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From the mountains to seas: altitudinal trends in New Guinea biodiversity

Convenors:
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Elevational gradients, particularly in the tropics, are among the most important centers, and generators, of biodiversity. They have been excellent model systems for the study of ecological and phylogenetic determinants of alpha, beta and gamma diversities across a wide array of environments in close geographic proximity. More recently, elevational gradients have risen to prominence as one of the best systems to demonstrate, and model, the dynamics of biodiversity in response to climate change. These studies, pioneered in the temperate zone ecosystems, are now expanding also to the tropics. New Guinea, the largest tropical island, is exceptionally well suited as a testing ground for altitudinal research as it harbors several complete rainforest altitudinal gradients from lowland to the alpine zone in a high-biodiversity settings. There are presently several research groups studying various aspects of biodiversity along elevational gradients, from ecosystem surveys through experimental manipulations to modeling and macroecological perspectives, and spanning a wide range of taxa, from plants through insects to vertebrates. These diverse emerging lines of research are now ready for review and synthesis, which we propose to initiate by this symposium.

Tuesday 22 July 2014

0700–1800	Registration and speakers support centre open				
Opening plenary session **Venue: Hall A**					
0830–0915	James Cook University Vice Chancellor and President Address (Chair: Susan Laurance, President ATBC)				
0915–1000	Plenary Speaker: Senator Christine Milne (Chair: Susan Laurance)				
1000-1030	Coffee break and posters				
Concurrent sessions					
	Restoration and Regeneration	**Species Diversity**	**Forests, Soils & Ecosystems**	**Wildlife Ecology & Plant Ecophysiology**	**Methods**
Room	**Hall A**	**Meeting Room 2**	**Meeting Room 1**	**Meeting Room 3**	**Meeting Room 4**
	SYMPOSIUM: Conservation, evaluation, and valuation of secondary forests *Chair: Calen May-Tobin*	***SYMPOSIUM: From the mountains to seas: Altitudinal trends in New Guinea biodiversity*** *Chair: Maurice Leponce*	***ORAL SESSION: Forests & ecosystems*** *Chair: Chris Margules*	***SYMPOSIUM: Movement for change: emerging research and technology for understanding movement and biodiversity responses to global change*** *Chair: Soumya Prasad*	***SYMPOSIUM: Multi-taxa biodiversity surveys in the tropics: Integrating taxonomy, phylogeny, ecology, and conservation*** *Chair: Christopher Baraloto*
1030–1045	Robin Chazdon *What is a secondary forest? Implications of legal and ecological definitions*	Robert K Colwell *Modelling Elevational Range Attractors Under Geometric Constraints*	Peter Okello Alele *Influence of Tropical Wetland Ecosystem Alteration and Disturbance on Microbial Communities*	Hamish Campbell *Integrating telemetry data with stable isotopes: rehashing old tools*	William Magnusson *RAPELD methodology for surveying and monitoring in the Program for Biodiversity Research (PPBio)*
1045–1100	David Edwards *Do secondary forests provide cheap carbon and biodiversity co-benefits?*	Vojtech Novotny *Vegetation change along a complete rainforest altitudinal gradient at Mt. Wilhelm*	Imam Basuki *Soil dynamics in tropical forest transition: a case study from Borneo, Indonesia*	Lisa Davenport *Migratory Connectivity in Orinoco Geese from Peru, Brazil, Bolivia and Colombia*	Michael Liddell *SuperSites - three new ecosystem observatories in the Tropics of Northern Australia*
1100–1115	Douglas Boucher *Policy barriers to protecting 'disturbed forests'*	Daniel Bickel *The Diversity of Diptera and Hymenoptera on Mt Wilhelm: faunal changes with elevation*	Benjamin Morgan *Precipitation drives arbuscular mycorrhizal fungal community composition in dry seasonal forests of the Yucatan Peninsula*	Soumya Prasad *Not so far? Seed dispersal by a large-bodied avian frugivore, the Oriental Pied Hornbill (Anthracoceros albirostris)*	Louise Ashton *Altitudinal multi-taxon surveys in Australian and Chinese rainforest*
1115–1130	Arturo Sanchez-Azofeifa *Characterizing the extent and status of secondary forests using advanced and emerging remote sensing techniques*	Kalsum Mohd Yusah *Ant-mediated nutrient redistribution rates along gradients of altitude and disturbance in Borneo and New Guinea*	Kei-ichi Okada *Productivity and nutrient concentration of fine roots under contrasting nutrient availabilities on Mount Kinabalu, Borneo*	Philipp Sommer *Towards Continental-scale Tracking of Flying Foxes with Delay-tolerant Wireless Networking*	Jean-Marc Hero *Monitoring biodiversity using standardized methodology and scale, on an international systematic LTER plot network*

1130–1145	Michael Pescott *The High Carbon Stock Approach - no deforestation in practice*	Yves Roisin *Shifts in wood decomposer insect community along an elevation gradient in New Guinea*	Peter Van Der Meer *Sustainable management of peat swamp forest in South-East Asia*	David Westcott *Movement, disease and seeds: flying-fox as vectors in complex landscapes*	Christopher Baraloto *Coordinated Turnover Of Amazonian Tree, Arthropod And Fungal Communities Across Geographic And Environmental Gradients*
				ORAL SESSION: Biogeorgraphy *Chair: David Westcott*	
1145–1200	Jeffrey Sayer *Secondary forests provide conservation opportunities in Indonesia*	Maurice Leponce *Arboreal ant mosaics meltdown with elevation*	Michael Murray-Hudson *Hydro-climate pulsing at different time scales drives □, □, and □ diversity in the Okavango Delta*	Ryan Burke *Top-down effects of an herbivorous primate: Ecosystem processes mediated by Geladas in the Ethiopian Highlands*	Flavia Costa *Near-infrared spectroscopy facilitates rapid identification of both young and mature plants of diverse Amazon forests*
	ORAL SESSION: Secondary forests *Chair: Miriam Goosem*				
1200–1215	Miriam Goosem *Tree and sapling diversity in chronosequences of successional rainforest*	Pagi Toko *Altitudinal, alpha and beta diversity trends in moths and butterflies in Papua New Guinea and their biological drivers*	Silvio Ferraz *A tropical forest restoration-planning framework for water and aquatic ecosystem conservation in agricultural landscapes*	Pui Sze Li *Historical biogeography of Asimina-Disepalum (Annonaceae): origins of tropical intercontinental disjunctions and diversifications in Southeast Asia*	
1215–1230	Aida Rodrigues *Site fidelity by army ant-following birds in primary and secondary forests of the Central Amazon*	Bonny Koane *Herbivore damage increases avian and ant predation of caterpillars on trees along an altitudinal gradient*	Scott Saleska *Tower-mounted cameras confirm remotely sensed dry-season "green-up" of Amazon forests, revealing mechanisms underlying tropical seasonality*	Markus Gastauer *Diversification of extant Atlantic rainforest species richness: radiation in isolated dominions*	
	1230-1245 Daniel Magnabosco Marra *The effects of large-scale wind disturbances on forest structure and species composition in Central Amazon*		**1230-1245** Tobin Northfield *Coevolution and the effects of climate change on interacting species*		
1230–1345	Lunch break and posters				

Plenary session Venue: Hall A					
1345–1425	Plenary Speaker: Dr William Laurance (Chair: Nigel Stork)				
Concurrent sessions					
	Restoration and Regeneration	**Species Diversity**	**Forests, Soils & Ecosystems**	**Plant Ecophysiology**	**Climate Change & Land Use**
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1430–1445	Shogoro Fujiki *Algorithm to estimate the ages of tropical secondary forests after shifting cultivation*	Katerina Sam *Explaining the species richness of birds along a complete rainforest elevational gradient in the tropics*	Gita Kasthala *Phenotypic plasticity in response to habitat heterogeneity in a New Guinea crayfish (Cherax pallidus)*	Owen Atkin *Leaf photosynthetic and respiratory CO2 exchange in two thermally-contrasting Australian tropical rainforest ecosystems*	Alan Andersen *Ant community responses to disturbance: an overview*
1445–1500	Catarina Jakovac *Land use as a filter for species composition*	Chris Dahl *Where is the peak of altitudinal diversity in New Guinea frogs?*	Tianjiao Li *Fish Diversity In Nee Soon Swamp Forest, Singapore*	Lucas Cernusak *Strong Response of Tropical Conifers but not Angiosperms to Altered CO2 Concentration*	Fernando Augusto Schmidt *Response of ant communities to recovery time after human disturbances*
1500–1515	Victor Hugo Gutierrez-Velez *Land cover change interacts with drought severity to change fire regimes in Western Amazonia*	Mark Ziembicki *Rapid response of game wildlife to community-established 'no-take' zones in the YUS Conservation Area, Papua New Guinea*	J Pablo Arroyo-Mora *Detection of mangrove species from airborne hyperspectral imagery in Sierpe, Costa Rica*	Raymond Dempsey *Photo-Protective Responses in the Leaves of Tropical Trees During the Dry Season Transition*	Ricardo Campos *Effect of land use on sodium limitation by ants*
1515–1530	FB Vincent Florens *Impact of invasive alien species on the orchid community of a tropical island's wet forest*	Dirk Nikolaus Karger *Comparing elevational and latitudinal gradients of fern diversity: from New Guinea to Hokkaido*	Tomoya Inada *Neighboring tree effects on shorea johorensis under post-logging management with line planting in Central Kalimantan*	Ruginia Duffy *Non-linear responses to seasonal precipitation in a conifer, Agathis atropurpurea, from tropical Queensland*	Benjamin Hoffmann *Invasive ants: impact patterns, control prospects and climate change predictions*
1530–1545	Hathai Sangsupan	Andrew Krockenberger	Eric Katovai *Recovery*	Alfredo Huete *Evidence of*	Jonas Maravalhas *Variable*

	Seasonally Dry Tropical Forest				
	1545-1600 Rahayu Sukmaria Sukri *Acacia: Another Nail In The Coffin For Kerangas?*	**1545-1600** Miriam Supuma *Growth and survivorship of trees at different elevations in Papua New Guinea*			**1545-1600** Israel Del Toro *Biodiversity along a rainfall gradient: insights into climate change impacts on Australia's ant biodiversity*
1545–1615	Coffee break and posters				
	Restoration and Regeneration	**Species Diversity**	**Forests, Soils & Ecosystems**	**Plant Ecophysiology**	**Climate Change & Land Use**
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1615–1630	Eduardo Van Den Berg *Composition divergence between highly diverse pastures' tree community and associated forest remnants*	Tom Fayle *Ant-plant mutualistic interaction networks, altitudinal gradients, and ant partner sharing*	Oliver Wearn *Local-scale alpha- and beta-diversity of Bornean mammals: Implications for conservation in logged and fragmented habitats*	Jonathan Lloyd *Five myths of tropical tree response to climate change*	Gabriela Burle Arcoverde *Grazing impacts on savanna ant communities in the Australian seasonal tropics*
1630–1645	Marcus Bulstrode *Managing Riparian Vegetation Towards Systems Recovery in the Wet Tropics: why throw out the baby?*	Legi Sam *The structure of plant-herbivore food web along an altitudinal gradient in Papua New Guinea*	Silke Buschmann *Stand dynamics, regeneration requirements, and genetic variability in populations of Terminalia carolinensis on Kosrae, Micronesia*	Louise Neo *Last Swamp Standing: Freshwater Swamp Vegetation Ecology In The Face Of Climate Change And Urbanisation*	Alex Salas-Lopez *Effects of habitat transformation by humans on the trophic ecology of ants in French Guiana*
1645–1700	Lih Chyun Loo *The regeneration of native tree species in human disturbed forests at Meinong, Kaohsiung, Taiwan*	Roger Kitching *Australasian Altitudinal Transects: the Challenge of the Comparative Dimension*	Tomas Ariel Carlo *Negative frequency-dependent frugivory and seed dispersal increase plant diversity in early successional forests*	Suat Hui Yeoh *When Do Rainforest Trees Bloom?*	Rebecca Sandidge *Tiny savannas and deep seas: ant diversity and distribution on several small Indonesian islands*

17 participants to the symposium

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1. MODELLING ELEVATIONAL RANGE ATTRACTORS UNDER GEOMETRIC CONSTRAINTS

Robert K. Colwell[1,2], Nicholas J. Gotelli[3]

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Species richness distributions along elevational gradients show many different patterns, but for the majority, maximum richness is reached at some intermediate point on the domain. It is tempting to explain the location of peak richness as an optimum environment. Certainly, some portions of the gradient may be environmentally more favorable than others. But we show that environmental favorability interacts, sometimes strongly, with geometric constraints to influence the pattern of richness along bounded gradients. We model the simplest possible pattern of favorability on elevational transects from sea level to the highest habitable point on a mountain massif: somewhere along this elevational gradient lies a single "attractor" that represents the optimum environment for some specified group of species. We model the influence of the attractor on species' ranges by envisioning it as a magnet for their elevational range midpoints: a *midpoint attractor*, with mean elevation *A* and standard deviation *B*. Using hypothetical and empirical datasets, we show how geometric constraints interact with environmental favorability to produce a wide variety of richness patterns over elevational gradients. In an informal Bayesian framework, we use a simple custom Monte Carlo Markov Chain (MCMC) sampler to find the model (*A*, *B*) that best explains each set of empirical data.

Plants

2. VEGETATION CHANGE ALONG A COMPLETE RAINFOREST ALTITUDINAL GRADIENT AT MT. WILHELM

Kenneth Molem[1], Legi Sam[2], George Weiblen[3], Salape Tulai[1], Kipiro Damas[4], Clant Alok[1,5], and Vojtech Novotny[1,6]

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Trends in plant biomass, alpha and beta diversity, phylogenetic diversity and vegetation structure are described along a complete rainforest gradient from 200 to 3700 m above sea level sl. at Mt. Wilhelm in Papua New Guinea, and analyzed with respect to climate, soil and land area. The study focuses on entire vegetation, using 20 x 20 m plots, as well as on *Ficus* trees, and an example of a species-rich genus, using 10 x 500 m transects.

3.GROWTH AND SURVIVORSHIP OF TREES AT DIFFERENT ELEVATIONS IN PAPUA NEW GUINEA

M Supuma1, B Gamui1, A Arihafa2, L Salas3, DWright4, A Mack5 miriam.supuma@my.jcu.edu.au

1. PNG Institute of Biological Research
2. Wildlife Conservation Society
3. Point Blue Conservation Science
4. Green Capacity
5. Indo-Pacific Conservation Alliance

We analyzed re-census data for trees on 13 ha of plots across three elevational zones, lowland (Lakekamu Basin; 100-210m), middle (Crater Mountain; 1000-1200m) and upper (Mt. Stolle; 1500-1600m). On these plots 9,472 trees were tagged and re-censused 5-8 years later to determine growth, mortality and recruitment. Growth rates (Δdbh) decreased with elevation from 0.4 cm/yr at the lowest plot to 0.18 cm/yr at the highest. Annual mortality rates were similar for the low and high plots, 11.2-12.2 trees/ha/yr and highest in the middle plots on Crater, 17.9-22.6 trees/ha/yr. This is possibly due to the steeper, less stable terrain at Crater where trees had higher probability of dying: .02.8-.03.4 percent per year compared to the lower plots (.01.6-.01.9 percent year^{-1}) and higher plots (.01.2 percent year^{-1}). Although growth rates might correlate with changes in temperature and insolation at different elevations, overall dynamics of survivorship appear to be driven by factors other than elevation. Recruitment on plots varied from well below mortality (12 trees/ ha less) to above mortality (5 trees/ha more) averaged over the sample periods. This suggests that recruitment is not tightly correlated with mortality and might occur over longer time spans than episodic mortality (e.g., high mortality at an episodic treefall or landslip might be followed by replacement recruitment many years later).

Invertebrates (6 talks)

4. THE DIVERSITY OF DIPTERA AND HYMENOPTERA ON MT WILHELM: FAUNAL CHANGES WITH ELEVATION.

D Bickel[1], C Villemant[2], S McEvey[1], G Duvot[2], S Agovaua[3]
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2. Museum National d'Histoire Naturelle, Paris
3. PNG National Agricultural Research Institute, Port Moresby

The Malaise trap program of the IBISCA Mt Wilhelm transect produced 16 daily samples from each of 4 Malaise traps at 8 elevations (500 m intervals), generating 512 samples. The Diptera and Hymenoptera comprise the two most abundant orders in Malaise trap samples. All Hymenoptera were pulled and sorted to family level in Paris, while the large volume of the Diptera residues necessitated "triage," and the targeted families were chosen because they were abundant, readily extracted from the residue soup, *and* had active and willing workers. The Hymenoptera fauna, based on some 7300 specimens (ants excepted), is reviewed and the large parasitoid superfamily Ichneumonoidea (some 1100 Ichneumonidae and 1400 Braconidae) is treated in more detail. The Diptera are reviewed and two families, Drosophilidae (some 1300 specimens) and Dolichopodidae (some 1550 specimens) are discussed. Species richness and change with elevation, biogeography and other aspects of the Mt Wilhelm fauna are reviewed. Also noted are the practical aspects of Malaise trapping, especially trap placement and intra-site variation.

5. ANT-MEDIATED NUTRIENT REDISTRIBUTION RATES ALONG GRADIENTS OF ALTITUDE AND DISTURBANCE IN BORNEO AND NEW GUINEA

Kalsum M. Yusah[1], Rob M. Ewers[2], Petr Klimes[3,4,5], Jimmy Moses[5], Vojtech Novotny[3,4,5], Tom M. Fayle[2,3,4,5]

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Climate change and habitat degradation are two of the largest challenges for the persistence of biological communities. While the impacts of these two processes on biodiversity are becoming increasingly well-known, the effects on ecosystem functioning have been more poorly quantified. Ants are potentially important recyclers of dead animal material. However, the rate at which this nutrient redistribution occurs is seldom studied. To predict potential climate change impacts we assess ant-mediated nutrient redistribution rates using compressed dried earthworm baits along altitudinal gradients in Borneo and New Guinea. We also measure redistribution rates along a gradient of habitat disturbance in Borneo, from old growth forest to logged forest to oil palm plantation. We find that rates are similar between Borneo and New Guinea and decrease with increasing altitude, indicating that the dissimilar ant communities on either side of the Wallace line support ecosystem function in the same way. The reduction in redistribution rates with increasing altitude is probably due to reduced activity and density of ants with decreasing temperature. Redistribution rates decrease with habitat disturbance, although this reduction only occurs beyond a certain critical threshold of degradation. We speculate that this pattern is caused primarily by loss of ant species, since increases in temperature in disturbed areas are likely to increase activity of the remaining ants. Our results indicate that rising global temperatures could increase rates of ant-mediated nutrient redistribution, while habitat degradation has an opposing effect, tending to decrease the rate of this important ecosystem process.

6. SHIFTS IN WOOD DECOMPOSER INSECT COMMUNITY ALONG AN ELEVATION GRADIENT IN NEW GUINEA

Yves Roisin

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Insects play a major role in the decomposition of wood in tropical rainforests. In lowland forests, termites (clade Isoptera) occupy a dominant place among wood feeders, but their abundance and diversity clearly decline with altitude. However, other insect groups such as Blattodea (excluding Isoptera) and Coleoptera retain a substantial diversity in montane forests. Yet, the pattern of occurrence of wood-feeding insects with elevation remained to be documented. Specifically, we hypothesized that cockroaches and beetles could compensate for the rarefaction of termites at higher altitudes. In 7 plots spaced by 500 m along an elevation gradient (200–3200 m) on the slopes of Mt Wilhelm, Papua New Guinea, we systematically sampled soft fallen logs in search for wood decomposing insects.
The three major taxa observed in logs were termites, cockroaches and Passalidae. Passalidae were common up to 2700 m, but were especially abundant in the 700–1700 m range. Cockroaches occurred at all altitudes, but were most common in the moss forest at 1700 and 2200 m. Termites were found with decreasing frequency up to 1200 m. These three taxa are dominant at different altitudes along a single transect: occurrence in more than 30% of the logs was recorded at 200 and 700 m for Isoptera, from 700 to 1700 m for Passalidae, and at

1700 and 2200 m for cockroaches. The altitudinal shift in Passalidae and cockroach frequency suggests that they suffer from competition by termites at lower elevations.

7. ARBOREAL ANT MOSAICS MELTDOWN WITH ELEVATION

Maurice Leponce[1], Petr Klimes[2,3]

[1]Biological Evaluation unit, Royal Belgian Institute of Natural Sciences, Brussels, Belgium (Maurice.Leponce@naturalsciences.be); [2] Biology Centre of ASCR, Czech Republic; [3]Faculty of Science, University of South Bohemia in Ceske Budejovice, Czech Republic.

Mosaics of ant territories resulting from the mutual exclusion of dominant arboreal ants from tree crowns are common in tree plantations and in lowland tropical forests. In temperate zones arboreal-nesting ants, especially territorial ones, are much less abundant probably because of unfavourable climatic conditions. Therefore along a tropical mountain one can expect the decay of ant mosaics with increasing elevation. We mapped the distribution of numerically dominant ant colonies, often spreading on several neighbour trees, in ¼ ha plots distributed between 200 and 2700m asl along Mt Wilhelm, Papua New Guinea. Ants were captured at tuna/honey baits spread along tree trunks from the ground to the top of canopy trees. In lowland forests (200-700m) *Crematogaster polita* large carton nests were omnipresent and often formed supercolonies. Other major players were *Oecophylla smaragdina* nesting in leaves and *Anonychomyrma* cf *scrutator* nesting in live plant tissues. At mid-elevation (1200-1700m) dominant ants were *Anonychomyrma* spp. and two species found in myrmecophytes (*Monomorium sp. nov. aff. edentatum* and *Philidris* cf. *cordata*). At 2200m ants found in the canopy (e.g. *Ancyridris*, *Pheidole*) were probably living in suspended soil. No ants were observed at 2700m. In conclusion, with increasing elevation it seems that there is a progressive filtering of the most abundant arboreal ant species. Typical territorial ants, living in carton or leaf nests are eliminated first. At mid-elevation myrmecophytes allow to maintain high ant populations in trees. At high elevation only species nesting in suspended organic matter remain.

8. ALTITUDINAL, ALPHA AND BETA DIVERSITY TRENDS IN MOTHS AND BUTTERFLIES IN PAPUA NEW GUINEA AND THEIR BIOLOGICAL DRIVERS

Pagi Toko[1], Legi Sam[2,3], Vojtech Novotny[4,5]

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Understanding the abiotic and biotic factors along altitudinal gradients have huge potential in advancing our understanding of species distributions, species richness patterns and conservation. Using standard light traps and butterfly transects, we recorded 15000 moths in 978 species, and 8800 butterflies in 276 species. This dataset was collected along a complete altitudinal gradient from 200 m *asl.* to 3700 m *asl.* at the foothills of Mt. Wilhelm, Papua New Guinea. The altitudinal transect included 8 study sites in undisturbed tropical primary rainforest separated by 500 m altitudinal difference. Using univariate and multivariate statistics, we describe trends in species composition, species diversity and abundance of moths and butterflies along altitudinal and successional gradients, as well as, specific habitat preferences of common butterfly species. Further, we test relationships between altitudinal

range, habitat specificity and geographic range for common species of butterflies. Ultimately, we illustrate how abiotic factors change with elevation, and how moths and butterflies respond to these changes to uncover their biological drivers.

9. HERBIVORE DAMAGE INCREASES AVIAN AND ANT PREDATION OF CATERPILLARS ON TREES ALONG AN ALTITUDINAL GRADIENT

Bonny Koane[1], Katerina Sam[2,3], Vojtech Novotny[2,3]

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Signals given off by plants to alert predators to herbivore attack may provide exciting examples of coevolution among organisms from multiple trophic levels. We examined whether signals from herbivore- damaged trees attract predators of insects along a complete altitudinal rainforest gradient in tropical region, where various predators are expected to occur at particular altitudinal belts. We studied predation of artificial caterpillars on trees with and without herbivorous damage; as well as diversity and abundances of potential predators at eight study sites along the altitudinal gradient (200 – 3700 m). We focused on attacks by ants and birds, as the main predators of herbivorous insect. The predation rate decreased with altitude from 10% day^{-1} at 200 m to 1.8% day^{-1} at 3700 m. Predation by ants was more important towards the lowland forests (200 – 1700 m) and it decreased with altitude; whereas bird predation became more important at mid-altitudes (1700 – 2700 m). Caterpillars exposed on trees with herbivorous damage were attacked significantly more than caterpillars exposed on trees without damage. In conclusion, our study demonstrates (i) the large importance of plant damage as a cue of herbivore presence for predators, (ii) decreasing attack rate of predators with increasing altitudes in tropical forests, and (iii) a transition in predator dominance from ants in the lowland forests to birds at the mid to high altitudes. Further, the change in dominant predator group with altitude could lead to dramatic changes in anti-predation strategies of herbivores, and the structure of local food webs, along altitudinal gradients.

10. ELEVATIONAL PATTERNS OF BAT DIVERSITY ON THE HUON PENINSULA, PAPUA NEW GUINEA

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This project provides the first description of bat community structure across a complete altitudinal gradient in the Huon Peninsula of Papua New Guinea (from sea-level to 3000m), assembles the largest reference collection of echolocation calls for Papua New Guinean bats (22 species, a valuable tool for species inventory work), and provides species accounts for all 22 microchiropteran (& 4 megachiropteran) bats captured in the YUS Conservation Area.

Microchiropteran bat communities vary across altitudinal gradients, with greatest species abundance at lowland sites, and greatest individual abundance at mid-altitude sites. Despite the reduction in species with increasing elevation there is still a significant number of potential high-altitude species (6) occurring at or above 3000m.

Acoustic monitoring techniques proved to be a cost and labour effective method of surveying bat communities, revealing twice the number of microbats with only one half the surveying effort of traditional capture techniques. When implemented in concert, traditional survey techniques based on captures (using mist net and harp traps) and more recently developed techniques (acoustic monitoring) significantly advance our understanding of the bat fauna of the YUS Conservation Area, the Huon Peninsula and Papua New Guinea, resulting in 22 new species-specific echolocation call types for YUS and the Huon Peninsula, 2 new species records for the Huon Peninsula and 5 altitudinal range extensions for Papua New Guinea. Species accumulation curves indicate that the total number of bat species detected in the YUS Conservation Area will increase with greater sampling effort.

Vertebrates (5 talks)

11. EXPLAINING THE SPECIES RICHNESS OF BIRDS ALONG A COMPLETE RAINFOREST ELEVATIONAL GRADIENT IN THE TROPICS

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Our understanding of the underlying mechanisms that shape patterns along elevational gradients is in many ways still in its infancy. This study analyses distribution, diversity and abundance of bird from a complete rainforest altitudinal gradient of Mt. Wilhelm in Papua New Guinea (200 - 3700 m), in order to explain observed patterns and determine distinct communities. Avifauna was surveyed on eight sites (500-m altitudinal increment) during three independent surveys, by three methods – point counts, mist-netting and standardized random walks. Three complementary data sets on forest birds partitioned into feeding guilds were analysed. Five predictors of diversity were tested: locally measured habitat complexity and weather, regional species pools and area available at altitudinal belts, and mid-domain effect simulated from empirical ranges. Bird species richness (238 species; 33,639 individuals) displayed a monotonic decline with elevation. This decline was driven by herbivores, whose species richness decreased steeply between 200 m and 1200 m, while species richness of insectivores exhibited a plateau from 200 to 1700 m. The observed patterns of species richness were best explained by habitat complexity for the whole bird community and insectivores, whilst climate was best predictor for herbivores. Abundance patterns were well explained by available food resources. The highest rate of change in community composition was recorded in mid-elevations. We found that the avian species richness was predicted by habitat complexity, climate, and regional species pool. The results, however, vary among feeding guilds. In contrast to previous studies, we find evidence of an elevational zonation of distinct communities within a seemingly homogeneous habitat.

12. WHERE IS THE PEAK OF ALTITUDINAL DIVERSITY IN NEW GUINEA FROGS?

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New Guinea is amongst the few tropical areas where it is possible to study faunal diversity along a complete, continuous rainforest altitudinal gradient, starting near the seacoast and climbing towards the alpine zone. We report on such study for frogs, a highly diverse taxon in New Guinea with 353 species described so far. We quantitatively surveyed eight primary rainforest sites regularly spaced from 200 to 3700 m a.s.l., and recorded 3390 individuals frogs representing 55 frog species in four families (Hylidae, Limnodynastiade, Microhylidae and Ranidae). We demonstrate the usefulness of the DNA barcode sequences of COI in frogs, particularly in defining a species altitudinal limits along different environmental gradients.
We also analyzed patterns of beta diversity along the gradient and found that most frog species have a restricted altitudinal range distribution. This has interesting consequences for community rearrangement and species range shift as a result of climate change. We found local frog diversity peaked at 1700 m a.s.l. Further, we swabbed frog populations for *Batrachochytrium dendrobatidis* (BD) infection, an important conservation issue for frog populations in Australia but we found no BD infection in our frog samples. Finally, we discuss perspectives for ecological and conservation research of amphibians in Papua New Guinea.

Keywords; amphibian, geographical distribution, New Guinea, species richness, tropics

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Global changes impact not only the distributions of species, but also the distributions of species interactions. Understanding how a warming climate might

affect species interaction networks is therefore of interest. Here we investigate how the mutualistic interaction network between ants and their host plants changes along an altitudinal gradient (up to 1600m asl) on Mt Wilhelm in Papua New Guinea, with a quantification of benefits of the interaction for a subset of the species involved. We also use an experimental seedling transplant approach to see whether ant-plants might undergo an Allee effect, whereby reduction in host plant density leads to reduced ant partner sharing by mature plants with younger, uninhabitated plants. In the lowlands multiple ant and plant species are involved in the mutualistic network, with little apparent specialisation. At higher altitudes, the interaction network becomes dominated by *Anonychomyrma*-inhabited *Myristica subalulata*. With increasing altitude, the *Anonychomyrma* inhabiting *Myristica* plants patrol less and take longer to find a model herbivore with parallel increases in herbivory. The driver of this pattern may be reduced ant activity due to lower temperatures at higher altitudes, thus reducing the benefits for plants of ant inhabitation. Experimental transplants indicate that although ant protection of seedlings is important, these ants do not originate in nearby mature ant plants. We have demonstrated that interaction networks shift with altitude, and also, for one particular interaction, that the corresponding change in temperature may drive a shift in the balance of costs and benefits for one partner.

13. RAPID RESPONSE OF GAME WILDLIFE TO COMMUNITY-ESTABLISHED 'NO-TAKE' ZONES IN THE YUS CONSERVATION AREA, PAPUA NEW GUINEA

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Rapidly growing human populations accompanied by changes to customary laws, economic drivers and technology are increasingly threatening local wildlife populations in Papua New Guinea. Recent conservation initiatives in the country have emphasised the establishment of community-based 'no-take' zones where hunting is prohibited. Critical to the success and management of such areas is cost-effective monitoring. Here we assess the effectiveness of areas designated by a local community as 'no-take' zones for protecting key game wildlife species and providing a sustainable resource in buffer areas in the YUS Conservation Area, Papua New Guinea's first conservation area. Survey transects were established along nominal clines in hunting intensity in relation to twelve focal villages. The relative abundance of three broadly defined focal game taxa, macropods, possums (including cuscus) and cassowary,
were assessed using standing faecal counts at varying distances from focal villages and within and outside 'no-take' zones. Relative abundance was higher in protected areas than other sites for each of the three broad taxa groupings considered, and a notable effect of distance from village (a proxy measure for hunting intensity) was demonstrated for macropods and possums. Our results suggest that setting aside 'no-take' zones can rapidly increase key game

populations within community-based protected areas where participation is voluntary and enforcement limited. However, long-term and more detailed information is required for assessment of the status and ongoing population viability of individual species. Such efforts should also consider socio-economic factors driving hunting. The study lays a foundation for more detailed examination of the effects of hunting and protected areas on individual species, for the design of 'no-take' zones in the region and for predicting the potential effects of intensification of future threats in the area.

14. COMPARING ELEVATIONAL AND LATITUDINAL GRADIENTS OF FERN DIVERSITY: FROM NEW GUINEA TO HOKKAIDO

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Among the geographical patterns of biodiversity, the latitudinal gradient of increasing species richness from the polar regions towards the tropics is certainly the most prominent. For most organisms, diversity is highest in the tropics. Yet, the factors determining this high tropical diversity remain poorly understood partly due to the large geographic extent of latitudinal gradients. In this regard elevational gradients of species richness have become increasingly popular to disentangle potential drivers of diversity. They are easier to replicate than latitudinal gradients, and allow for disentangling ecological factors that vary differently along elevational gradients but not along latitudinal gradients. They are further more restricted in geographical extend, but also span from the warm (lowland) climates, to the cold (high alpine) climates. Due to the similar change in environmental conditions along both latitudinal and elevational gradients, diversity was long considered to decline monotonically towards high elevations in a manner similar to the decline from the equator towards the poles. Latitudinal and elevational gradients thus both represent biogeographical gradients along which diversity changes in a clear and often predictable way. Because of the different spatial extents and specific ecological transitions of the two types of gradients, a combination of latitudinal and elevational gradients offers the unique opportunity to disentangle the relative roles of different drivers of diversity patterns. Here we present a comparison between six elevational gradients along an latitudinal gradients in species diversity and composition ranging from the island of New Guinea via the Philippines, Taiwan, Kyushu, Honshu, to Hokkaido. We present changes in community composition as

well as diversity in ferns and discuss the challenges and opportunities that which arise from combining elevational and latitudinal gradients of species diversity.

Interactions

15. ANT-PLANT MUTUALISTIC INTERACTION NETWORKS, ALTITUDINAL GRADIENTS, AND ANT PARTNER SHARING

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Global changes impact not only the distributions of species, but also the distributions of species interactions. Understanding how a warming climate might affect species interaction networks is therefore of interest. Here we investigate how the mutualistic interaction network between ants and their host plants changes along an altitudinal gradient (up to 1600m asl) on Mt Wilhelm in Papua New Guinea, with a quantification of benefits of the interaction for a subset of the species involved. We also use an experimental seedling transplant approach to see whether ant-plants might undergo an Allee effect, whereby reduction in host plant density leads to reduced ant partner sharing by mature plants with younger, uninhabitated plants. In the lowlands multiple ant and plant species are involved in the mutualistic network, with little apparent specialisation. At higher altitudes, the interaction network becomes dominated by *Anonychomyrma*-inhabited *Myristica subalulata*. With increasing altitude, the *Anonychomyrma* inhabiting *Myristica* plants patrol less and take longer to find a model herbivore with parallel increases in herbivory. The driver of this pattern may be reduced ant activity due to lower temperatures at higher altitudes, thus reducing the benefits for plants of ant inhabitation. Experimental transplants indicate that although ant protection of seedlings is important, these ants do not originate in nearby mature ant plants. We have demonstrated that interaction networks shift with altitude, and also, for one particular interaction, that the corresponding change in temperature may drive a shift in the balance of costs and benefits for one partner.

16. THE STRUCTURE OF PLANT-HERBIVORE FOOD WEB ALONG AN ALTITUDINAL GRADIENT IN PAPUA NEW GUINEA

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Studies in the tropics show herbivore communities are rarely saturated with species, so their diversity is determined by the size of the regional species pool from which they are assembled. Unfortunately, these species pools remain poorly documented in the tropics. Although food webs are often inventoried, few studies explore their potential for novel trophic interactions, e.g. by feeding experiments. These hypothetical food webs can become important tools for the assessment of the effect of species dispersal caused by changing environment. Plant and insect species are already responding to changing climate in their altitudinal distribution, but we remain unable to predict the structure of new food webs arising in the process. Here, we present findings from New Guinea, one of the few tropical areas with undisturbed rainforests along complete altitudinal gradients from seacoast to the alpine zone. Folivorous insects feeding on *Ficus* trees – keystone species are used here as a model system. All externally feeding holometabolous larvae (Lepidoptera) including leaf rollers and leaf tiers, and adult insects (Orthoptera, Phasmatodea and Coleoptera) were collected by hand from 1500 m^2 of foliage area in 5 ha of forest per altitudinal site starting at 200 m *asl*. to 2700 m *asl*. All altitudinal study sites were separated by 500 altitudinal metres. Combining local and regional analyses of food webs with experimental assessments, we attempted to predict (possibly for the first time), the structure of new plant-herbivore food webs arising from the dispersal of species along altitudinal gradients in response to changing environment.

Conclusion

17. AUSTRALASIAN ALTITUDINAL TRANSECTS: THE CHALLENGE OF THE COMPARATIVE DIMENSION

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Altitudinal transects describe local biodiversity effectively and enable the exploration of the relationships among environmental variables (particularly synoptic climate) and dimensions of species diversity. The Mt Wilhelm transect is now the most northerly of such sets of sites within Australasian rain-forested landscapes. My group has established sets of comparable sites in the Australian subtropics in Lamington and Border Ranges National Parks, and tropical sites at Mt Lewis and Eungella National Parks. At each of these sites we have surveyed a range of arthropod target taxa as well as local vegetation. Meta-analyses of data from these (and other) transect presents a set of analytical challenges which we are currently exploring. The first of these challenges is the search for a common currency to align sites established at different latitudes and over different ranges. The use of the notional tree-line at each elevation holds promise and captures both latitudinal change and contrasting study- ranges. An alternative approach may be to use the deuterium:hydrogen-1 ratio in selected marker species to "self-define" the effective altitude of samples. This ratio is known to change with altitude but its sensitivity and consistency within, say, insect samples, has not hereto been

tested. We will examine both of these approaches critically using insect and plant data from the Australasian and other transects. Last, the challenge of connecting ecological diversity with ecosystem function through the conversion of taxon-based data to functional group based data will be discussed and exemplified using beetle and moth data from the Australian transects.