscape pattern and ecological processes, and subsequently our understanding about the pervasive negative effects of habitat fragmentation on biodiversity.

Oral 11.3 in *Anthropogenic Impacts on Frugivory and Seed Dispersal: Mechanisms, Scales and Consequences*: Einstein Auditorium, 16.06.2010, 14:45-15:00

Pollination and seed dispersal in human-shaped landscapes

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Urbanization and agricultural intensification have destroyed and fragmented habitats causing changes in biodiversity and community composition. Consequently, modifications of ecological services such as pollination and seed dispersal might threaten isolated populations of plant species in the surviving remnants. We therefore investigated the pollinator and frugivore assemblages as well as the relative functioning of pollination and seed dispersal of rowan trees (*Sorbus aucuparia*) in forest, field margins and villages in the vicinity of Marburg, Germany. Pollinator diversity and abundance did not differ among the habitat types. Also, the proportion of flowers setting seeds was similar across the habitat types despite differences in community composition. Frugivore diversity did not differ among the habitat types. However, abundance of birds as well as the number of seeds dispersed per tree differed among the habitat types with decreasing number of visitors and dispersed seeds from forest over field margins to villages. These findings suggest a promising natural regeneration potential in human-shaped landscapes.

Oral 11.4 in *Anthropogenic Impacts on Frugivory and Seed Dispersal: Mechanisms, Scales and Consequences*: Einstein Auditorium, 16.06.2010, 15:00-15:15

Changes in the frugivore assemblage reduce seed dispersal potential in fragmented Australian rainforest

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Declined frugivore abundance potentially has consequences for the dispersal and regeneration of a large number of rainforest plants. Here, we describe consequences of forest clearing and fragmentation for frugivores and seed dispersal in rainforests of subtropical Australia. First, we quantified frugivorous bird and bat abundance in forest fragments and patches of regrowth rainforest. Second, we assessed the potential of frugivore species to disperse the seeds of different rainforest plants based on dietary information. Third, we identified the plant taxa that were likely to experience substantially reduced dispersal in fragmented rainforest as a result of frugivore declines in these areas. As in other regions of the world, larger-bodied frugivore species are most disadvantaged in the fragmented forest landscape, meaning that there are fewer dispersers of large-seeded plants in these areas. There are also likely to be few dispersers of plants from certain families (e.g., Lauraceae, Myrtaceae and Rubiaceae) in fragmented rainforest. We predict reduced dispersal and altered patterns of regeneration of this significant suite of plants in rainforest fragments. However, in contrast with what has been reported for other regions, it appears that the majority of native plants retain the potential for dispersal in the study region. This may be due to high functional overlap among frugivore species, a relatively high inherent tolerance of forest fragmentation, and/or a low level of hunting in this part of the world.

Oral 11.5 in *Anthropogenic Impacts on Frugivory and Seed Dispersal: Mechanisms, Scales and Consequences*: Einstein Auditorium, 16.06.2010, 15:15-15:30

Altered frugivore communities in changing landscapes- consequences for plant recruitment

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Seed dispersal by frugivores plays a key role in plant community and population dynamics, yet direct and indirect effects of habitat and landscape changes on the recruitment of animal-dispersed plants remain poorly known. We examined if, and to what extent, recruitment at early life-stages of a bird-dispersed tree differs between and within forest fragments varying in size, surrounding matrix and microhabitats. Three years of field experiments revealed that patterns of seed germination and seedling survival were largely inconsistent, both in space and time. However, two clear patterns emerged from this study. First, performance of seeds and seedlings was consistently better away from than under conspecific fruiting trees. This indirectly translates into reduced recruitment in heavily disturbed fragments, where most seeds remain undispersed due to the loss of key disperser species. Second, exotic plantations bordering indigenous forest fragments may provide suitable conditions for native tree recruitment. Individual based modelling predicts a 90 % recruitment increase in tiny forest remnants buffered by exotic plantations compared to those surrounded by farmland, this nursing effect being less effective under dryer conditions. We conclude that habitat changes affect frugivorous seed dispersal and plant recruitment in complex and context-dependent ways, having important implications for on-site habitat management in view of current global change.

Oral 11.6 in *Anthropogenic Impacts on Frugivory and Seed Dispersal: Mechanisms, Scales and Consequences*: Einstein Auditorium, 16.06.2010, 15:30-15:45

Megafaunal losses: when does a forest become empty?

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Animal seed dispersal is a key ecological process that maintains forest diversity and ecosystem function by shaping the distribution and regeneration of plant species. In particular, large vertebrates are important long distance seed dispersers of large-seeded plants due to their large home ranges and long gut retention times. Unfortunately, increased hunting pressure and habitat loss are seriously threatening these animals and their role in the ecosystem. Thus, it is necessary to understand whether "empty forests" can sustain their species diversity in the long term. In this study, we explore the possibility that forests become functionally "empty" before megafauna species are lost due to the disruption of ecological processes such as long distance seed dispersal. Our study focuses on the interaction between the Baird's tapir (*Tapirus bairdii*), the largest neotropical terrestrial mammal, and the large-seeded plant species, *Manilkara zapota* (zapote). We hypothesized that a disruption in the long distance seed dispersal by tapirs can cause a decrease in their effectiveness as seed dispersers, triggering a cascade of ecological effects. We extend our observations to other megafauna-large seeded plant interactions and suggest that forested areas where megafauna species are still present might become 'empty' if key elements of seed dispersal are lost. Future research on long-distance seed dispersal by megafauna is necessary to prevent the loss of functional ecosystems.

Oral 11.7 in *Anthropogenic Impacts on Frugivory and Seed Dispersal: Mechanisms, Scales and Consequences*: Einstein Auditorium, 16.06.2010, 15:45-16:00

Defaunation drives rapid evolutionary shrinkage of seeds

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Large frugivorous birds, such as toucans, are important seed dispersers of large seeds in neotropical ecosystems. We present evidence demonstrating that seed size of the palm *Euterpe edulis* has been reduced in forests where these birds are rare or extinct due to poaching or fragmentation. We argue that similar evolutionary changes in seed size may be underway worldwide, since large frugivores are the first to disappear in the current extinction crisis.

Plenary 12.1 in *Evolution of Dispersal*: Einstein Auditorium, 16.06.2010, 16:30-17:00

An overview of evolutionary models for the evolution of dispersal

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Dispersal allows to escape local competition (with either kins or unrelated individuals of the same species, or with different species) by moving to less crowded sites. Such new sites can either be produced by local extinctions through disturbance, or by environmental changes extending the potential distribution range of a species. Dispersal can also evolve as a bet-hedging strategy, to avoid transitory locally bad conditions (such as those leading to local extinctions). Finally, dispersal allows to avoid inbreeding. The evolution of dispersal thus depends on the amount of temporal and spatial variability, on the cost of dispersal, on local population sizes, and on the mating system, which are all likely to vary with dispersal distance and hence the spatial scale of dispersal. Whether environmental changes lead to increased or decreased dispersal depends on their effects on these parameters and the spatial scale considered. Because such changes are likely to affect suite of traits rather than just dispersal, it is necessary to consider the joint evolution of dispersal with other life-history traits (e.g., reproductive effort, dormancy) in order to predict evolutionary patterns. Plant dispersal can concern both pollen and seed dispersal, thus it might also evolve through the evolution of mating systems. Last, dispersal might be phenotypically plastic, e.g. might respond to local crowding; it might also be directed, leading to the evolution of habitat selection and specialization.

Oral 12.2 in *Evolution of Dispersal*: Einstein Auditorium, 16.06.2010, 17:00-17:15

Can long-distance seed dispersal respond to natural selection?

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Long-distance seed dispersal (LDD) is of paramount importance for the large-scale and long-term dynamics of plants, and for their ability to respond to future environmental change. Moreover, LDD has large fitness consequences suggesting that it should be subject to strong natural selection. However, a widely accepted dogma of plant ecology states that LDD cannot respond to natural selection because it results from chance events over which plant phenotypes (and hence genotypes) exert no control. Here I re-examine this dogma by making use of the exceptionally good knowledge we have on the seed dispersal and macroevolution of Proteaceae from the South African Cape Floristic Region. In a comparative study of 35 species of Proteaceae, I combine mechanistic models for seed dispersal by wind with species-specific measurements of dispersal traits and a molecular phylogeny. This combination of data and mechanistic models is then used to address four key questions about LDD evolution: 1) to what extent is variation in LDD driven by variation in dispersal traits rather than environmental variation? 2) Is LDD merely a by-product of short-distance dispersal or could it evolve independently? 3) To what extent do covariances between dispersal traits constrain LDD evolution? 4) Has LDD responded adaptively to natural selection? Finally, I place the results in the context of a review on LDD mechanisms to assess to what extent the findings obtained for Cape Proteaceae can be generalized to other plant species.

Oral 12.3 in *Evolution of Dispersal*: Einstein Auditorium, 16.06.2010, 17:15-17:30

Geographic varation in seed dispersal; islands vs. mainland and central vs. marginal populations

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Reduced dispersal ability of species living on island relative to mainland has often been reported. One evolutionary scenario explaining this is strong selection against dispersal on the island to reduce dispersal out to see. Variation in life-history traits is also expected among population in central and marginal populations due to different selection operating among such sites. Here I present data from two studies on dispersal ability from plants with wind dispersed and ants dispersed seeds growing on mainland and adjacent island (wind dispersal) and in central and marginal (ant dispersed) populations. Significant differences in dispersal ability was found between mainland and islands, but varied among species showing either reduced or increased dispersal on islands. Differences in dispersal ability (elaisome/seed ratio) among central and marginal populations of two closely related *Corydalis* species was found. The species share the same habitat and are often found growing side by side, but one species is an obligate selfer and the other an obligate outcrosser. The obligate selfer invested significantly more in dispersal traits than the obligate outcrosser. Cafeteria experiments confirmed that diaspores with a higher elaisome/seed ratio were removed more by ants, suggesting that ants could act as selective agents on this trait. Evolutionary scenarios explaining the variation among central and marginal and among selfing and outcrossing species are proposed.

Oral 12.4 in *Evolution of Dispersal*: Einstein Auditorium, 16.06.2010, 17:30-17:45

Evolution of dispersal and fragmentation: testing some model predictions using natural experiments

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Habitat fragmentation is a complex process, involving many aspects including the reduction of the number of habitat fragments in the landscape, their size and connectivity. At the landscape scale, fragmentation may increase the mortality associated with dispersal as a result of reduced connectivity among habitat fragments. Under this scenario some theoretical models predict that traits favoring dispersal might be selected against. Some field observations and experimental data also suggest that plant traits related to dispersal can evolve after just a few generations in response to habitat isolation and fragmentation. However, at present, field-based evidence for the evolution of plant dispersal in relation to predictions arisen from theoretical models is rather limited. All the species are naturally found forming a wide range of spatial deme structures throughout its range, therefore providing scenarios with varying levels of fragmentation. Studies on the evolution of dispersal in this natural or semi natural settings might be useful to get further insights on the relationship between deme landscape structure and the evolution of dispersal. In particular, they might help in testing whether dispersal ability might evolve as a consequence of landscape fragmentation. We are following this approach in some short-lived plant species, among them the wind-dispersed Asteraceae *Mycelis muralis*. Testing the potential role of habitat fragmentation on the evolution of dispersal implies: 1) selecting landscapes with different degrees of fragmentation; 2) determining the extent of phenotypic variability in plant traits

related to dispersal; 3) assessing whether the observed phenotypic variability in dispersal-related traits have a genetic basis; 4) testing for a significant relationship between landscape fragmentation and plant dispersal potential. Our data on *M muralis* does suggest that plant dispersal ability can evolve as a result of habitat fragmentation, seed dispersal potential declining with decreasing connectivity. The results are in agreement with theoretical predictions suggesting that dispersal is selected against as a result of the loss or death of propagules during dispersal.

Oral 12.5 in *Evolution of Dispersal*: Einstein Auditorium, 16.06.2010, 17:45-18:00

Rapid evolution of seed dispersal in urban environment in the weed *Crepis sancta*

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Dispersal is a ubiquitous trait in living organisms. Evolutionary theory postulates that the loss or the death of diaspores during dispersal episodes (cost of dispersal) should select against dispersal. The cost of dispersal is expected to be a strong selective force in fragmented habitats. We analysed patchy populations of the heterocarpic weed *Crepis sancta* occupying small patches on pavements, around trees planted within the city of Montpellier (South of France) to investigate the recent evolutionary consequences of the cost of dispersal. First, we showed that, in urban patches, dispersing achenes have a 55 % lower chance of settling in their patch compared to non-dispersing achenes and thus, fall on concrete matrix unsuitable for germination. Second, we showed that the proportion of non-dispersing achenes in urban patches measured in a common environment is significantly higher than in surrounding, unfragmented populations. Third, using a quantitative genetic model, we estimated that the pattern is consistent with short-term evolution that occurs over approximately five to twelve generations of selection which is generated by a high cost of dispersal in urban populations. This study provides a demonstration that a high cost of dispersal following recent fragmentation causes rapid evolution towards lower dispersal.

Oral 12.6 in *Evolution of Dispersal*: Einstein Auditorium, 16.06.2010, 18:00-18:15

When did fruits become important to leaf-nosed bats? The evolution of frugivory in phyllostomids

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In the Neotropics, plants of more than 40 families and about 200 species (many of them with an important role in primary and secondary succession) are seed dispersed by phyllostomid bats. On the other hand, frugivory is present not only as strict and predominant feeding habit in 21 genera of Phyllostomidae, but also as complementary in other lineages that feeds mainly from other resources (nectar, insects, meat). The evolution of this plant-disperser interaction is assessed on the basis of the timetree of flowering plants, and a new molecular phylogenetic hypothesis of Phyllostomidae on which divergence times were also estimated. Seed dispersal by bats occurs in a few families of plants, and most of them originated before the diversification of phyllostomids. A few exceptions include Moraceae and Cactaceae, which are two of the families with the greatest number of genera containing bat-dispersed fruits. In Phyllostomidae, predominant frugivory evolved only once from predominant insectivorous bats about 16 Myr, and not in three independent events, as it was stated. The specialization to strict frugivory did occur in independent lineages at least four times. Our results supports the scenario in which frugivory in phyllostomid bats evolved from a group of genera of bats dispersing soft fruits of species of secondary growth to more specialized bats that feed on harder or more fiber-rich fruits of plants of primary growth and canopy

Oral 12.7 in *Evolution of Dispersal*: Einstein Auditorium, 16.06.2010, 18:15-18:30

Incorporating density-dependence into the directed dispersal hypothesis

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The directed dispersal (DrD) hypothesis, asserts that enhanced seed arrival to favorable establishment sites is advantageous for plant fitness. However, as anticipated by the ideal free distribution theory, enhanced seed deposition may impair site suitability by increasing density-dependent mortality, thus negating the advantage postulated by the DrD hypothesis. Although the role of density effects is thoroughly discussed in the literature, this *DrD paradox* remains largely overlooked. To investigate possible solutions to the DrD paradox, we combine two modeling approaches: (1) a simple analytical model calculating the optimal DrD level at which seed arrival to favorable establishment sites yields maximal fitness gain. (2) A simulation model exploring the temporal dynamics of the invasion process of the DrD strategy into a randomly dispersed population, and the resistance of a DrD population for invasions. These models demonstrate the invasion process and how various attributes of the plants, the dispersers, and the habitat affect its outcomes. These results highlight the need to revise the DrD hypothesis to include the countering effects of density-dependent mortality inherently imposed by enhanced arrival of seeds to specific sites. We illustrate how the revised hypothesis can elucidate previous contrasting results from empirical studies testing the DrD hypothesis, and suggest its incorporation in designing empirical studies of plant recruitment and in management practices.

Plenary 13.1 in *Ecology and Evolution of Frugivory and Seed Dispersal*: Einstein Auditorium, 17.06.2010, 08:30-09:00

Visual communication between fruits and frugivores

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The detection of fruits is a first crucial step in the interaction between fruits, seed dispersers, and fruit predators. The selective pressures acting upon the detection of fruits can be understood under the framework of communication theory. Communication theory expects that traits evolve so that they increase the detection of mutualists while minimising the risk of detection by predators. Visual traits such as the colours of fruits and their accompanying structures also encode information on the quality of fruit rewards. As such fruit-eating animals can impose differential selective pressures upon fruit colours resulting in trade-offs between signal efficacy and signal content that may partly explain the diversity of fruit colouration. For example, fruit-eating birds can select for increased conspicuousness against the background and they can also select for increased contents of pigments as nutritional antioxidant rewards. Fruit colours and their reliability in indicating fruit rewards are partly influenced by the environment. The intensity of surrounding light can influence concomitantly the sugar rewards of fruits and the visual signals of fruit displays. The phenotypic linkage between signal design (pigment production) and sugar quality of fruit rewards are probably widespread resulting in reliable plant–animal communication. Consequently, there are distinct evolutionary and ecological parameters that determine fruit colouration and its relative importance of long-distance detection.

Plenary 13.2 in *Ecology and Evolution of Frugivory and Seed Dispersal*: Einstein Auditorium, 17.06.2010, 09:00-09:30

In a new landscape: dispersal ecology and genetics of *Miconia* invasion in Australia

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Biological invasions have been identified as a key threatening process with significant negative impacts for global biodiversity. To better understand the process of plant invasion and spread for woody weeds in Australia's rainforests, we ask how individuals and species move across the landscape and whether genetic bottlenecks constrain invasive potential in three related Melastomes, *Miconia calvescens*, *M. nervosa* and *M. racemosa.* All three species are actively being eradicated, and while they have similar growth forms, fruit presentation and occur in similar habitats, the nature of their invasions differs. *M. calvescens* is present at more than 30 sites across the Wet Tropics, whereas *M. nervosa* and *M. racemosa* are each known from a single location. Even though these weedy Melastomes were only recently introduced to Australia, they are well dispersed within their novel environments (up to 1-2 km). Hence, native frugivores are effectively providing dispersal services. Genetic diversity is lower in *M. calvescens* and *M. racemosa* than that observed in *M. nervosa*, which is consistent with few founding individuals (or closely related individuals) being responsible for introduction in those populations. In contrast, the *M. nervosa* population was likely founded by more individuals or from multiple sources that were less closely related. Interestingly, multiple introductions of *M. calvescens* have not resulted in increased genetic diversity; and the more genetically diverse *M. nervosa* has, at least to date, failed to demonstrate the level of invasiveness characterised by *M. calvescens*.

Plenary 13.3 in *Ecology and Evolution of Frugivory and Seed Dispersal*: Einstein Auditorium, 17.06.2010, 09:30-10:00

Effect of sugar type and concentration on diet choice and digestion in a range of South African avian frugivores

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The effects that different fruit sugar types and concentrations have on the digestive efficiencies and food preferences of avian frugivores have been relatively poorly studied. While fruit choice by avian frugivores may be influenced by a number of non-nutritive factors such as fruit colour, size, and secondary compounds, the bird's digestive ability and the fruit's nutritional value are considered to be important factors. This may have important implications for their role as seed dispersal agents. Consequently, the digestion of sugars and sugar preferences in equicaloric and equimolar artificial fruit of different sugar types at varying concentrations and molarities were investigated in a range of South African avian frugivores, Knysna Turaco (*Tauraco corythaix*), Purple-crested (*Gallirex porphyreolophus*) Turaco, Red-winged Starling (*Onychognathus morio*), Speckled Mousebird (*Colius striatus*) and Dark-capped Bulbul (*Pycnonotus tricolor*). Results from sugar preference experiments suggested that local frugivores display different feeding strategies when it comes to preferential selection of specific sugars of varying energy levels and molecular mass in fruits on offer. Generally digestive transit rates of species were slower with an increase in sugar concentration and molarity, irrespective of sugar type. Species generally increased food intake as concentration and molarity decreased, irrespective of sugar type suggesting compensatory mechanisms for energy requirements. Apparent assimilation efficiencies of most species were lower than most previous nectar and fruit studies. Generally preferences for sugar type varied with concentration and sugar type. At high concentrations species showed no preference for either equicaloric or equimolar artificial fruit diets. The results of this study suggest that most species except Red-wing Starlings appear to be tolerant of sugar type. These results have implications for fruit preferences and emphasize the need for future studies looking at the composition of indigenous forest fruit sugars in order to obtain insight into the role of these avian frugivores as potential seed dispersers of fruiting tree species.

Plenary 13.4 in *Ecology and Evolution of Frugivory and Seed Dispersal*: Einstein Auditorium, 17.06.2010, 10:00-10:30

Rethinking the benefits of vertebrate seed dispersal – escape, camouflage or pathogen removal?

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The primary benefit of vertebrate dispersal is often considered to be "escape" – vertebrates move seeds away from the parent plants, where competition and high predation rates limit fitness. Yet vertebrate dispersal involves changes in seed location (escape) and changes in seed condition (seed handling). While these two benefits are often acknowledged, their relative benefits are rarely compared. Here we directly compare escape-related impacts to condition-related impacts in a shrub, *Capsicum chacoense*. We found no evidence for escape-related benefits. In contrast, we found strong support for condition-related impacts: gut passage removed lipids from seeds, making them chemically camouflaged from ant seed predators. In addition, gut passage cleaned seeds of fungal pathogens; gut passage removed 30 % of the fungal infection, resulting in a doubling in germination. Our results suggest that the benefits of animal seed dispersal may be far more diverse than previously appreciated.

Plenary 14.1 in *Ecology and Evolution of Frugivory and Seed Dispersal (continued)*: Einstein Auditorium, 17.06.2010, 11:00-11:30

The functional value of plant-frugivore mutualistic networks

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Recent advances in field techniques, molecular tools, and GIS-based methods allow a thorough analysis of the functional value of plant-frugivore interactions and the ecological service derived from fruit food provisioning and animal-mediated seed dispersal. Mutualistic seed dispersal interactions build up into mega-diverse networks of interacting species. Every interaction mapped in the network has a functional value for the whole mutualistic system described, and the diversity of functional roles embedded generates extensive complexity in the process of plant regeneration and frugivore population dynamics. Because seed dispersal (and its counterpart interaction, fruit food) is serviced by multiple species, studies focusing on pairwise interactions in isolation will underestimate levels of biodiversity required to maintain multifunctional networks. Here I review and develop specific guidelines for the analysis of complex network patterns that incorporate the details of natural history of the interacting species. The network approach has been useful to unveil basic patterns that pervasively influence the resilience of these ecological networks to extinction of species and their interactions. However, a much needed step is to develop early warning signals of ecosystem “health” or to identify key steps to rebuild functional ecological services (e.g., seed dispersal) during habitat restoration actions.

Plenary 14.2 in *Ecology and Evolution of Frugivory and Seed Dispersal (continued)*: Einstein Auditorium, 17.06.2010, 11:30-12:00

A brief history of fruits and frugivores in time and space

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Many angiosperm plants produce fleshy fruit and rely on birds and mammals to disperse their seeds in contemporary habitats. This mutualism has had a long evolutionary history, beginning in the late Cretaceous for flowering plants. Modern fruit-frugivore interactions date from the Oligocene or Miocene, by which time most elements of modern floras and faunas had evolved. In this talk I will review this mutualism from a plant and animal phylogenetic perspective, emphasizing major themes in the evolution of frugivory and seed dispersal. One of these themes will be how biogeographic history has influenced this evolution. I will close with comments on the contemporary conservation implications of this ancient plant-animal interaction.

Plenary 14.3 in *Ecology and Evolution of Frugivory and Seed Dispersal (continued)*: Einstein Auditorium, 17.06.2010, 12:00-12:30

Frugivory in tropical forests: what don't we know and why do we need to know it?

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Studies of frugivory in the tropics usually focus on what eats what, but a lot happens before eating starts and basic questions about how fruits are located and selected remain. Some of these questions may appear esoteric, but it seems likely that a more mechanistic understanding of frugivory will be needed if we are to predict and mitigate the dispersal-related impacts of deforestation, fragmentation, logging, invasives, and climate change. What is the role of spatial memory, as opposed to cue-based searching, in foraging on patchy fruit resources? Does any frugivore have a temporal map as well? How important is olfaction in long-range fruit detection, given that odors travel further than light (and sonar) in dense forest? What are the relative roles of vision, olfaction and touch in close-range discrimination between fruits? How important are internal senses-taste and texture before swallowing and a variety of gut sensations afterwards? What feedback on nutritional quality in relation to needs does the frugivore receive after digestion, and how does this influence future choice? How do the answers to all these questions vary within and between the major groups of frugivores? How are the answers influenced by the anthropogenic impacts mentioned above? Gaps in our current knowledge reflect real technical difficulties, but are also influenced by preconceptions (e.g. birds don't use olfaction) and the very different traditions involved in research on primates, bats, birds, rodents, and other animals.

Oral 15.1 in *Anthropogenic Impacts on Frugivory and seed Dispersal (part II)*: Einstein, 17.06.2010, 14:00-14:15

Human frugivory and seed dispersal in Neotropical forests

TAREK MILLERON[1], ZENT EGLEÉ[2], ZENT STANFORD[2]

[1] Caura Futures
[2] IVIC

In Neotropical forests, indigenous people gather wild fruits and travel from hundreds of meters to tens of kilometers per day. Thus, they disperse seeds over a wide range of distances. Seeds may be spit out along trails (e.g., *Inga* spp.), discarded on rubbish heaps (e.g., *Oenocarpus* spp.), or purposefully planted (e.g., *Pourouma* spp.). Groups with the least frugivory might consume only a few species of wild fruits, while others, such as the Joti, in Venezuela, consider 222 species of wild tree fruits edible, and regularly consume fruits of two dozen species. Despite these facts, documented primarily by ethnobiologists, ecologists who study distributions of tropical trees almost uniformly ignore the human dimension of seed dispersal, even though historical effects of seed dispersal by humans may persist for centuries. For example, groves of *Ecclinusa guianensis* are apparently maintained and visited regularly by the Joti. Not solely as hunters of frugivorous vertebrates should humans be considered part of the seed dispersal equation, and the effectiveness of seed dispersal by humans should be measured. Human hunting, frugivory and seed dispersal coupled with activities of non-human frugivores, seed dispersers, and seed-eating animals might together impact select tree populations. We will discuss data on human movement patterns, their potential for very long distance dispersal of large seeds, and the known scope of frugivory among different indigenous groups in Neotropical forests.

Oral 15.2 in *Anthropogenic Impacts on Frugivory and seed Dispersal (part II)*: Einstein, 17.06.2010, 14:15-14:30

Vanishing endemic frugivorous birds and endangered plants in the islands of Eastern Polynesia (South Pacific): an extinction cascade?

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Islands are known to be extinction hotspots for endemic birds, including many frugivorous species. Their role as dispersers of native and endemic plants is critical for island colonization, plant succession, and forest regeneration. On the remote oceanic islands of Eastern Polynesia (South Pacific), human colonization by Polynesians around 1,000 years ago triggered a wave of avian extinctions, which have continued with the arrival of Europeans in the 18th century and into the present. Palaeo-archeological and historical records reveal that half of the ca. 50 known frugivorous species (fruit doves *Ptilinopus*, pigeons *Ducula*, starlings *Aplonis* and cuckoo-doves *Macroptygia*) from 29 islands have been lost. All frugivorous species have disappeared on at least seven islands, and more than 50 % on four other islands. We assessed the conservation status of large-fruited (> 1 cm in diam.) endemic woody plant taxa, including large trees (*Nesoluma* and *Planchonella*, Sapotaceae, *Hernandia*, Hernandiaceae), small trees (*Santalum*, Santalaceae, and *Ochrosia*, Apocynaceae), shrubs (*Ixora* and *Psychotria*, Rubiaceae, *Cyrtandra*,Gesneriaceae) and palms (*Pritchardia*, Arecaceae) in these islands, based on IUCN Red Lists and recent botanical surveys. Results show that a high proportion of endangered and presumed extinct plants occur on islands that have lost frugivorous birds, suggesting a cascading extinction effect. Other important factors contributing to the increased vulnerability of the endemic flora are habitat destruction and fragmentation, seed predation by rats and plant invasions.

Oral 15.3 in *Anthropogenic Impacts on Frugivory and seed Dispersal (part II)*: Einstein, 17.06.2010, 14:30-14:45

Different ecological patterns in the seed dispersal systems of two endemic junipers (*Juniperus cedrus* and J*. brevifolia*) in the Macaronesian archipelagos

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Representative populations of the two endemic endangered junipers that occur in the Macaronesian islands (*Juniperus cedrus* from Canary Islands and Madeira, and *J. brevifolia* from the Azores) were selected to study their respective seed dispersal systems. Droppings and pellets from the potential frugivores were collected and analysed, subjecting undamaged seeds to germination experiments. Results indicate that the wintering *Turdus torquatus* and the native *T. merula* were the main seed dispersers for *J. cedrus* and *J. brevifolia*, respectively. The endemic lizard *Gallotia galloti* was quantitatively outstanding as seed disperser of *J. cedrus*, although its qualitative effect does not appear to be beneficial. A seasonal replacement pattern of the main seed disperser agents allows *J. cedrus* seeds to be dispersed throughout the year. Nevertheless, the introduced rabbit *O. cuniculus* acts as a disruptor in the natural seed dispersal systems of both junipers, as inferred from the high percentage of damaged seeds found in their droppings. *Juniperus cedrus* and *J. brevifolia* are primarily adapted to ornithochory processes, *T. torquatus* and *T. merula* being legitimate seed dispersers and probably playing a key role in the connectivity of fragmented populations. However, the dependence of *J. cedrus* on a migrant bird for the long distance dispersal of its seeds implies a notable fragility of the system, conservation of *T. torquatus* being the key to the persistence of this endangered juniper.

Oral 15.4 in *Anthropogenic Impacts on Frugivory and seed Dispersal (part II)*: Einstein, 17.06.2010, 14:45-15:00

The importance of piling wood debris on bird-dependent seed dispersal in Mediterranean burned forests

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Salvage logging is the most frequent management practice in recently burned pine forest in the Mediterranean region, and has important impacts on bird communities. Therefore, it is likely to affect bird dependent seed dispersal as well. Different microhabitats appear as a result of logging and postfire succession: cleared areas, unlogged patches, snag perches, regenerated shrubland, etc. Non-commercially profitable wood debris can be spread on the ground or piled, as erosion barriers in steep slopes or as small piles. We investigated the effect of these microhabitats on frugivorous disperser birds' occurrence, seed rain and distribution of dispersed plant species, in Mediterranean lowland pine forests. We found that birds select wood debris piles above other microhabitats, which is likely to be the cause of the greater seed density found under those piles. Some of the dispersed seeds came from unburned areas, which involves a colonization of bird-dispersed plants to burned areas in the short time after fire, possibly affecting vegetation recovery. Furthermore, wood debris piles also have a longer term effect on the spatial distribution of some dispersed plant species, which are more abundant in piles than out of them, especially in driest areas. Therefore, it is highly recommendable to build wood piles in burned and salvage logged pine forests, since they have an important role in the conservation of the seed dispersal process by frugivorous birds in such areas

Oral 15.5 in *Anthropogenic Impacts on Frugivory and seed Dispersal (part II)*: Einstein, 17.06.2010, 15:00-15:15

Seed dispersal by animals in a shaded coffee agroecosystem in Mexico: how prevalent is it, and how is it perceived by people?

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Shaded plantations are recognized worldwide for their potential use as ecologically-friendly matrices that might be compatible with long-term conservation goals in anthropogenic landscapes. Most of these plantations occur in rainforest areas, where many native plant species depend on animals for seed dispersal. In this study we quantified the number of tree and shrub species maintained in shaded coffee plantations and assessed the prevalence of zoochory. We also interviewed farmers and high-school students to determine their knowledge and perception regarding seed dispersal by animals. We found that shade-coffee plantations have a high richness (86) of trees and shrubs, and that 81 % of these species are dispersed by animals. However, about half of the plant species present as adults, were not recorded as juveniles. In terms of the knowledge and perception of people, all farmers perceived seed dispersal as important, while only 63 % of students did. Regarding knowledge, most farmers were able to explain, to some degree, why seed dispersal is important. Almost all farmers mentioned birds as seed dispersers, while only 25 % indicated non-flying mammals, and only one mentioned bats. Results on knowledge were similar for students. If animals and their roles in plant regeneration are understood, and perceived as being important, by the local people responsible for managing these agroecosystems, then their potential for conservation purposes will be enhanced.

Oral 15.6 in *Anthropogenic Impacts on Frugivory and seed Dispersal (part II)*: Einstein, 17.06.2010, 15:15-15:30

Impact of gold mining on seed dispersal and extractive resources in a Papua New Guinea rainforest

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Papua New Guinea is among the planet's five High Biodiversity Wilderness Areas. Enga Province (12,800 km²) comprises more rainforest than any other province of Papua New Guinea, but has received the lowest biological survey effort in the country. This biodiverse province has also sustained extreme anthropogenic impacts related to the development of one of the world's largest gold mines (Porgera). Our understanding of the impact of the Porgera mine on the relationships among plants, their seed dispersers, and human use of forest resources is virtually non-existent. Here, we present preliminary data on the distribution, richness, abundance, and extractive resources of zoochorous tree species. Data were collected in Enga Province 1998 – 2006; methods include participant observation and interviewing of local Ipili and Engan speaking inhabitants, GIS analysis, and plant/animal survey. In addition, transects (50 x 10 m) were established and all trees > 10 cm DBH were classified with regard to their utility for extractive resources. Seven species (3 families) of frugivorous mammals were identified in the study area, including terrestrial, arboreal, and volant forms. Of 104 bird species, 21 were identified as frugivorous seed dispersers. 200 tree species were identified by local inhabitants, many of which are both zoochorous and yield extractive resources. The implications of these preliminary data for plant-animal-human interactions in a rapidly changing habitat will be discussed.

Oral 15.7 in *Anthropogenic Impacts on Frugivory and seed Dispersal (part II)*: Einstein, 17.06.2010, 15:30-15:45

The consequences of hunting for frugivores, seed dispersal and plant species composition in tropical forests

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Hunters reduce frugivore abundances and the dispersal of frugivore-dispersed seeds in tropical forests. This can have far reaching effects on the structure, dynamics and species composition of tropical forests by favoring woody climbers or lianas. The seeds of > 60 % of tropical liana species are dispersed by wind while the seeds of > 80 % of tropical tree species are dispersed by frugivores. In central Panama, lianas are 100 % more abundant in the seedling layer at heavily hunted sites than at protected sites even though both types of sites have similar canopy tree species compositions. Lianas replace the leaves of their host trees on a one-to-one mass basis, reduce host tree growth rates and increase host tree mortality rates. Thus, hunters and reductions in frugivores might contribute to many of the long-term changes that have been documented for the structure and dynamics of tropical forest tree communities.

Oral 16.1 in *Consequence of the Loss of Large Frugivores*: Einstein, 17.06.2010, 16:15-16:30

Large fruits without large frugivores: can variance save dispersal?

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Large frugivores have been disproportionately reduced in many parts of the world, which raises concerns for the dispersal of the largest-fruited plant species which may be left without a competent dispersal agent. However, evaluations of likely risks are often based on only the mean sizes of fruit and frugivores. Here we consider whether considering variances as well as means reduces the apparent risk of dispersal failure, using New Zealand as an example. In New Zealand a number of large frugivorous birds have become extinct, leaving the New Zealand pigeon Hemiphaga novaeseelandiae as the sole apparent disperser of fruits for 11 tree species with fruits over 10 mm mean diameter. However, recent work shows that nine of these 11 species are sometimes dispersed by other birds, which is possible because larger-than-average individual birds can swallow below-average sized fruits. Only one tree species, *Beilschmiedia tarairi* (Lauraceae), has no fruits small enough for other common birds to swallow and is thus entirely dependent on the New Zealand pigeon for dispersal. Hence the variance in fruit size and bird gape size is not just a sampling problem – it also provides opportunities for alternative dispersers to maintain dispersal service in the face of fauna losses.

Oral 16.2 in *Consequence of the Loss of Large Frugivores*: Einstein, 17.06.2010, 16:30-16:45

Seed dispersal with the wreckage of an avifauna: consequences for large-seeded trees in New Zealand

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Large-seeded plants may be more prone to dispersal failure, as fewer animal species are capable of dispersing the seeds, and large frugivores are more often affected by human impacts. Human arrival in New Zealand drove a number of large frugivorous birds to extinction. The extant New Zealand pigeon (*Hemiphaga novaeseelandiae*, Columbidae) is the primary disperser for five large-seeded native trees. However, this mutualism is at risk as pigeon numbers have declined from illegal hunting, habitat loss, and introduced mammalian predators. We investigated the consequences of dispersal failure and introduced mammal seed and seedling predation for the large-seeded tree species taraire (*Beilschmiedia tarairi* Lauraceae, seed 16 x 29 mm) and karaka (*Corynocarpus laevigatus* Corynocarpaceae, 15 x 23 mm). We recorded seed predation, germination, and seedling survival for two years in the field for seeds under conspecific adults ("parents") vs. 20 m away, whole fruits vs. cleaned seeds, at high vs. low densities, and enclosed in mammal-proof cages vs. uncaged. For both species, undispersed seeds (whole fruits, under parent at high density) had much lower survival than dispersed seeds (53-80 % decrease in survival over two years). The combined effects of dispersal failure and introduced mammals decreased survival after two years by 82-90 %. Both dispersal failure and introduced mammals have substantial negative effects on the regeneration of large-seeded trees in New Zealand forests.

Oral 16.3 in *Consequence of the Loss of Large Frugivores*: Einstein, 17.06.2010, 16:45-17:00

Big fruit for small mouths: the ability (or inability) of gibbons and flying foxes to disperse megafaunal fruits

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The largest fruit found in Asia's tropical forests ("megafaunal" fruit) may have evolved to attract a succession of very large frugivores. Only declining remnants of these megafaunal communities remain, however, making it critical to determine whether smaller frugivores can compensate for the lost roles of large dispersers. Gibbons (5-8 kg) and flying foxes (0.3-1.6 kg) are considered to be among the most effective seed dispersers in Asian forests, but the extent to which their effectiveness is limited by fruit size is poorly understood. Here I investigate the ability of gibbons and flying foxes to disperse seeds of megafaunal fruits. Both animal groups regularly consume large fruits. Gibbons can swallow and disperse large seeds (< 23 mm wide) for their size, but this excludes the seeds of many megafaunal fruit species and dispersal distances (< 500 m) are constrained by home range size. Dispersal by flying foxes is limited primarily by fruit weight; they can carry fruit > 20 % of their body weight for 100s of meters, with lighter fruit carried at least 2 km. For some plant species with megafaunal fruit, gibbons and flying foxes can function as effective dispersers; however, other plant species may be dependent on megafauna for the large quantities of seeds moved and/or specific factors influencing post-dispersal fate. In summary, some large-fruited plant species can be dispersed efficiently by under-sized frugivores, but the extent to which these frugivores contribute to effective plant recruitment is variable.

Oral 16.4 in *Consequence of the Loss of Large Frugivores*: Einstein, 17.06.2010, 17:00-17:15

Successional trajectories of defaunted tropical forests: effects of vanishing large frugivores and the role of remaining seed dispersers

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Forest fragmentation, hunting and habitat degradation reduce populations of large vertebrates but can favor small-bodied frugivores such as fruit-bats. Therefore, the study of seed dispersal in defaunted forests is crucial to understand successional trajectories of altered habitats. We aimed to show how shifts in seed rain as well as seedling recruitment patterns along a fragmentation/defaunation gradient can be correlated with changes in composition of fauna of seed dispersers. First, in a semi-deciduous forest of southern Mexico, we successfully demonstrate that seed rain in defaunated forest fragment tend to be more clumpled and varied greatly between years due to low activity of seed dispersers. Furthermore in the same site, we were able to show that seedling recruitment in small forest fragments lacking large frugivores was biased towards a low representation of large-seeded species. Finally, we studied seed rain generated by small tent-roosting in Costa Rica and demonstrate the potential role of frugivorous bats in disperse several species of large-seeded plants of both mature forest and successional habitats. Therefore, understanding the balance between the effects of elimination of large-bodied vertebrates as well as the role of the remaining fauna on the composition and dynamics of the regenerating stands should be crucial to predict differing successional trajectories of forests in response to habitat alteration and defaunation.

Oral 16.5 in *Consequence of the Loss of Large Frugivores*: Einstein, 17.06.2010, 17:15-17:30

Bush meat hunting disrupts forest regeneration in African rainforest

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Changes in forest composition resulting from the decimation of large seed-dispersing species by hunting in continuous, otherwise intact Neotropical forests have been recently reported. However, in previous studies mature tree composition, which may to a large extent determine what is present on the forest floor, has not been accounted for. It is also not known if the reported trend is a pan-tropical phenomenon as evidence from Africa has been lacking. Here we compare continuous unlogged forests in southeastern Nigeria, differing in protection from hunting, but with similar composition of mature trees. Forests that are hunted, and so have few large primates, experience lower recruitment of primate-dispersed trees, and have higher recruitment of abiotically-dispersed trees. Our results show that recruitment of a group of focal fruiting tree species with large fleshy fruits, adapted to dispersal by large frugivores, was different between hunted and protected sites, even though the densities of mature trees of these species did not differ between sites. Our findings are similar to effects reported for forests in the Neotropics and Asia, suggesting that changes on the forest floor caused largely by hunting is a pan-tropical phenomenon.

Oral 16.6 in *Consequence of the Loss of Large Frugivores*: Einstein, 17.06.2010, 17:30-17:45

A basin-wide study of seed rain patterns in lowland western Amazonia

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We analyzed seed rain patterns of several common lowland western Amazonian tree species using data collected from high-density seed trap grids (a total of 1269 individual traps) set up at six mature floodplain forest sites distributed across the ~85,000 sq.km Madre de Dios River basin in southeastern Peru. Three sites are located in forests with an intact faunal assemblage and three in defaunated forests. For the majority of species examined, seed fall decreases sharply with increasing distance from fruiting trees, with a small subset of potential adult trees making disproportionately large contributions. Contrary to previous studies, we found that dispersal at faunally intact sites is limited in fecundity but not spatially. Spatial distribution patterns of undispersed and dispersed propagules are drastically different, with dispersed seeds found at significantly greater distances away from fruiting adults than undispersed fruit, forming a diffuse tail of the seed shadow. The average distance “gain” from dispersal was 6.9 m or 1.7 crown radii. Seed rain patterns of primate dispersed species were drastically different in faunally intact vs. defaunated sites, with spatial patterns in the latter sites closely resembling the distribution of only undispersed propagules at the former sites. We examine long-term consequences of hunting-induced defaunation and absence of primate seed dispersal on sapling recruitment processes and patterns.

Oral 16.7 in *Consequence of the Loss of Large Frugivores*: Einstein, 17.06.2010, 17:45-18:00

What is the fate of a silent forest? The impact of the complete loss of frugivorous forest birds from the island of Guam

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The ecological importance of vertebrate seed dispersal is difficult to study due to the large spatial and temporal scales over which vertebrate seed dispersal occurs, as well as the functional redundancy present in many dispersal systems. The Mariana Islands provide a unique opportunity to learn about the role of frugivorous birds in tropical forest: four islands - Guam, Saipan, Tinian and Rota -contain similar native forest communities, with about 70 % of the tree species dispersed by birds. However, all forest birds were functionally extirpated from Guam by the invasive Brown Treesnake in the 1980’s. Saipan, Tinian and Rota have relatively healthy bird populations and thus are suitable controls. To examine the importance of bird dispersal for forest structure, we focused on three bird-dispersed tree species across the four islands. We used seed traps to measure the effect of birds on dispersal distance and greenhouse experiments to determine whether bird handling influences germination. Finally, we measured the distance between a randomly selected seedling and its nearest conspecific adult to determine if differences in dispersal could be observed at the seedling stage. On Guam (no birds), seeds fall directly underneath the parent tree and are less likely to germinate, and seedlings are found closer to a conspecific adult than in forests with birds. Collectively, our results suggest that birds play an important role in the recruitment of fleshy-fruited species.

Oral 17.1 in *Organismal and Natural History Oriented Research (Part II)*: Joffre A/B, 17.06.2010, 14:00-14:15

Interannual variability in fruiting affects the diet of frugivores

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The diets of gibbons and other frugivores have been studied on the Mo Singto Forest Dynamics Plot, central Thailand, for many years, and the phenology of a sample of 60 tree species has been studied since 2003. The gibbon diet includes the fruit of at least 105 species of trees and lianas, and leaves of about 50 species. The diet includes about 30 species of high quality "preferred" species, less preferred occasional species, and "fallback" species that are widely available but eaten when preferred species are not available. A six-year record of phenology shows that most of the preferred species have high interannual variability in fruiting, or masting behavior, which is not synchronized among species. An intensive study of feeding and ranging of the gibbons was made during April-May in each year from 2006-2009 to study dietary variability. During year 2006-2008, the top ten species in the diet changed about 50 % per year, and half of the species on the lists were present in only one year's list. Gibbons, as well as other frugivores, must constantly change their diet from year to year, which is the reason that gibbons (as well as most other frugivores) are dietary generalists. On the other hand, fruiting plant species may be either dispersal generalists or specialists. Several fruit species depend mostly or entirely on gibbons for dispersal, and appear to have staggered fruiting periods. Gibbons provide dependable and stable dispersal services for these species, regardless of their rarity or the interannual variability.

Oral 17.2 in *Organismal and Natural History Oriented Research (Part II)*: Joffre A/B, 17.06.2010, 14:15-14:30

Liana seed dispersal by white-handed gibbons (*Hylobates lar*) in the seasonal evergreen forest, Thailand: dispersal distance, germination rates, and dispersal quality

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Seed dispersal is the most important ecological process in a plant's life cycle. Past research provides answers mainly for tree species, ignoring lianas even though they are obviously important structures in forest ecosystems**.** I studied seed dispersal of liana species eaten by White-handed gibbon (*Hylobates lar*). I investigated feeding behaviour of gibbons on trees and lianas during the year 2004, with one year's further monitoring of germination and seedling survival of liana seeds dispersed by gibbon. In this study, gibbons are good potential seed dispersers for some liana species in both quantitative and qualitative aspects-liana fruit formed a significant component of gibbon diet, especially in the cool dry season (Dec-Jan) and seeds were usually dispersed away from fruiting crowns. Liana recruitment is likely to be limited in the dispersal process since gibbons dropped seeds in a relatively small region of the area they use each day. However, early life stage recruitment of lianas is not limited only by gibbon behaviour, but also by fruit production and seed germinability. In addition, this is the first study to highlight the potential importance of lianas during periods of food scarcity for gibbons and probably other animals.

Oral 17.3 in *Organismal and Natural History Oriented Research (Part II)*: Joffre A/B, 17.06.2010, 14:30-14:45

Post-dispersal seed removal and seed germination of *Cercopithecus nictitans* dispersed seed in a West African montane forest.

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Factors that determine the effectiveness of primates as seed dispersers include i) the microsite into which they deposit seed ii) secondary removal of seed by other taxa and iii) the effect of gut passage and/or spitting on subsequent seed germination. This contribution evaluated these factors in the little studied putty-nose monkey, *Cercopithecus nictitans* in a Nigerian montane forest. Field experiments showed that C*. nictitans* has greatly increased in its importance as a disperser of medium-sized seed (> 5 mm) because other large primates have been hunted to near extinction. *C. nictitans* disperses seed across habitats through spitting and defecation. Rates of secondary seeds removal were high for all seed species irrespective of the presence or absence of *C. nictitans* faecal matter, size or microsite variables. Gut passage enhanced germination relative to hand-cleaned seed, while spitting had either no effect, or decreased the germination rate.

Oral 17.4 in *Organismal and Natural History Oriented Research (Part II)*: Joffre A/B, 17.06.2010, 14:45-15:00

Linking tamarins' behaviour with spatiotemporal pattern of seed dispersal and seedling recruitment

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The incorporation of animal behaviour data into seed dispersal models can help to better understand the spatiotemporal pattern of seed deposition, and hence the seedling recruitment. Feeding and ranging behaviours of the animal seed disperser are now usually studied while resting behaviour has, until now, attracted little attention. However, the resting sites and their use by seed dispersers could affect the spatial seed deposition: repeatedly used sites are related to repeated defecations and increased seed density. We studied the spatial pattern of seed deposition by analyzing the feeding, ranging and resting behaviours of a mixed-species group of tamarins and monitored the fate of dispersed seeds to compare the seedling recruitment and survival within and outside the resting areas. Tamarins dispersed a high percentage of large seeds involved in later stages of regeneration in the secondary forest when they balanced their time eating a high diversity of fruit species in primary forest and pioneer species in secondary forest. They dispersed significantly more seeds within the resting areas than away of them and the seed density per quadrant (50 x 50 m) increased with the resting time. Feeding, ranging and resting behaviour of tamarins affected the spatial distribution of seeds dispersed in faeces. We assume that resting sites could be potential seedling recruitment centres playing an important role in forest regeneration.

Oral 17.5 in *Organismal and Natural History Oriented Research (Part II)*: Joffre A/B, 17.06.2010, 15:00-15:15

Giant African rats and an endemic tree: dispersal and harvesting pressures

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Non-timber forest products, such as fruits and seeds, are becoming important economic incentives to local human communities, especially in tropical regions. Studies focusing on seed dispersal and on the impacts of harvesting fruits and seeds for local and global markets are numerous for the Neotropical region, whereas native forest trees in Africa have received little to no attention. We here examine the relationship between the Giant pouched rat *Cricetomys gambianus* and an endemic African tree species. Using a preliminary study, we first show the importance of this rodent species in the dispersal of seeds during peak and low fruiting periods. We then relate these results to comprehensive harvesting data from three different protection regimes in a forest-agriculture landscape in Tanzania.

Oral 17.6 in *Organismal and Natural History Oriented Research (Part II)*: Joffre A/B, 17.06.2010, 15:15-15:30

High levels of seed predation for three important primate food species, within the tropical peat swamp forests of Central Kalimantan; a gap in the loop?

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Throughout the tropics, studies have repeatedly identified the pivotal roles small mammals, play in secondary seed dispersal. In response to this a preliminary study of seed fate, was carried out in the lowland tropical peat swamp forests of Central Kalimantan, Borneo. Three species *Parartocarpus venenosus* (Moraceae), *Tetramerista glabra* (Tetrameristaceae) and *Blumeodendron tokbrai* (Euphorbiaceae), were identified as favoured food trees, by dominant primate species; the Orangutan (*Pongo Pygmaeus*) and Southern bornean gibbon (*Hylobates Albibarbis*). This study was carried out during the dry season creating favourable ground conditions for predation and caching. Vegetation structure around *T. glabra* was measured to identify the effects seed predation, as previous studies shown seedlings aggregation inferring potential caching. Results of a time series analysis showed insect predation rates lagged vertebrate predation rates for *T. glabra* and *B. tokbrai* spp. Previous seed-fate studies found much higher removal rates than *in situ* predation, however both *in situ* predation and removal rates were found to be similar. When removal was observed, distances were found to be low (maximum 8.4 m), with little evidence of caching. *T. glabra* showed vegetation surrounding the parent tree had no significant impact on seed predation. The low levels of secondary removal found places a further emphasis on primary seed dispersal, or on an unidentified secondary seed dispersal strategy. To date this lack of seed removal and caching differs from findings in other tropical forests, has potential implications for the forests regenerative capabilities, and further suggests tropical peat swamp forests are an unusual or unique forest ecosystem.

Oral 17.7 in *Organismal and Natural History Oriented Research (Part II)*: Joffre A/B, 17.06.2010, 15:30-15:45

Germination consequences of non-dispersal in fleshy fruited plants

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There has been much interest in the consequences for fleshy-fruited plants of dispersal failure. Consumption of fruits by frugivores can affect germination by removal of the fruit flesh (the deinhibition effect) and by other effects on the seed coat (the scarification effect). If frugivores become rare or absent because of human actions such as hunting or habitat clearance, it is important to know whether undispersed fruits can still allow regeneration of the plant. We examined this for the New Zealand flora with field germination trials on 19 woody species, including 16 of the 18 largest-fruited species (with mean fruit diameters 8-21 mm), many at several sites or years. Four conclusions emerged. (1) Germination sometimes failed in particular sites or years, due to environmental factors such as drought or outbreaks of seed predators. (2) There was no consistent difference between hand-cleaned and bird-excreted seeds, showing that the scarification effect was inconsistent and generally small. (3) Final germination percentages were significantly lower for seeds in intact fruits than for cleaned seeds (bird or hand-cleaned), but by such a small amount as to be biologically unimportant (59 vs. 66 % respectively). (4) Four New Zealand trees have thick endocarps, which has been speculatively linked to protection of the seeds from crushing in the gizzards of now-extinct flightless moa species. We found three of these four plants had low final germination percentages, possibly the first known “anachronistic” dispersal effects of the extinction of moa. However, for most of these woody species the net effects of non-dispersal on germination are small and unlikely to cause regeneration failure.

Oral 18.1 in *Movement Ecology, Dispersal Kernels, and Genetic Effects (Part II)*: Joffre A/B, 17.06.2010, 16:15-16:30

Spatial patterns of seed dispersal by Neotropical tamarin monkeys, *Saguinus mystax* and *S. fuscicollis*

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Spatial patterns of primary seed dispersal provide the template for further processes like secondary dispersal and regeneration and are important for understanding gene flow and plant genetic population structure. Following the fate of individual seeds, which is necessary for spatial analyses, is an inherently difficult task. In a field study in Peruvian Amazonia we determined dispersal distances and kernels produced by two small Neotropical monkeys (*Saguinus mystax* and *S. fuscicollis*). We employed a rigid criterion for data collection (seed dispersal distances were only determined if between seed swallowing in a given tree and defecation of seeds no other tree of the same species was visited by the monkeys). In a second field study, we focussed on a specific plant genus (*Parkia*) and – additionally to the observational approach – used microsatellites to identify maternal trees of dispersed seeds. Observational and genetic dispersal distances match closely, giving reliability to previous purely observational data. Our spatial data indicate that tamarins produce strongly leptokurtic seed dispersal curves and may vary between plant species, but very few (< 3 %) seeds actually land close to source trees. Furthermore, dispersal kernels show that sleeping sites may represent foci of tamarin seed dispersal. We conclude that once the reliability of observational data has been confirmed through genetic analyses, they can provide insights into the on spatial patterns of seed dispersal.

Oral 18.2 in *Movement Ecology, Dispersal Kernels, and Genetic Effects (Part II)*: Joffre A/B, 17.06.2010, 16:30-16:45

Seed dispersal of the Brazil nut tree (*Bertholletia excelsa*) by scatter-hoarding rodents in a central Amazonian forest

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This paper summarises recent work on dispersal of the Brazil nut tree (*Bertholletia excelsa*) by scatter-hoarding rodents in central Amazonia, Brazil. We provide results from three different experiments, including the first ever study to track the fate of cached Brazil nuts across seasons. We also describe an entirely new method to study natural Brazil nut dispersal; tracking manipulated and tagged fruits containing individually marked seeds. Results show that agoutis usually moved intact fruits away from their original location below the parent tree before either hiding them or gnawing through the pericarp to reach the seeds inside. Caching behaviour was strongly affected by seasonal resource abundance; caching rates, dispersal distances and cache longevity differed significantly between seasons. Agoutis also appear to be highly skilled at retrieving their buried Brazil nuts, although cache pilferage may account for large numbers of retrieved seeds, as shown by our third experiment. We conclude that our new method does not inhibit fruit handling by agoutis and provides a realistic approach to investigate natural seed dispersal of Brazil nuts. Agouti behaviour is, to a large extent, driven by resource seasonality and cache pilferage appears to be a prominent feature of Amazonian scatter-hoarding systems.

Oral 18.3 in *Movement Ecology, Dispersal Kernels, and Genetic Effects (Part II)*: Joffre A/B, 17.06.2010, 16:45-17:00

Ecological significance of seed secondary metabolites in a rodent-dispersed tree: adaptation to seed-eating dispersers?

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Large, rodent-dispersed seeds often contain secondary metabolites that exhibit deterrence to antagonists. While such compounds can discourage seed eaters, their significance for seed-eating dispersers is complex; seeds should both attract dispersers and escape predation. To elucidate the role of seed secondary metabolites, as well as seed size, in tree-rodent mutualism, we focused on escin, which is a major secondary metabolite in *Aesculus turbinata* seeds. We determined escin concentrations in 150 mature seeds and found substantial variation (1.4-6.8 %) among individual seeds. As escin concentration was independent of seed size, we followed the fate of seeds of known escin concentration and weight to explore how they affected rodent behavior. Results showed that seed removal was unaffected by both factors, whereas consumption was mainly influenced by escin concentration. Thus, escin is an important determinant in the dispersal success of this species. We also examined seasonal patterns of escin content in immature seeds to test if the observed variations in mature seed escin concentrations coevolved with the seed-rodent interactions. Escin concentrations varied similarly in immature seeds and did not correlate with the extent of predation by insects. We therefore conclude that the variation in escin concentrations may be a compromise between minimizing predation and facilitating dispersal, and that this polymorphism may stabilize rodent responses by providing low-escin seeds.

Oral 18.4 in *Movement Ecology, Dispersal Kernels, and Genetic Effects (Part II)*: Joffre A/B, 17.06.2010, 17:00-17:15

Effectiveness of seed dispersal by five frugivorous carnivores: implication for their differential role in forest recruitment and regeneration

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Fleshy-fruited plants are usually dispersed by an array of frugivores, differing in the effectiveness of the dispersal service they provide to the plant. The digestive characteristics, body size, feeding behaviour and movement patterns of animal dispersers are hypothesized to affect seed dispersal distances and consequently their effectiveness as dispersers. We tested this hypothesis by comparing the seed dispersal effectiveness of five frugivorous carnivores, masked palm civets (*Paguma larvata*), Chinese ferret-badgers (*Melogale moschata*), yellow-throated martens (*Martes flavigula*), black bears (*Ursus thibetanus*) and hog-badgers (*Arctonyx collaris*) in a fragmented subtropical forest of central China. Our results indicate five frugivorous carnivores as seed dispersers, using the terminology of Schupp (1993), have differential effectiveness. An empirically parameterized mechanistic model showed that the five dispersers switch roles as a function of spatial-scale. Civets took many fruits and acted across heterogeneous habitat, thus they had the significant accelerating role in forest recruitment and regeneration. Martens dispersed most seeds within the local habitat and had the significant accelerating role in forest recruitment within homogeneous habitat while tiny role in forest regeneration across heterogeneous habitat. Our findings indicate that common species, which are usually neglected by conservationists, have multi-function in forest ecosystem.

Oral 18.4 in *Movement Ecology, Dispersal Kernels, and Genetic Effects (Part II)*: Joffre A/B, 17.06.2010, 17:15-17:30

Dispersal and recruitment patterns of palms inferred through parentage analysis

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Palms are keystone species in many tropical lowland rainforests. In many regions overhunting and illegal poaching are depleting the population of key seed dispersers including agouti, pacas, monkeys, and tapirs. In this study we consider the dispersal and recruitment patterns of a fully censused population of the palm *Attalea phalerata* in a protected forest of the Peruvian Amazon, and seek to understand the contribution of frugivores to palm population dynamics. Using microsatellite markers, we genotype all seedlings and juveniles to putative seed-producing parents in the study plot. Our preliminary results indicate nearly half of palm seedlings and juveniles originate from palms outside of our study area suggesting high levels of seed dispersal activity and gene flow at this scale. The majority of the oldest juveniles also originated from outside of the study plot. We also found the spatial patterns of offspring recruitment are consistent with Janzen-Connell's predictions of distance- and density-dependent mortality. Our preliminary findings highlight the importance of frugivore-mediated seed dispersal and gene flow to *Attalea phalerata* population and their importance in facilitating the escape of seedlings and survival to reproductive age. We predict severe impacts on the long-term persistence of *A. phalerata* populations if hunting activities are not mediated.

Oral 18.6 in *Movement Ecology, Dispersal Kernels, and Genetic Effects (Part II)*: Joffre A/B, 17.06.2010, 17:30-17:45

Gastropodochory in myrmecochores: when slugs do the job of ants

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In beech-dominated forests in Central Europe, many spring geophytes show adaptations to seed dispersal by ants. Ants, however, can be rare. Motivated by observations of slug feeding on seeds we investigated seed consumption of myrmecochores by slugs. In a seed predation experiment in beech forests we found that seed removal was strongly reduced when gastropods were excluded. The contribution of insects including ants and rodents to seed removal was less. In the laboratory, slugs either consumed elaiosomes or swallowed seeds intact. Swallowed seeds were defecated undamaged and germinated as well as control seeds, indicating the potential for seed dispersal by slugs. We also recovered seeds of myrmecochores in the faeces of slugs caught in forests. We calculated seed dispersal distances by slugs combining data from slug tracking in forest plots and of gut passage times assessed in the laboratory. Mean dispersal distance was 4.3 m for a dry and 5.7 m for a wet tracking event. This is several times higher than mean dispersal distances assessed for ants in other studies. We also found that slug defecated seeds were less attractive to rodents than control seeds, suggesting that slug gut passage reduces seed predation risk. Seed removal in the forest was reduced for defecated seeds, too. Our results demonstrate that slugs are significant consumers of elaiosomes or entire seeds of ant-dispersed plants. They also indicate that slugs act as seed dispersers of these plants.

Oral 18.7 in *Movement Ecology, Dispersal Kernels, and Genetic Effects (Part II)*: Joffre A/B, 17.06.2010, 17:45-18:00

How does pollen and seed movement influence local spatial genetic structure of a tropical understory plant?

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Studies evaluating the contribution of pollen and seed movement to local gene flow are rare. We conducted such study on the herbaceous plant *Heliconia acuminata*, a hermaphroditic, self-incompatible, hummingbird pollinated and bird-seed dispersed species in Central Amazonia. Using 9 microsatellite loci we analyzed parentage and characterized fine-scale spatial genetic structure of reproductive plants and seedlings in one site of continuous forest in the Biological Dynamics of Forest Fragments Project, Brazil. By assigning seedlings to the most likely parent pair, medians of effective pollen and seed dispersal were 56.6 m (3.2-119.7 m) and 35.4 m (4.5-105.8 m) respectively, which exceeded median distances between neighboring reproductive plants (2.52 m) and between seedling and the nearest reproductive plant (2.98 m). This indicates that pollination and, especially, seed dispersal might not be as spatially limited as previously thought. Accordingly, *Heliconia* population presented a weak genetic structure as evidenced by *Sp,* a metric of decrease of pair-wise kinship coefficients between individuals with distance (*Sp* = 0.004 for seedlings and 0.002 for reproductive plants). *Heliconia* frugivores (*Turdus albicollis* and manakins) might disperse seeds farther than recently estimated. In addition, post seedling establishment processes, such as density dependent mortality and biparental inbreeding depression are likely to act on early recruitment resulting in longer effective gene movement.

Oral 19.1 in *Ecology and Evolution of Frugivory and Seed Dispersal (Part II)*: Joffre C/D, 17.06.2010, 14:00-14:15

Black bears (*Ursus americanus*) are effective seed dispersers, with a little help from their friends

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Black bears (*Ursus americanus*) are generally considered effective seed dispersal agents for fleshy-fruited plants because they can consume hundreds of fruits at once and have large home ranges. Seedlings can emerge from fecal piles, but if any seeds are removed from feces by rodents, it is often considered seed predation. In theory, removal of seeds from bear feces by seed-caching rodents could represent a second phase of dispersal that benefits fleshy-fruited plants, yet this idea has never been tested. I tested four hypotheses regarding the idea that a second phase of seed dispersal by seed-caching rodents is beneficial to fleshy-fruited plants that are initially dispersed by black bears in the Sierra Nevada. We determined that deer mice (*Peromyscus maniculatus*) removed seeds from bear feces and cached them in soil. These seeds escaped several sources of mortality by being moved to relatively safe locations. A field germination study confirmed that caching can benefit seedling emergence. In addition, rodents discovered seeds in bear feces more quickly than those in bird feces, suggesting that a bear-rodent tandem could be the most effective seed dispersal syndrome for some fleshy-fruited plants. With further study, the two-phase seed dispersal syndrome presented here could help elucidate patterns of species diversity and distribution of fleshy-fruited plants.

Oral 19.2 in *Ecology and Evolution of Frugivory and Seed Dispersal (Part II)*: Joffre C/D, 17.06.2010, 14:15-14:30

Microsatellite analysis of seed dispersal of *Myrica rubra* by the Yakushima macaque (*Macaca fuscata yakui*) on Yakushima Island, Japan.

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Primates are considered to be efficient seed dispersers. It is impossible to directly track seed movement once an animal has ingested seeds, and also little information exists regarding the spatial pattern of seed dispersal by primates using maternity analysis based on genetic methods. The objective of this study was to describe the spatial pattern of seed dispersal of *Myrica rubra* by the Yakushima macaque (*Macaca fuscata yakui*) by genotyping seed maternal tissues in the forest of the Japanese island of Yakushima. Macaques are habituated to observers without provisioning and their social and feeding habits have been under constant study since 1976 at our study site. The fruits of *M. rubra*, a tree widely distributed in evergreen forests, are an important source of food for macaques in early summer. Conversely, macaques are major seed dispersers for *M. rubra* because the fruit and seeds of *M. rubra* are large (fruit: 13.2 mm in diameter, seeds: 7.7 mm in diameter). Here, we conducted direct observation of macaque's feeding behavior, collected *M. rubra* seeds dispersed by macaques, and analyzed the maternal origin of seeds dispersed by macaques. We showed by field survey that macaques selected more profitable patches according to ripe fruit availability. By genetic methods, we detected a high level of diversity among the dispersed seeds in each feces with long dispersal distance. We discuss the spatial pattern of seed dispersal of *M. rubra* by macaques in relation to their behavior.

Oral 19.3 in *Ecology and Evolution of Frugivory and Seed Dispersal (Part II)*: Joffre C/D, 17.06.2010, 14:30-14:45

"Liaisons dangereuses" in the Mediterranean dwarf palm: the defensive role of fresh pulp against seed predators

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We chose the interaction between the Mediterranean dwarf palm (*Chamaerops humilis*) and its major seed disperser, the Eurasian badger (*Meles meles*) to evaluate the hypothesis that endozoochory is characterized by a mixture of conflicting and overlapping interests, with the capacity of being positive or negative for the palm fitness. Our experimental results from field sowing monitored over two years revealed the multifunctionality of *C. humilis* fruit pulp and that pulp consumption by badgers had conflicting outcomes for the palm. Seed survival was much lower and seed predation by bruchids much higher for badger-ingested than for control seeds, supporting a defensive role of *C. humilis* ripe fruit pulp. All seedlings emerging during the first months after sowing came out from badger-ingested seeds, suggesting an early inhibitory function of fruit pulp. Badgers imposed a sizeable short-term fitness cost to *C. humilis* and therefore could be categorized as a 'dangerous liaison'. Nonetheless, because of badger high mobility, their dispersal service appears paramount given the severe fragmentation and isolation of most *C. humilis* populations across the highly humanized Mediterranean basin. Our study, thus, illustrates the necessity of integrative analyses in which focal plant-animal interactions (e.g., fruit-frugivore systems) are accounted in conjunction with other species interacting with the plant at different stages of the life cycle and recruitment process.

Oral 19.4 in *Ecology and Evolution of Frugivory and Seed Dispersal (Part II)*: Joffre C/D, 17.06.2010, 14:45-15:00

Establishment of novel dispersal mutualisms between introduced plants and resident birds in California, USA

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Vertebrate dispersal may promote plant invasiveness. I examined the role of bird-plant dispersal mutualisms in invasion potential of three non-native plant species: *Triadica sebifera*, *Ligustrum lucidum*, and *Olea europaea*. I paired foraging observations in California, USA, with aviary experiments to quantify dispersal, assess bird preferences, and compare mutualism features between the non-natives and a native species, *Heteromeles arbutifolia*. Fruit removal was highest for *H. arbutifolia* (94 %) and lowest for *T. sebifera* (24 %). Most foraging was done by dispersers (vs. seed predators) and by "pulse feeders" with potential for long-distance dispersal (vs. "background feeders"). The number of conspecific plants per stand was significantly related to bird visitation; larger source stands may promote bird-mediated invasions. Disperser-defined niches were narrow, indicating that a few bird species did most dispersal, but niche overlap between *H. arbutifolia* and *L. lucidum* highlighted the diffuse nature of these mutualisms and suggested that *L. lucidum* may compete for dispersers with *H. arbutifolia*. In aviaries, native birds (*Turdus migratorius* and *Catharus guttatus*) preferred native fruits but switched to non-natives when native fruits were withheld. Accustomization to non-native fruits did not alter preference. Non-native European starlings (*Sturnus vulgaris*) preferred *O. europaea*. No case study species appear dispersal limited and all have established mutualisms with local birds.

Oral 19.5 in *Ecology and Evolution of Frugivory and Seed Dispersal (Part II)*: Joffre C/D, 17.06.2010, 15:00-15:15

Fruit choice and seed size selection in an eclectic primate omnivore and implications for plant community dynamics in West Africa

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Olive baboons (*Papio anubis*) in West Africa are highly frugivorous and disperse seeds of 26 % of the regional pool of woody plant species. They are characterised as eclectic feeders yet the role of morphological fruit and seed traits in baboon fruit choice remains largely unexplored. We investigated a) if baboons prefer particular traits relative to the availability among plant species and b) which suites of traits best predict fruit choice and seed handling (dispersal vs. predation). Seed size is an important plant fitness trait and often varies considerably also within plant species. We thus tested for c) intra-specific seed size selection, expecting baboons to choose fruits with smaller than average seeds in species the seeds of which they swallow with pulp and larger seeds when they predate on the seeds. Among plant species, baboons seemed to consume whatever fruit type, colour, and size of fruit and seeds available, though they especially included larger fruit into their diet. Fruit type and colour best predicted whether a species was part of baboon diet whereas fruit type and seed size best predicted seed predation. Within species, baboons were seed-size selective in 9 out of 11 plant species which can impact dispersal distance and plant reproductive success. As most plant species in the savanna-forest mosaic of West Africa have medium-sized to large fruits and seeds, large frugivores like baboons seem particularly important for plant community dynamics in this ecosystem.

Oral 19.6 in *Ecology and Evolution of Frugivory and Seed Dispersal (Part II)*: Joffre C/D, 17.06.2010, 15:15-15:30

A spatial test of the ultimate null hypothesis: White-faced capuchin dispersal of *Genipa americana*

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The “ultimate null hypothesis” of tree spatial distributions predicts that adult distributions closely reflect primary seed shadows (Howe and Smallwood 1982). Due to post-dispersal variables (e.g. secondary dispersal and predation), primary seed shadows are not expected to closely mirror adult tree distributions. We tested this null hypothesis for *Genipa americana* (GA), an angiosperm that fruits in the early wet season (May-June), and the dispersal pattern generated by its primary disperser, capuchins (*Cebus capucinus*) in Santa Rosa National Park, Costa Rica. We mapped each adult GA tree within a 60-ha plot of pasture land abandoned 40-50 years ago (N = 206 trees). We mapped defecations for a group of capuchins whose 103-ha home range encompasses the 60-ha plot during focal follows on all adults (N = 248 defecations). We analyzed the degree of clustering for both wet-season defecations and GA trees using Nearest Neighbour Analysis and a multi-distance spatial cluster analysis (ArcGIS 9.3). Capuchin defecation patterns are significantly clustered, with a mean distance between points of 23 m ($p = 0.00$, $Z = -9.3$). GA trees are also significantly clustered, with a mean distance between trees of 12 m ($p = 0.000$, $Z=-10.1$). The clustering is significant for both capuchin wet season defecations and GA trees at all ten levels of multi-distance analysis ($p = < 0.05$). Results support the “ultimate null hypothesis” that adult tree distributions reflect primary seed shadows for capuchin-dispersed GA.

Oral 19.7 in *Ecology and Evolution of Frugivory and Seed Dispersal (Part II)*: Joffre C/D, 17.06.2010, 15:30-15:45

Testing the Janzen-Connell hypothesis at the community level with functional traits

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We conducted a novel test of the Janzen-Connell hypothesis (J-C), which proposes that seedling mortality increases with increasing proximity to (or density of) conspecific adults. Though this hypothesis has been extensively tested, and by and large supported, we still lack interpretations at the community level, in large part because many species are too rare to permit rigorous tests of their spatial distribution. Previous tests of J-C at the community level have been limited by the difficulty of acquiring data on the survival of seedlings of rare species. Thus, previous studies have focused upon one or few common studies, making it difficult to infer the generality of distance-dependent mortality patterns. We make a general test of J-C at the community level by using functional traits. Essentially, we recast J-C to ask whether seeding survival is affected by the proximity of adults with similar functional trait values. In a pristine tropical rain forest in French Guiana, we observed the survival of 8600 seedlings over seven years, and identified all adult trees within 15 m of seedling plots. We integrated these datasets with data on adult traits and phylogenetic distances collected as part of the BRIDGE project. We report on the increase in seedling mortality resulting from the proximity of functionally similar adult trees. Our results should have important implications for the extent to which J-C mechanisms contribute to the maintenance of diversity in species-rich tropical forests.

Oral 20.1 in *Animal-Plant Interactive Networks and Seed Dispersal Services*: Joffre C/D, 17.06.2010, 16:15-16:30

The backbone of seed dispersal: within- and among-network variation in the importance of different dispersers

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In seed dispersal services some species are more important than others. Furthermore, as species are mosaics of local populations with different interactions, the importance of each species probably varies among sites. We assessed the relative importance of seed dispersers as their “accessibility”. Widespread species were expected to exhibit different accessibilities among networks. Primary frugivores were expected to be more accessible than secondary frugivores. 15 Neotropical datasets on bat-fruit (8) and bird-fruit (7) interactions were transformed into one-mode diet-overlap networks and for each animal we calculated accessibility to their direct and indirect neighbors (species with similar diets). 32 bat, 125 bird and 443 plant species were analyzed. Animal species that were more accessible to direct neighbors were also more accessible to indirect neighbors. 14 bat and 27 bird species occurred in two or more networks, and their accessibility varied largely among sites. Primary and secondary frugivores were similarly accessible in the networks. Our findings suggest that the importance of seed dispersers should be assessed at a local scale. Furthermore, opportunistic frugivores may be also important as backups in the maintenance of seed dispersal services.

Oral 20.2 in *Animal-Plant Interactive Networks and Seed Dispersal Services*: Joffre C/D, 17.06.2010, 16:30-16:45

Disentangling seed dispersal of an endangered conifer

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Ecological interactions form the backbone of ecological communities. In particular, mutualistic interactions, such as seed dispersal, have received much attention. Recently, the static, structural picture of mutualistic networks has been well described. However, their spatio-temporal variability is still poorly understood, despite numerous empirical and theoretical studies. Here we focus on an endangered conifer, *Taxus baccata* L., and its associated frugivorous community over two consecutive years in Western Spain. Our central objective is to disentangle the role of landscape features from frugivore's guild characteristics – such as frugivore identity or foraging behaviour – in explaining components of the observed seed shadow. Specifically, we develop a GIS-based, spatially-explicit model. We find a variable frugivorous community; nevertheless, we find consistent, spatially-structured patterns of seed shadows across years. We argue that this spatial structure results from the interaction between frugivores and landscape features. Frugivorous birds display predictable interaction patterns with the surrounding vegetation and thus generate predictable seed shadows. Currently, we are complementing our analysis with molecular techniques to draw the complete picture of the underlying processes.

Oral 20.3 in *Animal-Plant Interactive Networks and Seed Dispersal Services*: Joffre C/D, 17.06.2010, 16:45-17:00

Specialization of seed-dispersal networks decreases at edges and disturbed sites of an African rain forest

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Human disturbance is a prevailing threat to tropical rain forests and affects frugivores and their seed-dispersal services in manifold ways. We analyzed how tropical seed-dispersal networks respond to forest edge and local disturbance in Kakamega Forest, Kenya. In a two-factorial design, we carried out frugivore observations on eight species of canopy trees in the interior and at the edges of a disturbed and an undisturbed forest. Frugivore abundance and richness were not affected by local disturbance, but were higher at the edges than in the interior, although fruit availability did not differ. Forest visitors were more abundant at the edges and in the disturbed forest, whereas forest specialists followed the opposite pattern. These differences in community composition changed the specialization in the seed-dispersal networks. Specialization of plants and animals was much lower at the edges than in the interior and in the disturbed than in the undisturbed forest, resulting in the most specialized network in the undisturbed forest interior. In this tropical forest, edge effects increase the visitation frequency on fruiting trees, while forest edge and disturbance change the composition of the frugivore community. Our findings suggest that tropical seed-dispersal networks are more redundant in disturbed habitats, which may increase the stability of seed-dispersal services, but may also lead to a decoupling of co-evolved seed-dispersal systems in response to human disturbance.

Oral 20.4 in *Animal-Plant Interactive Networks and Seed Dispersal Services*: Joffre C/D, 17.06.2010, 17:00-17:15

Network theory and the seed dispersal loop

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Existing network representations of plant-frugivore interactions allow for a greater understanding of community complexity, but generally do not use temporal and spatial factors that are known to be important for seed dispersal. Incorporating these factors will thus be a crucial component of developing dynamical network models of seed dispersal. Currently, we are exploring temporal patterns in plant-frugivore networks of forest communities in Puerto Rico. Thus far, we have found that system phenology, in both fruit availability and frugivore diet, contributes to structural properties that are common in mutualistic networks. Preliminary results suggest that generalist species can either be always generalists or serial specialists. Generalists have been hypothesized to be the backbone of mutualistic communities, but these two different modes of generalization may differ in how they protect the community from disturbances. In addition, in order to assess the relationship between network generalization and successful seed dispersal by frugivores, we present network models that include more stages of the seed dispersal loop. Initial results show that not all generalists are effective seed dispersers, and that the most highly generalist frugivores may not be as important as other frugivores for recovery from disturbances, especially during community assembly. Overall, network theory not only improves our understanding of seed dispersal from a community-wide perspective, but also highlights exciting new areas of research.

Oral 20.5 in *Animal-Plant Interactive Networks and Seed Dispersal Services*: Joffre C/D, 17.06.2010, 17:15-17:30

Can we scale up seed dispersal? Incorporating dispersal into vegetation-climate models

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Dynamic Global Vegetation Models (DGVMs) simulate the distribution and structure of vegetation as a function of climate. These models are used to simulate biogeochemical cycles and vegetation shifts in response to paleo, current and future climate change. DGVMs have been criticized for not including biological interactions, which also play an important role in shaping ecological communities. Most significantly, none of the current DGVMs include a representation of seed dispersal. The models assume *perfect dispersal*, where plants can arrive at any location, regardless of distance or physical barriers. Model predictions likely overestimate vegetation migration rates, and underestimate the sensitivity of vegetation to rapid climate change. I will be presenting the first attempt to incorporate a phenomenological representation of seed dispersal into a regional dynamic vegetation-climate model (LPJ-GUESS). I will illustrate an approach that allows us to represent dispersal across large spatial scales, while still maintaining dispersal biology. Incorporating seed dispersal and migration limitations into vegetation-climate models will improve future predictions and help illustrate the factors which influenced historical vegetation migration rates.

Oral 20.6 in *Animal-Plant Interactive Networks and Seed Dispersal Services*: Joffre C/D, 17.06.2010, 17:30-17:45

Linking frugivore behaviour to plant population dynamics: thrushes and fleshy-fruited trees in the Cantabrian range

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We present results from simulations of frugivore-dispersed plant dynamics and observational studies of *Turdus* spp foraging for fruits to show that frugivore behaviour can have an important role in determining plant spatial distribution and abundance. Simulated plant dynamics showed increased clustering and smaller population sizes as dispersing agents were less willing to move larger distances while foraging. This tendency was further modulated by how selective animals were. Field work was conducted in a 400 x 440 m plot in Sierra de Peña Mayor (Asturias, N Spain) during three fall-winter seasons (2007 to 2010). The plot was divided into 20 x 20 m cells where we estimated forest cover and fruit abundance. We followed individual birds, recording their position and time spent on different perches and the species and number of fruits eaten on fleshy-fruited trees. Birds where highly mobile, but net travel distances from source plants were short, as birds frequently returned to the same feeding patches. *Turdus merula* and *T. philomelos* moved shorter distances and were more selective for fruit abundance than *T. iliacus* and *T. viscivorus*. Furthermore, *T. iliacus* was more associated to forest cover than *T. viscivorus*. Overall these movement behaviours would result in highly aggregated seed dispersal but with seeds deposited in open areas occasionally. However, in order to fully link seed dispersal patterns to plant demography, studies of plant establishment and survival are required.

Oral 20.7 in *Animal-Plant Interactive Networks and Seed Dispersal Services*: Joffre C/D, 17.06.2010, 17:45-18:00

The role of animals for Dandelion seed dispersal

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Adaptations of dispersules are often interpreted as morphological dispersal syndromes, assuming a close relationship with dispersal types. Dandelion seeds, for example, have a pappus and are thus classified as wind dispersed. However, this assumption may be misleading, as dispersal may also be caused by non standard means. To assess the role of non standard dispersal means, especially animal mediated seed dispersal. A variety of methods was used to assess the importance of different dispersal types for Dandelion. The methods comprise literature compilation, experimental measurement of indicator traits, and process based modelling of dispersal kernels with SEED (animal dispersal) and PAPPUS (wind dispersal). Dandelion is regularly dispersed by non standard means. Dandelion ranks among the 10 % of the herbs with the highest wind dispersal potential, among the 20 % with the highest potential for epizoochory and has a medium potential to survive digestion. Simulation of dispersal kernels showed that dispersal by animals may be several orders of magnitude more efficient than wind dispersal at distances from 10 to several 1.000 m. Animals are effective seed dispersers via epi- and endozoochory. Even for species like Dandelion, which is unquestionable adapted to wind dispersal, animal mediated seed dispersal may be much more efficient for long distance dispersal than wind dispersal, given that animal move over large distances.

Poster 21.1 in *Organismal and Natural History Oriented Research*

The influence of El NIño/La Niña Southern Oscillation on tropical fruit phenology: consequences for seed dispersal

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Periodic life-cycle events of organisms, i.e. phenology, are extremely sensitive to inter-annual variations in climatic conditions. Changes in plant phenology may affect seed dispersal patterns, given that seed predators and dispersers may be satiated or starved by abundant/scarce seed crops respectively. Nevertheless, in tropical forests, the interactions between climatic variability, fruit production and seed dispersal are more complex and unknown. The objective of this study is to understand whether inter-annual climatic events (such El Niño/La Niña) affect seed dispersal thanks to the increase of fruit and seed production. With this purpose, we have taken benefit of a nine-year dataset of fruit and seed rain collected in the pristine Amazonian forest of Nouragues (French Guiana). Our results show an influence of climatic indices such as the Multivariate ENSO Index (MEI) on seed and fruit production, being the two El Niño events of the 2001-2009 series preceded by an increase of the crop production. However, this general pattern was highly variable between species. Following the Janzen Satiation Hypothesis, increased seed crops may satiate seed predators and thus, increase the possibilities of seed dispersal by frugivorous species. However, high crop productions may also satiate frugivorous animals. Although many questions remain open, our results already show the influence of large climatic variation on fruit phenology and point out the consequences for seed dispersal in tropical forests.

Poster 21.2 in *Organismal and Natural History Oriented Research*

Fruit-frugivores networks in Amazonian varzea and terra firme forests

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Fruits and seeds are extremely important in sustaining vertebrate populations in tropical forests yet there is still limited information on the complex networks between vertebrate frugivores and plants bearing fleshy fruits. In particular very little attention has been paid to seasonally flooded forests such as the Amazonian várzea forest. This project investigates fruit-fugivore interactions in adjacent areas of várzea and terra firme forest in the Jurua region of western Brazilian Amazonia, combining line-transect censuses of terrestrial and arboreal frugivores and a detailed study of fruit phenology and productivity using three complementary techniques (direct tree crown inspections, fruit/seed traps, and residual fruit fall). Temporal and spatial variation in vertebrate abundances and fruit productivity has been recorded for two years to document seasonal differences, particularly in response to the flood pulse. In addition, this project attempts to predict the potential distortion of fruit-frugivore networks by hunting depletion of frugivore species and the selective logging of tree species.

Poster 21.3 in *Organismal and Natural History Oriented Research*

How does dispersal limitation facilitate species coexistence in temperate forests?: Comparison among three forests in Japan

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Seed dispersal patterns of trees could determine spatial distribution of seed rain, subsequent mortality, and consequently, structure and dynamics of forest community. We test this prediction using 12-years data of seed rain (seed traps more than 100) and distribution and fate of new seedlings (quadrats paired with the seed traps) at three forests: An evergreen forest dominated by trees with fleshy fruits, a deciduous forest mainly dominated by trees with wind-dispersed seeds, and a deciduous forest dominated by trees with acorns (i.e., Faguceae). First, mortality of dispersed seeds and new seedlings was modeled by GLMM using biotic factors (distance to or density of to conspecifics) and abiotic factors (light condition, soil moisture, substrate composition, etc.) as explanatory variables. Second, various seed dispersal patterns were simulated for every species (observed, uniform, and random), and resulting distribution of survived seedlings were expected by the model estimated above. By these analysis, we would like to assess whether observed dispersal patterns facilitate coexistence of tree species or not.

Poster 21.4 in *Organismal and Natural History Oriented Research*

Difference in foraging patterns of fruits by Asiatic black bears in relation with abundance, timing and duration of various fruit production

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Asiatic black bears are known to forage on various kinds of fruits, and act as seed dispersers for fleshy-fruited plants. Our aim is to clarify how the temporal variation in abundance of various fruit species affect the fruit choice of bears. We observed the temporal change in fruit abundance of *Quercus crispula* in 2007 and of 12 more species in 2008 and 2009. We also searched for feeding signs of bears from 2007-9. From the results of 2008-9, food items were classified into two groups: main food (MF) which were foraged intensively for a certain time and alternative food (AF) which were foraged less frequently and at times when switching to another MF. Most of the AF items were fleshy fruits which were distributed sparsely in the habitat, suggesting that the home range of bears expanded. Therefore, species which produce fruits at periods when bears switch MFs will have a greater probability of being consumed, and of being dispersed over long distance. MF in autumn was *Q. crispula* acorns for all three years, while summer MF was year-specific according to the species production. In response to this variation, timing of bears to start foraging acorns changed: Sep 27 in 2007, Sep 15 in 2008 and Aug 26 in 2009. Presumably, this will affect the bears' choice of AF item. In summary, the kind of fruit consumed was affected not only by its abundance, but by its fruiting period, especially for AF items. This showed the ability of bears being a seed disperser for various species, even for those with low abundance.

Poster 21.5 in *Organismal and Natural History Oriented Research*

The Japanese black bear (*Ursus thibetanus japonicus*) as seed dispersers and ecosystem engineers.

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We studied fruit use by the Japanese black bear (*Ursus thibetanus japonicus*) and seed clumping in bear scat using fecal analyses in broad-leaved deciduous forests in central Japan. Also, we investigated light condition and seed production of fleshy-fruited plants under oak trees (*Quercus crispula*) with small gap that Japanese black bears often make, when they climb trees and break branches in a part of the canopy to feed the fruits. The fruit size of plants used by bears and the species composition and intactness of seeds contained in scat were examined in five transects (10 km × 10 m). Light intensity and fruiting of fleshy-fruited plants were examined at six layers under 20 oak trees with small gap and 20 those without small gap. Seven of the nine plant species detected in scats had medium-sized fruits (6–15 mm width), whereas the other two had relatively large fruits (20–100 mm width). In total, 14,492 seeds were detected, of which 97.6 % were intact; the remainder were damaged. Japanese black bears seldom digest ingested seeds and thus contribute to the seed dispersal of their food plants, including species with fruits that are too large to be swallowed by frugivorous birds. Light intensity and fruiting of fleshy-fruited plants in canopy layers were improved under oak trees with small gap then those without small gap. The small gap formation by Japanese black bears changes in the light condition and seed production of fleshy-fruited plants under the trees and thus they act as ecosystem engineers.

Poster 21.6 in *Organismal and Natural History Oriented Research*

Dung beetles as unknown acorn dispersers in Mediterranean oak forests

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The plant-dispersers mutualism in Mediterranean oak forests has been largely studied, emphasizing the interactions between oaks and small vertebrates (especially rodents and jays). We have recently documented the striking behaviour of an Iberian endemic, beetle species-*Thorectes lusitanicus*-that buries and feeds on acorns of the two *Quercus* species (*Q. suber* and *Q. canariensis*) that dominate the oak forests of southern Spain (Los Alcornocales Natural Park). In laboratory bioassays, we have significantly demonstrated their feeding preferences for acorns in comparison with the main type of food previously described for this beetle species (dung of large herbivorous). Acorn consumption confers it ecophysiological advantages, improving its resistance to low-temperature conditions and increasing its reproductive capacity. From the point of view of the tree, *T. lusitanicus* not only act as post-dispersal seed predator but also as authentic secondary disperser, since a large proportion of these buried acorns are abandoned or not completely consumed by them, this behaviour enabling a higher survivorship of the seeds and increasing their protection from more efficient seed predators. In spite of the seed removal rate due to *T. lusitanicus* is relatively small compared with that due to other predators, recent

field studies suggest that the disperser potential of these insects could be crucial for natural regeneration and tree population dynamics of the two study oak species.

Poster 21.7 in *Organismal and Natural History Oriented Research*

Eating all or leaving something? The role of partially gnawed acorns in oak regeneration.

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We examined if partial predation of acorns could limit acorn dispersal and oak regeneration. We used wire tagging method to monitor acorn fate. Then, we conducted laboratory experiments to examine capability of partially gnawed acorns to germinate and establish. Partially eaten acorns resulted in a 15.1 % (N=110) of the relocated acorns. Most acorns presented cotyledon loss in the basal part (60.0 %; N=66) and only 10.9 % (N=12) resulted in non-viable seeds (embryo damaged). Dispersal distances for partially eaten acorns in the first cache did not differ from intact acorns. 83.3 % of partially predated acorns were able to establish compared to 96.6 % for intact acorns. We found that partially eaten acorns germinated significantly sooner than intact acorns, with no differences in root length compared to intact acorns. However, partially gnawed acorns produced less root biomass, which could affect seedling development. These results provide that partial consumption of acorns by rodents is not a very rare event, enabling effective dispersal. This study supports the satiation hypothesis at seed level since larger acorns presented greater uneaten cotyledon mass. However, the percentage of acorns with the embryo undamaged was not related to acorn weight, which leads to the same proportion of potentially viable acorns regardless their weight. We conclude that partially gnawed acorns play an important role in natural regeneration of oak forests with ecological and evolutionary implications.

Poster 21.8 in *Organismal and Natural History Oriented Research*

Effects of subindividual variation in seed traits on seedling establishment success in a deciduous oak, *Quercus serrata*

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It is frequently reported that seed traits varies largely within a species and even within an individual plant. Unlike mean in measurements of plant traits, variance has been rarely treated as a variable representing an individual plant in any types of analyses, but recently the importance of considering the level of variance as a independent variable has been recognized (Herrera 2009). In this study we examined effects of means and variances of seed traits (size and tannin content) on seedling establishment success of individual oak trees, *Quercus serrata*, in Japan. We measured weight and tannin content of seeds collected from 27 trees (8596 seeds in total), returned them with an individual tag, and traced their seed fate. Tannin content was estimated nondestructively using near infrared spectroscopy. Multiple regression analysis revealed that trees with smaller mean in seed size and larger variance in seed tannin content exhibited higher establishment ratio of seedlings in next spring. Contrary to this, variance in seed size and mean in tannin content had no significant effects. High density of wood mice during this period may favor smaller seeds because of their preference for large seeds. In addition, this result suggested that seed consumers did foraging in variance-averse manner to tannin content. The present study revealed that variance level in seed traits may be more influential to plant fitness than mean of measurements in some cases.

Poster 21.9 in *Organismal and Natural History Oriented Research*

How evolutionarily conserved are the dispersal systems of *Ficus* and *Quercus*?

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Since phenotypic traits regulating species interactions are largely a legacy of their ancestors, it is widely assumed that ecological interactions are phylogenetically conserved, with closely related species interacting with similar partners. Here we study the evolution of the dispersal system in a specialized tree genus, *Quercus*, and a generalist tree genus, *Ficus*. We obtained from the literature information on seed dispersal for 48 oak species and 260 fig species and on phylogenetic relationships for 11 oaks and 55 fig trees. Dispersers were identified at the family level. Oaks were dispersed on average (± 1 SD) by 1.96±0.14 families, ranging between 1 and 4, whereas figs were dispersed by 6.06±0.40 families, ranging between 1 and 45. Another difference was the overall number of animal families dispersing each genus, which was much higher in figs (102) than oaks (8). We used network techniques to classify oak and fig species into dispersal groups according to the similarity in disperser assemblages. We found two dispersal groups for *Quercus*, those dispersed by rodents and those dispersed by squirrels and jays. In *Ficus* we found four dispersal groups (one dispersed mostly by Muridae and Tragulidae, a second by Columbidae and Pteropidae, a third by old world Primates, Sciuridae, and Bucerotidae, and the last by Phyllostimidae, Cebidae and Psittacidae). We found a phylogenetic signal for figs but not oaks, indicating the dispersal system is evolutionarily labile in oaks but conserved in figs.

Poster 21.10 in *Organismal and Natural History Oriented Research*

Influence of neotropical bats on germination parameters of free-standing and strangler figs (*Ficus sp.*, Moraceae)

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In tropical lowland rainforests, figs (*Ficus*, Moraceae) are considered a keystone resource for numerous frugivores. Neotropical frugivorous bats (Phyllostomidae) are regarded as efficient seed dispersers of *Ficus* as they are abundant and highly mobile. However, their influence of ingestion upon germination success of seeds as an important aspect within the seed dispersal loop is little known. Furthermore, many studies about germination success after gut passage lack a clear experimental design which makes existing studies difficult to interpret. We applied a rigid experimental design to test the influence of gut passage of *Artibeus jamaicensis* (Phyllostomidae) on percentage and rate of seed germination in figs. We studied three species of free-standing figs (Pharmacosycea) and three strangler figs (Urostigma) on Barro Colorado Island, Panama. Seeds removed from fruit pulp either manually or by ingestion germinated in most of the cases (> 92 %), while seeds that were not removed from fruit pulp were quickly destroyed by fast growing fungi. Consequently, ingestion of seeds by *A. jamaicensis* has a strong positive influence on germination. While the response to ingestion did not differ among fig species, germination parameters differed significantly between the two subgenera of figs which can be interpreted as adaptation to specific microsite characteristics necessary for successful establishment, such as a tree fall gap for free-standing figs or adequate host tree for stranglers.

Poster 21.11 in *Organismal and Natural History Oriented Research*

The role of birds and bats on seed dispersal of cloud forest species to burned pine forests in Western Mexico

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Western Mexico montane forests are dominated by pines and oaks, but patches of cloud forest are also found in hollows and ravines. High-intensity disturbances create open areas in the cloud forest that are readily colonized by pines. Vertebrate dispersers are likely to be one of the main vectors of the later replacement of these secondary pines by cloud forest. In this study we wanted to assess the importance of birds and bats on seed rain from cloud forest to surface-burned adjacent pine forests, in the Sierra de Manantlán Biosphere Reserve. We hypothesized that seed rain intensity would depend on the distance from the seeds source, i.e. the nearest cloud forest patch. We sampled seed rain once a month during a year using seed traps in two areas burned five years ago located near two ravines, surrounded by cloud forest that was also sampled. Seeds traps were located at 10, 25, 50 and 100 m from the cloud forest edge. We also sampled frugivorous birds with point counts near the seed traps sites, and sampled bats using mist-nets in one of these sites. 10 frugivorous bird species and 2 frugivorous bats were detected, and 834 seeds of 16 different taxa with fleshy fruits were collected. 102 seeds were found in the burned area out of the control cloud forest, being more collected at the shortest distance. Our results show that bird and bat dispersers can have an important role in the forest succession from disturbed pine forests to cloud forests in suitable areas.

Poster 21.12 in *Organismal and Natural History Oriented Research*

Do differences in dispersal quality in a fleshy fruit species with mixed dispersal (birds and mammals) affect plant recruitment?

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Seed dispersal of *J. thurifera* is carried out mainly by thruses, but also by other animals. Most studies evaluate seed dispersal just in terms of quantity of dispersion assuming that more seeds is more efficient from a demographic an even evolutive perspective. However this approach may be seriously biased therefore we propose a change on the approach “from quantity to quality” evaluating reproduction as an integrated process from dispersion to sapling survival. Our aim was to evaluate the quality of the dispersal agents (seed treatment and deposition pattern): *Turdus* spp, foxes, martens, rabbits and sheeps on *J. thurifera* Woodlands in central Spain. Seed dispersal, post-dispersal predation, seedling emergence, and seedling and sapling survival were evaluated in two forest stands, in two different habitats (mature forests and new colonization areas) and in three microhabitats (beneath *J. thurifera* tree, beneath shrub and in the open). We calculated the total probability of reaching sapling stage (<seven years, SS) for each microhabitat, habitat and forest stand. Moreover, we asses the effect of gut passage on seed size, seed viability and seed germination. Our Study shows that sheeps gut passage damage most seeds, thruses seemed to choose fruits with smaller seeds and foxes improved seed germination. Regarding deposition pattern seeds had higher SS under *J. thurifera* trees. Therefore thruses and rabbits are the best dispersal although there were site and habitat differences.

Poster 21.13 in *Organismal and Natural History Oriented Research*

Coupling mistletoe infestation rate, frugivorous bird activity and seed rain

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Trees infected by mistletoe *Viscum album subs austriacum,* present a frugivorous-bird visitation rate proportional to their parasitic infection level. Consequently, trees which offer an abundant mistletoe fruit crop, should receive higher frugivorous visits. This would result in a disproportionate zoochorous seed concentration close to trees hosting a higher number of parasite plants. To test this hypothesis we have analysed frugivorous-birds-behaviour and zoochorous-seed rain in pines with different mistletoe infection levels in a Mediterranenean mountain Baza´s Natural Park, southern Spain. We used two plots situated at different altitudes. These plots represent a typical Mediterranean pine forest of *Pinus nigra*, which is a typical mistletoe host in these areas. We selected a total of 40 pines with different infection levels and 40 uninfected pines as control. Within each pine, we made frugivorous-bird observations and we quantified seed rain using seed traps and sampling plots below the canopy. We quantified the number of mistletoe seeds stuck on tree branches. As frugivorous birds concentrate their activity in infected pines, trees which host many mistletoe plants also present a higher number of stuck seeds on their branches. Infected trees undergo a reinfection dynamics which can ultimately result in the host death. Infected trees concentrate under their crown the majority of the dispersed seeds from different fleshy fruit species shrubs generating an aggregated pattern of seed rain for all these species.

Poster 21.14 in *Organismal and Natural History Oriented Research*

A method borrowed from animal ecology to estimate detectability and occupancy of mistletoe seeds as a function of host characteristics

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When a given species is not detected in a site, it does not necessarily mean that it is absent. Identifying the factors leading to imperfect detectability may thus help us to improve precision and efficiency when conducting surveys of organisms. I borrowed a method from animal ecology to estimate the detectability of mistletoe seeds as a function of host covariates: host size, presence of adult infections on the focal host, and proximity to infected hosts. I also evaluated the effect of taking detectability into account to obtain the occupancy estimates for mistletoe seeds. I showed that the detection of mistletoe seeds decreased 50 % from smallest to tallest host trees, and 21 % from non-isolated to isolated individuals. The presence of infections had a negligible effect on the detectability of seeds. I conclude that this repeated-survey approach should be useful in order to have better estimates of mistletoe seed deposition on taller and isolated host trees. Furthermore, because long-distance seed dispersal is very important to promote risk spreading in plant populations, it should be extremely important to increase sampling effort mainly for isolated host trees.

Poster 21.15 in *Organismal and Natural History Oriented Research*

Lizards as seed dispersers of the cactus *Melocactus curvispinus* in Margarita Island (Venezuela)

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Fruit consumption by reptiles has been mainly described from islands. We evaluated the role of lizards as seed dispersers of *Melocactus curvispinus* in Margarita Island (Venezuela), a cactus with herpetochory syndrome. Focal observations showed that three lizards consumed fruits of this species: *Ameiva bifrontata, Tropidurus hispidus*, and *Cnemidophorus senectus*. Visit rates were low (2.2 visits/day) and consumption rates even lower (0.3 fruits/day), but 63 % of *Ameiva*'s feces and 30 % of *Tropidurus*', had *Melocactus* seeds (n=21). These lizards had similar population abundances and *C. senectus* was scarcer. *Ameiva* used open areas and patches with vegetation. *Tropidurus* was mainly associated to sites with vegetation. *Melocactus* is more abundant in areas without vegetation. Comparing morphological measurements, *Melocactus* fruits are 27.7mm long and 11.6mm wide, *Ameiva*'s mouth has a similar size than fruits (length 20.9mm; head width 11.3mm), but *Tropidurus*' mouth is smaller (length 17.1mm; head width 9.5mm). Transit time through the gut was shorter for *Ameiva* (40±12 min) than for *Tropidurus* (323±103 min). Seed germination percentage was 100 % for washed seeds, 96 % for seeds with pulp and 87 % for seeds from lizard feces. Morphological, ethological, and physiological traits suggest that *Ameiva* is the main legitimate seed disperser. Even though defecated seeds possess reduced viability, it is still high, and the additional benefit would be the dispersion of seeds away from the source plant and seedling establishment in favorable sites.

Poster 21.16 in *Organismal and Natural History Oriented Research*

The relative importance of passerine birds and the Canarian endemic lizard (*Gallotia galloti*) as seed dispersers in a threatened insular Mediterranean ecosystem

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In the present study we evaluated the relative importance of two native vertebrate groups (birds and lizards) as seed dispersers year-round in a thermophilous woodland, the most threatened habitat in the Canary Islands. This was assessed from the perspective of seed dispersal effectiveness: 1) quantitatively (number of seeds in faeces and frequency of their occurrence), and 2) qualitatively (seed damage and germination pattern after disperser gut passage). The quantity of consumed fruits was dependent on the abundance of both dispersers and fruit availability, and the endemic lizard (*Gallotia galloti*) performed a greater role than birds. Passerine birds were more important than lizards only for those plant species with peak crops during the wet season (autumn and winter), just when reptiles were less active. Regarding effectiveness, although reptiles caused more seed damage in most plant species, seeds from lizard faeces germinated at a higher proportion and rate than seeds eaten by passerine birds. In this study, a positive correlation was recorded between these two components (quantitative and qualitative) and the endemic lizard proved to be more important disperser than passerine birds for most plant species in this island ecosystem. However, it is also fundamental to evaluate another very important qualitative aspect for the future: the suitability of each microhabitat in which the different dispersal agents eject the seeds they consume.

Poster 21.17 in *Organismal and Natural History Oriented Research*

Disperser-mediated plant-plant interaction in a secondary forest of northern Spain

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Plants, as sessile organisms, are strongly influenced by the presence of hetero- and homospecific individuals in their immediate environment. The structure of these *ecological neighborhoods* may influence largely the performance of plants by affecting the activity of their interacting animals, such as frugivores acting as seed dispersers. Ecological neighborhoods may therefore lead to complex outcomes for interacting plants, ranging from competition to facilitation for shared interactors. To study these effects we considered two fleshy-fruited tree species coexisting in secondary forests of northern Spain: Holy *Ilex aquifolium* and hawthorn *Crataegus monogyna.* These trees are the main fruit producers in autumn-winter in these forests, and share a common guild of frugivorous birds (*Turdus* spp), that act as dispersers. For three consecutive seasons (autumn-winter 2007-08, 2008-09 and 2009-10) we evaluated fruit removal by frugivorous birds in sixteen focal trees of each species distributed along a gradient of forest cover. We evaluated the effect of forest cover and fruit availability in the neighborhood of the focal trees (at two spatial scales) on fruit removal rate. Fruit removal rate on focal trees was partially predicted by the features of the *ecological neighborhood*, but this effect varied depending on the species, the year, and the feature (forest cover vs. fruit availability) characterizing the neighborhood.

Poster 21.18 in *Organismal and Natural History Oriented Research*

Fruit and seed fall in lek areas: a case study with white-bearded manakin (*Manacus manacus*)

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In lekking birds, males are often aggregated in an area where they stay most of the day seeking for mating opportunities. When such birds are frugivores, a high seed deposition is expected in lek areas compared to non-lek, control areas. We tested this prediction for the White-bearded Manakin (*Manacus manacus*) in the Atlantic forest of SE Brazil. Because lekking males often ate fruits in the immediate vicinity of the lek area, we further tested the prediction that fruits are more frequently removed from lek areas than in control areas, which should diminishes fruit fall in the former. We used fruit/seed traps (0.36 m^2) to assess the fruit and seed fall at three lek and three control areas arranged in a paired design. Seed density did not differ between lek and control areas, but overall seed limitation, calculated as the proportion of traps not receiving seeds, were higher at control areas. Thus, lekking activities promote a more evenly distribution of seeds in lek areas. Fruit fall were also higher at control areas, suggesting that plants growing near leks have a higher fruit removal. These results indicate that lekking *M. manacus* may alter the spatial distribution of the seed fall, and optimize the reproductive effort of plants growing near leks.

Poster 21.19 in *Organismal and Natural History Oriented Research*

Composition and Diversity of *Ramphastos* Toucan Foraging Flocks at La Selva, Costa Rica

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We evaluated the temporal and spatial relationships between *Ramphastos* toucan foraging flock composition and fruit availability at La Selva Biological Station, Costa Rica. We hypothesized that fruit density affects species composition of frugivorous flocks and that flock composition and diversity would fluctuate as fruit abundance changed in the tree crown. Foraging observations of the Chestnut-mandibled Toucan (*R. swainsonii*) and Keel-billed Toucan (*R. sulfuratus*) were recorded from 4-29 July 2008 and 5-17 January 2009 (N=320); observations included determining species and abundance of other frugivores foraging in the focal tree. Fruit abundance data from focal trees were recorded to illustrate changes within a single tree over the study period. Toucans were observed in 18 focal trees during the 2008 study period and 11 during the 2009 study period. We found that fruiting phenology of individual trees and interspecies interactions of tropical frugivores determine composition of foraging flocks in this dynamic system.

Poster 21.20 in *Organismal and Natural History Oriented Research*

Frugivory and dispersal of *Livistona jenkinsiana*, an economically important tropical palm of north-east India

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Livistona jenkinsiana is an important palm which is harvested for thatching roofs. High harvest levels have led to its increasing rarity. The species has supra-annual fruiting patterns, bears large-sized drupes, and is animal-dispersed. We observed 10 fruiting individuals for 216 hours to determine the fruit consumers/seed dispersers of *Livistona* fruits. We observed 10 birds and 4 arboreal diurnal mammals. There were clear differences in fruit handling between large-gape birds (two species of hornbills and Mountain Imperial pigeon) and small-gape birds. While fruit removal rates by small-gape birds were higher, most seeds (81 %) were dropped below fruiting crowns by these birds, while 64 % of fruits handled by large-gape birds were swallowed with seeds regurgitated and dropped away from the fruiting tree. Diurnal mammals were observed to peck at fruits. Using camera traps, we recorded 6 terrestrial mammal species, of which the Himalayan black bear, barking deer, and sambar were occasional visitors and possibly dispersed seeds, while the wild pig and Himalayan crestless porcupine were seed predators. Forty-one percent of seeds were consumed on-site, while 100 % of fruits were removed or consumed. Our observations show that the main fruit consumers are small birds. However, given that most seeds that are dropped are preyed upon, only the large-gape birds such as hornbills and Mountain Imperial pigeon provide better quality dispersal as they swallow fruits and drop seeds away from fruiting crowns.

Poster 21.21 in *Organismal and Natural History Oriented Research*

What makes a nutmeg rare?-fruiting, seed dispersal and recruitment in a Myristicaceae species

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We examined the fruiting patterns, seed dispersal, seedling recruitment and survival of *Horsfieldia kingii* (Myristicaceae) in the tropical forests of Arunachal Pradesh. *Horsfieldia* is rare, patchily distributed and fruiting was absent or low in some years and maybe pollinator-limited in this dioecious species. Fruiting coincides with the breeding season of hornbills who consume the lipid-rich aril and regurgitate intact seeds. Regurgitated seeds had marginally higher germination success than seeds from fallen fruits. Limited observations and the large seed size suggests that hornbills and the Mountain Imperial pigeon are the main dispersers of *Horsfieldia.* which was among the top fifteen species in the breeding season diet of hornbills. However, its contribution to the hornbills' diet was low (0.03-2.87 %), possibly because of its rarity and low fruit availability. Rodents prey heavily on *Horsfieldia* seeds, seedling density below parent trees and hornbill nest trees is low, however seedling density and survival was marginally higher at nest trees, suggesting that hornbill dispersal is critical for the recruitment of this rare species.

Poster 21.22 in *Organismal and Natural History Oriented Research*

Distribution and reproductive effort of two species of Nutmeg Trees (*Virola,* Myristicaceae) from Brazilian rain forest

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Virola bicuhyba and *V. gardneri* co-occur in Brazilian Atlantic Forest. We studied the micro-scale distribution of these dioecious species in 12ha of primary forest. Adults were measured, the sex was determined and their reproductive effort was followed for one year. Plants were aggregated by species but not by sex. In both species there was no aggregation of juveniles near females. Morphological variables were correlated and DBH was used as descriptor of size. *V. bicuhyba* showed a positive correlation between flower production and DBH only in males. *V. bicuhyba* males show average flower production for 4.2 months; females have low flower production over 1.6 months. In *V. gardneri* both sexes synchronize a massive flower production over two months. Fruit production is positively correlated with DBH only in *V. bicuhyba.* Both species show high variation in flower and fruit production between individuals of similar sizes that may promote competition for pollinators and dispersers. Aggregation of juveniles near females was expected for both species, since they share the same avian dispersers which often regurgitate seeds near feeding sites. The lack of aggregation of juveniles of both species near the females indicates that its distribution is determined by factors other than just seed dispersion. Despite the species relatedness, different reproductive strategies may be related to resource partitioning influencing their spatial organization. CNPq, FAPESP-Biota Gradiente Funcional.

Poster 21.23 in *Organismal and Natural History Oriented Research*

The biology and zoochory of nutmegs (*Virola* spp.) in a Brazilian Atlantic forest fragment

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Two *Virola* species *(V. bicuhyba* and *V. gardneri)* are found throughout Brazil's Atlantic Forest. Both species produce large, round-to-oval, fleshy arilate, and single-seeded fruits. The genus is widely recognized as an important food resource for large-bodied frugivores in the tropics, in particular to primates of the Atelidae. We collected data on the biology and zoochory of these two sympatric *Virola* spp which are part of the diet of the endangered Atlantic Forest Atelidae, the northern muriqui *(Brachyteles hypoxanthus)*. Our phenological investigation of 47 marked individuals trees revealed that ripe fruit production occurred between September and December. In total, less than 1 % of muriqui diet included ripe and unripe fruits, mature and young leaves, and petioles of both *Virola spp*. From *V. bicuhyba* northern muriquis ate mostly ripe fruits whereas from *V. gardneri* mostly leaves . When eating the fruits, monkeys often ingested their arilate seeds whole. Analysis of 948 fecal samples showed that monkeys passed large intact seeds (mean length: 24.5±2.8 mm; N=10) of both nutmeg species. The relatively extensive daily path lengths of northern muriquis allows for long-distance dispersal of nutmeg seeds ensuring the long term survival of both *Virola* species in this forest. As northern muriquis are now rare in the Atlantic Forest, along with other large bodied frugivroes, the long term survival of *Virola spp* is threatened by a lack of a seed dispersers.

Poster 21.24 in *Organismal and Natural History Oriented Research*

Dispersal spectra of four tree physiognomies along an altitudinal gradient of the Brazilian Atlantic Rainforest

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Plant diaspores are grouped accordingly to a general set of morphological characteristics, known as dispersal syndrome. Studies that evaluate the proportion of plant species with different dispersal syndromes within a community (dispersal spectra) have shown that the great majority of tropical tree species are zoochorous. However, these studies have not considered the syndromes within a syndrome, such as divisions of zoochory and, specially, mamalochory. The aim of this study is to identify the dispersal syndromes of tree species of four physiognomies along an altitudinal gradient of the Atlantic Rainforest in SE Brazil. To do so, we have considered and hierarchically organized all dispersal syndromes. Specifically, we ask whether the occurrence of syndromes in the same hierarchical level differs among the four physiognomies. We are identifying the dispersal syndromes of 353 tree species collected in four 1 ha-plot placed from 10 m to 1,000 m above sea level. Each individual was already measured and its species, identified. We will use chi-square tests to check for differences in the occurrence of syndromes in the same hierarchical level among the four physiognomies. Most of the species identified so far are zoochorous and ornitochorous, as found in other studies. When this study is concluded, we will have very refined dispersal spectra. Considering the syndromes within a syndrome will provide valuable information for further researches into seed dispersal.

Poster 21.25 in *Organismal and Natural History Oriented Research*

Linking specialized frugivores birds with complex tree assemblages at the atlantic rainforest, Brazil.

BERNARDO CLAUSI[1]

[1] Myrtlau nursery

Specialized frugivores birds from the neotropics are mainly Cotingidae and Pipridae, with a few exceptions. Eating fruits along the whole year they produce an interesting synergy with the fruiting trees, acting as a force in tree speciation. In this study I focus in two Cotingidae species, and their role in the dispersion and structure of their forest habitats, and also if their presence reflects a complex tree diversity assemblage. The bird species were the hooded berryeater (*Carpornis cucullatus*) and the bare throated bellbird (*Procnias nudicollis*), and the study sites consisted in 5 areas at eastern Paraná state south Brazil. The study started in 2005 and still is going on until late 2011. The bellbird was present in all 5 areas, while the berryeater was in only 2 of them. For the feeding ecology, seeds were searched below the male bellbirds singing areas, and for the berryeater only direct observations (bird eating the fruit) were recorded. Some overlap ocurred in their diet, most at sites where both species ocurred. However the seed dispersal pattern of each bird tends to complement each other, as the bellbird disperse mainly in clusters and the berryeater in a very homogenized web. The tree diversity index was higher in the areas where both bird species ocurred, allowing the opportunity to infer that any area without both species will start to lack the natural dispersion pattern of the forests in the region, reflecting in lower tree diversity in a couple of decades after the dispersers are absent.

Poster 21.26 in *Organismal and Natural History Oriented Research*

Zoochoric tree flora and frugivorous avifauna in a preserved area in South Brazil: the role of interactions on Araucaria Pine forest conservation.

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Plant-animal interactions are key components in forest communities. Birds are one of the most important seed dispersers, contributing to habitat maintenance. In south Brazil, the Araucaria Pine forest belongs to the Atlantic Forest Biome. The importance of this kind of work comes from the need to bring scientific information that will help to preserve the Araucaria forest. We surveyed tree and bird communities at the Ronda Natural City Park, in São Francisco de Paula, south Brazil. We sampled 30ha, classifying the trees according to dispersal mode (zoochoric, anemochoric, autochoric) and birds according to trophic guild (omnivorous, frugivorous, granivorous, insectivorous). We also attempted to record any observations of bird consuming fruits from the trees.We identified 67 tree species, 73 % of which zoochoric. The prevalence of species dispersed by animals is a pattern for tropical forests, which reaffirms the relation between animals and plants. Myrtaceae, an exclusively zoochoric family, was the most representative, indicating the relevance of this family for fruit availability. We identified 201 species of birds, with 34 % of them being frugivores or omnivorous. We observed 17 bird species consuming fruits of four tree species. We highlight the presence of three and six endangered species of zoochoric trees and frugivorous birds, respectively. Their presence reinforces the importance of an effective dispersal, together with the preservation of natural areas in Brazil, for maintaining local biodiversity.

Poster 21.27 in *Organismal and Natural History Oriented Research*

Importance of pigtailed macaques (*Macaca nemestrina leonina*) in seed dispersal: impact on the ecological balance of the tropical rainforest at Khao Yai National Park, Thailand

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Today, many countries of South-East Asia know about the alarming state of the forests existing on their territory and all agree that it is essential to save the remaining primary forest but also to enable the regeneration of degraded areas, through natural or artificial reforestation. The conservation of tropical rainforests thus passes by the necessity to better understand the plant-animal interactions, and in particular, the seed dispersal process. While following a troop of pigtailed macaques (*Macaca nemestrina leonina*) accustomed to Man in Khao Yai National park (2 168 km ²), Thailand, we will bring important data relating to these seed dispersers potentially necessary but unfortunately vulnerable. Indeed, this vulnerable but little known species, seems to be essential to maintain forest diversity by dispersing many plant species, particularly those inaccessible to smaller frugivores. First results already show that they disperse many seed species, of all kind of size, in all forest types, from primary forest to secondary forest, thanks to various handling techniques. They also seem to show an adaptation in their daily travels according to resources availability. The next fieldworks will enable us to bring more precision in these results and their temporal variations and thus to conclude on the potential role of *Macaca nemestrina* in the tropical rainforest regeneration.

Poster 21.28 in *Organismal and Natural History Oriented Research*

Functional uniqueness of small carnivore as seed dispersal agents: a case study of the common palm civets in the Tabin Wildlife Reserve, Sabah, Malaysia.

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Most carnivorous mammals regularly consume fruits and disperse the intact seeds to specific and conspicuous sites. Despite its potential importance and functional uniqueness, few studies have attempted to quantify this seed shadow and evaluate its effectiveness. In this study, we demonstrated that one frugivorous Carnivora, the common palm civets (*Paradoxurus hermaphroditus*) generated distinct seed shadows from sympatric frugivore, the pig-tailed macaques (*Macaca nemestrina*), and play important role in the regeneration of *Leea aculeata* (Leeaceae). We found that (1) the macaques nearly randomly deposited the seeds, while the civets non-randomly deposited them to certain sites such as the banks of small rivers (26.9 %), rain-flow paths (20.5 %), abandoned trails (17.9 %), treefall gaps (16.7 %), which are commonly characterized by fewer stems growing in the surrounding area and a lower canopy cover, and (2) the seeds deposited at river banks and gaps had significantly higher survival and growth rate, while the seeds at rain-flow paths or abandoned trails had lower survival rates than macaques or random dispersals. Although the effects of the civets on seed fate were not straight forward, we also confirmed that (3) the civets significantly enhanced the survival and growth after one year viewed as a whole. These results indicate that the non-random dispersals by the civets are highly effective for *L. aculeata*. They probably disperse many other plant species in a similar way, thus having profound effect on forest dynamics.

Poster 21.29 in *Organismal and Natural History Oriented Research*

Community-wide characterization of seed dispersal in a faunally-intact dry tropical forest: examining the relative contribution of extant mega-fauna

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Community-wide seed dispersal characterization at sites having an intact fauna is essential to understand the evolution of dispersal syndromes and the contribution of megafauna. Dispersal modes were inventoried for 92 % and fruit traits for 84 % of 73 woody plant species found on Mudumalai forest dynamics plot, India. Fruit-frugivore interactions were studied using tree watches and camera traps. Although 60 % of the species were animal-dispersed, mechanically-dispersed species constituted 70 % of the stand. Three broad dispersal modes were identified (mechanical, mammal and bird-mammal) and these displayed strong associations with fruit traits. Among the 11 frequently-observed frugivore groups, the largest frugivores, deer, bear and elephants, together dispersed 40 % of the plant community. There was low overlap in diets of these three megafaunal groups, although deer and bear overlapped with smaller frugivores. Deer and bear showed significant associations with fruit traits, but not elephants. Large fleshy fruits and large-seeded fruits had fewer dispersers. Although, large fruits and seeds were often dispersed by megafauna, few were exclusively dependent on megafauna. The three megafauna were the only potential long range dispersers for 25 % of the community. Given the range contraction experienced by these megafauna in tropical Asia, nearly one fourth of the plant community would have limited ability to disperse across fragmented landscapes in response to changing climates.

Poster 21.30 in *Organismal and Natural History Oriented Research*

Seed production, dispersal and establishment limitation: Effects on plant diversity in a tropical rainforest.

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Recruitment of plants can be limited by 3 components: Seed production limitation, dispersal limitation and establishment limitation. Recruitment limitation has been proposed as one of the multiple theories that explain the maintenance of high diversity of plants in tropical rainforests. In this study we evaluated the relative importance of each component and its possible effects on the diversity of plants in a tropical rainforest in Colombia. We estimated seed production and dispersal limitation using 400 traps located in 4 types of forest that were revised every 15 days during 1 year. We did experiments of seed addition and seedlings transplant to evaluate dispersal limitation, establishment limitation and the possible effects of both over the diversity of seedlings. For these experiments we use a dominant species and a combination of various species. In the seed addition experiments we considered the influence of predators. We found that seed production and dispersal are limited; nevertheless, experiments showed that establishment is the most limited component, and seed predation is a main cause of this. We did not find that dispersal limitation increases plant diversity. In conclusion, we found that effective seed dispersal increases the diversity of regenerating plants and that seed predation is a relevant factor influencing the lack of strong competition among seedlings and this processes could help in the maintenance of the diversity.

Poster 21.31 in *Organismal and Natural History Oriented Research*

Secondary dispersal by dung beetles of seeds defecated by two primate species in Colombia

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Secondary dispersal by dung beetles, of seeds defecated by frugivorous mammals is common in rainforests, and it can affect the final fate of seeds. Many factors can influence the outcome of a seed-beetle interaction. For example, dung type can in some cases determine whether a seed is buried or not by beetles. Here we compare seed fate for two tree species, *Pseudolmedia laevis* and *Clarisia racemosa*, defecated by two primates, *Alouatta seniculus* and *Lagothrix lagothricha.* We also assessed if edge effects associated with forest fragmentation affect the outcome of the interaction. We found that seed and primate species (but not the interaction) affected seed burial by beetles. A higher percentage of seeds of the smaller species (*P. laevis*, 29 %) were buried by beetles in comparison to the larger species (*C. racemosa*, 15 %). Also, a higher percentage of seeds were buried when defecated by *Lagothrix* (51 %) compared to *Alouatta* (37 %). We also found a significant edge effect on the probability of seed burial by dung beetles, with the lowest values in the pasture and steadily increasing values through the edge and into the forest interior (25, 50 and 75 m from the edge). With this study we show, once again, the relevance of quantifying secondary seed dispersal by dung beetles when comparing the dispersal effectiveness of different mammalian primary dispersers. We also show, for the first time, that this plant-animal interaction is negatively affected by edge effects associated with forest fragmentation.

Poster 21.32 in *Organismal and Natural History Oriented Research*

Diplochory and soil seed bank: the case of some pioneer species

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Primary seed dispersal through defecation by primates and subsequent secondary dispersal by dung beetles have a prominent effect on seed fate thus on patterning of the plant community. Clump dispersal by howler monkey *Alouatta seniculus* is at the origin of an increased seedling abundance and diversity under sleeping sites. This has been interpreted as a result of 1) increased seed input, 2) increased survival of seeds due to burial by dung beetles and 3) increased seedling establishment due to soil effects of dung deposition. The fate of small seeds (< 5 mm) forming the soil seed bank, once incorporated into the topsoil through dung beetle and other invertebrate activity, remains unknown. In this study, we compared the abundance of dominant pioneer species (2 *Cecropia* and 2 *Ficus* spp.) on defecation sites with controls at five different depth levels (up to 15 cm) conducted in French Guiana. More seeds were found in defecation sites compared to controls. We observed that seed concentration was all the more elevated that the sleeping site was frequently used. Seed density decreased with depth. Experiments conducted with beads suggested that dung beetles may be the major actor after primary dispersal in a typical case of processing chain commensalism.

Poster 21.33 in *Organismal and Natural History Oriented Research*

Rhamnus: a case of diplochory

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Seed dispersal is the active process (dynamic) to transport the seeds from the plant mother to another place in germinate conditions. We define zoochory when the disperser agents are biotic, and epizoochory or endozoochory if the transport is external or internal, respectively. When participate two disperser agents in the zoochory we named diplochory. We studied the second phase of ant dispersal in 8 species of genus *Rhamnus* in the Northeast Iberian Peninsula at the Mediterranean region: *R. alaternus, R. ludovici-salvatoris, R. saxatilis, R. lycioides, R. cathartica, R. alpina, R. pumila*, i *R. frangula* (*Frangula alnus*). The genus *Rhamnus* is a particular case of diplochory because the seeds are dispersed by vertebrates (mainly birds) in a first stage stimulated by the presence of fleshy pulp on the fruits. These seeds deposited in the faeces can be dispersal by ants in a second phase promoted by the presence of a elaiosome in the seeds. The geographic distribution of the plants and tbe ants, and the morphologic and structural of the *Rhamnus* seeds determine the rates of transport by ants to the nests. The presence of elaisome is the most significant factor that stimulate the transport by different ant species.

Poster 21.34 in *Organismal and Natural History Oriented Research*

Joshua tree seed dispersal: dead end anachronism or contemporary mutualism?

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Joshua tree is a charismatic and popular symbol of the Mojave Desert. Despite its popularity, we know little about the ecology of this species. Seed dispersal of Joshua tree, in particular, has not been thoroughly studied to this point. Here we examine the possible mechanisms acting to disperse Joshua tree seeds and their resulting fate. We hypothesized that Joshua tree seeds are cached by scatter-hoarding rodents and that other dispersal syndromes are unlikely. The majority of Joshua tree fruits monitored were taken directly from Joshua tree canopy by white-tailed antelope ground squirrels, and seeds and fruits on the soil surface were quickly removed by animals. Rodents given seeds labeled with scandium-46 cached them between 0.1 cm and 4.1 cm deep. Seedling emergence was most common for seeds planted between 1 cm and 3 cm in the field, and at 1 cm in a growth chamber. Seeds placed on the soil surface were unlikely to germinate. Anemochory is unlikely because the wind speeds required to move Joshua tree seeds and fruits across the soil surface were high (mean 43.6 km/h and 31.9 km/h, respectively), and rodents are likely to remove seeds before abiotic burial. These data show that the most common fate of Joshua tree seeds is hoarding by rodents. Caches made by rodents are an effective means of dispersal for Joshua tree.

Poster 21.35 in *Organismal and Natural History Oriented Research*

Seed Dispersal of Wild Peony (*Paeonia brownii*) in Western Nevada, USA

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We studied dispersal characteristics of wild peony (*Paeonia brownii*), an herbaceous perennial that produces large seeds and is found in Jeffrey pine forests at elevations between 1950-2000 m and in sagebrush scrub at elevations between 1550-1580 m in the Carson range of western Nevada, USA. Rodents removed seeds from under peony plants at an average removal rate of 5.1 % and 6.9 % per day at high and low elevations, respectively. We tracked radio-labeled seeds at 6 source plants at the high elevation site and recorded 72 caches with an average dispersal distance of 6.5 ± 4.4 m, an average depth of 7.6 ± 9.9 mm, and an average of 1.3 ± 0.9 seeds per cache. These results demonstrate that rodents disperse peony seeds. We monitored cache pilferage along transects. We used two seed types, peony and Jeffrey pine, because Jeffrey pine is a dominant, rodent dispersed tree with preferred seeds and serves as a reference species. Average cache detection rates for three cache types at two sites were 4.8 %, 3.7 %, and 5.1 % per day for peony, Jeffrey pine, and peony-Jeffrey pine mix caches, respectively. Jeffrey pine seeds were always removed if detected, but only 65 % of the peony seeds that rodents excavated were removed from cache locations. This indicates that peony seeds may be at a dispersal disadvantage compared to Jeffrey pine seeds. Scatter-hoarding is an unexpected dispersal mechanism for peony, considering that most rodent dispersed plants are large, woody trees and shrubs.

Poster 21.36 in *Organismal and Natural History Oriented Research*

Seed dispersal and microhabitat patterns of *Juniperus osteosperma* recruitment

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Juniper juveniles in woodlands of western USA are frequently found beneath shrubs. This is generally attributed to facilitation of germination or early survival through amelioration of the microclimate by shrubs. However, experiments suggest that in our populations facilitation of *Juniperus osteosperma* recruitment by shrubs is relatively weak, suggesting other factors might be important. One potential factor driving patterns of recruitment is seed dispersal. Here we present a preliminary study addressing the observed pattern of seedling recruitment in juniper woodlands and whether seed dispersal can explain that pattern. In two woodlands in western Utah, USA, juniper juveniles were more frequent than expected beneath shrubs and less frequent than expected in open interspaces, as has been suggested before. In a third population recruits were distributed among microhabitats as expected based on cover of microhabitats, although only 15 recruits were located. There are two dispersal agents of *J. osteosperma* in the study area, lagomorphs and rodents. Lagomorphs eat fruits off the ground and pass intact seeds, but the seeds are disproportionately dispersed to open microhabitats, with very few arriving under shrubs. Rodents harvest seeds, remove pulp, and cache seeds. Caches are disproportionately placed beneath shrubs and rarely in the open. Thus, seed dispersal by rodents, but not lagomorphs, potentially contributes to the observed spatial pattern of *J. osteosperma* recruitment.

Poster 21.37 in *Organismal and Natural History Oriented Research*

Effects of frugivore diversity on the functional environmental heterogeneity encountered by *Juniperus thurifera* seedlings: microhabitat role on plant recruitment

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In heterogeneous environments, seed dispersal can modify the functional heterogeneity encountered by a plant (the structural complexity of a system that affects ecological processes). This heterogeneity can be reduced or ampliflied depending on the animal behaviour. Here we compare changes in soil conditions experienced by *Juniperus thurifera*, a relictic species which is currently occupying abandoned agricultural lands, after being dispersed by thrushes, sheeps, rabbits, foxes and martens. We study seed rain in different habitats (mature forest and new colonization areas) from two separated continental Mediterranean systems in central Spain. Mean and variances of gravimetric water content, soil density and compaction and stone cover were compared before and after seed dispersal. All animals deposited seeds underneath *J. thurifera* trees, while carnivorous also placed a huge proportion of seeds under two species of shrubs. Therefore, the soil environment of *J. thurifera* during establishment was more homogeneous and heterogeneous when it was dispersed by thrushes or herbivorous, and carnivorous, respectively. We found more seedlings and saplings underneath *J. thurifera* females in mature forest, where gravimetric water content was higher and soil bulk density and compaction were lower. However, in new colonization areas, saplings were also found in opens and underneath shrubs. Other factors in the multiphase process of plant recruitment could explain that result.

Poster 21.38 in *Organismal and Natural History Oriented Research*

Prosopis seed dispersal by mammals in the Monte desert (Argentina).

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In the arid areas of Argentina, *Prosopis* (*Fabaceae*) plays an important role in the functioning of communities. The fruits of some *Prosopis* species are indehiscent pods, with a mesocarp rich in sugars and protein and palatable to animals. The aim of this study is to summarize the role of wild and domestic mammals in seed dispersal and seed germination. Small rodents (*Graomys griseoflavus, Akodon molinae, Calomys musculinus, Eligmodontia typus*, and *Microcavia asutralis*) remove and hoard fruits and seeds after primary dispersal and can act as predators or dispersers. Non-native mammals (cow, horse, donkey, European hare, wild boar) and native mammals (*Dolichotis patagonum*, *Pseudalopex griseus*, *Lama guanicoe*) are endozoochorous dispersers. The passage through the digestive tract of mammals modifies seed germination capacity and speed, with great variability depending on the particular mammal and *Prosopis* species involved. Subsequently, seedling establishment and sapling survival are related to defecation sites and to the activity of animals such as cattle. Small mammals and ants also remove seeds from cattle dung, and the importance of each removal group depends on season and on seed availability in the field. Animals constitute an important range of dispersal agents of *Prosopis* seeds through strategies that can delay or speed germination. This is of great importance in deserts where climate conditions are unpredictable, and the seed must consequently wait for opportune moments.

Poster 21.39 in *Organismal and Natural History Oriented Research*

Seed tannin content has weak influence on co-evolved scatter-hoarding rodent behavior

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The mutualistic interaction between scatter-hoarding rodents and their seed plants is highly complex and poorly understood. Defensive compounds, such as tannins, are thought to be a major mechanism for plant to control over rodent behavior. Previous studies, using naturally occurring seeds, have not provided conclusive support. Here, we test the importance of tannin concentration on the scatter-hoarding behavior of rodents using artificial seeds, thus to understand the interaction from its co-evolutionary history and context. Now, we combine feeding trials and field observations to examine the overall impact of tannin concentration in seeds on rodent behavior and health. We found that these rodents favored seeds with an intermediate amount of tannin (~ 5 %) in field and also performed better when fed the diets with intermediated tannin. In the co-evolutionary arms race between plants and rodents, our results indicate that while tannins may play a significant role in reducing general predation by the faunal community, they provide no precise control over the behavior of their mutualistic partner. Instead, the two partners appear to have reached an evolutionary detente where both receive adequate benefit but the year to year outcome depends on a wide range of factors beyond the control of either partner.

Poster 21.40 in *Organismal and Natural History Oriented Research*

Modelling the spatial-temporal pattern of post-dispersal seed predation in Stone Pine (*Pinus pinea* L.) stands in the Northern Plateau (Spain)

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Stone pine forests constitute an important environmental element and economical resource in the Northern Plateau (Spain). However, natural recruitment usually fails under the current management model. One of the main factors involved in this failure is post-dispersal seed predation, as it conditions the availability of seeds on the ground. In this study we intend to determine the spatial-temporal pattern of the predation process in four different sites, differing in density, index site and understory, throughout the Tierra de Pinares county (Valladolid province). The study was extended for 12 months in 4 sample plots, where a factorial design was installed, placing 16 seed points and monitoring monthly the predation rate. The factors taken into account were a) distance to natural elements (stems and stumps; 4 levels, 4 replications) and b) the seasonal effect (12 levels). Data analysis was performed using Generalized Linear Mixed Models (considering the effect of seed points as a random factor). Results indicate that the effect of location within the plot was only significant in a few cases. The seasonal effect was strongly significant in all plots, with a high rate of seed consumption (over 90 %) except in summertime (dispersal period). As a conclusion, post-dispersal seed predation in *Pinus pinea* does not severely modify seed shadow in relative terms, although it could impede natural regeneration if fall climate conditions are not suitable enough for early germination.

Poster 21.41 in *Organismal and Natural History Oriented Research*

Is the evolution of within-individual variability in plant traits mediated by animal selection?

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Phenotypic selection exerted by frugivores on plants may act on every moment of the distribution of traits and not just on the average value. Hence, selection may be exerted on the mean, on the variation and even on the bias or kurtosis of the distributions. Within-plant variability in fruit and seed size could be selected by frugivores in specific situations as small within-plant variability may reduce assessing time and predation risk. The selection on within-individual variability would suggest that the particular levels of within plant variability may be, at least in part, the adaptive consequence of animal-mediated selection. We studied the phenotypic selection exerted by mutualist and antagonist animals over within-individual variability in fruit and seed size of *Crataegus monogyna*. We found a negative phenotypic selection exerted by both seed dispersers and predators on within-individual variability. Nevertheless, those selective pressures varied among populations and the differences in within-individual variability in fruit and seed size among populations were not explained by the differences in selective pressures. Hence, it seems that both seed dispersers and predators might be involved in the evolution of within-individual variation of fruit and seed sizes, although their relative role and the way this selective pressures change from site to site deserves further attention.

Poster 21.42 in *Organismal and Natural History Oriented Research*

Is fruit color polymorphism in insular populations of *Myrtus communis* maintained by disperser selection on fruit size rather than color?

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Past studies on fruit-color polymorphisms have generally disregarded the potential effects of selection on correlated fruit traits. For example, fruit-morph choice by frugivores may be influenced by correlated variation in fruit size or shape, and between-morph differences in dispersal quality may be influenced by correlated variation in seed size or gut-passage time. We evaluated the effect of several fruit traits (fruits size and seeds weight) on the dispersal effectiveness provided by blackbirds (*Turdus merula*) to the two fruit-color morphs (blue and white) of *Myrtus communis* from Mallorca Island (Spain). Fruits from white-morph individuals had less but larger seeds than the blue morph, and they showed a trade-off between seed number and pulp content that correlated with fruit shape. Experiments with blackbirds showed that all variables tested were affected by both fruit color and (fruit or seed) size: larger fruits were preferred, and differences in size selection were larger for the blue morph; seed gut-passage time was longer for the blue morph and for larger seeds; and the increase in germination probability with seed weight varied between morphs for non-ingested seeds, but this difference dissapeared following gut passage. Our results suggest that the maintenance of the fruit-color polymorphism in *Myrtus communis* is influenced by multiple relationships and trade-offs between fruit and seed traits, frugivore choice and gut-passage effects.

Poster 21.43 in *Organismal and Natural History Oriented Research*

Patterns of tree dispersal and regeneration in tropical forests at Reunion island (Mascarene archipelago)

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Seed dispersal issue in the Mascarene archipelago (Mauritius, Rodrigues, Reunion) usually refers to Mauritius where the Dodo was hypothesized as the main disseminator of large-seeded trees. We focus here on Reunion island where no Dodo has ever occured and where tropical native forests still cover 57 000 hectares. We report on tree dispersal and regeneration patterns at the island scale. Patterns detected relies on a recent database of fleshy fruited species traits and on several years of monitoring of tree regeneration in primary forest and in disturbed habitats. On lava flows of different ages, we found that roughly half of fleshy fruited tree species displayed a low dispersal rate inferior to 10 cm per year. A the local scale, in older lowland forest, a spatially limited seedling recruitment was observed for several large-seeded woody species and related with the historical extinction of native frugivore vertebrates. At the island scale, alternative hypothesis are discussed, based on fruit traits analysis in a regional and evolutive perspective.

Poster 21.44 in *Organismal and Natural History Oriented Research*

A preliminary assessment of avian endozoochory as an ecosystem service.

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Seed dispersal by birds is geographically widespread and taxonomically diverse within both birds and plants. The interaction occurs in all types of terrestrial habitats and is one of the most important ecosystem services provided by birds. The most common type of seed dispersal by birds is endozoochory, in which birds ingest fleshy fruit (or an analogous structure), followed by gut passage and defecation or regurgitation of the seed. Most plants dispersed by birds in this manner are trees, woody shrubs, and vines. In many woodland and forest biomes birds are primary drivers of plant succession and recruitment. In an ecosystem services context seed dispersal is a supporting service from which other services that benefit humans are derived. Assigning value (economic or otherwise) to such indirect services is difficult but progressing rapidly. Here I present a preliminary valuation of seed dispersal by birds, with emphasis on eastern North America.

Poster 21.45 in *Organismal and Natural History Oriented Research*

The potential role of various southern African frugivores as dispersers of alien invasive fruit and their effect on germination rates

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Long-distance dispersal is a key aspect of the spread of invasive species. Many highly invasive plant species have fleshy fruits which are eaten by native frugivorous animals, but the effect of these frugivores on the germination of invasive plants' seeds is still poorly understood. The aim of this study was to determine if generalist frugivores enhance or decrease seed germination of alien species by either pulp removal or seed coat abrasion, or if they serve as dispersers only. We considered four fleshy-fruited alien invasive plant species namely: *Solanum mauritianum* (bugweed), *Cinnamomum camphora* (camphor), *Lantana camara* (lantana), and *Psidium*

guajava (yellow guava). Red-winged Starlings (*Onychognathus morio*), Speckled Mousebirds (*Colius striatus*), and Dark-capped Bulbuls (*Pycnonotus tricolor*) were fed fruit of the alien plant study species. Seed retention time (SRT) during diet trials was recorded as this translates into the distance of dispersal and the time that the seeds are exposed to the effects of the gut. Seeds were removed from their excreta and planted in soil trays which were housed in a greenhouse. Concurrently manually pulp removed seeds and whole fruit were planted as controls. Daily germination counts were carried out, after which germinated seedlings were removed. Seed retention times differed significantly between bird species for all fruits, except for those of *C. camphora.* Germination percentages for *S. mauritianum* and *C. camphora* seeds varied significantly among frugivores which had ingested them, but this was not evident for *L. camara* and *P. guajava* seeds. For all plant species, germination of pulp removed seeds did not differ from that of ingested seeds, suggesting that seed coat abrasion was not important for germination. Pulp removal resulted in significantly earlier germination for *L. camara* and *P. guajava,* and higher germination percentages of ingested *C. camphora* and *L. camara* seeds than whole fruit controls. Frugivores are therefore important for pulp removal in fruit with tough, waxy exocarps. Gut passage is important for long-distance dispersal, but not for enhanced germination of seeds of the invasive plant study species.

Poster 21.46 in *Organismal and Natural History Oriented Research*

The effect of seed loads on digestion and food preference by Purple-crested (*Gallirex porphyreolophus*) and Knysna Turacos (*Tauraco corythaix*)

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Avian frugivores may select fruit based on their seed loads and pulp to seed ratios and this may have important implications for their role as seed dispersal agents. Consequently the effect of different seed loads was investigated in two relatively large South African frugivores, Knysna (*Tauraco corythaix*) and Purple-crested (*Gallirex porphyreolophus*) Turacos. Small-seeded artificial fruits containing five black plastic beads (2.24 mm diameter) and large-seeded artificial fruits containing a single black plastic bead (3.85 mm diameter) were used to investigate transit rates and food preference. The total seed volume in the two fruits was approximately equal (29.42 mm^3 and 29.88 mm^3 for small- and large-seeded fruits, respectively). Bead transit rates ranged from 38-45 min for Knysna Turacos and 36-50 min for Purple-crested Turacos with faster transit rates on the small-seeded diet. Pulp transit rates ranged from 25-39 min for Purple-crested Turacos and 34-40 min for Knysna Turacos. Purple-crested Turacos had significantly shorter pulp transit rates on the large-seeded than the small-seeded diet whereas Knysna Turacos had no significant difference on either diet. Knysna Turacos preferred the small-seeded to the large-seeded artificial fruits whereas Purple-crested Turacos showed no preference for either diet. Both species, however, consumed significantly more of the small-seeded than the large-seeded fruit diet. Future studies establishing suitable seed sizes and volumes for use in determining the effect of seed loads on larger birds are required as well as studies looking at seed loads of indigenous forest fruit and the effects of seed loads on digestion and food preference in indigenous avian frugivores may give insight into the role of avian frugivores as fruit consumers and seed dispersers.

Poster 21.47

Sex and Rock'n Roll in the endangered plant *Borderea chouardii* (Dioscoreaceae); a rare case of double mutualism

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In environments poor in traditional pollinating and seed–dispersing animals, some plant species rely on double mutualism, i.e. they use the same animals as both pollinators and seed dispersers. However, this is a risky strategy to plants and may jeopardize their survival. The endangered, non–clonal, dioecious herb, *Borderea chouardii* (Dioscoreaceae) grows on vertical rocky walls in less than 1 km^2 in the Pyrenees. We studied the pollination and seed dispersal by ants of this small geophyte, and here present the first report of ants as double mutualists. The seeds have elaiosome, and are harvested by ants moving through crevices in the rock. One third of the few seedlings recorded over the last 15 years in the population would come from ant dispersed seeds, and they did not perform worse than other seedlings. Recruitment of seedlings is a very rare event for the endangered *B. chouardii*, who counter–acts its risky sex life by becoming largely independency of it. In fact, this rupicolous endemic plant has a World–record in individual life–span among non–clonal herbs: >300 years old.

Poster 22.1 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*

Estimating seed dispersal at the landscape scale: the case of feral oilseed rape populations

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Many crop species are known to have the ability to establish feral populations, escaped from fields, by seed dispersal. As agro-ecosystems are mosaics of cultivated fields and semi-natural populations, this introgression of cultivated plants into natural communities can alter the biodiversity of marginal spaces such as roadsides and field margins. This question is of major interest in the case of GM plants escape as for oilseed rape (*Brassica napus*), whom seed dispersal along the roadsides is partly driven by seed transport among fields. The aim of our study was to explain the genetic composition of feral populations estimating the relative contribution of known and unknown sources of seeds. We focused on the agro-ecosystem of Selommes (France) where fields and feral populations were mapped and genotyped from 2002 to 2005 using 8 microsatellite markers. We used methods based on the genetic analysis of kinship, adapted to the case of seed flow in agro-ecosystems. Seed dispersal (modelled by a dispersal kernel) and the relative contribution of each source were both estimated using a maximum likelihood method. In a first step of this study, we focused our estimate of seed dispersal on a sub-area of Selommes (7 km^2). We plan to enlarge the scale of this area to highlight the rare events of long distance seed dispersal, known to be of major importance to explain the coexistence of GM and non-GM plants.

Poster 22.2 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*

Deer mediated progression of a rare plant species

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Seed dispersal by animals is a major mechanism by which plant species spread over long distances. Furthermore, ungulates are said to be particularly relevant vectors in forest habitats. Based on coupled floristic and browsing surveys, we described and analyzed the causes of the spatio-temporal progression of the rare epizoochorous species *Cynoglossum germanicum* over 30 years in a large forested area. Paradoxically, although rare and protected, *C. germanicum* displayed a strong colonization dynamic. It was absent in the initial 1976 survey, but occurred in 20 plots in 1981 and 120 plots in 2006, only in the northern part of the forest, which had the highest deer populations. In 1981, the probability of occurrence of *C. germanicum* did not depend on browsing pressure whereas results for 2006 showed that it increased significantly with past browsing pressure. In a second step, a multiple logistic model linking C. germanicum presence with browsing pressure and ecological site variables (soil water reserve, Ellenberg indicator values) proved that its distribution not only depended on its ecological requirements (notably for nitrogen) but also remained dependant on past browsing pressure. *C. germanicum* not only benefited from epizoochorous dispersal by deer but also due to the presence of toxic proteins in its tissues also avoids deer browsing once settled. Factors not well controlled such as browsing pressure can however emerge as possible causes of rare plant species progressions.

Poster 22.3 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*

Forest-dwelling ungulates and seed dispersal using a comparative approach of three different species: roe deer, red deer and wild boar.

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In this project, we will quantify the role of forest-dwelling ungulates as long-distance seed dispersers using a comparative approach of three different species: the red deer (*Cervus elaphus*) as a grazer species, the roe deer (*Capreolus capreolus*) as a browser species and the wild boar (*Sus scrofa*) as an omnivorous frugivorous species. These ungulates are widespread in France and especially in the Centre administrative region. We will adopt an integrative approach by monitoring the fate of seeds from the time they have been eaten or carried out by the animals to their release in the ecosystem.We will treat three main components of the dispersion *i)* the emigration phase (potential for epi- and endozoochory), *ii)* the transfer phase (seed retention time converted into a distance covered by wild animals using GPS locations) and *iii)* the immigration phase (studying ungulates' ability to modify seed germination rate). These 3 key phases will be put together to finally establish seed dispersion curves of a selected pool of forest plant species. This innovative project has the ambition to propose new research hypotheses on the spatial and genetic structuring of ungulate-disseminated plant populations.

Poster 22.4 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*

Simulation of seed dispersal in bibosoop plantation based on species dispersal ability and rarity in Korean agricultural landscapes

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Seed dispersal is a key ecological process in maintaining local plant diversity. In the Korean agricultural landscape, there exist traditional village groves, 'bibosoop', are expected to provide a refuge for forest plant species. We simulated the patterns for the number of seeds dispersed into bibosoops based on two traits of the species: a rarity and dispersal ability. For individual landscapes within one kilometer radius of 18 bibosoops in Jinan region, we calculated the number of seeds deposited in bibosoop for a range of plant species. Species with same seed production were randomly distributed in forest areas at different frequencies and with different gamma dispersal kernels. The simulated number of seeds dispersed into bibosoops was largely influenced by the dispersal ability. When the species dispersal ability increased within the same frequency values, they dispersed more seeds into bibosoops. Rare species with long dispersal dispersed relatively more seeds into bibosoop than frequent species with short dispersal. In particular, this phenomenon was conspicuous in bibosoops highly isolated from the forest areas. Typically, bibosoops exist at the edge of forests or isolated areas from the forest; therefore, the “common-short” species do not have much chance to use bibosoop as a refuge compared to “rare-long” species. The results highlight the importance of long distance dispersal and also guide us to focus on examining the proportion of forest species with long and short dispersal in bibosoops.

Poster 22.5 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*

Estimate of the seed shadow created by the Asiatic black bear (*Ursus thibetanus*) and its characteristics as a seed disperser in Japanese cool-temperate forest.

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We estimated the seed shadow created by the Asiatic black bear in order to evaluate the bear's effectiveness as a seed disperser. The purpose of this study was to answer the following questions: 1) Does GRT differ between seasons or in the size of contents? 2) Does seed shadow vary among sex, seasons, estimation method (*ASS* or *PSS*), and years? 3) Does the masting affect seed shadows? We combined data from bear movements, determined by GPS telemetry, with data from gut retention time (GRT). We estimated plant seed shadows in two ways: from direct movement data to give the actual seed shadow (*ASS*), and from cumulative movement data to give the potential seed shadow (*PSS*). There were no differences in median GRT among seasons or seed dimensions. Combining these data, the seed shadows produced by long GRT and large daily movements suggest that the bears effectively move 40 % of the seeds they consume to a distance greater than 500 m and can potentially move the seeds up to a maximum distance of more than 22,000 m. The results also indicate that bears make complex seed shadows caused by multiple defecations and long periods of daily movement. Bears have the potential to influences on forest succession. In summary, *PSS* did not differ between sexes, but *PSS* can be expected to be larger in autumn than in summer of each year. *ASS,* however, can be expected to be larger in males than females, and to be larger in autumn than in summer. *ASS* may become especially large during a poor hard masting year as compared to good hard masting years.

Poster 22.6 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*

Long-distance seed dispersal by Trumpeter Hornbills in a fragmented landscape

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Frugivorous birds and bats provide important ecosystem services by transporting the seeds of fleshy-fruited plants. So far, it has been assumed that the seed dispersal kernels generated by these highly mobile animals are leptokurtic, with a peak close to the seed source, followed by a rapid decline and a long tail, resulting in little dispersal among fragmented habitat patches. In our study we investigated the movement and seed dispersal patterns of Trumpeter Hornbills (*Ceratogymna bucinator*) in a fragmented landscape at the East Coast of South Africa. Novel GPS data loggers provide high quality location data without any bias against recording long distance movements. The data are stored in the tag and can be downloaded to a handheld base station through a radio link. Recording the bird's location every 15 min during daytime, we received on average 17.5 days movement data per individual. Together with data of gut passage times we calculated distributions of seed dispersal distances. The seed dispersal distribution, pooled over all individuals, was bimodal, with potential seed dispersal distances up

to 14.5 km. This suggests that seed transport among habitat patches might be more frequent than previously assumed.

Poster 22.7 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*

Landscape effects on acorn dispersal by blue jays in Eastern North America

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The behavioral responses of seed dispersers to landscape heterogeneity can potentially produce complex seed shadows in animal-dispersed plants. From 2007-2010, we tracked 835 radio tagged acorns and 43 blue jays (*Cyanocitta cristata*) at 8 study sites in Indiana and Pennsylvania, USA, to investigate the hypothesis that landscape patterns combine with individual seed profitability and background mast abundance to determine seed fates in 3 jay-dispersed oak species: white oak (*Quercus alba*), black oak (*Q. velutina*), and northern pin oak (*Q. palustris*). Tagged acorns were presented on feeders, and dispersed seeds were subsequently relocated to track primary and secondary movements and to estimate the effects of acorn species, study site, mast abundance, and disperser species on initial caching probabilities, cache residence times, dispersal distance, and daily seed survival rates. Data on cache substrates and habitat types, as well as detailed blue jay movement paths, were also collected. Preliminary analyses indicate that acorn survival varied among species and years, and by Julian date within years. Dispersal kernels varied among species, sites, and years. Blue jay movements also varied among sites, with jays in row-crop-dominated landscapes largely avoiding agricultural land covers. These results suggest a substantial behavior-mediated effect of landscape pattern on acorn dispersal in eastern North American forests.

Poster 22.8 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*

An ecological *ménage à trois*: a three-way interplay of plants, animals, and fire

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Three inclusive hypotheses have been suggested as to why seed dispersal benefits plants; the most understudied being the directed dispersal hypothesis. This hypothesis confers that a benefit of animal-mediated seed dispersal is that seeds are dispersed to microsites that facilitate seed germination. We examined this hypothesis in a novel way by studying the interaction between plants, animals, and fire. We hypothesized that in fire-prone systems, that seed-caching animals will provide a benefit to plants by caching seeds in microsites that are safe from fire events. We used manzanita (*Arctostaphylos* sp., Ericaceae) as a model system because most manzanita seeds are sensitive to heat and need charate scarification to germinate. Manzanita is also a diverse woody taxon, providing us with a variety in responses to fire and fruit and seed morphology. By radiolabeling seeds, we followed their dispersal and found that scatter-caching rodents disperse seeds away from parent plants on the order of tens of meters and cache them in sites safe from fire events. Medium to large mammals disperse seeds farther away from parent plants that may be on the order of hundreds of meters. These findings suggest that two-phased seed dispersal may be occurring in this system. We further speculate that in fire-prone systems, seeds that are scatter-cached have an advantage over those that are otherwise abiotically incorporated into the soil and that this syndrome is ubiquitous throughout these systems.

Poster 22.9 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*

Frugivores with character: incorporating individual variation in habitat selection strategies into spatially-explicit models of seed dispersal

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The habitat use and movement patterns of frugivores are often key determinants of the seed shadows of their food plants. However, few studies have considered the consequences of within-population variation in frugivore habitat choice on the resulting seed shadows. We used a multidimensional approach (the k-selec method) to identify within-population variation in habitat preferences of the arboreal marsupial *Dromiciops gliroides*, and estimated the effect of such preferences on the seed shadows of five fleshy-fruited epiphytes. Our analysis evaluated the degree of congruence between individual habitat use (based on hourly relocations of 16 individuals followed over 8 nights, N = 60-80 per individual) and the spatial distribution of a set of variables describing habitat structure and resource availability (440 grid points mapped at 20 m intervals). Habitat selection varied considerably among individuals, though it could be assigned to three major groupings that respectively exploited structurally-different habitats (old-growth forest; young, undergrowth-rich forest; and open areas) with specific combinations of food resources. The existence of individual variation in the habitat selection strategies has two contrasting effects on modelled seed shadows: while it ensures the effective removal of fruits from plants growing at all three habitat types, it may favour the dispersal of seeds within each habitat type, hence facilitating the sympatric selection of specific ecotypes.

Poster 22.10 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*

Visualizing the ghost of dispersal limitation: frugivore behaviour leaves a lasting signature on plant spatial distribution

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The spatial distributions of plants depend on the interplay between their ecological requirements and the spatial template set during the dispersal process. Here, we hypothesize that habitat selection by the lizard *Podarcis lilfordi* directly influences the spatial distribution of the fleshy-fruited shrub *Daphne rodriguezii*. We first analysed lizard habitat selection during the plant's fruiting period, and identified its main determinants using several scales of spatial aggregation. In a second step, the key determinants of lizard habitat selection (LHS) plus the variables describing habitat structure were used to predict the spatial distribution of reproductive and juvenile shrubs. Predictability of LHS was higher at medium-to-coarse spatial-scales of habitat aggregation (i.e. 75 m). Both the selection of and the relocation-distance to the home range's core area were the two strongest determinants of LHS. Juvenile spatial distribution was best predicted by the LHS whereas, for reproductives, by a combination of LHS and habitat structure. The occurrence of reproductives was more predicted at fine-scale (i.e. 1.5 m) habitat variability whereas juveniles depended on the scale of habitat aggregation of the lizard core area. Our results suggest that habitat use by the disperser determines the spatial patterns of juvenile occurrence while the subsequent effects of habitat structure on juvenile survival dilute such spatial patterns.

Poster 22.11 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*

Mechanistic models of seed dispersal by wind in heterogeneous environments

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Mechanistic seed dispersal models are central to quantitative prediction of dispersal patterns and understanding their underlying mechanisms. For wind dispersal, most current mechanistic models assume homogenous environment. Although both topography and sharp transitions in vegetation height profoundly affect wind flow, previous models did not account for these factors. Such models are needed to inform ecosystem managers about consequences of landscape fragmentation. We modified the Coupled Eulerian-Lagrangian closure (CELC) mechanistic dispersal model to represent scenarios of wind flow over a sharp transition from low to tall vegetation or over hilly terrain, and predicted the resulting dispersal distances and direction. For the low-to-tall vegetation transition, the main features of the modeled wind field are an exponential decay of the mean horizontal wind velocity downwind of the edge and a consequent strong upward mean vertical velocity component. We found that the modeled LDD events were longer than those predicted for the corresponding homogeneous vegetation scenario for seed release both upwind and downwind of the edge, while median dispersal distances were only increased for release downwind of the edge. The main attributes of the modeled wind field over a forested hill are acceleration of the topography-following mean wind component uphill and its deceleration downhill to the point of reversed direction. For seeds released uphill, the modeled median dispersal distances were longer than for the flat scenario, while for release downhill the median distances were similar. Median dispersal direction fitted the local wind direction; hence, seeds released downhill disperse mainly uphill, opposing the regional wind.

Poster 22.12 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*

Effects of food availability on seed dispersal by the Central American agouti (*Dasyprocta punctata*)

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Rodents are hypothesized to be major agents of secondary seed dispersal through their scatter-hoarding. Alternately, rodents may be poor seed dispersers because documented dispersal distances are typically short and cache survival rates low. Determining the fate of seeds after cache recovery is crucial to solve this issue. In this study we used a new radio-tracking technology to follow seeds in areas with differing food availability. We tested the hypothesis that in sites with relatively low food abundance, agoutis (*Dasyprocta punctata*) will disperse more seeds, but dispersed seeds will have lower survival. This study was conducted in the tropical forest of Barro Colorado Island, Panama. We placed tagged nuts of the palm *Astrocaryum standleyanum* inside agouti territories that varied in *Astrocaryum* abundance. We monitored seed removal with camera traps. Seeds cached by marked agoutis were radio-tagged and monitored for five months. We found that agoutis removed seeds faster from sites with lower food, but initial dispersal distances were not correlated with food availability. However, final dispersal distances were greater in low food territories. Some seeds moved up to 12 times and more that 250 m away from the source. Survival probabilities were significantly lower in sites with low food (0.5 survival), supporting our hypothesis. We conclude that agoutis provide effective multi-step long distance dispersal and overall dispersal distances increase as food availability decreases.

Poster 22.13 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*

Impacts of volcanic activities on a plant animal interaction of island ecosystem – focusing on pollination and seed dispersal of two *Theaceae* species

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Ecological observation at and after any volcanic activity provides indispensable opportunities to study how ecological systems respond to environmental devastation; we have been surveying ecological processes and consequences of several subsystems of biological communities on a volcanic island, Miyake-jima, that experienced an eruption in the summer of 2000. In an effort to study these community recovery processes, we examined the effects of volcanic activity on a plant–animal system comprising a common broad-leaved evergreen tree species, *Camellia japonica* and *Eurya japonica,* from climax forests, and pollen- and seed-dispersing birds. These flower densities were affected by a volcanic eruption and subsequent large emissions of volcanic gases. The genetic diversity of pollen grains (*C. japonica*) adhering to pollinators and seeds (*C. japonica* and *E. japonica*) in areas with low flower density was greater than in an area with high flower density. This result was consistent with bird movement elucidated by radio tracking. In areas with low flower density, resulting from volcanic activity, pollen- and seed-dispersing birds ranged over larger areas to satisfy their energy demands rather than moving to areas with higher flower density. Low flower density also enhanced the efficiency of maternal reproductive success of *C. japonica* (i.e. pollination rate and seed set rate). These results indicate that compensation mechanisms ensure better reproductive success at sites that are more affected by volcanic activities.

Poster 22.14 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*

Spatial dynamics across multiple recruitment stages in the tropical tree *Prunus africana*

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Dispersal patterns created by animal pollinators and seed dispersers have pivotal impact on demographic and genetic processes in recruitment dynamics of trees. Seed dispersal, generating the initial spatial recruitment pattern, allows offspring to escape the high mortality near mother plants (Janzen-Connell hypothesis). Furthermore, seed and pollen dispersal determine gene flow rates and influence plant genetic structure. Both the demographic and genetic structure of plant populations alter after the initial patterns created by dispersers. Understanding these processes requires quantifying the successive change of spatial patterns at different stages of recruitment. We used microsatellite markers to investigate demographic and genetic processes across four recruitment stages of *Prunus africana*, a tropical tree pollinated and dispersed by animals. First, we studied spatial patterns of pollen and seed dispersal and investigated changes in patterns across consecutive recruitment stages. Pollen dispersal crosses longer distances than seed dispersal and patterns are extensively altered during later recruitment stages. Second, we show that dispersal patterns are translated into genetic structuring. Finally, we looked more closely at potential Janzen-Connell effects across the four recruitment stages. Our study illustrates the use of genetic markers for investigating the role of pollen and seed dispersal by animals in determining spatial recruitment dynamics of a tropical tree.

Poster 22.15 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*

Gene dispersal and population history inferred from spatial genetic structure of a Central African timber tree with low regeneration, *Distemonanthus benthamianus* (Caesalpinioideae)

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The spatial genetic structure (SGS) of a timber tree, *Distemonanthus benthamianus*, is characterised at various spatial scales in Central Africa. Displaying a large continuous distribution, this is a model species to study gene dispersal and past population history. (1) This species presents a deficit of natural regeneration, jeopardizing the sustainability of its exploitation. Data are thus needed on the spatial extent of gene dispersal by means of seeds and pollen. Significant patterns of SGS gave us preliminary estimates of gene dispersal distances from 400 to 1200 m. Genetic relatedness analyses are also used to reconstruct separately the events of seed and pollen dispersal. Aims are to address questions about the amount of selfing, the risk that extremely isolated individuals may not reproduce, and the chances that seeds end up in an exploitation opening (needed for regeneration). (2) Besides, African rainforests have undergone major distribution range shifts during the Quaternary but few studies have investigated their impact on the genetic diversity of plant species and we lack knowledge on the extent of gene flow to predict how plant species can cope with such environmental changes. SGS analyses were used to differentiate gene pools at this regional scale and link them to the biogeographical history of the region. A comparison is drawn with two other tree species living in the same region in the light of Quaternary refuges and recolonisation pathways.

Poster 22.16 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*

Separating the roles of seed and pollen dispersal and recruitment on the genetic heterogeneity of the seed rain

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Seed dispersal affects plant population dynamics and also genetic diversity in conjunction with pollen dispersal. Because spatial heterogeneity of seed dispersal can influence the subsequent recruitment process, disentangling the effects of dispersal and recruitment on the demographic and genetic structure of regeneration is a challenging issue. This study aims at elucidating the respective roles of pollen and seed dispersal and early recruitment mortality on the genetic structure of regeneration in the common beech (*Fagus sylvatica*), an anemophilous tree species with seeds dispersed by gravity and by several scatter-hoarders. We first estimated seed and pollen dispersal kernel using two temporal cohorts of established seedlings, and spatially explicit mating models to link spatial relationships between parents and offspring and their genetic compatibilities. Results highlight that both pollen and seed dispersal occur mainly locally with a mean pollen dispersal distance of 42 m and a mean seed dispersal distance of 12 m for the young cohort and 15 m for the old one, differences being significant. Using simulations, we then showed that early recruitment mortality does not affect estimates of the dispersal kernel based on parent-offspring genetic data. Differences in mean seed dispersal distances between the two temporal cohorts thus reflect heterogeneity in dispersal patterns, and can shed light on the roles of the whole assemblage of seed dispersers.

Poster 22.17 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*

Effect of past climate change on the distribution of tropical forest species: inferences of demographic events and colonization roads from genetic data in the endemic palm, *Astrocaryum sciophilum*

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Several theories have been developed to explain the high specific diversity of the Neotropics and its distribution. Among these theories, the Quaternary refuge theory developed by Haffer (1969) suggests that tropical forests were fragmented into small patches or 'refuges' during Quaternary dry climate periods, leading to species diversification by allopatric speciation. However, recent works have shown that diversification and speciation took place, except for some minor groups, much earlier than Haffer's theory states. Alternative theories stipulate that Quaternary climate variations did not induce forest fragmentation, although forest composition was affected. The existence of changes in forest cover is thus still largely debated. Here we question the existence of such Quaternary refuges in French Guiana, with the example of *Astrocaryum sciophilum*, an understorey palm endemic to the rainforests of the Guiana Shield. We will present inferences of past demographic history and colonization pathways from patterns of chloroplastic DNA polymorphism and nuclear microsatellite markers. Our results will be discussed in light of available data on seed dispersal and in light of the postulated refuges from De Granville (1982) and Tardy (1998)

Poster 22.18 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*

Dispersal dynamics of the invasive willow, *Salix cinerea*, in southeastern Australia

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Willows are aggressive exotic components of many river systems in southeastern Australia and they have the potential to expand their range. Current controls efforts for the most highly invasive species, *Salix cinerea*, are extensive, costly and not always successful due to rapid post removal reinfestation. An improved knowledge of the dispersal dynamics of this species will help to minimise future expansion and make current control efforts more effective. A survey of populations in the Ovens River catchment of southeastern Australia has been undertaken to determine seed and pollen movement within and between populations of *S. cinerea*. Preliminary paternity analysis using molecular markers show that up to 50 % of seed on trees are sired from outside the home population. Genetic profiling of populations in surrounding rivers will allow us to identify the most likely pollen sources thus providing data on the scale of pollen movement. Parentage analysis to ascertain the origin of seedlings in these same populations will allow us to directly measure the scale of seed dispersal. The results from this study will provide information on patterns of willow seed and pollen movement and its relationship to landscape structure. These results will assist land managers responsible for controlling willows to develop more effective eradication strategies.

Poster 22.19 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*

Seasonal Seed dispersal in *Swida controversa*: Temporal change in dispersers, seed source tree, and dispersal distance

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The species composition of frugivorous birds often changes seasonally due to their migration. The amount and distribution of fruit also change seasonally due to the phenological variations among individuals and species. Thus, to understand the maintenance and evolution of fruit-frugivore interactions, seasonality is an important factor, particularly in temperate zones. The aim of this study was to reveal seasonal changes in the seed dispersal pattern of *Swida controversa*, one of the major fleshy fruit trees in East Asia. The research was conducted in 6-ha plot at Ogawa Forest Reserve in Japan. We observed bird visitation and fruiting phenology for 9 adult trees throughout the fruiting season. We genotyped bird-dispersed fruits and all adult trees using SSR markers to identify the maternal trees of the fruits. We recorded 335 individuals (15 species) visiting *S. controversa*. Species composition of visiting birds changed seasonally. The fruits of early-fruiting trees were dispersed earlier than those of late-fruiting ones. Genetic analysis revealed the maternal trees for 64 fruits. Fruit dispersal distances in September (median, 15 m; max, 157 m) and October (median, 27 m; max, 168 m) were not significantly different. Every trap analyzed contained fruits from various trees regardless of the season. In conclusion, phenologically different *S. controversa* depends on different dispersers; however, active movement of frugivorous birds throughout the fruiting season was suggested.

Poster 22.20 in *Movement Ecology, Dispersal Kernels, and Genetic Effects*

Avian seed dispersal across forest edges is low for tropical understory plants

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The conversion of tropical forest into farmland has resulted in mosaics of forest and agricultural land in many parts of the tropics. However, it is unclear whether bird communities in forest and farmland are distinct or whether birds frequently pass habitat boundaries and thus can disperse seeds between different habitats. We caught birds with mist nets in the Kakamega Forest region, western Kenya, along a transect from the forest interior into the farmland. We used stable carbon isotope analysis of blood and claws to detect whether carbon is derived from C_3 plants (e.g. indigenous trees, shrubs) or C_4 plants (e.g. maize, sugar cane) and stable nitrogen isotope analysis to assess the trophic level of the species. Most understory birds in both habitats relied on invertebrate food sources. The communities of forest and farmland strongly differed in species composition indicating a separation of forest and farmland bird communities. Correspondingly, carbon sources of birds were not affected by distance to the forest edge, demonstrating hardly any carbon flow across the forest-farmland habitat boundary. Carbon and nitrogen sources were similar in samples from blood and claw tissues, indicating that seasonal changes in foraging strategies do not affect these findings. These results show that understory birds of tropical rain forests hardly forage in adjacent farmland and vice versa and that seed dispersal of tropical understory plants across forest edges by opportunistic frugivores is probably low.

Poster 23.1 *in Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal*

Effect of human disturbance on seed and seedling distribution patterns of the Andean Oak (*Quercus humboldtii* Bonpl.)

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Animals affect the spatial occupation patterns of tropical forest plants throughout the seed dispersal they perform. Therefore, decrease in vertebrate populations by human disturbance might affect regeneration dynamics of plant species. We studied the differences in the spatial distribution patterns of seeds and seedlings of the Andean oak (*Quercus humboldtii*) between two forests with different densities of seed dispersers as a consequence of anthropogenic influence. Density and spatial distribution of seedlings were evaluated in 490 and 484 1 m^2 plots located in a 28-ha area, in a high and a low disturbed site, respectively. The seeds were evaluated in 0.25 m^2 subplots placed in the same plots described above. Results show a higher number of seedlings, higher density and an aggregated pattern in the most disturbed site, as well as a marked decrease in seedling density as age increases. Although seed predation is similar in both sites, predation by invertebrates becomes more important in the most disturbed site. It seems that human disturbance results in a higher density and aggregation due to a reduction of vertebrate seed dispersers, seed predators and herbivores. Considering that the Andean oak usually occurs in groves, it is discussed whether or not the aggregated pattern resulting from a limited seed dispersal compromises the regeneration process of the species. Additionally, in order to maintain plant populations in the long term, presence and viable populations of seed dispersers should be also maintained.

Poster 23.2 *in Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal*

Seed dispersal and post-dispersal seed predation of small seeded species by mammals in a burned Mediterranean pine forest

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We studied seed dispersal and post-dispersal seed predation by mammals in a burned Mediterranean pine forest as a function of the distance to the unburned surrounding area. We measured the distance from the nearest unburned area of each mammal dropping collected, and counted and identified its seed's content. We also tested seeds germination and seedling success under different treatments. Post-dispersal seed predation was studied at seven distances going from the fire border to the centre of the burned area. A 57 % of all faeces had seeds, most of them of non-native species, especially *Celtis australis* and *Vitis vinifera.* Most common seeds were dispersed between 0-500 m from fire border. Emergence success of *C. australis* seedlings was low (20 %), although germination rates were higher after pulp was removed manually (63 %) or after having passed through mammal's guts (49 %) than for whole fruits (9 %). Only 20 % of surviving seedlings established after the first summer drought. Post-dispersal seed predation occurred at all distances from the fire border. It was highly variable and due to rodents (8- 66 %), whereas ants predation rates were lower (0.1-9.2 %). Results show the main role of mammals in the dispersal of non native plant species and seed predation of small seeded species in burned areas. This may have a negative effect on the post-fire vegetation recovery in such areas by affecting the recruitment of native fleshy fruited shrubs.

Poster 23.3 *in Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal*

Characteristics of possibly seed recruitment limited broad-leaf species in conifer plantations

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We set out to find what are the functional traits of species that may be potentially recruitment-limited in *Cryptomeria japonica* plantations in Ogawa, Ibaraki Prefecture, Japan. We studied seedlings and saplings of broad-leaf species at increasing distances (0-1000 m) from the natural forest edge to the conifer plantations. Species that are moderately shade-tolerant, are shrubs, have small seeds, and are frugivore-dispersed increased in the plantations. In comparison, species that are tall trees, have large seeds and are gravity-dispersed decreased in the plantations. Multi-trait analysis showed that propagule size was the trait that could best explain the difference in the distribution of broad-leaf species in the plantations. For saplings, there was no overall significant trend in the abundance, species richness, and Shannon index with respect to distance. Seedlings on the other hand showed a decrease in abundance and species richness with increasing distance from the primary forest, implying that should recruitment limitation occur in the plantations, it will be stronger at the seed-to-seedling transition than at the seedling-to-sapling transition.

Poster 23.4 *in Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal*

Linear infrastructures affect the seed rain generated by mammals: preliminary results in a Mediterranean shrubland

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Some mammals often act as long-distance seed dispersers. These events can greatly influence plant biology. In humanized landscapes, the presence of linear infrastructures (roads, firewalls) could modify the distribution, mobility, and habitat selection of seed vectors, and therefore, it is likely that affect seed rains. In the relatively humanized Doñana National Park (SW Spain), we predicted that the amount of seeds that arrive next to the roads/firewalls (r/f) will be higher than away from them. To evaluate it, during autumn 2009 we collected mammal faeces in 3 independent study sites (*MG*, *RO* and *RE*). There, we considered two transects (500 m ea) along the r/f and two other parallel transects (500 m ea) but at sixty meters away from r/f. Collected faeces (N = 264) were processed and all seeds (N = 3291) of fleshy-fruited shrubs (12 species) were counted. The spatial pattern of fecal delivering varied among places ($P < 0,0001$). In *RO* and *RE*, the number of faeces was 1.2-1.3 times higher next than away from the r/f. In *MG* the number of faeces were 5.4 times lower next than away from the r/f. Nevertheless, as predicted, the seed rain was always more intensive next than away from the r/f, being for *Rubus*, *Phillyrea*, *Pyrus* and *Corema* was, respectively, 36.77, 56.83, 68.56 and 158.16 times higher next than away from the r/f ($P < 0,0003$). Our data suggest that linear developments could alter the distribution, abundance and diversity of zoochorus species. This could have paramount consequences for habitat conservation and management.

Poster 23.5 *in Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal*

Dispersal limitation in *Primula vulgaris* in a fragmented landscape

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Perennial forest herbs have been shown to have a restricted colonization capacity because of their low dispersal ability. This limitation is especially relevant in fragmented landscapes, as it hampers populations to extend over the remnant available habitat. We investigated dispersal limitation in *Primula vulgaris* in fragmented forests of the Cantabrian Range (Asturias, Spain) using two complementary approaches. Firstly, we mapped the species occurrence across a wide extent in a fragmented landscape, and related the species occurrence in a given point to the species abundance in the surrounding area. The probability of occurrence increased with the abundance of potential nearby seed sources, reflecting the existence of dispersal constraints. Secondly, we set up a seed-sowing experiment in plots where the species was present or absent and with different habitat availability, seeking to distinguish the importance of dispersal vs. establishment limitations for recruitment. The strength of recruitment limitation by the different processes depended on the amount of available forest habitat.

Poster 23.6 *in Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal*

Avian seed predators determine seed dispersal success of *Myrtus communis* populations in an extremely fragmented landscape

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Anthropogenic habitat fragmentation can shift frugivore assemblages, disrupting patterns of frugivory. I investigated spatial variation of fruit removal by avian seed dispersers and predators from *Myrtus communis* (myrtle) shrubs in relation to the degree of fragmentation of Mediterranean woodland patches. The study was conducted within the extremely fragmented landscape of the Guadalquivir Valley (SW Spain), characterized by ~1 % of woodland cover within > 20,000 km^2. The abundance of dispersers and predators was not affected by woodland fragmentation. The proportion of myrtle fruits consumed by dispersers and predators varied greatly between patches, but did not depend on bird abundances or habitat fragmentation by itself. Seed predators greatly conditioned the crop fraction available to dispersers and, thus, the seed dispersal success of the populations. The geographical location of patches determined the presence/absence of interactions between myrtles and seed predators, probably due to regional differences in the fleshy-fruited plant assemblage. Moreover, predation rates were lower (and dispersal rates higher) in large patches dominated by myrtle, which can be explained by predator satiation. Results show that the feeding behaviour of seed predators influenced by the abundance and diversity of fruits at different spatial scales may be of great importance for determining the seed dispersal success of *M. communis* populations throughout the study area.

Poster 23.7 *in Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal*

The role of seed fate in South African scarp forest regeneration

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Habitat fragmentation and land use change endanger biodiversity and ecological processes, such as seed predation and secondary seed dispersal, which influence the regeneration potential of forests. We assessed small mammals and seed fate in different types of scarp forest in South Africa. The forest types were: 1) continuous natural forests, 2) natural forest fragments, 3) forest fragments in plantations, 4) forest fragments in agricultural matrix, 5) forest gardens, and 6) secondary forests. We determined species richness, abundance, and turnover of small mammals using pitfall traps connected with drift fences and Sherman live-traps. Further, we conducted seed predation and seed dispersal experiments in open and exclosure treatments. We recorded no significant differences in species richness and abundance of small mammals. Yet, high species turnover among the forest habitats indicated variations in species composition. Seed predation differed significantly between the different forests. It was higher in agricultural fragments and secondary forest, compared to the other forest types. A slight correlation of rodent abundance and depredated seeds confirmed rodents as important seed predators, whereas we observed no seed dispersal. These findings indicate lowered forest regeneration potential in agricultural fragments and secondary forest. However, additional studies are needed to find out if high seed predation leads to reduced seedling and sapling recruitment.

Poster 23.8 *in Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal*

Bird communities and seed dispersal of *Celtis africana* in different forest types in South Africa

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Fragmentation and disturbance are major threats to forest ecosystems modifying species diversity and ecological processes. We assessed the overall bird community and seed dispersal of *Celtis africana* using point counts and direct observations in different scarp forest types in South Africa. Forest types ordered by decreasing tree cover were: 1) continuous natural forests and 2) natural forest fragments in nature reserves, 3) forest fragments in timber plantations, 4) forest fragments in agricultural matrix, 5) forest gardens and 6) secondary forest in game reserves. Rarefied bird species richness did not differ among the forest types. However, alpha diversity and abundance varied significantly among forest types with highest numbers of species and individuals in gardens. High species numbers in forest gardens comprised mainly forest generalists, shrubland and open-country species while forest specialists were highest in forest types with highest tree cover but lowest in forest fragments in plantations. Frugivorous birds showed no clear pattern among forest types. However, by investigating seed dispersal of *Celtis africana* we detected that fruit removal by frugivorous birds was highest in natural forest fragments, fragments in agricultural matrix, gardens and secondary forest compared to low fruit removal in continuous forest and fragments in plantations. Consequently, mobility of birds seems to maintain seed dispersal of animal dispersed trees even in isolated forest types.

Poster 23.9 *in Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal*

Does seed size mediate reduction in secondary seed removal in a hunted forest?

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The disproportionate loss of large-bodied seed predators and dispersers in hunted and fragmented forests is well documented. Therefore, it might be expected that large seeds may experience a greater reduction in seed removal in defaunated forests relative to protected forests. To test this hypothesis, I set up seed arrays in a protected forest and an adjacent hunted forest in central Panama. Twelve species with seeds ranging in size from 0.002 to 63 g were tested, using the same species or genera in each site to the extent possible. Contrary to expectation, I found neither a strong correlation between seed removal rate and seed mass, nor a positive correlation between differences in removal rates and seed mass. Camera trapping of arrays for seeds larger than 2 g revealed that agoutis (*Dasyprocta punctata*) were the removal agent in almost all cases, regardless of site. These results suggest that the impact of defaunation on secondary seed removal is likely influenced by hunting intensity, floral and faunal context, as well as traits in addition to seed size.

Poster 23.10 *in Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal*

Evidence of seed removal and secondary dispersal of *Carapa grandiflora* (Meliaceae) tree in Nyungwe National Park, Rwanda

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Elephants are known to act as primary seed dispersers of large-seeded fruit species in Central Africa. However, poaching and ivory trade are threatening local populations of elephants with extinction, which may impose critical constrictions for seed dispersal of some large-seeded species, although the existence of secondary dispersal could compensate for the lack of primary dispersal by elephants. Seed removal and fate of *Carapa grandiflora* (Meliaceae) was studied at Nyungwe National Park, Rwanda, where elephants went extinct in 1999. Seed removal was monitored simulating two scenarios: seed dispersal by elephants (SDE), and no seed dispersal (NSD). In SDE, seeds were exposed in 8 clumps along two 3.5 km transects. In NSD, seeds were accumulated under adult trees in 4 sets per tree. Also, seed fate was explored by tying seeds to a 50-cm nylon thread, and searching for places where seeds were moved after exposure. The majority were removed within two weeks with evidence of scatter- and larder-hoarding into caches and burrow, respectively. This result along with observations of one year old seedlings with their cotyledons buried several centimeters below the ground surface and dispersed within 20 m from the nearest adult suggest that *C. grandiflora* seeds are most likely secondarily dispersed by a large ground dwelling as observed in other tropical rainforests.

Poster 23.11 *in Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal*

Effect of forest fragmentation on seed dispersal, seed predation and forest regeneration in the Brazilian Amazon

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I hypothesized that forest fragmentation negatively affects the diversity of regenerating neotropical forests and alters species composition of forest regeneration through changes in seed dispersal and seed predation. I tested these hypotheses at the Biological Dynamics of Forest Fragments Project site, located in the Brazilian Amazon. In 120 10 m^2 experimental plots I measured tree and shrub seedling species richness and composition in continuous forest controls and forest fragments of different sizes (1, 10, and 100 ha). To measure seed predation, I placed seeds of 5 species of tropical forest trees of varying seed sizes near these plots and recorded percent seed removal after one month. To quantify seed rain, I placed two 0.5m^2 seed traps near each of the experimental plots and recorded density and species composition of seeds falling in these traps for 2 years. Multiple regression analysis and canonical multivariate analysis results indicate a significant relationship between percentage seed removal (seed predation), seed rain species richness and the response variables seedling species richness and species composition. I conclude that high seed removal rates in forest fragments and low species diversity of dispersed seeds may be important factors contributing to lower species richness and altered species composition of forest regeneration in forest fragments in the Brazilian Amazon.

Poster 23.12 *in Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal*

Extinction of seed-dispersing iguanas compromises recruitment of *Chrysobalanum icaco* (Chrysobalanaceae) in Cuba

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Many plants are dispersed by a diverse guild of frugivorous species. Thus, when one of them goes extinct, no dramatic change in plant regeneration is generally detected. However, this is not the case for those species that bear large fruits (and seeds), and depend exclusively on large frugivores for their seed dispersal. In these cases, and since large species are more likely to be lost than smallers, the potential for functional substitution is relatively low, and being practically null where the frugivorous fauna is *per se* depauperate (islands). In such situations, drastic ecological consequences for plant recruitment may be expected.

Poster 23.13 *in Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal*

Invasive schrub predict the abundance of common native avian frugivores in a landscape of central Pennsylvania

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Biological invasions pose one of the most severe threats to global biodiversity. Still, invasions can create positive ecological relationships. Here we studied the mutualisms that can be formed between invasive alien plants and native frugivorous birds by examining the correlation between *Lonicera* spp, a highly invasive plant in eastern North America, and avian communities in central Pennsylvania. We conducted counts of birds and fruiting plant species in a landscape that included many different land types. *Lonicera* fruits accounted for 54 % of all the fruits available on the landscape during the fall, with the second most abundant fruit crop accounting for 10 %. The abundance of birds showed a strong positive association with the presence of *Lonicera* fruits, with *Turdus migratorius* and *Dumetella carolinensis* being the most abundant. We also found that dense areas of *Lonicera* can accelerate the fruit-removal rates of a native plant species up to 30 % when compared to rates in areas with lower densities of Lonicera. Our results suggest that Lonicera currently serves as a main axis for the organization of bird communities and the networks of frugivore-plant interactions in central PA. This poses a challenge for many conservation efforts, as populations of key avian frugivores may be currently depending on *Lonicera* resources. We argue that control measures should account for the effects losses of this abundant fruit resource could have on native bird communities in invaded regions.

Poster 23.14 *in Impact of Anthropogenic Disturbance and Climate Change on Seed Dispersal*

Simulating postglacial migration of the European Beech

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Even though climate is the major determinant of species distribution at the global scale, it is commonly thought that biotic factors such as competition and dispersion have to be taken into account at finer scales. Yet, in a climate change context such as Global Warming, biotic interaction and dispersion may reveal to be of primary importance to predict accurately species distribution at global scale. In particular, species potential of migration determines whether they will be able to follow their climate optimum. The evolution of the distribution of *Fagus sylvatica* during the last postglacial is well documented and debated. From late-quaternary palynological data, the influence of climatic change seems to explain the postglacial migration and abundance changes of *Fagus sp* but modelling studies also highlighted an important role of the long distance dispersal processes. In the order to disentangle climate effects from dispersal effects in *Fagus sylvatica* distribution along the last 12,000 years, we coupled a process-based species distribution model to a new dispersal model, recently developed and based on the Gibbs method. The Gibbs-based dispersal model allowed to simulate species migration pathways at large scale taking into account both dispersal and post-dispersal processes. Using these models, we present and discuss the simulated evolution of the European beech distribution during the last 12000 years.

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