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# Abstract Book

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The 2010 International Meeting of the Association  
for Tropical Biology and Conservation

Tropical biodiversity: surviving the food, energy and  
climate crisis

Partnerships



# ATBC 2010

## Abstracts

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## Plenary talks

### **Bioethical-friendly strategy for biodiversity exploration**

Umar Anggara Jenie; *Former Chairman, Indonesian Institute of Sciences; Indonesian National Bioethics*

The term “Bioethics” refers to the systematic, pluralistic and interdisciplinary study and resolution of ethical issues raised by medicine, life and social sciences as applied to human beings and their relationship with the biosphere, including issues related to availability and accessibility of scientific and technological developments and their applications. In the Universal Declaration on Bioethics and Human Rights (UDBHR), which was approved on October 2005 by the UNESCO 33rd General Conference, shows that the principles on bioethics consists of 15 articles, and includes interconnection between human beings and other form of life. The Article-17: “Protection of the Environment, the Biosphere and Biodiversity”, states that ‘Due regard is to be given to the interconnection between human beings and other forms of life, to the importance of appropriate access and utilization of biological; and genetic resources, to respect for traditional knowledge and to the role of human beings in the protection of the environment, the biosphere and biodiversity’. By inclusion of human responsibility to other living organisms and protection of environment, biosphere and biodiversity, the UDBHR becomes comprehensive bioethics document, not only concern with human beings but also with other form of living organisms and their environment. Based on those bioethical principles set out in the UDBHR, strategy for biodiversity exploration must be designed and carried out. A harmony between exploration and conservation of biodiversity must be taken as prime strategy on treatment to the nature.

### **Reconnecting ecology and evolution to cope with global change**

Michael Donoghue; *G. Evelyn Hutchinson Professor, Department of Ecology and Evolutionary Biology, Yale University; Member of US National Academy of Sciences*

I will argue, using examples, that our understanding of global change and its consequences will be greatly enhanced by better integrating ecological and evolutionary/phylogenetic perspectives. I will focus special attention on broad biodiversity patterns that stem from the relative rarity of major niche shifts that entail substantial physiological adjustments. As a consequence, the functions and responses of ecological systems depend in important ways on which lineages happen to be present/absent as a function of their historical biogeography. The vulnerability of ecosystem services in the face of global change can be gauged by taking into account the phylogenetic distribution of key ecological functions in relation to the distribution of traits that govern responses to particular global change drivers. Proper unification of these disciplines requires us to re-think our approach to education in these areas.

### **Coping with multiple-stressors of our time: how tropical biodiversity survive?**

Daniel Murdiyarmo; *Senior Scientist, Center for International Forestry Research*

Human well-being is confronted with increasing demand for food, fiber and energy. Natural and man-made production systems have been overly extracted to meet such demand causing detrimental effects that threaten the sustainability of the systems themselves. Moreover, economic-driven behavior of man-kind, often termed as development, has extensively eroded vulnerable biotic and as well as abiotic components of the ecosystems. Loss of biodiversity, reduced productivity, and declining ecosystem resilience are resulted. Diverse biological constructs is only one of the indicators of how stable ecosystem would survive. It is in our time that we experience a dramatic loss and degradation of biological diversity at all levels. These are mainly associated with extensive land-use change that one single generation can observe. The situation is worsened by the adverse impacts of anthropogenic climate change which takes place in a gradual trend. However, dramatic abrupt changes due to climatic variability and extreme weather events are getting more frequently experienced. It is timely that collective actions should be promoted. Strategies to cope with the impacts and mitigate the causes need to be governed at both ends, globally and locally. There is no single recipe that cures everything. Knowledge has been generated by science and yet a lot more need to be done. Linking science and communicating science-based knowledge to policy community and practitioners is both challenging and but also demanding. Likewise, fine tuning policy-relevant research agenda would eventually lessen dichotomous views on development and conservation.

### **Climate change and coral reefs**

Charlie Veron; *Former Chief Scientist of the Australian Institute of Marine Science*

Temperature-induced mass coral bleaching causing mortality on a wide geographic scale started when atmospheric CO<sub>2</sub> levels exceeded ~320ppm. When CO<sub>2</sub> levels reached ~340ppm, sporadic but highly destructive mass bleaching occurred in most reefs world-wide, often associated with El Niño events. Recovery was dependent on the vulnerability of individual reef areas and on the reef's previous history and resilience. At today's level of ~387ppm, allowing a lag-time of 10 years for sea temperatures to respond, most reefs world-wide are committed to an irreversible decline. Mass bleaching will in future become annual, departing from the 4-7 year return-time of El Niño events. Bleaching will be exacerbated by the effects of degraded water-quality and increased severe weather events. In addition, the progressive onset of ocean acidification will cause reduction of coral growth and retardation of the growth of high magnesium calcite-secreting coralline algae. If CO<sub>2</sub> levels are allowed to reach 450ppm (due to occur by 2030-2040 at the current rates), reefs will be in rapid and terminal decline world-wide from multiple synergies arising from mass bleaching, ocean acidification, and other environmental impacts. Damage to shallow reef communities will become extensive with consequent reduction of biodiversity followed by extinctions. Reefs will cease to be large-scale nursery grounds for fish and will cease to have most of their current value to humanity. There will be knock-on effects to ecosystems associated with reefs, and to other pelagic and benthic ecosystems. Should CO<sub>2</sub> levels reach 600ppm (by the 2050s in worst case scenarios) reefs will be eroding geological structures with populations of surviving biota restricted to refuges. Domino effects will follow, affecting many other marine ecosystems. This is likely to have been the path of great mass extinctions of the past, adding to the case that anthropogenic CO<sub>2</sub> emissions could trigger the Earth's sixth mass extinction.

## **Why Biodiversity Matters in a Changing World**

Kathy MacKinnon; *Former Lead Biodiversity Specialist in the Environment Department of the World Bank*

The three key environmental concerns of coming decades will be biodiversity loss, water shortages and climate change. These three environmental challenges are inextricably inter-linked; together they will impact on agricultural productivity and food security, influencing our ability to address poverty alleviation and influencing national economic growth in many of the world's poorest and least developed nations. Global attention to climate change has rightly focused attention on reducing carbon emissions and greenhouse gases from transport and energy sectors and adopting new technologies. Unfortunately this has often diverted attention away from support for other simpler, and already available, natural solutions. The great rainforests of Indonesia, the Congo Basin and Amazon as well as tropical wetlands and coastal habitats serve as carbon stores and sinks. Healthy ecosystems maintain essential water services, reduce vulnerability to climate shocks and natural disasters, protect the web of life, support local livelihoods and increase local and national resilience, helping communities to adapt to climate change. A key challenge for conservationists is how to increase awareness, political support and funding for biodiversity conservation as an essential, proven, cost-effective and sustainable part of local and national climate change strategies.

## **Surviving the crises: not by biodiversity alone**

Frans Bongers; *ATBC President; Professor Tropical Forest Ecology, Wageningen University*

The food, energy and climate crises pose serious challenges for the conservation and sustainable use of tropical biodiversity and tropical ecosystems. In this Biodiversity Year 2010, and also during this week's conference, much focus is on the most diverse tropical ecosystems. And yes, in many cases the most diverse ecosystems are also the most undisturbed ecosystems. But also other systems deserve our attention, and in many cases less diverse systems have great importance for human populations as well. I will give examples of such systems. I will plea for more new forests (but not replacing old growth forests), question the paradigm "the more biodiverse, the better" (do less diverse ecosystems value less?), and ask if common species are worthless because they are common. If we want to survive the crises we will have to diversify our thinking as well. We will need both high and low diverse ecosystems, both rare and common species. Diversification also means that we need to develop close collaboration with specialists from a wide array of other fields as well. Do we, tropical biologists and conservationists, collaborate wide and well enough? Only then tropical biodiversity may survive the crises.

## Verbal presentations

### Amphibian population declines in tropical Asia and Australia: differences, similarities and lessons learned (#01)

(July 21 pm; Wantilan rear)

Organized by: **Mirza D. Kusriani, Jodi J. L. Rowley**

*Amphibian population declines and extinctions have been well-documented in Australia, but there is an almost complete lack of information on amphibian population trends in neighbouring Asia. Indeed, Wallace's Line, dividing the biogeographical region of Asia and Australia, appears to also divide the state of amphibian knowledge between regions. However, both Australia and Asia face urgent amphibian conservation challenges. In Australia, amphibians underwent declines attributed to the amphibian disease chytridiomycosis over a decade ago, and present conservation challenges largely relate to managing amphibian populations in a landscape where disease is endemic. In tropical Asia, the foremost threats to native amphibians are habitat loss, overharvesting, and an overall lack of knowledge. While there is currently no evidence of amphibian population declines related to amphibian disease in Asia, the amphibian disease chytridiomycosis has recently confirmed from a number of sites throughout Asia, presenting a possible new threat to amphibian conservation. This symposium aims to bring together researchers and conservation practitioners working in Australasia to discuss the current state of knowledge and main challenges facing amphibian research and conservation in the region, and share lessons learnt. The symposium will also facilitate international collaborations on amphibian research and conservation in the region.*

#### V-01-1: Amphibian Population Declines in Tropical Australia: Lessons Learnt

Ross A. Alford; *School of Marine and Tropical Biology, James Cook University*

Eleven species of frogs in tropical Australia experienced severe population declines during the 1980s and 1990s. Until the rediscovery of one species in 2008, it was thought that five species had gone extinct. Monitoring showed that declines were sudden and precipitous, with adult populations crashing over a few weeks. Almost all declines occurred in protected areas. At a local scale, there was a very clear spatial pattern; all populations of vulnerable species at high elevations were affected by declines, while populations at low elevations were not. In 1998, the disease chytridiomycosis was described. Retrospective analyses show that it probably caused the declines. The disease is now endemic throughout the Australian Wet Tropics region. Host defenses and microenvironment use, as well as macroenvironmental conditions, strongly affect the fates of infected individuals and populations. Small changes in the environment may cause rapid population declines, disrupting present patterns of apparently stable coexistence between host and pathogen populations. A population of one of the missing species was rediscovered in 1998 in habitat outside its former known range that provides environmental conditions less suitable for the development of disease. Interactions among microbes living on amphibian skin may also be an important determinant of vulnerability to the disease, and we are investigating potential probiotic approaches to protecting frog populations from the threat of future epidemic outbreaks. The Australian experience shows that simply protecting what is thought to be the core habitat of species is not enough to ensure long-term conservation; it is necessary to fully understand distributions and to protect populations occupying the full range of environments available to species. It is also essential to prevent the global transport of pathogens and pests, and to be prepared to detect, interpret, and respond rapidly to changes in the status of taxa at risk.

### **V-01-3: Tasty Frogs and Cute Frogs: The Implications of International Trade of Indonesian Frogs to Conservation**

Mirza D. Kusrini, Ani Mardiasuti, Mikrimah; *Institute Pertanian Bogor (IPB)*

It is widely known that Indonesia is the biggest frog legs exporters in the world. Edible frog harvest has been scrutinized by the international community for the past several years; almost all argued the need of proper regulation. Edible frog harvests in Indonesia mostly focus on big-legged frogs from the genus *Ranidae* i.e. *Fejervarya cancrivora*, *Limnonectes macrodon*, *L. blythii*. More than ten species is harvested but so far only three species is known to be heavily harvested in Java Island. On the other hand, more than forty species of frogs were exported as pets from Indonesia, in which two species from Papua, the *Litoria caerulea* and *L. infrafrenata* are among the highest number of amphibian exported. In term of the number taken from the wild, the harvest of edible frogs might lead to detrimental impact to the population of the harvested frogs compared to pet industry. However, sustainability of edible frog harvest depends on its population size, life history, hunting pressure and habitat availability. The confirmation of *Batrachochytrium dendrobatidis* in Indonesian wild species showed that international trade of live Indonesian frog may facilitate the spread of disease thus calling the need for more rigorous regulation.

### **V-01-4: The Role of Defining Species Boundaries in the Conservation of Southeast Asian Amphibians**

Bryan L. Stuart<sup>1</sup>, Rafe M. Brown<sup>2</sup>; *1. North Carolina Museum of Natural Sciences, 2. University of Kansas*

Species are the fundamental units used in conservation and almost all fields of comparative biology, making the process of defining species critically important. New species of amphibians are being rapidly discovered, with an ~50% increase in the global number of recognized species over the past two decades. Southeast Asia is one region experiencing such rapid amphibian species discovery, largely from new fieldwork in previously unexplored areas and the use of molecular and acoustic tools in defining species. Recent molecular genetic analyses of Southeast Asian amphibians have revealed numerous morphologically cryptic species, often in sympatry. Our results suggest that many widespread, single species actually consist of multiple species, each having smaller geographic ranges that are more vulnerable to extinction, and that amphibian species diversity in Southeast Asia remains significantly underestimated.

### **V-01-5: Is Chytridiomycosis an Emerging Amphibian Disease in Asia?**

Jodi J. L. Rowley<sup>1</sup>, Mirza D. Kusrini<sup>2</sup>, Vance T. Vredenburg<sup>1</sup>; *1. Australian Museum, 2. Bogor Agricultural University*

The disease chytridiomycosis has caused dramatic amphibian population declines and extinctions in Australia, Central and North America, and Europe. The causative agent for this disease, *Batrachochytrium dendrobatidis* (Bd), proliferates in epidermal cells of post-metamorphic amphibians and in the mouthparts of tadpoles, and is capable of killing individuals rapidly via the disruption of skin function. The mechanism behind the rapid global emergence of the disease is poorly understood, in part due to an incomplete picture of the global distribution of Bd. At present, there is a considerable amount of geographic bias in survey effort for the Bd, with Asia being the most neglected continent. To date, Bd surveys have been published for few Asian countries, and infected amphibians have been reported only from Indonesia, South Korea and Japan. In order to gain a more detailed picture of the distribution of Bd in Asia, we undertook a widespread, opportunistic survey of over 3,000 amphibians for Bd throughout Asia and adjoining Papua New Guinea. Survey sites spanned 15 countries, approximately 36° latitude, 111° longitude, and over 2000 m in elevation. Bd prevalence was very low (1.4%) and overall, infected animals were not clumped as would be expected in epidemics or outbreaks. Although the susceptibility of Asian amphibians to Bd remains unknown, there is currently no evidence of Bd infection causing morbidity or mortality in Asian amphibians, and there have been



no reports of dramatic, enigmatic population declines of the kind that have been attributed to Bd in other areas. The observed pattern in Asia appears different to that in many other parts of the world, including Australia.

#### **V-01-6: Integrating Species Traits with Extrinsic Threats: Closing the Gap between Predicting and Preventing Species Declines**

Kris A. Murray<sup>1</sup>, Dan Rosauer<sup>2</sup>, Hamish McCallum<sup>1</sup>, Lee Skerratt<sup>1</sup>; *1. University of Queensland, 2. University of New South Wales, 3. University of Queensland, 4. University of Queensland*

In studies of extinction risk, it is insufficient to conclude that species with narrow ranges or small clutch sizes require prioritized protection. To improve conservation outcomes, we also need to know which threats interact with these traits to endanger some species but not others. In this study, we integrated the spatial patterns of key threats with species' ecological/life-history traits to both predict declining species and identify their likely threats. In addition to confirming the importance of previously identified traits (e.g., narrow range size), we find that extrinsic threats (primarily the disease chytridiomycosis and mosquitofish) are equally important and interact with intrinsic traits (primarily ecological group) to create guild-specific pathways to decline in Australian amphibians. Integrating the spatial patterns of extrinsic threats in extinction risk analyses will improve our ability to detect and manage endangered species into the future, particularly where data deficiency is a problem.

#### **V-01-7: The Impact of Pioneer Frogs on Rainforest Frog Assemblages: Implications for Conservation**

Oliver Konopik<sup>1</sup>, T. Ulmar Grafe<sup>2</sup>; *1. University of Würzburg, 2. Universiti Brunei Darussalam*

Movement patterns, habitat use, and diet of the frog *Hylarana glandulosa* were studied in Brunei Darussalam, Borneo. Radio-telemetry revealed that both males and females are pioneers that invade pristine lowland mixed dipterocarp rainforests using dirt roads. Road construction led to formation of ponds used for reproduction. Invasion impacted the resident species assemblages by reducing species richness and functional diversity. Impacts were most apparent in pond-associated breeders that showed a significant decline in densities. Furthermore, stomach flushing revealed that pond breeders were preyed on by the invading pioneer species, suggesting that changes in community composition were a direct result of predation.

#### **V-01-8: Impacts on Amphibians at the Dumbara Highlands, Sri Lanka**

Thasun A. A. Amarasinghe, D.M.S. Suranjan Karunarathna; *Taprobanica Nature Conservation Society*

Sri Lanka is a biodiversity hotspot, a total of 94 out of 111 amphibian species are endemic. We are currently facing a period of biodiversity mass extinctions; 21 amphibians have become extinct in Sri Lanka. Also the human population growth is getting higher around in protected areas, a serious threat to the remaining biodiversity trapped in rain-forested Southwestern wet zone, Knuckles & the Central highlands. Only few natural forests now survive, with many of the relicts threatened by invasive alien plants. Habitat loss & fragmentation, climate change, diseases, pesticides use, gene flow, deformities, etc., have been hypothesized as major causes in the global decline of amphibians which is a solemn issue nowadays. Chena cultivations, illegal timber felling & encroachments, man-made fire, soil erosion, garbage dumping, habitat destruction, unplanned constructions, rock exploitations, illegal gem mining & land fillings, conditioned the habitat loss & fragmentation in the Knuckles range. Climate changes; prolonged droughts, forest dieback & acid rains are also an identified growing threat for amphibians. Several diseases & deformities have been observed in addition to several dead adult amphibians, although reasons for mortality are unknown. The aforementioned threats are exacerbated by montane forest fragments surrounded by cardamom & tea plantations involving intensive pesticide

application. Road kills have also been identified as a major threat to amphibian fauna. 7 out of 30 amphibian species which recorded in the Knuckles range are point endemic; but several previously unknown species await description. They would be at risk of extinction before they are even named. Threats to the unique recognized biodiversity & the challenges to its conservation, demand urgent international & national level scientific attention, policy & planning. Therefore, it is our own responsibility to conserve our natural heritage without any delay.

**V-01-9: Effects of Increased Salinity and an Introduced Predator on Lowland Amphibians in Southern China: Species Identity Matters**

Nancy E. Karraker, James Arrigoni, David Dudgeon; *University of Hong Kong*

Approximately 30% of amphibian species are threatened due to a variety of factors affecting their habitats and physiology, yet contributions that interactions among factors make to population declines are not well-explored. Two factors, introduced mosquitofish (*Gambusia affinis*) and increased salinity, may coincide in lowland habitats used by breeding amphibians. Mosquitofish have been introduced worldwide and can be significant predators of amphibian larvae. Salinization of wetlands is an increasing problem globally due to (1) application of road deicing salts in temperate regions, (2) irrigation practices associated with intensive agriculture, particularly in Australia, and (3) saltwater intrusion due to sea-level rise. We investigated the effects of mosquitofish (*Gambusia affinis*) and increasing salinity on five species of lowland wetland-breeding amphibians from southern China. We exposed anuran hatchlings to four salinity levels and two fish treatments and all combinations of the two factors in a series of experiments. Four of the species were susceptible to predation by mosquitofish, two were sensitive to increased salinity at concentrations >6‰ seawater, and one was tolerant of both increased salinity and mosquitofish. We found no interaction between the predator and increased salinity. Salinization and mosquitofish represent significant threats to lowland amphibians in this region and, coupled with the ongoing loss and degradation of lowland wetlands, portend a bleak future for lowland amphibian populations in the region.

**V-01-10: Attempt at Artificial Breeding and Analysis of Genetic Diversity in an Endangered Frog *Odorrana ishikawae*: Case Study of Fauna Conservation from Japan**

Masayuki Sumida; *Inst. for Amphibian Biol., Hiroshima Univ.*

*Odorrana ishikawae*, a species endemic to the Okinawa and Amami Islands, is described as the most beautiful frog in Japan. Over-hunting and environmental destruction over the last several decades have devastated the population of this species. *Odorrana ishikawae* has therefore been listed as class B1 endangered species in the IUCN Red List, and designated as a natural monument in both Okinawa and Kagoshima Prefectures. In the present study we: (1) artificially bred frogs and tested a farming technique in the laboratory to preserve this species; (2) analyzed mitochondrial DNA to evaluate the genetic diversity and the population composition of this species; and (3) extracted antimicrobial peptides from the skin to find biologically active agents with strong antimicrobial effect. The sample animals were artificially bred from four male/female pairs of Amami Island via artificial insemination. Among 3,078 eggs, 2,742 cleaved normally, and 1,761 metamorphosed normally. About 400 six-year-old mature frogs produced via artificial breeding are now being raised in the laboratory. During last year's breeding season, second-generation offspring were produced by natural mating activities of these frogs. The mitochondrial ND2 gene was found to be the most useful for elucidating genetic diversity and population composition of this species. The genetic diversity was relatively low (1.0%) within the Okinawa and Amami populations, however, comparatively high (7.5%) between the Okinawa and Amami populations. The Okinawa population was also differentiated from the Amami population both morphologically and reproductively. These populations can be appropriately regarded as different species. We succeeded in identifying 11 antimicrobial peptides from the skin of this endangered species. Some peptides showed strong antimicrobial activity and wide antimicrobial spectrum against bacteria. There is a chance that these peptides will contribute to the production of new antibiotics in the future.

## **Biodiversity informatics for biological conservation and management: CBD meets RDF (#04)**

**(July 23 pm; Garuda)**

Organized by: **Teguh Triono and Campbell Webb**

*Recent years have seen an explosion in technological capabilities for organizing and cross-linking biodiversity information. At the same time, the loss of natural habitats continues rapidly in megadiversity countries, and the conservation needs for biodiversity data are greater than ever. Many developing countries are struggling to meet the taxonomic reporting requirements for the Convention on Biological Diversity deadlines for 2010. At this key time (also the International Year of Biodiversity), we want to bring some leading developers of biodiversity informatics together in a symposium at a conference focused on tropical biodiversity, to expose some of these new technologies and to demonstrate their real-world applications in conservation and management. We hope to bring the energy and content of exciting recent meetings like eBiosphere and TDWG 2009 to a wider audience of tropical field biologists, because it is upon the latter that the future of biodiversity data collection in megadiversity areas depends.*

### **V-04-1: Biodiversity Knowledge from Existing Biodiversity Data**

A. Townsend Peterson<sup>1</sup>; *Biodiversity Institute, University of Kansas*

The biodiversity crisis is one of accelerating biodiversity losses in the face of broadening human impacts on global landscapes. Clearly, facing this crisis places a premium on effective and informed decision-making, which in turn requires solid information about biodiversity patterns and processes. Unfortunately, time for such steps is limited, meaning that effective use of existing information is crucial. I here review ideas and strategies for deriving useful information products from existing biodiversity data by means of a suite of explorations, visualizations, and analyses, and taking care to avoid overinterpretation of results. Existing biodiversity inventories can be quality-controlled and assessed for completeness; geographic distributions of species can be estimated, and gaps in knowledge identified; likely effects of land use change and climate change can be forecast, and patterns of biodiversity change and loss estimated. This immediately-feasible step is important, as it allows marshalling of existing knowledge to answer immediate questions; it does, however, place a premium on digitization and integration and sharing of existing biodiversity data on a global scale.

### **V-04-2: The Biodiversity Information System Needs for Network of Ecological Plots in Tropics**

Motomi Ito<sup>1</sup>, Noriaki Sakaguchi<sup>2</sup>; *1. Univ. Tokyo, Japan, 2. Biodiversity Center, MoE, Japan*

We have many observation plots of forest ecology in South East area. However, it cannot say that we share information among the observation projects. Thus, we need an information system for sharing and integrating the information of them. AP-BON, a biodiversity observation network in Asia and Pacific areas had been established in connection with GEO-BON, and we are now constructing basic information system for it. Here, I would introduce the information system for forest ecology observation plots, and its utility for promoting more effective observation.

### **V-04-3: Challenges and Solutions for Planning and Implementing Large-scale Biotic Inventories.**

Maurice H. Leponce<sup>1</sup>, Yves Basset<sup>2</sup>, Christopher Meyer<sup>1</sup>, Christoph Häuser<sup>1</sup>, Philippe Bouchet, Jacques Delabie & Lee Weigt; *1. Royal Belgian Institute of Natural Sciences, 2. Smithsonian Tropical Research Institute*

2010 was declared the international year of biodiversity. Yet there is still no complete or near complete information on the total biodiversity of any species-rich ecosystem around the world, even in protected areas. Large-scale inventories can maximize the biodiversity information collected through the coordinated effort of a multidisciplinary team. They produce an overall picture of highly complex ecosystems and may be instrumental for conservation and management decisions. Based on our experience with the IBISCA and Moorea Biocode projects and on a review of the literature related to All Taxa Biodiversity Inventories, we identified four kind of challenges that comprehensive biodiversity inventories basically face. First, biological challenges, as species distributions are heterogeneous in space and time. Representative results may thus only be achieved with adequate spatio-temporal replicates. Second methodological challenges, since any sampling method provides a biased image of species composition and abundance. The use of complementary collecting methods helps to circumvent this problem. Third, taxonomical challenges, as large inventories generate an impressive amount of material to process and identify. To avoid work overload of expert taxonomists the material should be pre-processed by assistants (students, amateurs, parataxonomists, volunteers) supervised by professionals. Fourth, planning and implementation challenges, since security and legal issues, coordination of collection and processing of material, centralization of data, and follow-up of the project may not be straightforward. An ideal implementation requires an organizational structure composed of coordinators, advisors, workgroups and external partners. Comprehensive inventories typically span over several years. To keep the motivation of participants and of stakeholders the project output should include fast deliverables in addition to long-term research.

#### **V-04-4: Integrating and Sharing Biodiversity Data Online**

Jeremy Miller<sup>1</sup>, Charles Griswold<sup>2</sup>, Pham Dinh Sac<sup>1</sup>; *1. Department of Terrestrial Zoology, Nationaal Natuurhistorisch Museum Naturalis, 2. Department of Entomology, California Academy of Sciences*

Within the past few years, advances in technology and cyberinfrastructure have finally given us the tools to realize the full potential of taxonomy: an integrated consortium of resources for organizing, interconnecting, and recombining fundamental information about the world's biodiversity for multiple user groups. Publications in taxonomy stereotypically contain a limited number of data classes. Community resources are now available for curating these data online, including Zoobank for nomenclature, Morphbank for images, GBIF for specimen data, and Encyclopedia of Life for descriptions and synthesis. If taxonomists continue to produce the data products they always have but also make those data available through online resources, the cumulative contribution of taxonomic research will become much more accessible and useful to scientists, decision makers, and the other information consumers. Images and data from inventories posted online can likewise increase the relevance and impact of collecting expeditions. We highlight examples from recent taxonomic publications and collecting expeditions.

#### **V-04-5: Borneo's Remaining Forests**

Niels Raes<sup>1</sup>, J.W. Ferry Slik<sup>2</sup>, E. Emiel van Loon<sup>1</sup>, Hans ter Steege<sup>1</sup>, Marco C. Roos, Pieter Baas; *1. Leiden University, 2. Xishuangbanna Tropical Botanical Garden*

Although it is widely recognized that Borneo harbours one of the world's most important biodiversity hotspots, the spatial patterns of botanical richness, endemism, the 'centres of endemism', and Borneo's floristic regions, have largely been based on informal expert opinion until now. Recent digitization of the botanical collections of Borneo, housed at the National Herbarium of the Netherlands, has provided us with a database that allowed a quantitative, spatial analysis of the components of botanical diversity of Borneo.

We developed species distribution models (SDMs) for species treated in 'Flora Malesiana' and represented by at least five unique records. The 2273 SDMs were statistically tested against a null-model, resulting in 1439 significant models (63.3%), covering 8577 grid cells (5 arc-minute resolution ~ 100 km<sup>2</sup>) of Borneo. The 1439 significant SDMs were combined to generate patterns of botanical richness and endemism. We constructed a presence/absence matrix, which was analysed with a hierarchical cluster analysis. The resulting cluster dendrogram was pruned using indicator species analysis (ISA) and partitioned into eleven floristic regions.

The highest botanical richness was predicted for northern and north-western Borneo. The northern Crocker Mountains range with Mount Kinabalu and the mountains of central East Kalimantan are predicted to have the highest endemism values. Together with the southern Müller Mountains, the east side of the Meratus Mountains, and the Sangkulirang peninsula these are predicted 'centres of endemism'. The cluster analysis revealed that the lowland rain forest, previously recognized as one floristic region, should in fact be divided in at least four (and possibly six) different floristic regions; the lowlands of (i) Sabah and Sarawak, (ii) East Kalimantan, (iii) southern Borneo, and (iv) the 'Wet hill forest of Sarawak'.

Overlaying the patterns of biodiversity, endemism, and floristic regions with the Global Land Cover 2000 reveals Borneo's remaining forests covering 64% of its surface.

#### **V-04-6: Extending Red List Assessments from a Herbarium Database**

Kwek Yan Chong, Richard T. Corlett, Hugh T.W. Tan; *National University of Singapore*

The assessment of threatened species is a key baseline objective in setting conservation priorities. To date, only a handful of plant species have been assessed globally, while national and regional assessments are disparate and often incomplete. Using spatial and temporal data extracted from digitized herbarium records, and a national red listing of plant species, we employ classification tree techniques with parameters verified by regression analyses to produce an 'optimal' decision algorithm for classifications of extinct and threat status, and compared this with that of an earlier study. We also explore the feasibility of using species subsets as training data for application to the overall database. Information from collections deposited in herbariums offers an avenue for rapidly generating preliminary assessments of threat status, although problems such as synonymy and data quality would slow down the analysis of larger datasets. Our methods can be extended to form global working lists for formal IUCN assessments, but would require greater progress in the digitization of collections in major herbariums around the world.

#### **V-04-7: Mobilising and Using Biodiversity Data beyond Borders in Africa: The TanBIF Experience**

Flora A.R. Ismail, Mkabwa K.L. Manoko; *University of Dar es Salaam*

Tanzania boasts a vast array of biodiversity as well as Africa's richest and most diverse flora. This biodiversity is an essential source of biological resources such as food and medicines as well as ecosystem services such as water availability, soil protection and climate regulation and cultural services such as cultural values and research and education. Tanzania's Poverty Reduction Strategy (MKUKUTA) has identified biodiversity as a cross-cutting issue bearing on poverty reduction. Access to biodiversity data helps address important issues such as land-use planning, agricultural pests and diseases, and spread of invasive species. Biodiversity information is an important tool in development planning as it is a basis for sustainable development. However, a study in Tanzania revealed unsatisfactory links between biodiversity data providers and those who use them; being it development planners, policy makers or the public at large. This weakness is to be rectified by creation of the Tanzania Biodiversity Information Facility (TanBIF). TanBIF is a National coordinating body established with the overall aim of furthering technical and scientific efforts to promote the mobilization, sharing and utilization of biodiversity data and information in Tanzania. Its vision is to make scientific biodiversity data and information the common property of everyone in

service to science, economy and public good. It serves to enhance knowledge sharing among scientists, policy and decision-makers and the general public by ensuring that biodiversity data and information that was previously unavailable to users is made accessible via the internet through the TanBIF portal. It is the intention of TanBIF to advance its use for fine-scale analysis of risk analysis (e.g. on diseases spread, protected area management, scientific discovery related to biodiversity and technology advancement) required or related to use or conservation of biodiversity in Tanzania.

#### **V-04-8: Enhancing Biodiversity Data and Building Local Capacity Through Student Expedition**

Mila Rahmania, Raden Tirtayasa, Yeni A. Mulyani, Arzyana Sunkar; *Institut Pertanian Bogor*

Student expeditions are common for many universities in developed countries which aim to enhance students' knowledge in field work and supporting university research program. The latter are mostly led by academic staff and is adhere strictly to designated research program. Many rich biodiversity countries, such as Indonesia, are the target for that type of expedition. Local capacity building is critical for the continuation of research as well as conservation efforts in those countries. However, such international expedition sometimes unintentionally left out local students. Since 2003 students of Department of Forest Resources Conservation & Ecotourism, Bogor Agricultural University has initiated students' expedition to several conservation areas throughout Indonesia. Those expeditions have succeeded in improving basic biodiversity data as well as enhancing the capacity of students in conservation and research. However, there are several difficulties associated with this kind of expedition: a) cost, b) safety and supervision and c) timing. Although expeditions are able to produce valuable data on biodiversity in an area, data should be viewed with caution. Students need to conduct expedition according to standard research methods and report result in peer review journal. Additional exposure and networking with international organizations is needed to improve the quality of local student expedition.

#### **V-04-9: PrometheusWiki: PROtocols, METHods, Explanations and Updated Standards for Ecological and Environmental Plant Physiology**

Adrienne B. Nicotra<sup>1</sup>, Louis Santiago<sup>2</sup>, Lawren Sack<sup>1</sup>, Will Cornwell<sup>1</sup>; *1. The Australian National University, 2. University of California, Riverside*

Here we introduce PrometheusWiki, a site which seeks to build a new method of communication about methods within the research community. PrometheusWiki is web resource where researchers can upload protocols (and associated images, videos, code, etc) into given topics and post comments and commentary in a constructive and civil manner. PrometheusWiki uniquely combines the open communication of the www with the traditions of peer review that ensure quality and prestige to deliver a useful resource for anyone conducting experiments in the field of ecophysiology. Our site will provide a critical resource for students and experienced researchers alike. Science moves most rapidly when the majority of researchers uses similar methods and can easily repeat and build upon each others' discoveries thus there is a strong need for standardizing in ecological and environmental plant physiology. Traditionally information about protocols has been communicated either through conventional scientific peer-reviewed publications, which are slow and formal, or through word-of-mouth interactions and protocol sharing between specific lab-groups, which is inefficient in what is now a global field. The goal of PrometheusWiki will be to combine fast and informal wiki-based interactions with selected elements of traditional scientific publishing, to provide editorial review and a high quality resource. This wiki introduces the 'gold leaf protocol' editorial process to quickly and efficiently move the field towards best practices and standardized measurements in areas where community consensus is possible and desirable. The development of these protocols will combine the best of wiki open-access editing with limited editorial oversight. The site aims to engage established professionals in the field in debate and discussion of methods, while also providing an important resource to newcomers to the field. PrometheusWiki launches in July 2010.

**V-04-10: The Angiosperm Phylogeny Website: Mark Two**

Amy E. Zanne<sup>1</sup>, Peter F. Stevens<sup>1</sup>, Campbell O. Webb<sup>2</sup>; 1. *University of Missouri – St. Louis*. 2. *Arnold Arboretum, Harvard University*

We need tools to keep abreast of the rapid development of hypotheses for evolutionary relationships of seed plants to better integrate them with work in other fields (e.g., conservation, ecology). The Angiosperm Phylogeny Website (<http://www.mobot.org/MOBOT/research/APweb/>) allows researchers in systematics, ecology, and other disciplines convenient access to current and past literature on their plant groups, provides a novel synthesis of ideas, and is an educational tool for teachers and students alike. Importantly, it helps biologists across disciplines to communicate, as it is readily accessible, frequently updated, and uses a consistent terminology. We aim to make the information in APWeb more readily available to researchers for direct querying so that they can answer questions dependent on the hierarchically-structured information provided there. This entails conversion of the site from Hypertext Mark-up Language to Extensible Markup Language, which will allow data in the site to be automatically parsed by the user. Important new tools will include a complete generic synonymy for flowering plants that will depend on feedback and updating by the botanical community at large; this will greatly enhance communication among botanists of all persuasions.

**Cocoa agroforestry: opportunities and challenges for tropical conservation (#07)**

(July 23 am; Jauk)

Organized by: **Goetz Schroth, Jacques Delabie, Deborah Faria**

*The conservation of globally important biodiversity and ecosystem services in the tropics cannot rely on protected areas alone. In the face of a growing human population and increasing demands on tropical resources, the role of agro-ecosystems and agricultural landscapes as habitat of native plant and animal species (including rare and endemic ones) and provider of ecosystem services such as carbon sequestration, water regulation, pest and disease control, seed dispersal and soil fertility regeneration are increasingly recognized. At the same time, it is becoming clear that the intensification of tropical land use poses threats but also offers opportunities to the conservation and restoration of these landscape functions and services. This symposium focuses on a tree crop – cocoa – that is remarkable by being at the basis of some of the most biodiverse and forest-like agricultural systems and landscapes in the tropics. However, the biophysical, socioeconomic and technological contexts under which cocoa is grown in its major production regions differ widely, and so do the interactions between the crop and its natural environment. While cocoa agroforestry systems have been recognized as key building blocks of conservation landscapes in some regions, unsustainable production practices put pressure on natural ecosystems in others. This symposium brings together studies of biodiversity and environmental services in cocoa production landscapes in Latin America, Africa and Asia, combining an overview of the state of knowledge and recent research progress. Cross-cutting topics will include the linkages between native biodiversity and ecosystem services in cocoa landscapes; the identification of the factors and conditions that make cocoa production systems positive contributors to biodiversity and ecosystem conservation; and the opportunities for cross-regional learning and exchange of experiences in the pursuit of sustainable livelihoods and ecosystem conservation in tropical land use.*

**V-07-1: Cocoa Agroforestry, Biodiversity and Ecosystem Services – Challenges and Opportunities (Introduction to the Symposium)**

Goetz Schroth; *Mars Incorporated*

This short presentation provides an introduction and overview of the symposium. It emphasizes the role of agricultural ecosystems in general and cocoa agroforestry systems in particular, for the conservation of biodiversity and ecosystem services in human dominated landscapes, including major cocoa production regions such as the Atlantic Forest of Brazil, West Africa, and large parts of Indonesia. Some presentations in this symposium will highlight the extraordinary biodiversity that has been sustained up to now in landscape mosaics characterized by a mixture of cocoa agroforests and forest remnants in parts of these areas. The recent interest in the ecosystem services of agricultural landscapes further emphasizes the importance of traditional agroforestry systems with their high carbon stocks and relatively intact biological communities. While recognizing the positive contribution of cocoa agroforestry systems to the conservation of natural resources in many tropical landscapes, it must not be forgotten that the expansion and periodic shifts of cocoa farming have been a driver of deforestation in the past, and in some places continue to be a threat to natural ecosystems unless more sustainable forms of cocoa farming are adopted. On the other hand, the intensification of cocoa farming, which is a necessity given the low incomes of cocoa farmers in many regions, is in itself a potential threat to the biodiversity and ecosystem services of these agroecosystems, unless it is pursued with the objective of maintaining these services in mind. Integrated natural resource management strategies are therefore paramount, and the prospects of diversifying the incomes of cocoa farmers through timber or non-timber products, carbon trading or other forms of environmental service payments as part of such strategies are critically evaluated in some presentations. Following the presentations, there will be time for discussion.

#### **V-07-2: Biodiversity and Associated Ecosystem Services in Cacao Agroforestry Landscapes**

Teja Tschardtke; *Agroecology, University of Goettingen, Germany*

Agricultural intensification at local and landscape scales reduces ecological resilience of land-use systems and increase their vulnerability, whereas paradoxically, environmental change and climate extremes call for a higher response capacity than ever before. In many tropical rural landscapes, agroforestry systems are among the few forested habitats left. Rural adaptation strategies to environmental change include maintenance of shade in agroforestry to enhance rural livelihood, biodiversity conservation, carbon sequestration, biological pest control and to mitigate changing temperature and precipitation. However, conversion of shaded to unshaded systems to increase short-term income levels is common practice in many parts of the world. The ephemeral nature of shade in some cacao agroforestry systems, which is needed for young but not older cacao trees, is a great environmental drawback and different to the situation in coffee. Cacao boom-and-bust cycles are due to abandonment of old sun cacao in favor of thinning new forest sites to start again with young shaded cacao. Recommendations for sustainable management include pruning, but not removing shade trees, a diverse layer of shade trees, avoiding pesticides and keeping natural forest close to agroforests, accompanied by training and incentives for farmers to keep and adequately manage shade.

#### **V-07-3: Endemic Toads Control Invasive Ants in Cacao Agroforestry – Implications for Amphibian and Reptile Diversity?**

Thomas C. Wanger, Arno C. Wielgoss, Motzke; *University of Adelaide, Australia*

Interactions between native and invasive species can impact crop production. Invasive ant species, for example, substantially reduce native ant diversity with a potential impact on cacao diseases and thereby, cacao yield. In Indonesia (on the island of Sulawesi), the third largest cacao producer worldwide, we found that a predatory endemic toad (*Ingerophrynus celebensis*) controls invasive ant (*Anoplolepis gracilipes*) abundance, and affects native ant diversity. As ant diversity is known to affect insect mediated cacao pests, toad predation on this ant may help to prevent crop failure. Ironically, amphibians but also reptiles are globally threatened vertebrates and are strongly affected from land-use change of cacao plantations in Sulawesi. Suitable cacao plantation management is crucial to maintain free services maintained by herpetological diversity.



**V-07-4: Disentangling the Multiple Effects of Dominant Ants in Indonesian Cacao Plantations**Arno C. Wielgoss, D. Buchori Clough, B. Fiala, T. Tscharncke; *1. Agroecology, University Göttingen*

With our a large scale study in cocoa plantations at the margins of the Lore-Lindu National Park (Central Sulawesi, Indonesia), we give an example how single ant species ants can have a major impact on pests and diseases in tropical agroforestry and their entire ecosystem. The study plots differed in intensity of management, density and diversity of shade trees and distance to the nearest rainforest. We examined the abundances and interspecific interactions of ground and tree dwelling ants using standardised baits and tested for possible effects of ant species, environmental variables and management on pests and diseases of cocoa. 63% of the 440 test trees and 81% of the plots were ecologically dominated by the same ant species of the genus *Philidris*. This is the first time a *Philidris* species is reported to be highly dominant in a region. We show that this ant species acts as an effective vector of the pathogenic fungus *Phytophthora palmivora*. If *Philidris* is present the overall ant species richness declines sharply, which has an effect on the predatory pressure on the major pests of cocoa in SE-Asia, the lepidopteran *Conopomorpha cramerella* and the mirid *Helopeltis sulawesii*. These promising correlation results animated us to conduct a long term experiment in which we influence the local ant fauna (introduction and exclusion of ants species) of cacao plantations for three years and record possible effect on the cacao pest and diseases. The focus of this PhD-study are the Black Cacao Ant (*Dolichoderus thoracicus*) and *Philidris* sp.. Herbivore and spider surveys will complete the picture.

**V-07-5: Ecosystem Services from Birds in Cacao Agroforests and Natural Forests of Cameroon**Thomas V. Dietsch, 1, Dennis Sonwa2, Tom Smith1, Stephan Wiese1; *1. Earthwatch Institute, 2. CiFor*

The cocoa agroforests of southern Cameroon are known for their tree diversity and are seen as a potential model for sustainable cocoa production systems across West Africa. There is an interest in identifying the ecosystem services provided by biodiversity in these agroforests. This study sought to understand which birds are ecologically important in cacao agroecosystems. To assess the conservation value of Cameroon cacao agroforests, we used mist-netting and area searches at the farm level (~1 ha) to survey birds found in 7 cacao-producing villages (4 farms per village, 28 total). We found that Cameroon cacao agroforests support a high diversity of birds (150 observed species with 56 species in the cacao layer). This is not surprising considering the high diversity of trees observed in these farms (112 species). A high proportion of the birds found in the cacao vegetative layer were insectivorous and could help reduce pest outbreaks for farmers, providing an incentive for farmers to have an interest in their birds. In addition, many of the shade trees found in these cacao agroforests were also observed being used by hornbills in previous research in the nearby Dja Reserve. Many of these trees also provide economic value for farmers creating the possibility of a “win-win” scenario where farmer economic interests are in line with conservation. This research demonstrates the potential value of cacao agroforests for biodiversity conservation.

**V-07-6: Conservation of Rare and Endemic Fauna in the Cocoa Landscape Mosaic of Southern Bahia, Brazil**Deborah Faria1, Rudi R. Laps2, Leonardo C. Oliveira1, Cassiano Gato1, Brian Campbell; *1. Universidade Estadual de Santa Cruz, 2. Universidade Regional de Blumenau*

Traditional shade cacao plantations (cabruças) of southern Bahia, Brazil, are recognized as biologically rich habitats, although a critical question for the conservation value attributed to cabruças is whether these host species of conservation concern, such as endemic and rare species. Here we present information from published and on-going studies addressing the ability of cabruças to host species of birds and mammals that are endemic to the Atlantic rainforest biome. From 20 bird species,

15 species (85%) were recorded in cabruças, including 4 rare species of which 2 have only been recorded in cabruças (*Acrobatornis fonsecai*, *Herpsilochmus pileatus*), while five species that are notably abundant in forests have rarely been reported in cabruças (*Colaptes melanochloros*; *Drymophila squamata*, *Hemitriccus nidipendulus*, *Myrmotherula urosticta*, *Xipholena atropurpurea*). Among the 5 bird species not recorded in cabruças, 2 are represented only by 1 or 2 records in the entire region which precludes a reliable conclusion regarding their habitat use. The 6 endemic mammal species - all included in the IUCN red list - have all been recorded in cabruças, although the suitability of this habitat seems to vary among species. The yellow-breasted capuchin monkey (*Cebus xanthosternos*) and the thin-spined porcupine (*Chaetomys subspinosus*) tend to avoid these shade plantations. However, a growing body of evidence has shown that cabruças may be suitable for the maned three-toed sloth (*Bradypus torquatus*), the golden-headed lion tamarin (*Leontopithecus chrysomelas*), the masked titi monkey (*Callicebus melanochir*) and the painted tree rat (*Callistomys pictus*) for which cabruças comprise the main habitat type remaining. Although local management and landscape features influence the suitability of cabruças to host the assemblages of endemic birds and mammals, it is clear that the agricultural matrix provided by shade plantations does matter for the conservation of these target species.

#### **V-07-7: Conservation of Native Invertebrates in Brazilian Cocoa Agroforestry, Implications for Biological Control, Pollination and Soil Resource Cycling**

Jacques H.C. Delabie, Wesley D. Rocha, Fátima Q. Alves, José R.M. Santos, B. Jahyny, P.P. Santos, C.S.F. Mariano, C. Jared, K. Nakayama, A. Vasconcellos; *CEPEC-UESC*

The most important benefits of cocoa agroforestry for conservation are certainly due to its forest-like structure and microclimatic conditions, allowing colonization and development of a range of herbaceous and epiphytic plants, and preserving the forest-like structure and biological cycles of the soil. We present information on how Hymenoptera, termites, mollusks and onychophorans benefit from cocoa agroforestry in Bahia, focusing on the environmental services they provide through their activities in the agroecosystem, such as predation, seed dispersal, soil cycling, scavenging, litter decomposition as well as through their indirect effects on pollination, or by creating resources for other animals. As examples, we present evidence of the importance of shading for the conservation of native invertebrates, i.e. predators or pollinators, essentially when the architecture of shade trees allows establishment of a diversity of epiphytes. We focus also on the management of native gastropods in cabruça plantations, which are important for conservation of other invertebrates that recycle their shell as a shelter after their death. Termite nests, with or without their constructors, arborous, or on the ground, are key structures allowing a range of invertebrates to live in. The cocoa leaf-litter and soil strata provide good living conditions for a range of invertebrates, in which ecosystem engineers (ants and termites) are especially noticeable, but where environmentally fragile organisms, such as onychophorans, are also well preserved.

#### **V-07-8: The Influence of the Structure of Cocoa-based Agroforestry Systems on Biodiversity Conservation in Talamanca, Costa Rica**

Olivier Deheuvels<sup>1</sup>, Grimaldo Soto Quiroga<sup>2</sup>, Marcos Decker<sup>1</sup>, Julio C. Bravo<sup>1</sup>, Rolando Cerda, Guillaume Xavier-Rousseau, Eduardo Somarriba and Eric Malezieux; *1. CIRAD, 2. CATIE*

In the humid tropics, the rapid rate of deforestation has resulted in a race to protect remaining forest patches that are increasingly isolated within a rapidly expanding agricultural matrix. In these landscapes, a significant area consists of complex agroforestry systems with high structural and functional plant diversity, providing critical resources for biodiversity conservation, such as food and habitat. Although not a substitute for natural forests, these anthropogenic habitats are gaining increasing conservation value as deforestation progresses. Shaded tree crops, such as cocoa, provide habitats for numerous forest dependent species of high conservation value and may play a largely undocumented role in global biodiversity conservation. This conservation value is greatly influenced by their botanical composition and structural complexity. We characterized this complexity in a

sample of 36 contrasting cocoa agroforests and 3 forest fragments selected in the south east of Costa Rica. These agroforestry systems were chosen to maximize contrasts in terms of 1) altitude, 2) landscape context, 3) topographical situation, 4) vegetation structure of the cocoa agroforest, 5) soil quality and 6) management intensity. Biodiversity was assessed by : 1) amphibians and reptiles, 2) soil and litter invertebrates, 3) small mammals, 4) cocoa pollinators (Diptera) and 5) epiphytes sampled on cocoa and associated trees. Results show that the botanical structure and composition of the cocoa agroforests has an effect on species and functional diversity. In all taxonomic groups, we found that diversity was lower in cocoa agroforests than in forest remnants. However, the functional diversity for most of the groups in cocoa agroforests was not different from nearby primary forest patches, suggesting that ecosystem functions are conserved in these systems. Cocoa agroforests could finally be presented on a gradient of structure ranging from low to high functional biodiversity.

## Conservation knowledge for all (#08)

(July 20 am; Wantilan rear)

Organized by: Navjot S. Sodhi and Paul R. Ehrlich

*The global biodiversity crisis must be dealt with rapidly; what can be saved in the developing world will require an educated constituency both in the developing and developed world. Sadly, developing world conservation scientists have found it difficult to access an authoritative textbook, which is ironic since it is these countries where the potential benefits of knowledge application are greatest. We will present on a project that will provide free and open access to cutting-edge but basic conservation science textbook to developing as well as developed country inhabitants. The project represents an effort that the conservation community has deemed worthy of support by donations of time and effort.*

### V-08-1: Extinctions and the Practice of Preventing Them

Stuart L. Pimm, Clinton N. Jenkins; *Duke University*

We explore why extinctions are the critical issue for conservation science. Extinctions are irreversible, unlike many other environmental threats that we can reverse. Current and recent rates of extinction are 100 times faster than the background rate, while future rates may be 1000 times faster. Species most likely to face extinction are rare; rare either because they have very small geographic ranges or have a low population density with a larger range. Small-ranged terrestrial vertebrate species tend to be concentrated in a few areas that often do not hold the greatest number of species. Similar patterns apply to plants and many marine groups. Extinctions occur most often when human impacts collide with the places having many rare species. While habitat loss is the leading cause of extinctions, global warming is expected to cause extinctions that are additive to those caused by habitat loss.

### V-08-2: Synergies between Fire and Global Environmental Change, and the Future of the Tropical Savanna Biome

Brett P. Murphy, David M.J.S. Bowman; *University of Tasmania*

Tropical savannas cover about 20% of the earth's land surface and support about 20% of the global population, mostly in the developing world. The biome is unusual because, in many areas of moderate to high rainfall, it is widely believed to represent one of two alternate ecosystem states, the other being closed forest, with transitions between the two states mediated by fire, rather than climate. The ability of mesic savannas to form closed canopy forests in the absence of disturbance has led to them to be considered 'unstable'. Many researchers have suggested that elevated atmospheric CO<sub>2</sub> concentration ([CO<sub>2</sub>]<sub>a</sub>), will strongly favour trees over grasses in savannas, allowing them to escape the 'fire trap', and therefore promote savanna thickening and conversion to closed forest. In contrast,

we could expect higher temperatures and increased intensity of El Niño drought to promote frequent and intense savanna and forest fires. Hence, elevated [CO<sub>2</sub>]a and climate change may be acting in opposing directions with respect to savanna extent, leaving us to ponder the question of whether savannas will expand or contract in the future. Certainly for the Amazon, large scale ‘savannisation’ has been predicted by some, due to synergies between climate change (local and global), forest fragmentation and fire. Is this idea feasible for other tropical regions, and will rising [CO<sub>2</sub>]a counteract the effect? I will explore these issues and discuss ways that fire management can be used to maintain biodiversity in savanna landscapes.

### **V-08-3: Conservation in Human-modified Landscapes: Sidestepping the Tradeoffs of Oil Palm Expansion**

Lian Pin Koh<sup>1</sup>, Toby A. Gardner<sup>2</sup>, Jaboury Ghazoul<sup>1</sup>; *1. ETH Zurich, 2. University of Cambridge*

Growing global demands for food, energy and other commodities continue to turn pristine ecosystems into human-modified landscapes, especially in the developing tropics, where nations too often succumb to the financial lure to ramp up production. A case in point is the meteoric expansion of oil-palm agriculture in Southeast Asia and other tropical regions. Despite environmental and social concerns, it is difficult to deny that oil palm has contributed greatly to regional, national, and local economies. This trend is set to continue as Indonesia has indicated the potential for a near doubling of oil-palm cultivated land over the next 10 years. Oil palm may well improve the economies of rural communities, but can it really do so without incurring substantial environmental costs in terms of loss of forest cover and associated biodiversity? Additionally, can oil-palm expansion proceed without compromising the other priorities of meeting domestic and global demands for food (Indonesia is the world’s third largest producer of rice), or curtailing carbon emissions from land-use change and forestry (Indonesia is the world’s second largest emitter)? We modeled the outcomes of alternative development scenarios, and show that every single-priority scenario had substantial tradeoffs associated with other priorities. The optimal solution was a hybrid approach wherein expansion targeted degraded and agricultural lands that are most productive for oil palm, least suitable for food cultivation and contain the lowest carbon stocks. This approach avoided any loss in forest or biodiversity, and substantially ameliorated the impacts of oil-palm expansion on carbon stocks and food production capacity. Our results suggest that it is possible to pursue a course of development that minimizes and sidesteps the tradeoffs of oil palm expansion in Indonesia.

### **V-08-4: The Conservation Biologist’s Toolbox – Principles for the Design and Analysis of Conservation Studies**

Corey J.A. Bradshaw, Barry W. Brook; *University of Adelaide*

Conservation biology is a highly multidisciplinary science employing many different methods. We focus primarily on ecological methods and experimental design. It is impossible to census all species in an ecosystem, so many different measures exist to compare biodiversity: including inter alia species richness, Simpson’s diversity, Shannon’s index and Brouillin’s index. The scale of biodiversity patterns is important to consider for comparisons: alpha, beta and gamma diversity. Often surrogate species are required to simplify biodiversity assessments. Many similarity, dissimilarity, clustering, and multivariate techniques are available to compare biodiversity indices among sites. Conservation biology rarely uses completely manipulative experimental designs, with mensurative and observational studies dominating. Two main statistical paradigms exist for comparing biodiversity: null hypothesis testing and multiple working hypotheses – the latter paradigm is more consistent with the constraints typical of conservation data and so should be invoked when possible. Bayesian inferential methods generally provide more certainty when prior data exist. Large sample sizes, appropriate replication and randomisation are cornerstone concepts in all conservation experiments. Simple relative abundance time series can be used to infer more complex ecological mechanisms that permit the estimation of extinction risk, population trends, and intrinsic feedbacks. The risk of a species going extinct or becoming invasive can be predicted using cross-taxonomic

comparisons of life history traits. Population viability analyses are essential tools to estimate extinction risk: count-based, demographic, metapopulation and genetic. Many tools exist to examine how genetics affects extinction risk, of which perhaps the measurement of inbreeding depression, gene flow among populations, and the loss of genetic diversity with habitat degradation are the most important.

#### **V-08-5: Promoting Biodiversity Conservation Research by Undergraduate Thesis Students in the Philippines**

Nina R. Ingle<sup>1</sup>, Jodi L. Sedlock<sup>2</sup>, Lisa Paguntalan<sup>1</sup>; *1. Davao City, Philippines, 2. Lawrence University*

The Philippines is a geographically diverse global biodiversity hotspot; sound conservation management requires assessments of local conditions within a geographical context. But there are very few field ecologists to conduct the needed research and communicate results to local communities. A largely untapped resource is undergraduate students, particularly at rural state colleges. Students are required to write an individual or group thesis, but few choose biodiversity topics and basic design flaws are common. Impediments include a lack of familiarity with biodiversity-related research, difficulties obtaining technical advice and scientific literature, a lack of equipment, and fieldwork costs. We will address these difficulties with a program to support conservation research on Philippine bats, which are represented by over 76 species and provide important ecological services in pollination, seed dispersal, and pest control. Having low reproductive rates they are particularly vulnerable to disturbance, especially colonially roosting cave bats and flying foxes. A team of bat biologists will identify priority questions, key references, and possible methods appropriate for students and available equipment. Student-adviser teams that join the program would have access to a webpage with references and discussion topics, communication with bat experts, and even YouTube videos. Collaborations are sought, e.g., with bat researchers interested in geographical comparisons, undergraduates in developed countries with more access to literature to put questions and results in context. With an endowment fund we would fund 5-10 student research projects a year selected to maximize conservation benefits. The shared questions and methodology would enable comparisons among sites and a broader understanding of conservation issues facing bats while engaging undergraduate students especially in key biodiversity sites in local environmental issues.

#### **V-08-6: Communication for Conservation: Cross-sectoral Outreach Strategies to Mobilize Rural Communities in Amazonia**

Patricia Shanley, Fatima Christina da Silva, Murilo Serra, Terry Sunderland; *Woods & Wayside International*

In spite of technological advances, the ‘information explosion’ has often missed people living in remote areas with high conservation value. Given that local people can play a critical role in conservation, what means to engage, inform and collaborate with rural communities may be effective? Between 2003 and 2009, Brazil’s Federal government created 70 conservation units in Amazonia encompassing 26.4 million hectares. This “pro-poor, pro-forest” achievement has roots in rural education with underpinnings in Brazil’s highly developed social movement. Brazil’s social movement has worked to fortify the struggle for human rights and health care while advancing a sustainable forest use agenda. The dovetailing of social and natural resource interests, bolstered by strong national scientific capacity, paved the way for progressive policy changes in support of forest-reliant communities. Although substantial challenges remain, lessons can be learned from the communication and outreach strategies employed by civil society organizations to inform and mobilize rural communities. A case study of the National Council of Rubber Tappers (CNS) working with the Ministry of Health is used to highlight the how innovative partnerships across sectors could hold lessons for other regions.

## Coral reefs and climate change (#09)

(July 21 pm; Garuda)

Organized by: **David Smith and Stuart Campbell**

*Coral reefs are amongst the most productive and diverse marine ecosystems and support more than ½ billion people worldwide. They provide many key ecosystem services and support the economy of many maritime countries. Despite being physically robust systems they are susceptible to environmental change as demonstrated by the devastating 1998 El Nino when, primarily, elevated seawater temperatures resulted in the mortality of 16 % of the worlds coral reefs. The 2004 Tsunami and numerous high-energy storms have highlighted the physical fragility of many coral species. Moreover research in to ocean acidification suggests that the architecture of reef building corals and thus the physical as well as the biological integrity of tropical reef systems will be adversely affected in the very near future. This symposium will focus on these and other key climate change issues, will include research focused on likely taxonomic and physiological responses to environmental change, and will also explore the relationship between physical and biological complexity (architecture) and reef functionality. Many studies suggest that the reliance of reef systems is dependent on the diversity, integrity and general health of reef systems. Active management of reef systems, that capitalize on our knowledge of species susceptibility and natural resilience, provides our best chance to preserve future reefs. Consequently the second part of this symposium will focus on possible ways to mitigate against climate change by examining conservation and management strategies whilst highlighting international efforts aimed at enhancing coral reef resilience to multiple threats. Presentations will describe the efforts to capitalise on natural reef resilience and will discuss how marine protected areas are being designed and established so that as far as possible, coral reefs will stand the best chance of retaining functionality, productivity and high biodiversity and therefore continue to support the socio-economic welfare of many millions of people.*

### V-09-1: Mechanisms of coral bleaching

David J. Smith<sup>1</sup>, Sebastian Hennige<sup>2</sup>, Jamaluddin Jompa<sup>3</sup>, Tracy Lawson<sup>1</sup>, David J. Suggett<sup>1</sup>; 1. *The Coral Reef Research Unit, University of Essex, UK*, 2. *College of Earth, Ocean, and Environment, University of Delaware, Newark, USA*, 3. *University of Hasanuddin, Makassar, Indonesia*.

Coral bleaching is a major concern to researchers, conservations and the general public. To date, and not surprisingly, much of the high profile attention concerning “bleaching episodes” has coincided with major environmental anomalies (e.g. El niño events) and for many the term coral bleaching is directly associated with coral mortality (so-called “lethal” bleaching episodes). Whilst this synonymous association has undoubtedly been key in raising public awareness and support for conservation orientated research, it carries unfair representation: non-lethal bleaching is, and always has been, a phenomenon that effectively occurs regularly in nature as corals acclimatize to regular periodic changes in growth environment (days, seasons etc). In addition, corals can exhibit sub-lethal bleaching during extreme environmental conditions but mortality does not result and many coral species can recover once environmental conditions return to the norm. A greater degree of understanding, appreciation and reporting of coral physiological flexibility and species sub-lethal responses to environmental anomalies will no doubt increase our ability to predict reef responses to future anomalies and climate change. However, and again perhaps not surprisingly, much greater emphasis in the scientific, conservation and public media, is given to events that result in mass mortality that although of obvious importance, does represent a missed opportunity for wider

knowledge acquisition. For some species, particularly those with complex architecture, environmental anomalies do cause rapid mortality, and this can turn to the majority depending on frequency and / or extent of the anomalies. However the characteristics of rapid mortality are very different to the generic bleaching response often reported. Rather than the gradual paling of coral tissue, loss of zooxanthellae density but maintenance of the animal host tissue, the acute response causes mass coral tissue loss leaving behind the bare underlying skeleton. Such tissue loss does not enable post anomaly recovery and continuation of the species in any given impacted area is dependent on re-growth of unimpacted colonies (or parts of) and to a greater extent, recruitment mechanisms. Consistent with previous studies, we have termed the most severe (rapid lethal) response as a type-1 and a sub-lethal as a type-2 response and argue that the acute response would be termed Thermal-Induced Rapid Coral Tissue Loss (TI-RCTL) rather than coral bleaching. Importantly the signs and mechanisms of a type-1 and type-2 response differ considerably and during this presentation we will describe bleaching “types” and explore the possible mechanisms. Interestingly our research has shown that a species vulnerability to TI-RCTL can be moderated by environmental growth conditions giving rise to the possibility of ecological refuge sites that may re-seed heavily impacted reefs. During this presentation we will describe the possible mechanisms of TI-RCTL, how environments may regulate sensitivity and explain the next step in our research aimed at enhancing our understanding of the likely response of reef systems to future anomalies and climate change.

#### **V-09-2: Can Current Ocean Acidification Experiments be Used to Help Predict Future Reef Form and Function?**

David John Suggett, Tracy Lawson, Liang Dong, David J Smith; *Coral Reef Research Unit, University of Essex*

Understanding how ocean acidification (OA) shapes future coral community form and function has become a major concern. A rapidly rising number of studies generally demonstrate that OA conditions directly lower coral calcification, and hence reef formation, but also indirectly affect the physiology and behaviour of a variety of reef organism; in turn OA may impact the susceptibility of reef organisms to further stressors. Whilst these investigations have highlighted the alarming potential impact of OA, they have yielded many contradictory results most likely as a result of differences in approach (CO<sub>2</sub>/pH control) and speciation (genotype) of the organisms or communities of interest. Here we discuss how most current OA studies do not (1) have full experimental control of the dissolved inorganic carbon system, and (2) account for the simultaneous impact of additional stressors predicted to accompany changes in pH, notably temperature and light, that are proximal variables controlling growth and physiology and thus will mediate the ultimate response to OA. Such major limitations currently undermine predictions of future reef form and function based on OA experiments. Future OA studies thus need to move towards a more complex (yet systematic) treatment of climatic change. We will introduce a new state-of-the-art system, which provides complete control over seawater CO<sub>2</sub> chemistry, that will be critical a critical tool in improving how ocean acidification conditions are replicated as experiments move towards a much needed change of direction.

#### **V-09-3: Coral Reef Biodiversity and Ecosystem Structure: The Role of Species Composition in Providing Architectural Complexity**

Lorenzo Alvarez-Filip; *Centre for Ecology Evolution and Conservation, University of East Anglia*

Overall cover of reef-building corals is commonly used to describe patterns of change on coral reefs. However, changes in coral cover may not capture changes in habitat complexity, which are fundamental for the health of reef communities. Here we explore how coral composition and diversity influences reef architecture. This is especially important in the Caribbean context, where benthic communities are shifting towards reefs dominated by less complex corals. We use a broad range of sites in Cozumel Island to explore, taxonomically and morphologically, if greater coral species diversity is related to more architecturally complex reefs, whether sites with similar coral community

composition also tend to be similar in terms of architectural complexity, and how the taxonomic and functional attributes of coral dominance influence the coral cover–architectural complexity relationship. Our results indicate that: (i) architectural complexity is positive associated with the number of coral species and morphological groups but negatively or weakly associated with the evenness and taxonomic relatedness of the coral community, (ii) sites with high similarity in coral community composition tend to occur in reefs with very similar architectural complexity, and (iii) the most architecturally complex sites are dominated by few coral species (and morphological groups), which largely explains the differences in architecture among sites. Our findings suggest that low-diversity assemblages of important coral species would facilitate complex reefs in the Caribbean. In order to halt the rates of habitat loss in the Caribbean a major emphasis on facilitating the endurance of healthy populations of these species is required. Finally, our results highlight the importance of considering coral species composition and shifts in coral dominance on Caribbean reefs to understand how changes in these ecosystems will influence the associated biodiversity and environmental services.

#### **V-09-4: Effects of Climate Change and Anthropogenic Disturbance on Tropical Sponge Assemblages**

James J. Bell, Abigail Powell, Jade Berman, Leanne Hepburn, David J. Smith; *Victoria University of Wellington*

Coral reef ecosystems across the world are threatened by a range of human-mediated disturbances and the future effects of climate change. Although changes in some of the dominant reef fauna have already been well-documented in response to these threats, particularly for corals and fish, variability in other groups remain poorly described and understood. Given that sponges fulfil a number of important functional roles on coral reefs, changes in their abundance may have significant ecosystem functioning effects. Our work is focused on elucidating the relative roles of biological and physical factors in driving sponge variability in order to develop a predictive model to understand the future impacts of climate change and anthropogenic disturbance on sponge assemblages. Here we discuss our work on the temporal and spatial variability in the sponge fauna of the Wakatobi National Marine Park, SE Sulawesi, Indonesia. We examined changes in sponge assemblages at three different sites over a 5-year period. We found significant increases in the abundance of sponges, and major changes in assemblage composition over time. These changes correlated with declines in fish populations, but not with coral cover. We compared this level of temporal variability with spatial variability, and found that spatial variability appears to be driven by a mix of biological and physical factors. It is clear from our research so far, and perhaps not unexpectedly, that the factors driving sponge assemblages are complex and interacting. We discuss our progress towards predicting how sponges may respond to future threats of climate change and human disturbances.

#### **V-09-5: Coral Ecosystem Resilience, Conservation and Management on Reefs in the Caribbean and in Indonesia in the Face of Anthropogenic Activities and Climate Change**

M. James C. Crabbe; *University of Bedfordshire*

The coral reef ecosystem forms part of a ‘seascape’ that includes land-based ecosystems such as mangroves and forests, and ideally should form a complete system for conservation and management. Knowledge of factors that are important in reef resilience help us understand how reef ecosystems react following major anthropogenic and environmental disturbances. The North Jamaican fringing reefs have shown some recent resilience to acute disturbances from hurricanes and bleaching, in addition to the recurring chronic stressors of over-fishing and land development. Factors that can improve coral reef resilience in the Caribbean and on Indonesian reefs will be reviewed. Given the threats to reef systems, ecosystem-based management of other direct human-induced stresses on coral reefs, such as over-fishing, destructive fishing, coastal pollution and sedimentation, will be essential for the survival of coral reefs on which we are all dependent. We undertook a capacity-building exercise around Marine Protected Areas (MPAs) in Belize in the Caribbean which involved both local



Non-Governmental Organisation (NGO) community workers and a government fisheries officer, so that community engagement could be directly interfaced with fisheries operations and policy. This was successful, and resulted in collaborations so that MPAs in Southern Belize which were subject to illegal fishing activity will now be monitored and policed. Coral reefs are the most sensitive ecosystems on the planet to climate change, and mitigation of greenhouse gas emission will probably not be enough in the future if reefs ecosystems are to survive. This talk will also review a number of geoengineering options, and their potential influence on coral reefs. Longwave carbon dioxide removal techniques address the root cause of climate change, rising CO<sub>2</sub> concentrations, they have relatively low uncertainties and risks. They are worthy of further research and potential implementation, particularly carbon capture.

#### **V-09-6: Resilience of Marine Protected Areas in Indonesia**

Stuart J. Campbell, Rizya L. Ardiwijaya, Tasrif Kartawijaya, Sinta T. Pardede; *Wildlife Conservation Society*

Climate change is considered a long-term threat to coral reefs, with some future change inevitable despite mitigation efforts. The design of marine protected areas and their ongoing adaptive management is likely to require that areas of refuge for resilient reefs and communities are identified and management needs supported to ensure these can potentially withstand climate change impacts over time. Managers must therefore focus on supporting the natural resilience of reefs, requiring that resilient reefs and reef regions be identified. We used a modified version of a framework for assessing resilience and applied the framework to identify target management responses to climate change in 5 marine protected areas in Indonesia. The framework used generates a resilience score for a site based on the evaluation of 25 differentially weighted indicators known or thought to confer resilience to coral reefs and human populations. Scores are summed and sites within a region are ranked in terms of: 1) their resilience relative to the other sites being assessed, and 2) the extent to which managers can influence their resilience. The framework was applied to 5 sites in Sumatra, Java, Bali, Halmahera and West Papua across sites with past differences in disturbance and recovery from thermal stress. Resilience and 'management influence potential' were both found to vary widely within and among sites. Such information can inform site selection for the staged implementation of resilience-based management strategies. The assessment framework represents a step towards making the concept of resilience operational to reef managers and conservationists. Also, it is customisable, easy to teach and implement and effective in building support among local communities and stakeholders for management responses to climate change.

#### **V-09-7: Can Coral Industries Play a Role in the Future Conservation of Coral Reefs with a Changing World**

Philippa J. Mansell, Dr. David J. Suggett, Dr. David J. Smith; *Coral Reef Research Unit, University of Essex*

Coral reef products are heavily utilised by the aquaria trade; while this industry expands our natural reef systems are degrading. Literary examples identify poor non-sustainable exploitation practices whilst other research and initiatives point to good practices and commendable procedures that establish strict guidelines. This presentation will focus on trends within the trade and ask the question - Can reef based industries play a role in reef conservation? Corals within the aquaria trade come from wild type collections, in situ farming or through in-country husbandry. As industries knowledge of environmental regulation of growth expands so do the regularity of these techniques. Opportunities exist to utilise collections from the wild, through coral harvesting or mariculture providing strong linkage with direct conservation actions and reducing the pressure on the wild stocks but knowledge of species sensitivity and resilience needs to be incorporated if they are to have a conservation value in a changing world. Corals held in the aquarium trade are diverse, with over 2000 species (reef building, non-reef building and soft corals) being kept; one of the key questions raised within this presentation will be whether or not these species represent a control stock (or genetic bank) of coral

that can be used to preserve reefs of the future. The presentation will provide insight into the aquaria trade, opportunities for sustainable exploitation coupled with conservation action, particularly areas threatened by anthropogenic stressors and / or climate change whilst also raising questions as to the conservation value of corals held within industry and private stock. Can artificially held corals now represent a viable option for restocking reefs of the future? What problems will such activities bring about and should researchers and conservationist engage more with industry to enhance the impact of research activity and the conservation advantages of an expanding industry?

#### **V-09-8: Designing a Resilient Network of Marine Protected Areas (MPAs) for Coastal and Pelagic Habitats in the Lesser Sunda Ecoregion, Eastern Indonesia**

Joanne R. Wilson, Johannes Subijanto, Arief Darmawan, Alison Green, Benjamin Kahn; *The Nature Conservancy*

The Lesser Sunda Ecoregion lies at the southern end of the Coral Triangle and encompasses the chain of islands and surrounding waters from Bali to East Timor - an area of 325,000 km<sup>2</sup>. This region supports extremely high coral reef biodiversity which may be more resilient to elevated sea surface temperatures associated with global warming due to the unique oceanographic conditions of this region. Extremely strong and complex currents and strong local and seasonal upwellings cool surface waters to as low as 16°C. These upwellings also drive the rich productivity of the region which is an important migratory corridor for cetaceans, and supports one of the world's largest yellow fin tuna fisheries. Although the islands of the Lesser Sunda are sparsely populated, the ecosystem and sustainable fisheries are threatened by destructive, illegal and overfishing, mining and other large industries. In collaboration with the Government of Indonesia, a network of MPAs has been identified for the Lesser Sunda Ecoregion to help address these threats and improve the resilience of the region to the threat of climate change. A number of MPAs already exist in this region and additional areas for consideration of new MPAs were identified through a combination of 1) assessment of existing MPAs, 2) examination of over 60 data sets encompassing biological, oceanographic and socio-economic factors, 3) analysis using a decision support tool 'MARXAN', and importantly 4) inclusion of stakeholder and expert input. The design of this MPA network is based on principles of resilience including representation of 20-30% of coastal habitats and considerations of sustainable fisheries. An innovative feature of this MPA network is the identification of areas for the development of 'deep sea' MPAs to protect migratory corridors, persistent pelagic habitats and sustainable pelagic fisheries. The MPA has been designed to recognize the important interaction between these coastal and oceanic ecosystems.

#### **V-09-9: Applying Multiple Design Criteria Including Reef Resilience to Zoning the Kofiau Marine Protected Area in Raja Ampat, Indonesia**

Sangeeta Mangubhai, Andreas Muljadi, Joanne R. Wilson; *The Nature Conservancy*

Raja Ampat islands are located on the northwest tip of West Papua in Eastern Indonesia and encompasses over 4 million hectares of land and sea at the epicenter of the Coral Triangle. A total of 537 scleractinian corals (75% of the world's total) and 1320 reef fish species have been recorded in Raja Ampat, making it one of the most biologically diverse reef systems in the world. A network of six marine protected areas (MPAs) was declared in 2007 covering over 1 million hectares of marine waters and small islands. Currently zoning plans are being developed for each of these MPAs. This paper presents how multiple design criteria including reef resilience were used to develop a zoning plan for Kofiau MPA in southern Raja Ampat to address the impacts climate change, and incorporate social and economic needs and benefits to local communities. At Kofiau MPA, data collected on a wide range of biological, social and economic factors were analyzed using the decision-support software tool 'Marxan' to help identify and prioritize areas of high conservation value for inclusion in no-take zones. Reef resilience principles including size, spacing, representation and replication ('risk spreading'), critical habitats and ecosystem functions were applied in the final design to account for current threats and future climate change impacts. The results of reef resilience assessments in April

2009 at 32 sites examined coral recruitment, size class structure for 18 common corals, relative abundances of 60 genera of corals, and coral condition (e.g. disease, predation, bleaching) were also used to inform the final design.

### **V-09-10: The Effect of Marine Protected Area Establishment on Coral Reef Condition in Eastern Indonesia**

Ma'ruf Kasim; *Haluoleo University*

The study was conducted in 39 Marine Protected Areas within the Province of Southeast Sulawesi, Eastern Indonesia. In particular, the research would look at community participation in creating marine protected area (MPA) to preserve healthy fisheries around coral reef locations. To clarify coral reef condition in the marine protected areas, survey and monitoring of coral reef were conducted in all stations of this region. From 2007, local people in this region have started to create marine protected areas using community participation in their village marine areas. At the village level, MPAs were created through community participation. In 2007, our research on MPA in eastern Indonesia shows 30.16 % of live coral, 40 % of dead coral, 17.23% of other fauna, 10.46 % of abiotic (sands and stones), and 2.15 % of macro algae covered the entire coral reef in the region observed. In 2008, the coverage of live coral reef has increased to 33.3 %, dead coral has become 36 %, other fauna has reached 6.6 %, abiotic (sands and stones) has turned into 19.5 % and algae has grown to be 4.9 %. These figures describe that within 1 year, community involvement through this program has successfully increased 3.14% of live coral, 4% decreasing of dead coral, 10.6 % decreasing of other fauna, 9 % increasing of abiotic (sands and stones) and 2.8% increasing of algae. Moreover, most of coral fishes, particularly those of target fish group (economic fish) have increased during 2007-2009.

## **Governance and the conservation of tropical nature (#10)**

**(July 20 pm; Wantilan rear)**

Organized by: **William F. Laurance**

*Corruption afflicts all societies. One need look no further than the financial scandals that engulfed US-based corporations such as Enron and WorldCom, where company executives defrauded investors out of billions of dollars, to be reminded that this is so.*

*However, some societies suffer more from corruption than do others. Political corruption, where individuals abuse public office for financial or other private gain, is unfortunately pervasive in many developing nations. This often occurs because government officials in such countries are poorly paid, increasing the likelihood of bribery, particularly when officials control valuable natural resources, such as timber, oil, land, minerals, and gemstones. Other societal phenomena that are relatively common in developing countries, such as weak political institutions, limited checks and balances among different government agencies, and nepotism and political patronage, can also promote corruption. Given that developing nations usually rely heavily on the exploitation of natural resources for revenue and employment, corruption has a corrosive effect on governments and can seriously impede economic and social development.*

*Although corruption can reduce environmental pressures by hindering development activity, it is usually perceived as a threat to sustainable development. Corruption can have a significant impact on nature conservation by promoting overexploitation of forests, wildlife, fisheries and other resources, and by reducing the effectiveness of conservation programs. Many ecosystems, such as species-rich tropical forests and coral reefs, which are largely confined to developing countries, are highly vulnerable.*

*This symposium will bring together a range of experts to discuss the challenges posed by corruption and weak governance for the conservation of tropical ecosystems and biodiversity, and to highlight strategies to combat them. There will be some focus on the Asia-Pacific region but the symposium will be pantropical in scope. A range of perspectives will be presented, but the broad goal will be to provide a relatively balanced perspective on this pervasive challenge to tropical conservation, and to explore potential solutions and ongoing policy initiatives.*

### **V-10-1: Governance and the Fate of Forests in New Guinea**

William F. Laurance; *School of Marine and Tropical Biology, James Cook University*

The island of New Guinea, comprised by the Indonesian province of Papua and the nation of Papua New Guinea, is undergoing explosive environmental changes. Governance issues lie at the heart of much that is occurring. On the one hand, weak governance is apparent in the timber, mining, and some other industries. Available evidence suggests that bribery of government officials and local leaders in various guises is widespread, often instigated by aggressive Malaysian timber companies (particularly the mega-corporation Rimbunan Hijau) or Chinese timber importers. As a result, timber operations rarely comply with existing environmental guidelines and illegal timber exports (avoiding payment of government timber royalties or export duties) occur with some regularity. Indigenous landowners and forest ecosystems frequently suffer, with native forests increasingly being converted after logging into large-scale oil palm plantations. On the other hand, the nation of Papua New Guinea has become an international leader in efforts to promote REDD (reducing deforestation and forest degradation) via carbon-trading, which holds some promise to improve sustainability in the forestry sector. I will discuss some of the initiatives designed to reduce illegal logging and other illicit activities affecting biodiversity in New Guinea. A key part of the problem, I will assert, is that government bodies and timber companies often refuse to acknowledge the scale and pervasiveness of corruption in the forestry sector.

### **V-10-2: How to Build an Effective System to Address Illegal Logging in Southeast Asia**

Song Liu, Chuck Cannon; *Xishuangbanna Tropical Botanical Garden*

Illegal logging practise is rampant in Southeast Asia which, brings large sums of filthy lucre to companys or conglomerates, while degrades the forest quality and benefit almost trival to the local citizens. Mutual memorandums had already signed up around Southeast Asia to path the way for combatting deforestation and the lost of revenue. Yet, we don't witness the dwindle of illegal logging activity but more tricky means of illeagl logging practise which is harder to discern. Thus an effective system that able to deal with that problem seems to be the first priority for countries of Southeast Asia to prevent illegal logging. Latest technologies, well-design system and cooperations between governments could employed into a modular programme which address that problem.

### **V-10-3: Wildlife Trade in Indonesia: Identification of Areas Vulnerable to Smuggling**

Ani Mardiasuti; *Bogor Agricultural University*

In the international market, Indonesia has been known to be a big producer for various wildlife species and their products. Major destination countries are East Asia countries, Europe, and United States. Past experience showed that some species could be driven to extinction due to illegal trade and smuggling. A study was aimed to identify areas vulnerable to smuggling. Visits to suspected areas and series of interviews to relevant persons were conducted during 2009. The vulnerable areas can be identified as two red triangle areas (Medan-Pekanbaru/Palembang-Pontianak and Manado-Ambon-Sorong) and six yellow cities (Jakarta, Surabaya, Balikpapan, Makassar, Denpasar, Merauke). The red triangle areas are bordered with other countries (Singapore, Malaysia, Thailand, Philippines) and smuggling can be done by sea, air, or land. The small islands near these two areas can serve as intermediate hubs. The yellow cities have direct access to other destination countries (by air and sea).

Indonesian species have been traded for pet, consumption, traditional Chinese medicines, fashion, and ornament. Species smuggled highly varied, including live pangolin, primates (orang utan, slow loris), parts of sumatran tiger, live marine and freshwater turtles, Papuan snake-necked turtles, snakes and monitors (live, skins), several marine species, corals, agarwood. Bird smuggling has been greatly decreased lately due to the avian influenza incidence. Some illegal exotic species can be found in Jakarta market, indicated that this capital city is also vulnerable to illegal smuggling from other countries. The archipelagic situation of Indonesia with a long (81,000km) coastline creates difficulties in securing the entire country. A more intensive security and patrolling in the vulnerable areas and cities, coupled with regional cooperation such as ASEAN Wildlife Enforcement Network hopefully can help reducing the wildlife smuggling from and into Indonesia.

#### **V-10-4: Forest Frontier Governance and REDD in the Brazilian Amazon**

Daniel C. Nepstad; *Woods Hole Research Center*

From 2007 through 2009, the state governments of the Brazilian Amazon took historical steps towards “frontier governance”. Four states representing more than 80% of the region’s deforestation took on steep deforestation reduction targets and developed programs for achieving them. Deforestation in the Brazilian Amazon declined 64% below the 10-year average as of August 2009. This achievement was realized through a combination of governmental interventions, market trends (including attempts to exclude deforesters from the beef and soy supply chains), an increasingly pragmatic socio-environmental agenda within civil society, and novel alliances. This achievement has been assisted by a sharp reduction in the profitability of soy farming and cattle ranching and by the perception among landholders that carbon-based payments may soon flow to those who retain forests on their rural properties. Economic recovery, currency changes (weakening the Real), and significant delays in the development of carbon-based forest incentives threaten the opportunity to end deforestation over the coming decade. The state-wide REDD programs that are aligning with California’s AB32 “cap-and-trade” policy and could help secure gains made thus far, informing the Brazilian government’s climate mitigation policy as they draw investors towards Amazon forest carbon opportunities.

#### **V-10-5: REDD and the Challenges of Forest Corruption and Financial Fraud**

Christopher Barr; *Woods & Wayside International*

The emerging regime to Reduce Emissions from Deforestation and Degradation (REDD) offers unprecedented incentives for tropical forest countries to conserve forest ecosystems and to rehabilitate degraded forests. Globally, REDD is expected to channel large amounts of capital – potentially tens of billions of dollars annually – to forest-rich countries to compensate for policies and practices that keep forests standing. Yet REDD faces a fundamental contradiction in that many of the countries with the highest rates of deforestation also have long track records of mismanaging public funds, particularly in the forestry sector. To the extent that REDD funds are lost to corruption or fraud, it can be anticipated that initiatives to reduce carbon emissions in tropical forest countries will fail to meet their targets. This paper examines the challenges that corruption and financial fraud pose for successful implementation of REDD. Although it is generally assumed that the distribution of REDD payments will be performance-based, the monitoring, reporting, and verification (MRV) of carbon emission reductions in countries with weak forest governance faces both technical and institutional challenges which create entry points for financial abuse. Low levels of accountability on the part of forestry companies in many jurisdictions suggest that projects involving permanent credits may be particularly susceptible to moral hazard and financial fraud. In many tropical forest countries, weak fiscal management and revenue administration support conditions in which the influx of REDD funds is likely to introduce new opportunities for corruption and fraud. A case study of Indonesia’s multi-billion dollar Reforestation Fund highlights the need for improved financial governance as a critical step in the REDD ‘readiness’ process.

### **V-10-6: Cheap and Nasty: Global Conservation Prioritisation Schemes Based on Economic Data Should Consider Governance and Human Rights**

Erin McCreless<sup>1</sup>, Piero Visconti<sup>2</sup>, Josie Carwardine<sup>1</sup>, Robert J. Smith<sup>1</sup>; 1. *UC Santa Cruz*, 2. *James Cook University*

The financial cost of conservation projects varies widely and it is vital to consider such information when prioritising activities. Recent work has modelled protected area management costs for a large number of countries, and these data have been used to identify where conservation funds would be best spent to maximise return on investment. However, low management costs at a national level may correlate with other factors that influence conservation effectiveness, as well as broader impacts on stakeholders. Here we investigate these relationships and show that membership of conservation NGOs tends to be lower in countries with low management costs, indicating fewer opportunities for local fundraising and a lack of civil society involvement in conservation. Thus, conservation projects in these countries are more likely to be driven by outside organisations and implemented by state agencies. We also show that these management costs are positively correlated with measures of governance and human rights conditions, so that relying on these state agencies is more likely to produce perverse outcomes. Thus, we argue that conservation donors should account for such factors in future prioritisation schemes, either by avoiding countries where projects are likely to have these negative impacts, or by accounting for the extra costs needed to build civil society and avoid human rights abuses.

### **V-10-7: Determinants for Household Participation and Prospects of Reforestation in the Hutan Kemasyarakatan Scheme in Gunung Kidul, Yogyakarta, Indonesia**

Masahiko Ota; *Graduate School of Life and Environmental Sciences, University of Tsukuba*

This study aims to evaluate the effectiveness of the Hutan Kemasyarakatan (Community Forest) scheme in Indonesia taking up the case of a sub-village in Gunung Kidul, Yogyakarta, with special reference to the determinants for participation at the household level and the prospects of reforestation undertaken by villagers. It was discovered that a large part of the devolved forestland had been encroached upon by the launch of the scheme, and the primary determinant for household participation was whether a household had cultivated any plot of the devolved forestland or not. Since it was not feasible to force the participants to cease agriculture at their encroached plots, a compromise was made that allowed them to practice intercropping in-between the newly planted trees with planting intervals of 2×4m until crop cultivation became impossible due to the closed canopy. It was observed that tree planting had been implemented without visible boycotts and the growth of the trees was fair while the crop productivity at the plantation plots had significantly decreased. While this success of reforestation may be attributed to several aspects, it is inferred that the strength of regulation enforcement ability of the village-level committee concerned and vague expectations among the participants for timber benefits in the future are probably the two most important factors.

### **V-10-8: The Tug-of-war of Protected Areas Management in Indonesia under Decentralization**

Elizabeth Linda Yuliani; *CIFOR*

Indonesia's state's and community managed protected areas (PAs) are the last bastion for the protection of biodiversity and the provision of important environmental services. Unfortunately, since the decentralization act went into effect in January 2001, these areas have become a source of conflict between the national government, district government and local communities. Under the decentralization act, the state's PAs are managed centrally by the Ministry of Forestry, and therefore all benefits generated from the state PAs are delivered to the central government. Making no contribution to district revenues, PAs are considered 'costs' or 'burden' by the district government. In order to get benefits from PAs and gain local revenues, the district government is planning and

implementing many development programs and resources extraction within PAs, buffer zones and customary forests. Meanwhile, there are many traditional PAs managed by local communities through customary rules and local knowledge which are in line with fundamental conservation principles, but often unnoticed by government and international projects, and such systems are therefore not respected. Based on case studies in two state's PAs and one community's PA, this paper will describe power struggle, stakeholders' perceptions, and political-social dynamics that have led to deforestation and natural resource overexploitation of Indonesia's PAs.

## **Ecology, conservation and management of dipterocarp forest: the road to recovery (#11)**

**(July 22 am + 22 pm; Wantilan middle)**

Organized by: **Chris Kettle and David Burslem**

*The lowland dipterocarp forests of Southeast Asia support a substantial proportion of the world's biodiversity. They are of considerable environmental and economic value at the local, regional and global scales, providing many goods and services to a growing population. The forests of this region are among the fastest disappearing in the world. This symposium provides a synthesis of the breadth of knowledge covering the key ecological attributes of the dipterocarps from their reproductive ecology; population genetics, phenology, pollination, fruit production, seedling ecology and plant-microbe interaction, through to life history strategy and population dynamics. We examine the current conservation status of dipterocarp species, effective conservation strategies and the science behind sustainable management of dipterocarp forest in Southeast Asia. We will conclude with a panel discussion that focuses on novel solutions and policy instruments necessary to achieve a more resistant and resilient dipterocarp dominated landscape for S E Asia, meeting social, economic and biodiversity needs.*

### **V-11-1: Macroevolutionary Dynamics of the Dipterocarpaceae on the Sunda Shelf and Their Implications for Sustainable Management**

Charles H. Cannon; *Xishuangbanna Tropical Botanical Garden, Chinese Academy of Science*

Tropical trees, particularly species which participate in supra-annual mast fructing events like the Dipterocarpaceae, have several life history and reproductive strategies which do not fit traditional models of evolutionary theory. Additionally, the spatial distribution and overall connectivity of rainforest on the Sunda Shelf has been highly dynamic through the Quaternary Period. Understanding the long-term evolutionary dynamics of these trees requires a careful examination of the interaction between these complex systems. Here, I will review our current understanding of the important features of Dipterocarp biology which affect their macroevolutionary dynamics. Then, using a spatial model for the historical distribution of lowland forests during the most recent glacial cycles, I will discuss how Dipterocarp populations might have responded to through these periods of expansion and contraction. Finally, the implications of these dynamics on the future management, harvest, and conservation of Dipterocarpaceae species will be discussed in light of current trends of forest conversion and utilization.

### **V-11-2: What Triggers Mass Flowering in a Dipterocarp Forest of Southeast Asia?**

Mariya Chechina, Andreas Hamman; *1. Department of Renewable Resources, University of Alberta*

The trees of the Dipterocarpaceae family comprise a major forest type of Southeast Asia. This forest type is of great economic importance to the region because of its hard wood. Also, a great variety of wildlife depends on dipterocarps for seeds and fruits. The trees of this family exhibit a peculiar

phenology of irregular mass flowering which has been the topic of controversy for years. They don't seem to respond to a common environmental cue as do other mass flowering species. Various signs have been studied in the past. Some studies identified unusual drought as the trigger for mass flowering of dipterocarps. Other studies have found a correlation with El Niño and the occurrence of mass flowering. And yet other studies reported a drop of a minimum night time temperature as the main trigger of flowering. Lack of understanding of the reproductive process has hampered management efforts. If the forest is harvested prior to producing seeds, regeneration is compromised. So why do the trees of the same family respond to different triggers in different studies? The aim of my research project is to answer that question. The goal is two-fold: a) to explore different environmental cues of mass flowering in different regions of Southeast Asia and try to predict flowering events, and 2) to investigate a mathematical model of mass flowering based on resource accumulation and threshold. For the first part, we compiled and analyzed long term phenological data from previous studies using an array of univariate and multivariate statistical techniques. The results of PCA, CART, Random Forest and correlation analyses will be discussed in this research paper. Regional weather trends and associations with El Niño will be investigated in the project in order to understand why different cues are involved. Finally, the mechanism of synchronization will be illustrated by a resource budget model proposed here.

### **V-11-3: Resource Allocation to Reproduction in a Tropical Emergent Tree Species, *Dryobalanops aromatica***

Tomoaki Ichie<sup>1</sup>, Michiko Nakagawa<sup>2</sup>; 1. Kochi University, 2. Nagoya University

In this study, we examined the relation between the amount of storage resources and the participation in a general flowering event for reproduction in a tropical emergent tree species, *Dryobalanops aromatica* (Dipterocarpaceae), in Lambir Hills National Park, Sarawak, Malaysia. In the lowland mixed-dipterocarp forests of Southeast Asia, general flowering is a masting phenomenon involving various species and families and occurs at irregular intervals of 2-10 y at community level. We investigated the resource dynamics for reproduction of *D. aromatica* in the general flowering year of 2001. Also, we continuously monitored the resource concentrations and reproductive phenology of 30 individuals of *D. aromatica* from 2002 to 2005. We recorded the mast flowering and consequent fruiting of this species in the general flowering years of 2001, 2004 and 2005. Reproductive individuals in 2004 and/or 2005 showed higher phosphorus concentrations in the stems just before flowering than non-reproductive individuals. Moreover, the decrease in phosphorus concentration in the stems during the reproductive period correlated significantly with fruit produce in the reproductive years. We could not find such a relation with other nutrients such as carbon, nitrogen and potassium in the same reproductive years. Therefore, our results suggest that the storage of phosphorus resources in trees may be an essential factor in their participation in a general flowering event in this species.

### **V-11-4: Phenology and Pollination Biology of Co-occurring Dipterocarps in Sabah**

David F.R.P. Burslem, Colin R. Maycock, Penny Gardner, Chris Kettle, Eyen Khoo and Jaboury Ghazoul; 1. University of Aberdeen

We examined temporal patterns of flowering and flower visitor communities during three flowering events for 10 species of Dipterocarpaceae that co-occur in Sepilok Forest Reserve in northeast Sabah. Flowering phenology occurred sequentially, and the sequence was generally consistent between different flowering events. In addition, species that overlapped in sequence were frequently differentiated according to whether flowers opened during the day or night. Flower visitor communities were sampled using sweep nets, fly paper traps and dissection of flowers, morphotypes were sorted to order (family for Coleoptera) and individuals measured. Flower visitor communities were dominated by beetles and overlapped between dipterocarp species, suggesting a generalist pollination system among the dipterocarps in the sample. However, the median size of arthropod flower visitors was correlated positively with dipterocarp flower size, which was determined by an



absence of the larger arthropods in the samples from smaller-flowered species. Pollinator exclusion experiments suggested that insects with a small body size, such as thrips and small beetles, were most important for pollination of dipterocarps with small and medium sized flowers, while insects of larger body size, particularly Hymenoptera (including *Apis dorsata*) and trigonid beetles were more influential for the pollination of mid and large-flowered dipterocarp species. We conclude that temporal and diurnal partitioning of flower opening, and differential flower size, may contribute to pollinator niche partitioning in dipterocarps, although these three factors are not sufficient to separate all 62 species of Dipterocarpaceae that co-occur at Sepilok.

#### **V-11-5: Flower Size and Differential Pollination Success in Tropical Forest Trees**

Chris J. Kettle<sup>1</sup>, Colin R. Maycock<sup>2</sup>, J. Ghazoul<sup>1</sup>, Pete M. Hollingsworth <sup>1</sup>, Rahayu Sukri, David Burslem; *1. ETH Zurich, 2. University of Aberdeen*

Fecundity contributes to plant fitness and is implicit in many models of species coexistence. However the mechanisms that determine differential fecundity within plant communities remain poorly resolved, despite implications for management and conservation. We investigated how interactions of flower size, pollinator body size and pollination success contribute to fecundity of 12 species of Dipterocarpaceae. We combined direct and indirect estimates of contemporary pollen dispersal in two study species with published estimates of pollen dispersal in a further three species of dipterocarp to explore the relationship between flower size and pollen dispersal. Maximum flower production was two orders of magnitude greater in small-flowered than large-flowered species of dipterocarps, but small-flowered species also had smaller-sized pollinators, and lower mean pollination success than large-flowered species. Paternity analysis revealed lower average pollen dispersal distances and high frequency of mating between related individuals in a smaller-flowered species than a larger-flowered conspecific. Our synthesis of pollen dispersal estimates across five species of dipterocarp suggests that pollen dispersal scales positively with flower size. Our findings demonstrate the potential for differential vulnerability of species to the deleterious ecological and genetic consequences of fragmentation. Synthesis: Trade-offs embedded in the relationship between flower size and pollination success contribute to reduction in the variance of fruit production relative to flower production among species. These trade offs might contribute to equalisation of fecundity among species and thereby delay competitive exclusion. This work highlights that the pollination component of the regeneration niche may play a more substantial role in maintaining species diversity than has been recognised previously in this ecologically and economically important family of tropical trees.

#### **V-11-6: Spatial Genetic Structure of Ten Dipterocarp Species in a Tropical Rainforest, Sarawak, Malaysia**

Tsuyoshi Harata, Satoshi Nanami, Akira Itoh, Takuo Yamakura, Bibian M. Diway, Sylvester Tan; *Laboratory of Plant Ecology, Osaka City University*

We investigated the spatial genetic structure and genetic diversity of ten dipterocarp species belonging to genera (*Dipterocarpus*, *Dryobalanops* and *Shorea*) in a 52 Ha plot in Lambir Hills National Park, Sarawak, Malaysia. The population densities of *Dipterocarpus globosus* and *Dryobalanops aromatica* were particularly high and the corresponding genetic structure of these species was relatively weak. This weak genetic structure was assumed to be due to the overlapping seed shadows of conspecific trees. Conversely, while *Shorea acuta* and *S. beccariana* also had high densities, these species exhibited strong genetic structure. It is thought that the low average height of *S. acuta* trees (shortest of the 10 species examined) and the relatively large size of *S. beccariana* fruit may limit seed dispersal and concomitantly, the size of the seed shadow. The small patch distributions and strong genetic structure observed in *Dipterocarpus crinitus* and *S. ovata* were considered to have arisen as a result of seed dispersal occurring within a restricted area, with the aggregation of relatives within such patches contributing to increased genetic structure. Despite the limited patch distribution observed in *S. curtisii*, no spatial genetic structure was observed in this species and genetic diversity in *S. curtisii* was low. We assumed a homogenous distribution of individuals throughout the experimental plot with

trees having similar genotypes and no apparent genetic structure. The inbreeding coefficients ( $F_{is}$ ) of *D. globosus*, *D. aromatica*, *S. amplexicaulis* and *S. beccariana* were positive and showed significant deviation from HW equilibrium, while those of *D. crinitus*, *S. curtisii* and *S. ovata* did not. Interestingly, the former group of species produced relatively large fruit, while the latter group produced smaller fruit. We propose that inbreeding depression is weak in the former group which has highly nutritious cotyledons, and strong in the latter group which has less nutritious cotyledons.

#### **V-11-7: Hybridization in Shorea Species and Its Consequences**

Koichi Kamiya<sup>1</sup>, Shawn K.Y. Lum<sup>2</sup>, Harada K.<sup>1</sup>; *1. Ehime University, 2. National Institute of Education, Singapore*

It has been argued that the rate of hybridization is correlated with local species abundance. This relationship has important consequences in conservation, especially when a species threatened by extinction coexists with closely related species, which are locally more abundant. Anthropogenic environmental disturbances will provide new habitats where hybrid progenies can colonize. Human-mediated species introduction will also increase the chance of local species hybridizing with introduced species. Therefore, investigations are needed to understand such detrimental consequences of hybridization. Here we describe interspecific hybridizations occurring naturally between species in genus *Shorea*. We showed in our molecular phylogenetic studies that some species had DNA sequences that were more closely related to other species than the other conspecific individuals, suggesting hybridization had occurred between species. Population genetic studies of *Shorea* in Singapore and Malaysia indicated that natural hybridization was not an uncommon phenomenon, particularly between two ecologically and phylogenetically distinct species, *S. curtisii* and *S. leprosula*. Our recent phenological study in Singapore showed that flowering durations of *S. curtisii* and *S. leprosula* were totally consistent, although *S. parvifolia* flowered considerably earlier than these species. DNA sequence data indicated that all the morphologically defined hybrid individuals were considered F<sub>1</sub>s, and no post-F<sub>1</sub> hybrids were found, even though the F<sub>1</sub> hybrids were found to be fertile based on our field observation and germination tests. The DNA analysis also showed no evidence of introgression between the parental populations *S. curtisii* and *S. leprosula* in Singapore. These results suggest that the fitness of individuals from post-F<sub>1</sub> hybrids is compromised by hybrid breakdown. Further investigations to understand the relationship between habitat disturbance and the hybridization dynamics deserve attention in biodiversity conservation.

#### **V-11-8: Growth and Wood Density of 22 Species of Dipterocarpaceae Saplings**

Christopher D. Philipson, Philippe Saner, Turnbull, Hector; *Evolutionary Biology & Environmental Studies*

The diverse family of Dipterocarpaceae has many closely related species that coexist. Knowledge of the regeneration of dipterocarp forest is paramount to our understanding of both primary forest dynamics and the conservation and management of degraded landscapes. We present growth data and wood density measurements from a large number of dipterocarp saplings grown in controlled light conditions and relate it to saplings planted into natural forest. Previous work in this area has been shown to be heavily dominated by size differences between species and individuals. Size independent growth rates were derived using non-linear mixed effects models fit to multiple time point growth data. This enables us to really examine the true differences in intrinsic growth ability between species. We examine niche partitioning in response to different light environments, and investigate the trade-offs along this niche axis. We discuss why it is important to understand the real growth ability of different species and consider the implications for forest ecology and management.

#### **V-11-9: Sitting Ducks: the Ecology of Dipterocarp Seedlings**

Markus P. Eichhorn; *University of Nottingham*

A dense carpet of dipterocarp seedlings is one of the defining features of tropical rain forest understorey in South-East Asia. Their numbers are replenished by intermittent mast-fruiting, which appears to follow El Nino events, and it has been hypothesised that this allows exploitation of canopy gaps formed by related tree mortality. Once established they have remarkable longevity, often persisting for decades in a near-dormant state. During this time they are subject to attrition from a variety of sources: (a) mechanical damage from animals and falling debris, (b) natural enemies including insect herbivores, vertebrates and pathogens, (c) resource stress and (d) extreme environmental events such as drought or flooding. There are therefore many means by which the regeneration niches of seedlings might be defined, thereby promoting the maintenance of stand diversity, though the relative importance of these factors has yet to be established. The functional traits that allow them to tackle such threats are also poorly understood. While it is known that dipterocarp foliage contains relatively high levels of phenolics, their defensive chemistry is otherwise poorly described, and little is known about the importance of their mechanical design or the role of resprouting in tolerance of damage. Due to the limited seed dispersal of most species they may be particularly sensitive to Janzen-Connell effects. There is also evidence of frequency-dependent selection on seedling survival at community scales, indicating that the escape hypothesis might act at several levels. Once in a gap, differences emerge among dipterocarp species in their ability to respond to and utilise the additional light, though only a minority of seedlings will survive long enough to experience such conditions. In conclusion, it seems likely that survival rather than growth is the main process determining the distribution and probability of successful regeneration of dipterocarp seedlings.

#### **V-11-10: Community Structure of Ectomycorrhizal Fungi on Canopy Trees of Dipterocarpaceae**

Satoshi Yamashita<sup>1</sup>, Hirose Dai<sup>2</sup>, Nakashizuka Tohru<sup>1</sup>; *1. Kyoto University, 2. Nihon University*

Severe drought sometimes affects the forest ecosystem of aseasonal tropical rain forest dominated by Dipterocarpaceae in Southeast Asia. Such a drought might affect the community structure of ectomycorrhizal (ECM) fungi formed on roots of canopy trees. However, there is limited information on ECM fungal community formed on mature trees. We conducted a field observation to reveal the ECM community formed on canopy trees and a field experiment to reveal the effect of drought on ECM fungal community of a canopy tree in the Lambir Hills NP, Sarawak, Malaysia. We collected root samples with ectomycorrhizas directly from mature trees and identified ECM species by using a molecular technique. The field observation revealed that 3 of 18 ECM Basidiomycetes and 2 of 11 Ascomycetes were shared by two dipterocarp species, *Dryobalanops aromatica* and *Shorea beccariana*. This implies that canopy tree should potentially be tied each other by common mycorrhizal network. In the field experiment, to keep the forest floor dry, we intercepted rainfall by spreading a vinyl sheet on the wooden frame from the center of the to a distance of 15 m. Twenty two species from Ascomycota, Basidiomycota and Zygomycota was recorded in total. The average number of ECM species on the treated tree decreased from  $8.0 \pm 1.0$  to  $4.7 \pm 0.6$  (mean  $\pm$  SD) after the drought treatment. This suggests that tolerance to drought is likely to differ among fungal species, and such differences could explain the decrease in the number of fungal species caused by drought in the treated tree. Our study suggests that drought stress might cause changes in the dominance of particular ECM fungi, and this phenomenon might be related to the general flowering if the dominance of particular species of ECM fungi would encourage synchronization of nutrient uptake by host trees at the forest stand level.

#### **V-11-11: Effects of Topography on Tree Mortality Resulting from El Niño-induced drought: A Study in a Bornean Tropical Rain Forest**

Akira Itoh, Satoshi Nanami, Takuo Yamakura, Tatsuhiro Ohkubo, Lucy Chong, Sylvester Tan, Hua Seng Lee; *Osaka City University, 2. Osaka City University, 3. Osaka City University, 4. Osaka City University*

In general, El Niño-induced drought increases mortality of tropical rain forest trees. The degree of El Niño effect on tree mortality may vary among tree species, which differ in terms of drought tolerance. It was recently suggested that the current distributions of rain forest tree species were related to the degree of tolerance to water stress on a regional scale. However, differences among species with regard to mortality resulting from El Niño-induced drought within a local forest remain to be elucidated. The severe El Niño-induced drought that occurred in 1997–1998 in Bornean rain forests provided a good opportunity to analyze species-specific differences among the coexisting tree species with regard to the effects of the drought on tree mortality.

We analyzed mortality among all the trees with stem diameters  $\geq 1$  cm within a large-scale permanent plot (52 ha) during the pre-drought (1992–1997), drought (1997–1999), and post-drought (1999–2002) periods. Annual mortality was slightly increased because of the drought: 1.14%, 1.64%, and 1.51% during the pre-drought, drought, and post-drought periods, respectively. The spatial distribution of mortality rates was related to topography; higher mortality rates were observed among trees in the low-elevation sites than among those in the high-elevation sites during all the 3 periods. Interestingly, a greater increase in the mortality among trees in the low-elevation sites, where drought is expected to be less severe, was observed than among those in the high-elevation sites. A logistic regression analysis revealed that differences among the species with regard to habitat preference were related to drought effects. Species whose distributions were restricted to high-elevation sites were less affected by drought as compared to those whose distributions were restricted to low-elevation sites, possibly because the former exhibited higher drought tolerance than did the latter. Our results indicate that El Niño-induced drought may affect species composition and spatial distribution of tree communities in tropical rain forests according to species-specific drought tolerance.

#### **V-11-12: Associations between Topography, Soil Nutrients and Soil Water Availability and Their Effects on Dipterocarp Distributions in Brunei Darussalam**

Rahayu S. Sukri, David F.R.P. Burslem, Kamariah A. Salim; *1. University of Aberdeen*

Plant associations along edaphic and topographic gradients are well-documented in Bornean lowland forests but turnover in species composition may also reflect spatial autocorrelation. We examined habitat associations, species richness and diversity, and community composition of all dipterocarps  $\geq 1$  cm dbh along edaphic and topographic gradients at two contrasting lowland Mixed Dipterocarp Forests in Brunei Darussalam, northwestern Borneo: Andulau (nutrient-poor sandy soil) and Belalong (nutrient-rich clay soil). Over a 20-month sampling period, soil water availability was significantly lower at Belalong than Andulau, and ridges were significantly drier than slopes and valleys. Soil nutrient concentrations were significantly higher at Belalong than Andulau, but only total C, N and P showed significant topographic variations. Elevation, slope and topographic index were significantly higher at Belalong than Andulau. Dipterocarp tree density, species richness and diversity were significantly higher at Andulau than Belalong and also significantly different between ridges, slopes and valleys. Habitat associations were detected at both Andulau and Belalong, with 11 out of 37 species (30%) significantly positively associated with sandy soils and 8 species (22%) significantly positively associated with clay soils. Community composition at Belalong was strongly correlated with soil and environmental variables even when geographic distance was accounted for. In contrast, after controlling for geographic distance, community composition at Andulau was only significantly correlated to slope and the index of topography. These results suggest that both edaphic and environmental factors enable habitat specialisations and influence the composition of dipterocarp communities, but spatial autocorrelation influences on community structure is lower in a less variable environment.

#### **V-11-13: Six Decades of Vegetation Studies and Vegetation Diversity in Indonesia**

Kuswata Kartawinata<sup>1</sup>, Dedy Darnaedi<sup>2</sup>; *1. Field Museum & Herbarium Bogor, LIPI, 2. Herbarium Bogoriense, Research Center for Biology, Indonesian Institute of Sciences*

A review of natural vegetation studies since the end of World War II revealed that only a few have been done and mostly focused on forest. Data from plot studies show that tree species richness in forests in Sumatra and Kalimantan, which are dominated by dipterocarps, is higher than in Sulawesi, Maluku, Papua, Nusa Tenggara and Jawa and that in lowland forests is higher than in montane forests. To a certain extent it is related to habitat factors, such as rainfall, altitude, and soil water conditions. Based on these factors, physiognomy and structure, the vegetation of Indonesia may be classified into at least 40 types. The highest vegetation diversity occurs in the mountain region of Papua, particularly at the altitudes of 2400 m and 5000 m. The lowland forest of Java is practically gone and the remnants still occur in a few protected areas in West Java, such as the Gunung Gede-Pangrango N.P. (National Park), Gunung Halimun-Salak N.P. and Ujung Kulon N.P.

#### **V-11-14: An Assessment of the Conservation Status of the Dipterocarps of Sabah**

Colin R. Maycock, Nazahatul Anis Amaludin, Eyen Khoo, Joan T. Pereira, John B. Sugau, Robert C. Ong, Reuben Nilus & David F.R.P. Burslem; *University of Aberdeen*

In planning a road to recovery, a comprehensive assessment of what remains is required. We are using ecological niche models (ENM), current land-use maps, satellite imagery and ground-truthing to make an assessment of habitat loss for the dipterocarps of Sabah. Our preliminary results show altitudinal and regional patterns of habitat loss. Lowland dipterocarps have experienced a greater proportional habitat loss than upland or lower montane species and, lowland species restricted to the north of Sabah have suffered greater habitat loss than those in the south. Of particular concern are the dipterocarps of the North West geographical province (e.g. *Dipterocarpus lamellatus*, *Shorea foraminifera* and others). It is likely that many of these are locally extinct in Sabah, although further ground-truthing is required to confirm this. New restoration projects in the north of Sabah may present a road to recovery for some of these species.

#### **V-11-15: Biodiversity Conservation Considerations in Tropical Hill Production Forest Management in Peninsular Malaysia**

Christine Fletcher, Abd Rahman Kassim, Matthew Potts; *Forest Research Institute Malaysia*

In the last decades, the harvesting regime in Malaysian forestry had shifted towards production in hill forests and with it, concern for the conservation of biological diversity. In response to this, the Conservation of Biological Diversity Project (CBioD) was launched in 2006 to explore suitable sampling designs for assessment and monitoring of biodiversity in tropical hill forests to ensure that SFM is still achievable. The study was conducted between 2007 and 2009 in seven selected tropical hill dipterocarp forests in Peninsular Malaysia. Among the hypothesis that drove this project activity included; 1) a suite of selected functional taxa would give a meaningful assessment of the hill forest environment, and 2) larger areas set aside as part of the sustainable forestry practice in production forest will enhance the regeneration process in adjacent logged-over forest. Preliminary data using a suite of taxa; ants, insectivorous bats, understorey birds, dung beetles, stingless bees and moths suggested that 1) species abundance and distribution did not significantly vary according to topography in hill forest conditions, 2) more intense sampling effort is needed for more mobile groups e.g. bats, birds and moths to adequately represent the population thus is less effective for rapid assessments, and 3) the size of the protection area alone does not determine species richness and its capacity to enhance the regeneration of adjacent logged-over forest but also topography and anthropogenic factors. Keywords: conservation of biodiversity, tropical hill dipterocarp forest, production forest, sustainable forest management, Peninsular Malaysia

#### **V-11-16: Sustaining Diversity in Managed Dipterocarp Forest: The Role of Protected Areas**

Matthew D. Potts<sup>1</sup>, Abd Rahman Kassim<sup>2</sup>, Christine Fletcher<sup>1</sup>, Rhett D. Harrison<sup>1</sup>; *1. University of California, Berkeley, 2. Forest Research Institute Malaysia*

The value society places on biodiversity has led to the explicit incorporation of biodiversity conservation into tropical forest management plans, as stipulated in various global forest certification schemes. However, which management strategies best protect biodiversity from both ecological and economic perspectives is poorly understood. In this talk, I focus on the two main approaches for jointly producing timber and conserving biodiversity in tropical forests: segregated management, in which timber production is emphasized in some parts of the forest and biodiversity conservation in others, and integrated management, in which conservation measures are incorporated into logging regimes. I integrate results from spatial forest models and field studies in Malaysia. The results indicate that small-protected areas play important but varied roles in conserving floral and faunal diversity. The presentation concludes with a discussion of how these findings are informing the development of new sustainable forest management systems for dipterocarp forests.

## **Integrating evolution, ecology and biodiversity science (#13)**

**(July 21 am + 21 pm; Wantilan front)**

Organized by: **Lúcia G. Lohmann and Andrew Hendry**

*Although evolution underlies the origins of biological diversity and ecological process, evolutionary biology has only recently been incorporated into these fields. With this incorporation, it has become increasingly clear that the insights and tools of evolutionary biology are not just useful, but are also critical for these research areas. It is also increasingly clear that we must learn to make more effective use of evolutionary knowledge in our efforts to promote biodiversity science and conservation. In particular, knowledge of the evolutionary relationships among organisms (i.e., phylogenies) can provide insights into the importance of particular taxa and biotas to regional and global pools of biodiversity. Coupled with an understanding of the function of organismal traits, this information can then inform likely ecological consequences of biodiversity change. The aim of this symposium is to highlight the importance of evolution to biodiversity science and ecological research, and to stimulate discussion on ecological questions from a phylogenetic standpoint. The talks will provide a broad perspective on the interface between phylogenetics, ecology and evolution. They will also introduce the audience to the large realm of research opportunities in biodiversity science and conservation.*

### **V-13-2: Diversity and Function of Marine Bacteria with Special Emphasis on Light-energy Harvesting System.**

Kogure, Kazuhiro, Yoshizawa Susumu; *Ocean Research Institute, the University of Tokyo*

Photosynthesis by algal cells has long been regarded as the major pathway of harvesting light energy in marine environments. Recent genetic approach on microorganisms, however, revealed that there are two other potentially important systems, i.e., bacteriochlorophyll and proteorhodopsin. The former is present among aerobic heterotrophic bacteria and probably functioning as auxiliary mechanism especially under low-nutrient condition. The latter has been assumed to serve as ion pump which is coupled with ATP synthesis, but there was no direct confirmation of the activity. We succeeded in measuring the ion pump activity among several isolates and clarify their potential role in marine environments. The phylogeny of those newly recognized microorganisms and presence of genes involved among them will be discussed with special emphasis on their evolutionary aspects.

### **V-13-3: Speciation in Tropical Trees: the Role of Edaphic Gradients**

Paul V.A. Fine, Italo Mesones, Douglas C. Daly; *University of California Berkeley*

The tropical rain forests of the Amazon basin harbor the greatest diversity of trees on earth. What drives speciation in Amazonian trees? Does it occur by allopatric speciation separating populations

across geographic barriers or can environmental heterogeneity promote speciation via habitat specialization? An ideal study system is the flora found on white sand forest islands widely dispersed throughout the Amazon basin. These ancient white sand deposits are surrounded by other terra firme forests on more fertile soils, and harbor mostly edaphic endemics. A few tree species have been reported to occur in both white-sand and terra firme habitats. Investigating the genetic structure as well as the morphological and physiological divergence among these populations in both white-sand and terra firme habitats can provide insight into the relative importance of geography versus habitat heterogeneity in driving divergence among tropical tree populations across large scales. I present results from a phylogenetic and population genetic study designed to assess lineage diversification for ten populations of *Protium subserratum* (Burseraceae) that span neighboring sympatric but edaphically divergent forests in Peru, Guyana and French Guiana. In addition, individuals from seven Peruvian populations were planted into two common gardens (white-sand and clay) to test for the role of phenotypic plasticity in influencing morphological differences between soil types as well as to quantify population-level differences in growth rate, physiology and chemical defense. White-sand populations were most closely related to each other, even when geographically distant. We also found evidence of some gene flow across habitat boundaries at local scales. Populations exhibited significantly different growth rates, morphological and physiological measures in the common gardens. This evidence is consistent with the hypothesis that edaphic gradients promote ecological speciation in tropical trees.

#### **V-13-5: Evolution and Ecology of Tropical Plant Breeding Systems**

Simon A. Queenbrough; *NCEAS*

The evolution of dioecy is a fundamental issue in evolutionary ecology. Using a global network of large permanent plots incorporating spatially-explicit demographic information on thousands of plant species, I examine the distribution of breeding systems throughout the tropics and their correlates. Furthermore, I demonstrate novel insights into the influence of breeding system on plant trait evolution.

#### **V-13-6: Evolution of Animal-Plant Interactions in Bignonieae (Bignoniaceae)**

Lúcia G. Lohmann, Suzana Alcantara, Anselmo Nogueira, Flávio Gomes-Silva; *Universidade de São Paulo, Instituto de Biociências, Departamento de Botânica, São Paulo, Brazil*

Animal-plant interactions have fascinated scientists for several centuries. Indeed, numerous field studies have documented the importance of the associations between plants and pollinators, plants and herbivores, ants and plants, and plants and their dispersers. Despite the importance of these studies, much of the research on animal/plant interactions has remained non-evolutionary, limiting our ability to explain and interpret the dynamics of those relationships. As a result, very little is still known regarding the sequence of evolutionary events that has led to such great diversity in animal-plant interactions. Here, we use the tribe Bignonieae (Bignoniaceae) as a model to study the evolution of animal-plant interactions in the Tropics. More specifically, we use a time-calibrated phylogeny of Bignonieae as basis to: (1) conduct evolutionary correlations and test whether changes in some traits might be influenced by changes in other traits; (2) test whether changes are concentrated within a single branch (punctual) or spread out over multiple branches (gradual); and, (3) test for phylogenetic signal in order to determine whether the current variation in traits can be explained by their evolutionary history. The information obtained provides important evidence for a better understanding of the processes that may have driven morphological evolution in characters associated with animal/plant interactions in Bignonieae as a whole (Funding: Fundação de Amparo à Pesquisa do Estado de São Paulo, FAPESP/Brazil).

#### **V-13-7: Effects of Growth Habit on Woody Angiosperm Vessel Anatomy**

Amy E. Zanne<sup>1</sup>, David Coomes<sup>2</sup>, Iván Jiménez<sup>1</sup>, Peter M. Jørgensen<sup>1</sup>; 1. *University of Missouri – St. Louis*, 2. *University of Cambridge*

Recent regional and global analyses of vessel anatomy suggest strong constraints on the fraction of cross section of a woody angiosperm plant stem that is vessel (lumen fraction). Within this relatively narrow range in possible allocation, plants are able to adjust their water transport considerably. The upper boundary of lumen fraction is likely driven by lowered mechanical strength, while the lower boundary is likely driven by the need for some amount of water transport. How do plants with different growth forms explore the available lumen fraction space? Lianas are largely freed from mechanically supporting themselves and thus may invest greater amount of cross sectional area in vessels than would self-supporting plants. Within self-supporting plants (trees and shrubs), trees may be more efficient in their transport, with bigger vessels and higher conductivity for a given allocation in vessels, than shrubs. We use a global vessel anatomy database (<http://datadryad.org/repo/handle/10255/dryad.1138>), as well as growth habit data from Tropicos (<http://www.tropicos.org/>) for Neotropical plants to test these predictions. We find support for a shift to greater vessel fraction in lianas and larger vessels, and fewer but larger vessels in trees than shrubs. Furthermore, we find that these growth forms are scattered across the angiosperms phylogeny, but they show strong coordinated evolutionary divergences with vessel anatomy. These results support linkages between the ultrastructure (growth form) and microstructure (vessel anatomy) of plants.

### V-13-8: Ecology and Evolution of Leaf Physical Defense Traits

Kaoru Kitajima, Jared Westbrook, S. Joseph Wright, John Kress, David Erickson; *University of Florida*

Many leaf functional traits are believed to have evolved in relation to life history strategies and habitat specialization that contribute to local diversity of tropical woody taxa. Phylogenetic comparative methods provide a powerful approach for elucidation of evolutionary significance functional traits. Yet, in community-wide comparisons of functional traits encompassing broadly divergent taxa, non-phylogenetic and phylogenetic methods often yield virtually identical results. A lack of phylogenetic signals may reflect convergence, labile nature of the traits, and/or inadequate resolution of phylogenetic relationships among taxa. This talk focuses on two types of leaf physical defense traits, mechanical strength and silica contents of leaves, which are known to reduce herbivory. In a community-wide analysis of 198 woody species that co-occur in the 50-ha forest dynamics plot on Barro Colorado Island, Panama, the degrees of phylogenetic conservatism, as well as trait correlations, with roughly resolved angiosperm-wide tree (APGII) and finely resolved tree using information from DNA barcoding (barcode tree) were evaluated. Leaf toughness was strongly correlated with demographic traits in a strongly convergent manner across unrelated taxa. In contrast, silica accumulation exhibited strong phylogenetic signals at family and order-levels. Phylogenetic and non-phylogenetic analyses both demonstrate that foliar silica contents have no association with ecological strategy of the species within the community, even though it would be crucial to take phylogeny into account in evaluating evolution and biogeographical patterns of silica accumulation in leaves.

### V-13-9: Plant DNA Barcodes, Ecological Forensics, and Community Phylogenies

W. John Kress; *Smithsonian Institution*

The assembly of DNA barcode libraries is particularly relevant within species-rich natural communities for which accurate species identifications will enable detailed ecological forensic studies. In addition, well-resolved molecular phylogenies derived from these DNA barcode sequences have the potential to improve investigations of the mechanisms underlying community assembly and functional trait evolution. A three-locus DNA barcode applied to nearly 300 species of woody trees, shrubs, and palms found within the 50-ha forest dynamics plot on Barro Colorado Island (BCI), Panama, is able to correctly identify >98% of the species. A robust community phylogeny



reconstructed with these DNA barcode sequences is broadly congruent with the accepted phylogeny of flowering plants (APG III) and provides resolution to the species-level. A comparison to earlier work on the phylogenetic structure of the BCI forest dynamics plot, which employed less-resolved phylogenies, reveals significant differences in evolutionary and ecological inferences derived from these new data. These results illustrate how highly resolved phylogenies based on DNA barcode sequence data will enhance research focused on the interface between community ecology and evolution.

### **V-13-10: Integrating Phylogenies, Time, and Space in the Biogeography of the Mediterranean Region**

Elena Conti; *University of Zurich*

The fundamental goal of biogeography is to explain why species occur where they do. By integrating evidence from phylogenies, molecular dating and ancestral areas reconstruction with prior knowledge on past geologic (i.e., microplate movements, formation of temporary corridors, island formation) and climatic events (i.e., onset of the Mediterranean climate), we inferred the biogeographic origins of selected species endemic to the Mediterranean region, one of the 25 hotspots of biodiversity in the world, focusing especially on oceanic (Canary archipelago) and continental (Corsica, Sardinia) islands. Our analyses supported: (i) two main invasions of the Mediterranean by Araceae, one from an area connecting North America and Eurasia in the Late Cretaceous and one from the Anatolian microplate during the Late Eocene; (ii) an Anatolian origin for the Mediterranean Boraginaceae; and (iii) an invasion from the north before the onset of the Mediterranean climate for *Ruta* (Rutaceae), which diversified in situ as the climate became Mediterranean. These results confirm both the proposed heterogeneous origins of the Mediterranean flora and the importance of the Eastern Mediterranean as a reservoir for plant evolution in the basin. Concerning the origin of island endemics, our study supported the single colonization, followed by in situ diversification, of Canary endemics in Boraginaceae and *Ruta* and the hypothesized relictual origin, driven by tectonic processes, of Araceae endemic to Corsica and Sardinia. A recurrent theme of all our analyses is that land connections and interruptions, caused by repeated cycles of marine transgressions-regressions between the Tethys and Paratethys, favored geodispersalist expansion of biotic ranges from western Asia into the Mediterranean basin and subsequent allopatric speciation at different points in time from the Late Eocene to the Late Oligocene.

### **V-13-11: Impact of Demography and Selection on the Genetic Differentiation of Closely Related Tropical Tree Species**

Maxime G. Casalis, Luc Allard, Astrid Tempestini, Caroline Scotti-Saintagne, Henri Caron, Erwan Guichoux, Delphine Audigeos, Ivan Scotti; *INRA / UMR EcoFoG*

Origin of the strong level of species diversity in Amazonian forest constitutes a key question in evolutionary biology. In particular, we are interested by studying the evolutive forces involved in the maintenance of closely related species still exchanging genes. During a long time, sympatric speciation has not been considered as a strong alternative hypothesis to allopatric speciation, but today with the recent progresses in modeling and molecular biology, sympatric speciation is largely reconsidered. To infer evolutive forces involved in the maintenance of sister species, we focused our study on two species complexes chosen for their contrasted genetics and ecologic characteristics. In the genus *Carapa*, *C. procera* and *C. guianensis* can be differentiated at the genomic level whereas they do not differ by strong ecological differences. On the contrary, in the genus *Symphonia*, *S. globulifera* and *S. spl* colonise different habitats, especially for water soil composition, but a previous exploratory genetic analyses revealed absence of inter-specific genetic differentiation. To infer and compare the relative contribution of natural selection and demography in the maintenance of these sister species we first explored the level of neutral genetic diversity at both chloroplast and nuclear genome. Results confirmed the high level of gene flow between the sister species and permitted to delimit the hybrids zones. The role of natural selection has been inferred using both molecular and

quantitative approaches. Molecular strategies consisted first in testing divergent selection at candidate genes for water stress and secondly, consisted in scanning the genome for interspecific differentiation at AFLPs loci in order to detect outlier loci for divergent selection. The quantitative approach consisted in doing reciprocal transplantation experiments in order to estimate the link between genetic diversity and diversity for phenotypic traits such as mortality or growth.

#### **V-13-12: Comparative Phylogeography of Widespread Fig Species and Their Associated Wasp Pollinators**

Roosevelt García, Christopher W. Dick, Carlos Machado, Allen Herre; *University of Michigan*

The 60 million year old mutualism between fig trees (*Ficus*) and their pollinating wasps (Agaonidae) is one of the most tightly coevolved plant-animal interactions known, yet host shifts are known to occur. To examine the stability of the mutualism in a geographic context, we performed a comparative phylogeographic analysis of four widespread *Ficus* species and their agaonid pollinators sampled in Panama and the Peruvian Amazon. Fig tree phylogeographic divergences were compared to a similar data set for 12 non-fig tree species. The figs show a weak phylogeographic structure that suggests a history of dispersal around the northern Andes. The pollinating wasps, on the other hand, show high levels of CO1 divergence, indicating allopatric divergence and/or species turnover within their widespread host species

#### **V-13-13: Biodiversity Patterns & Processes in Southern South America Through Comparative Phylogeography**

Keith A. Crandall; *Brigham Young University*

Through the use of comparative phylogeography and phylogenetic diversity approaches, we use data from multiple species of the freshwater crabs *Aegla* to define high priority regions for conservation efforts in southern South America, in general, and Patagonia in particular. We also use this same approach to explore the biological and climatic processes impacting diversification and distribution of these species in Patagonia. We demonstrate the utility of comparative phylogeography for aiding in species discovery and understanding processes impacting speciation. We demonstrate the relative importance of glacial cycles and vicariance in the diversification of the freshwater crab fauna in Patagonia.

#### **V-13-14: Dispersal Routes of Amphibians and Reptiles in the Moluccan Archipelago Inferred from Molecular Data: Impacts of Geography, and Species Idiosyncrasies**

Muhammad Ikbal Setiadi<sup>1</sup>, Dwi Susanto<sup>2</sup>, Amir Hamidy<sup>3</sup>, Kellyopas Krey<sup>1</sup>, Ben J. Evans<sup>1</sup>;

*1. Center for Environmental Genomics, Department of Biology, McMaster University, 2. Natural Resource and Environmental Studies, School of Graduate Studies, IPB, 3. Museum Zoologicum Bogoriense, Research Center for Biology, LIPI*

The Moluccan Archipelago of central Indonesia lies on one of the most rapidly deforming tectonic regions on the planet. Two volcanic island arcs in the Moluccan Archipelago – the Outer Melanesian Arc and the Banda Arc – connect the islands of the Sunda Region (mainland Asia, Borneo, Sumatra, Java) with the Sahul Region (New Guinea and Australia). These arcs may have been migration routes for species with broad geographic distributions in this region. We used molecular data from multiple unlinked markers to explore alternative migration scenarios in reptiles and amphibians from the Moluccas. Two lizards, *Bronchocela cristatella* and *Lamprolepis smaragdina*, did not disperse in a way that reflects the geological proximity of islands currently or in the past. This is probably due to their ability to readily cross marine barriers. But three frog species, *Litoria infrafrenata*, *Platymantis papuensis* and *Limnodynastes cf. grunniens* dispersed through this archipelago in a fashion more consistent with the configuration of islands in the past and present, although differences in dispersal routes are detected. Genetic endemism on islands in all of these species highlights a common impact

of isolation on diversification in the Moluccas, whereas relationships among islands points to a variable and sometimes species-specific impact of geography.

### **V-13-15: Trees vs. Herbs: Difference in Patterns of Niche Differentiation between Related Species**

Tetsukazu Yahara; *Kyushu University*

In previous arguments on the mechanism of species coexistence in forests, it has been assumed that individuals are competing primarily for light, water and nutrients, and reproductive interference between simultaneously flowering plant species is mostly neglected. Here, I examine relative importance of vegetative competition and reproductive interference for species coexistence by examining the following hypothesis. (1) Pollinators easily found canopy flowers and disperse pollen long distance. Thus, stronger reproductive interference between simultaneously flowering species is expected. (2) In understory herbs, niche differentiation to microhabitats may function as an effective reproductive barrier. Thus, weaker reproductive interference is expected. I compared flowering time of closely related plant species in Yaku Island, Japan. Results showed that closely related canopy trees tend to flower in different seasons, while understory herbs tend to flower in the same season. Similar comparison made for altitudinal distribution showed that closely related canopy trees tend to occur in similar altitude, while understory herbs tend to differ in different altitudes. These findings suggest that niche differentiation to microhabitat is more important for understory herbs, and differentiation in flowering season is more important for canopy trees.

### **V-13-16: Integrated Evolutionary and Ecological Approaches to Predicting Endemism in Tropical Rainforests**

Craig Moritz, Ana Carnaval, Stephen Williams, Miguel Rodrigues; *MVZ, UC Berkeley*

One of the greatest challenges facing tropical biologists is to increase our knowledge of foci of species and genetic endemism so as to guide conservation planning in the face of ongoing habitat loss. To compound the problem, tropical biota, both lowland and montane, are expected to be challenged by rapid climate change over the coming century. This talk will present an approach to predicting spatial concentrations of unique species and genetic diversity – hotspots within hotspots. We explore how combining principles from evolutionary and macroecological theory with (i) spatial modeling of habitats and species under varying paleoclimates, and (ii) molecular phylogeography can improve prediction of spatial patterns of diversity. Case studies include the rainforests of north-east Australia and the Atlantic forests of Brazil. Understanding how diversity in such systems was shaped by past climate change could also improve prediction of response to future global climate change.

### **V-13-17: From Genes Regulation to Tropical Rain Forest Biodiversity Conservation**

Vedel, Vincent<sup>1</sup>, Scotti<sup>2</sup>, INRA ; 1. *INRA*, 2. *Ivan*

Natural selection changes molecular diversity pattern depending on environmental constraints. These patterns are visible in regulatory sequences of genes. Looking at these DNA sequences in adaptation genes, in a given tree species, allow us to comprehend its capacity of adaptation to a specific stress. Thus, it is possible, at the population level, to understand 1) the biogeography and the intra-specific diversity of this species and 2) its possible reaction (adaptation or replacement by another species) to environmental change. Here, we show the case study of the Guianese rain forest. We are studying, in several crucial species of trees, the regulation of three types of adaptation genes corresponding to the three major stresses caused by climate change and deforestation: hydric, anoxic and mechanical stresses. The use of a combination of new genomic techniques on wild non-model tree species allows us a novel view of natural adaptive mechanisms. Therefore, potential adaptation of the rainforest to climatic or anthropogenic stress might be anticipated, a central step in the understanding and conservation of the overall biodiversity of this ecosystem.

**V-13-18: Human Impacts on Adaptive Radiation in Darwin's Finches**

Andrew P. Hendry, De Leon, Luis F., Jeff; *McGill University*

Humans represent a common, and increasing, force influencing the evolution of natural populations. Potential arenas of influence include the evolution of traits within populations and the process of divergence among populations. We consider the latter possibility for the medium ground finch (*Gospiza fortis*) of Santa Cruz Island, Galapagos, Ecuador. We did so by comparing the *G. fortis* populations at a relatively undisturbed site (El Garrapatero) to that at a severely disturbed site (Academy Bay). The *G. fortis* at El Garrapatero currently show beak size bimodality that is tied to reproductive isolation. The *G. fortis* at Academy Bay were historically bimodal but have since lost this property in conjunction with a dramatic increase in human population density. We here consider the potential ecological-adaptive drivers of these differences by using individually-banded birds to quantify relationships between morphology (beak and head dimensions), functional performance (bite force), and environmental characteristics (diet). These associations were weaker at Academy Bay than at El Garrapatero, suggesting a general leveling of the selective playing field with respect to diet, morphology, and performance. These results support the idea that humans can smooth the rugged adaptive landscapes that promote diversification and thereby hamper or reverse adaptive radiation.

**V-13-19: Phylogenetic Diversity and a Global Scale Biodiversity Observation Network, GEO BON**

Daniel P. Faith; *Australian Museum*

Loss of evolutionary history is a major concern within the broader biodiversity crisis. A new project within the bioGENESIS program of DIVERSITAS will contribute to the monitoring and assessment of genetic and phylogenetic diversity. The project contributes to an emerging global scale biodiversity observation network, GEO BON (<http://www.earthobservations.org/geobon.shtml>). Global observation strategies can take advantage of a useful calculus for measuring various aspects of loss of evolutionary history, based on the PD (phylogenetic diversity) measure. Essentially, any conventional species-level index may have its counter-part at the level of evolutionary features, based on PD measures. PD related calculations include complementarity and endemism indices. These also form the basis for "phylogenetic risk analysis", which is providing insights into potential loss of evolutionary history of the world's corals. Microbial ecologists have extended the PD calculus through "PD-dissimilarities" (phylogenetic beta diversity) to compare samples based on molecular phylogenetic trees. These patterns link to environmental gradients explaining patterns of turnover in phylogenetic composition. We can extend the geographic coverage of PD dissimilarities to form a biodiversity surface for a given region. Within GEO BON, time series of remotely sensed changes in condition of land/water can be interpreted through the "lens" of this biodiversity surface.

**V-13-20: Providing an Evolutionary Framework for Biodiversity Science: bioGENESIS, a Core Project of DIVERSITAS**

Prieur-Richard<sup>1</sup>, Anne-Hélène<sup>1</sup>, Dan P. Faith<sup>2</sup>, Makiko Mimura<sup>3</sup>, Tetsukazu Yahara<sup>3</sup>; *1. DIVERSITAS, 2. The Australian Museum, 3. Kyushu University*

The exuberant diversity of life around us has been reduced or modified at an unprecedented scale and rate due to human interventions on the environment around the globe. Our lack of knowledge of biodiversity severely compromises our ability to respond appropriately to the rapid environmental changes that are occurring. There is an urgent need to identify, organize and monitor biodiversity with much improved accuracy and precision. While much fundamental work remains to be done, we can, even now, formulate areas of evolutionary investigation of direct significance to understanding and managing biodiversity. Answers to these challenges depend critically on bringing together our ever-expanding baseline data on species identities, distributions, and phylogenetic relationships, as well as

knowledge of the relevant underlying evolutionary processes. bioGENESIS, a core project of DIVERSITAS, the international programme of biodiversity science, aims at catalyzing scientific research that is necessary to make better use of evolutionary approaches to understand and manage biodiversity and, help policy-decision-processes. In this presentation, we introduce the activities of bioGENESIS to further develop integrated research projects at the interface of evolutionary biology and biodiversity science.

## **The Australasian floristic interchange (#15)**

**(July 20 am; Wantilan wing)**

Organized by: **Craig Costion**

*Southeast Asia is renowned for not only its richness of species but the complexity of both its biota and geology. First noted by the world's first biogeographer, Alfred Wallace, this complexity is now attributed to an ongoing influx and interchange of species from mainland Asia and Australia after the two continents first collided in the Mid-Miocene. Although the Laurasian and Gondwanan affinities of faunal groups have been long established, the affinities and evolutionary history of many plant lineages in the Australasian tropics have remained controversial or unresolved. Recent rapid advances in molecular methods and large-scale barcoding initiatives however hold promise to better understand the evolutionary history of plants in this region. This symposium will review a range of long held questions of plant biogeography and evolution in Australasia: 1) What are the Gondwanan and Laurasian affinities of plant lineages in the SE Asian and Australian Tropics and can we quantify the percentage of these lineages for entire biomes? 2) Are there particular lineages that demonstrate a west to east dispersal route across Wallace's line and/or vice versa. 3) How does the recent molecular data agree/disagree with previous paleobotanical and phytogeographic accounts and how does this updated understanding affect previous assumptions about and justifications for conservation areas? 4) What modern methods are most useful for addressing these questions and how do they supersede previous approaches?*

### **V-15-1: The “Intrusive” Laurasian Flora in Australia: Molecular Support for the Malesian Incursion into Australia’s Wet Tropics**

Craig Costion, Mark Harrington, Crayn, James Richardson; *Australia Tropical Herbarium/Uni Adelaide*

The Australian Wet Tropics (AWT) of northeast Queensland comprise only 0.2% of Australia's land area yet maintain the highest percentages of rainforest diversity and endemism on the continent. The importance of this region is widely supported however its origins have been subject to considerable debate. Much of the recent literature and international attention has emphasized the criteria for which its world heritage status area was established; this being, its antiquity and distinction for maintaining a refuge for the ancient Gondwanan flora. The region is often referred to as the oldest rainforest on earth. However, recent molecular work suggests a more complex evolutionary history. Early writings on Australia's phytogeography by J.D. Hooker, which became the dominant paradigm for the next 120 years, classified the region for its unique composition of 'Indo-Malayan' affinities in comparison to the mostly endemic (autochthonous) flora found throughout the rest of the continent. This paradigm held the region to have a mostly “intrusive” flora derived from the northwest. Conflicting hypotheses generated in the light of modern, detailed floristic analysis by Len Webb and Geoff Tracey call this into question, favouring instead a Gondwanan-dominant flora derived from the south. However, the proportion of Gondwanan- vs. Laurasian-derived lineages in the AWT has yet to be resolved in a comprehensive manner. This talk will introduce the symposium with a brief review of the literature on the Australasian floristic interchange then take an in depth look at the eastern flow of Laurasian

lineages into Australia. This will be done by assessing which plant lineages in Queensland the AWT have molecular support for Laurasian origins and those that are unresolved and require further work.

### **V-15-2: What has Gondwana Given Us? Phylogenetic Evidence for Plant Origins in the Australian Wet Tropics and SE Asia**

Mark T. Harrington, Craig Costion, Crayn; *Australian Tropical Herbarium*

The origins and evolution of the Australian tropical flora and its relationship with Asian floras has fascinated botanists for over 150 years. Nineteenth to mid-twentieth century notions of Australian rainforests as depauperate samples of southeast Asian floras and therefore ‘alien and invasive’ have given way to hypotheses that they represent remnants of an ancient Gondwanan flora. Key knowledge advances that promoted this paradigm shift include the acceptance of continent drift and the immense improvement in knowledge of the flora of the Australian Wet Tropics (AWT) including documentation of the so-called ‘primitive’ angiosperm families and discovery of many narrow endemics (especially genera). While maintaining that AWT rainforests are a centre of high diversity and endemism, the idea of a recent remixing between the Indo-Malesian and Australian floras after a long period of separation has recently been postulated. Recently developed methods of analysis such as fossil-calibrated dating of molecular phylogenies offer unprecedented power to evaluate competing hypotheses of the origins of the tropical flora. We analyse in a comparative framework, published and new data for some key lineages of the AWT including the ‘primitive’ angiosperms, to quantify the contribution of Gondwanan elements to the Australian and SE Asian tropical rainforest floras and to generate and test general explanations about tempo and direction of evolution of plants in this biome.

### **V-15-3: Distribution of Endemic Plants in Australian Rainforests**

Daniel J. Metcalfe, Andrew J. Ford; *CSIRO Sustainable Ecosystems*

Rainforest communities occupy only a small percentage of the Australian landmass, yet have a history stretching back millions of years, and represent the last remnants of the forest which formerly covered most of the continent. Repeated extensions and contractions of the range of rainforests during the Quaternary glaciations, and as a result of Holocene climate change, have resulted in serial mixing and then isolation of species in refugial habitat, leading to a high degree of endemism. Over 30% of the species in the bioregion are endemic to it, and a further 30% are endemic to Australia, yet the region is relatively poor in endemic genera and families. The Wet Tropics are also a haven for near-basal lineages, with 16 families represented, including an ANITA grade monotypic endemic family. Such levels of endemism are likely a result of repeated mixing and isolation, and in this paper we assess the sub-regional distribution of endemics both in the Wet Tropics and in the more Papuan-influenced forests of eastern Cape York. We comment on the distribution of plants across the disjunctions known to affect animal distributions, and identify other barriers presumed significant in limiting plant movement. Our data brings together extensive field collections and recent molecular studies, and will suggest future avenues for molecular assessment of potential disjunctions and isolations.

### **V-15-4: Southeastern Tip of Wallacea: Some Preliminary Insights into Tree Flora and Forest Types of the Tanimbar Archipelago, South Moluccas, Indonesia**

Yves Laumonier, Nasi, Robert, Yohanes; *CIRAD-CIFOR*

Very little biophysical and biogeographical information is available for the entire region of southeastern Indonesia. Located in the far south-eastern part of the Wallacea biogeographical subregion, the Tanimbar archipelago is part of the so-called “outer-arc” islands that are mainly raised coral reef and marine sediments. The forest cover of the main island Yamdena still represents two third of the island surface, and remains one of the relatively unexplored ecosystems in the country. Both in term of biogeographical subregion and forest types, there are large uncertainties in the literature, reflecting the very poor scientific knowledge of the area, especially for plants. For such

highly vulnerable environment, this lack of knowledge on the natural resources could lead to rapid biodiversity loss and other environmental consequences. Studies were conducted on the status, type, and ecology of the islands forests to propose adequate conservation versus agricultural development options. Although the islands of eastern Indonesia are known to form biogeographic subregions that have relatively high levels of faunal endemism, the phytogeographic boundaries are less clear. The eastern limit of the Malesian phytogeographic region is fuzzy, with a decrease of the Malesian elements percentage towards the East. The Tanimbar tree flora has been found to be primarily related to the flora of West Malesia, with some New Guinea elements, and very few Australian elements. Our detailed studies of the forest types compared to what was previously known in the literature however, reveal a more diverse picture. The archipelago harbors rain forest previously unreported or wrongly classified, including several monsoon forest types comparable to some northern Australian forests in forest structure but not flora.

#### **V-15-5: Biogeography of *Alocasia* (Araceae): Colonization of the Malay Archipelago**

Lars A. Nauheimer<sup>1</sup>, Peter C. Boyce<sup>2</sup>, Susanne S. Renner<sup>1</sup>; *1. University Munich, Systematic Botany & Mycology, 2. Universiti Sains Malaysia*

*Alocasia* is a genus of Araceae comprising c. 85 species distributed from Sri Lanka to subtropical Australia. Most species are lowland perhumid to everwet forest understorey herbs, although a few grow on exposed sites or at elevations above 1000 m. *Alocasia* is most diverse on Borneo (c. 40 species), the Philippines (c. 18), and New Guinea (c. 12). Rather few species occur in continental Asia and only a single indigenous species occurs in Australia. Molecular clock analyses based on a fossil-calibrated chloroplast and nuclear DNA dataset (>5000 nucleotides) imply divergence from *Leucocasia* (1 species) on the Laurasian continent in the Oligocene. The topology so far suggests repeated dispersal in the Late Miocene between continental Asia, the islands of the Sunda shelf and the Philippines, and a single dispersal to the islands of Wallacea, New Guinea, and to the Australian continent. This fits with the Miocene climate changing from cool/dry to warm/wet, enabling everwet forest, and with it *Alocasia*, to expand into the Malay Archipelago. Most crown group radiations date to the Pliocene. At least three species occur in Java, Sumatra, and the Malay Peninsula, illustrating possible across-island gene flow. Based on herbarium collections, we have begun climate niche modeling for a few well-collected species.

#### **V-15-6: Origin and Dispersal History of SE Asian and Australasian Tropical Angiosperms: New Case Studies and Emerging General Patterns**

Alexandra N. Muellner<sup>1</sup>, Livia Wanntorp<sup>2</sup>, Craig M. Costion<sup>1</sup>; *1. Senckenberg Research Institute, 2. Swedish Museum of Natural History*

The lack of well-resolved phylogenetic trees and fossils has long been a major limitation for biogeographical analysis of the SE Asian and Australasian angiosperm flora. We present some case studies, including well-resolved and fossil-constrained phylogenetic trees for members of the angiosperm order Sapindales, to investigate the origin and dispersal history of plant biotas in this area. One case study is on Aglaieae (Meliaceae), a plant group with good representation in the region in terms of abundance and species numbers, wide ecological attributes and known animal vectors east and west of Wallace's Line. We combined DNA data, fossil evidence and distribution data and used different molecular clock approaches to estimate divergence times. Putative ancestral areas were investigated through area-based and event-based biogeographical approaches. Information on dispersal routes and their direction was inferred from dispersal asymmetries between areas. Results indicate that Aglaieae date back to the Late Eocene, with major divergence events occurring during the Oligocene/Miocene. Dispersal over oceanic water barriers has occurred during geological time and was a major driving force for divergence events, with some old Gondwanan land masses, like Australia, colonized only during recent times. Divergence of living taxa from their closest living relatives peaked in the Pliocene. Present-day distributions must therefore predominantly have arisen as a result of dispersal rather than vicariance events. Colonization from Indomalesia to Australasia

and the Pacific has frequently been followed by speciation. Another case study is on *Hoya* (Apocynaceae), for which we present the latest available phylogenetic data and discuss how these will be used in future biogeographic analyses. In general, currently available studies point towards predominant movement across Wallace's Line from west to east. The relative importance of dispersal and vicariance is still controversial.

#### **V-15-7: A Biogeographic History of *Ficus*: Dispersal Rules over Vicariance**

Rhett D. Harrison, Lei Xu, Darong Yang; *Xishuangbanna Tropical Botanic Garden*

Studies on the evolution of tropical taxa have tended to stress the role vicariance and the break-up of Gondwana in explaining modern distributions, and earlier studies on figs (*Ficus* spp.) supported this view. We used an expanded sample (208 spp.) and improved molecular dating techniques to reconstruct the phylogenetic and biogeographic history of figs. Consistent with the earlier studies, our biogeographic analysis indicated that the ancestor of figs was present in Gondwana. However, a relaxed clock analysis, relying on uncorrelated rates in BEAST, suggested that after the Neotropical section *Pharmacosycea* split off 109 million years ago, other fig lineages originated in India. Most of the basal lineages appear to have diverged in the late Cretaceous and immediately following the KT extinction, and then diversified rapidly after approximately 45 mya. Some predominantly Afrotropical lineages may have evolved initially in Indian subcontinent and then dispersed to Africa via Madagascar in the late Cretaceous or, as with most other lineages, they may have dispersed to Africa following the Eocene collision of India with Asia. The Neotropical section *Americana* evolved from Afrotropical ancestors and must have either island-hopped to South America, or taken a northern route via Europe to the Americas before the terminal Eocene global cooling event. Australian species are also all derived from lineages that rafted with India. The strictly Eastern Melasian section *Malvanthera* and the predominantly Eastern Melasian section *Oreosyce* appear have dispersed across Wallace's line early - possibly on the Asian continental fragment of SW Sulawesi - and then radiated. Other lineages with species east of Wallace's line are apparently recent colonists and include many widespread species. Thus, contrary to earlier reports, our analyses suggest vicariance played a relatively minor role compared to dispersal and ecological opportunity in the diversification of figs.

#### **V-15-8: Wallacean Phylogeography Inferred from Insect Pollinators: Examples from *Ficus* (Moraceae)**

George D. Weiblen, Moe Annika M.; *Bell Museum, University of Minnesota*

The island region of Wallacea is a biogeographical transition zone that marks the meeting of two continental shelves, the Sunda, linking Borneo and Java to the Asian mainland, and the Sahul, connecting New Guinea to Australia. The two plates came into contact around 50 mya and brought distinct flora and fauna into close proximity. Molecular analyses of broadly distributed plant lineages in Wallacea are opportune for reconstructing the history of plant migration across Wallacea but low levels of DNA sequence variation at the species level may confound phylogeographic studies. We used DNA sequence variation in the species-specific pollinators of pan-Wallacean *Ficus* species (Moraceae) to estimate the extent and timing of dispersal and vicariance across the region. Given that fig pollination arose after the break-up of Pangea, closely-associated fig and pollinator lineages spanning the Wallace Line must have achieved their current distribution by dispersal across the Makassar Strait or the Philippine Sea. Divergence times estimated from DNA barcodes of fig pollinators suggest ancient dispersal and subsequent allopatric speciation as an explanation for regional patterns of endemism in one of the most species-rich Australasian plant genera.



## Tropical forest dynamics: long-term changes, disturbances and climate change (#16)

(July 23 pm; Wantilan rear)

Organized by: **Pieter Zuidema and Patrick Baker**

*Tropical forests are changing. Biomass of undisturbed forests has increased over the last decades and rates of tree turnover are changing. In some cases, the drivers of changing forest dynamics are clear (selective logging, drought, fragmentation), but in most cases one can only speculate about what has caused these observed changes (CO<sub>2</sub> fertilization, shifts in rainfall). Getting clarity on patterns and causes of changing forest dynamics is crucial to understand responses of tropical forests to disturbances and climate change. Tree ring series and re-measurements of old permanent plots provide unique long-term records of tree growth. And new techniques used in forest dynamics research (stable isotope analyses, sophisticated population modelling) generate additional information and new hypotheses. In this symposium we aim to share new insights into long-term forest dynamics using a variety of methodological approaches. Improved understanding of tropical forest dynamics helps to quantify the roles of these forests in the global carbon cycle.*

### V-16-1: Long-term Dynamics of an Amazonian Rainforest: A Signature of Global Change?

William F. Laurance; *School of Marine and Tropical Biology, James Cook University*

Amazonian rainforests are some of the most species-rich tree communities on earth. Over a period of nearly three decades, forests in a central Amazonian landscape appear to have experienced nonrandom changes in dynamics and composition. These analyses are based on a network of 18 permanent plots unaffected by any significant human disturbance. Within these plots, rates of tree mortality, recruitment and growth have increased over time. Of 115 relatively abundant tree genera, 27 changed significantly in population density or basal area—a value nearly 14 times greater than that expected by chance. An independent, eight-year study in nearby forests corroborates these shifts in composition. Contrary to recent predictions, pioneer trees have not increased markedly in abundance. However, genera of faster-growing trees, including many canopy and emergent species, are increasing in dominance or density, whereas genera of slower-growing trees, including many subcanopy species, are declining. Rising atmospheric CO<sub>2</sub> concentrations might potentially explain these changes, although inter-annual weather variation and other large-scale environmental alterations could also be important. These compositional changes could have important impacts on the carbon storage, dynamics and biota of Amazonian forests.

### V-16-2: Long-term Monitoring in Australian Plots

Daniel J. Metcalfe, Helen T. Murphy, Matt G. Bradford, Andrew J. Ford; *CSIRO Sustainable Ecosystems*

Rainforest communities persist in near natural states along many of the mountain ranges and massifs of the Australian Wet Tropics. We have been monitoring forest growth for nearly 40 years in twenty permanently marked 0.5 ha plots in unlogged forest from sea level to 1200 m. We assessed the impacts of disturbances such as cyclones, drought and disease on growth over this period. We have also traced mortality and recruitment into the 10 cm dbh size class, and relate our findings to stochastic events and trends in growth rates between taxa. We assess mean community-level trends in growth rates across environmental gradients and show how particular species and their relative abundances are the drivers of community-level patterns. These data allow us to consider the ramifications of changes in community composition on assessments of future growth and on predictions of forest response to climate change.

### **V-16-3: Changing Ecology of Tropical Forests: Insights from 400 Long-term Monitoring Plots from Across the Tropics**

Simon L. Lewis, Oliver L. Phillips, AFRITRON Consortium Authors, RAINFOR Consortium Authors; *School of Geography, University of Leeds*

Tropical forests are carbon-dense, highly productive, and biodiversity-rich. Therefore if small, yet consistent, changes across the biome occur they may have major impacts on biodiversity conservation and the rate and magnitude of climate change via changes to the global carbon cycle. Physiological theory, models and limited experiments each suggest that remote intact tropical forests may be altering in systematic, predictable ways, due to recent large-scale and global environmental changes, with both gross and net primary productivity increasing. However, a series of papers utilising networks of widespread long-term inventory plots of tropical trees showing average increases in the biomass (carbon storage), growth, recruitment and mortality of forest trees over recent decades has been controversial amongst some tropical ecologists. Here I (1) review the latest evidence for and against recent changes within remaining intact mature tropical forests, and (2) assess possible drivers of these changes, utilising approximately 400 long-term forest monitoring plots of trees  $\geq 100$  mm diameter, representing approximately 1 million diameter measurements, spread across the tropics. Lastly I briefly address possible future changes to the biome.

### **V-16-4: Asymmetric Density Dependence Shapes Tropical Tree Species Abundances**

Liza S. Comita<sup>1</sup>, Helene C. Muller-Landau<sup>2</sup>, Salomon Aguilar<sup>1</sup>, Stephen P. Hubbell<sup>1</sup>; *1. National Center for Ecological Analysis & Synthesis., 2. Smithsonian Tropical Research Institute*

An understanding of the causes of commonness and rarity in ecological communities is essential for determining how communities are structured and for designing effective strategies for biodiversity conservation. Yet, a solid understanding of the factors controlling species abundances has eluded scientists, particularly in highly diverse communities, such as tropical forests, where hundreds of species coexist with abundances that vary by several orders of magnitude. In these communities, individuals surrounded by neighbors of the same species often exhibit lower growth and survival, a phenomenon attributed to shared natural enemies or strong intra-specific competition for resources. While numerous studies have emphasized the importance of such negative density dependence (NDD) for species coexistence, little attention has been paid to variation among species in the strength of NDD experienced and the possible consequences of that variation for determining species abundances in ecological communities. We analyzed density-dependent survival of 30,000+ seedlings of 180 tree species in central Panama using a spatially-explicit hierarchical Bayesian approach, which, for the first time, allowed us to quantify variation in the strength of NDD among all species within a diverse tropical tree community. Here we show that the strength of NDD varies widely among species, contrary to assumptions of symmetry made by most theoretical models. In addition, we found that variation in the strength of NDD is significantly related to species' abundance in the community: rare species suffered more from the presence of conspecific neighbors than common species, even when accounting for variation in life history strategy. The relationship between the strength of NDD and species' abundance strongly suggests that density dependence plays a critical role in shaping species abundances in diverse ecological communities.

### **V-16-5: Physiological Consequences of Nutrient Limitation in Lowland Tropical Forest Seedlings**

Louis S. Santiago, Sarah C. Pasquini, S.J. Wright; *University of California, Riverside*

We investigated the consequences of nitrogen, phosphorus and potassium limitation of growth, photosynthesis, and water relations, of tropical forest seedlings in a 12-year, full factorial fertilization experiment at the Barro Colorado Nature Monument in Panama. Relative growth rate of height in five species of tree seedlings (*Alseis blackiana*, *Desmopsis panamensis*, *Heisteria concinna*, *Sorocea affinis* and *Tetragastris panamensis*) increased strongly with potassium addition. There was also a

nitrogen x phosphorus interaction indicating that the increase in height growth in response to phosphorus was greater when combined with nitrogen. Further studies on possible physiological mechanisms for increased growth with nutrient addition in *Alseis blackiana* revealed that potassium addition increased maximum photosynthetic rate and nitrogen addition increased both maximum photosynthetic rate and the rate of electron transport. The strong increase in stomatal conductance with potassium addition suggests that the osmotic effects of increased potassium in plant cells are linked to greater stomatal control and increased light-use efficiency of photosynthesis. Pressure-volume analysis in *Alseis blackiana* and *Heisteria concinna* will also be used to verify whether patterns of osmotic potential at full turgor are consistent with increased growth and gas exchange under increased potassium availability. Overall, the results demonstrate the potential for alterations of nutrient cycles to temper the responses of tropical plants to environmental change.

#### **V-16-6: What Tropical Tree Rings Can Tell Us About Changing Tree Growth and Forest Dynamics**

Pieter A. Zuidema<sup>1</sup>, Rozendaal<sup>2</sup>, Soliz-Gamboa<sup>1</sup>; *1. Utrecht University, 2. Danae MA*

Tropical forests harbour a large proportion of the global terrestrial carbon stock. Responses of tropical forests to atmospheric changes may therefore have important consequences for the global carbon cycle. For this reason, it is important to know whether tree growth and forest dynamics in the Tropics have shifted over the last decades and centuries. So far, re-measurements in permanent plots have shown that forest biomass has increased over the past decades and tree growth has increased. However, the short existence of most of these plots limits the period over which changes in tree growth can be detected. Tree ring analysis offers an alternative as it allows the reconstruction of lifetime growth trajectories of trees, at an annual time resolution. Using this technique, it is possible to evaluate whether decadal-scale growth increases are also present at longer timescales. We present results from tree ring studies on a number of Bolivian tree species from lowland moist forests. We measured tree ring widths on tree discs and increment cores of several hundreds individual trees of varying size and age. Our results suggest that (1) juvenile tree rings are also formed annually, in spite of differences in phenology between juvenile and adult trees; (2) juvenile tree growth has increased over the last ~200 y in certain size categories of several species, (3) fast-growing small juvenile trees have a higher chance to reach the forest canopy; (4) tree-turnover has not changed over the last two to three centuries; and (5) responses of juvenile trees to canopy gaps can range from none to strong and is highly species- and size-specific. We discuss the opportunities and limitations of applying tree ring analysis to understand tropical forest dynamics.

#### **V-16-7: Dendroecological Investigations in Bidoup Nui Ba National Park, Vietnam: A Millennial Perspective**

Brendan M. Buckley<sup>1</sup>, Nestor T. Baguion<sup>2</sup>, Philip Thomas<sup>1</sup>, Xuan Lan<sup>1</sup>, Le Canh Nam, Bidoup Nui Ba National Park, Vietnam; *1. Columbia University, New York USA, 2. University of the Philippines, Los Baños*

Given the near complete absence of temporally constrained data and ecophysiological research on most tropical tree species, major key questions in tropical forest ecology remain unanswered. Some of these questions are quite basic: 1) how long do individuals of a species live? 2) what are the age–size relationships of different species? 3) how variable are the age distributions for different species? More complex questions surround issues of co-existence of hundreds of species, determining the amount of carbon stored annually, and the role of climate variability in triggering episodic recruitment. Dendrochronological dating of tropical forest species can facilitate a detailed analysis of the time–dependent response of entire forest ecosystems to external forcing related to climate, and to endogenous influences of gap-phase dynamics that are intrinsic to complex forest systems. And yet there are very few absolutely crossdated tree ring records from tropical forests, despite several published reports that identify annual growth rings in tropical trees. We present a millennium length ring–width chronology from the species–rich montane forests of Bidoup Nui Ba National Park in Lam

Dong province, southern Vietnam. The species is the Vietnamese cypress *Fokienia hodginsii*, which we have used to produce a robust, statistically calibrated and verified reconstruction of hydroclimate for the past 750 years. The reconstruction reveals periods of episodic drought and pluvials, often lasting decades, that coincided with key periods of social upheaval across Southeast Asia and may have had important consequences for the historical dynamics of tropical forests across the region. We also demonstrate that several other species, including other millennial-aged conifers, from these forests produce annual rings, can be crossdated, and can be used for answering some of the key questions noted above.

#### **V-16-8: Isotope Analysis to Reconstruct Environmental Change and Tree Responses in Tropical Forests**

Peter Hietz, Charles Nock, Wolfgang Wanek, Patrick Baker; *Inst. Botany, Univ Nat. Res. Appl. Life Sci. (BOKU)*

We use stable isotopes (C, O and N) and nitrogen concentration to document long-term changes in tropical rainforests in Brazil and Panama, and a monsoon forest in Thailand, and analyse the effect of these changes on tree physiology. Rising CO<sub>2</sub> concentrations have resulted in increased water use efficiency (WUE, i.e. C fixed per H<sub>2</sub>O lost), with higher gains in the drier forests. In rainforests, WUE likely results from an increase in C uptake as well as a reduction of water loss, but in drier forests, the increase in WUE appears to be more an effect of reduced water-loss rather than increased CO<sub>2</sub> uptake and we see no increase in growth. Tree rings and herbarium records reveal a substantial change in N isotope ratios and point to an increase in N concentrations. The importance of these trends to understand past changes and to predict the future of tropical forests will be discussed.

#### **V-16-9: Soil Charcoal Abundance, Distribution and Age in the Amazon Foothills of Ecuador and Peru**

Sanford, Jr., Robert L.1, Sally P. Horn2; *1. University of Denver, 2. University of Tennessee*

More than 80% of terrestrial organic C is in soils. We measured an under-evaluated form of soil C that has been sequestered for millennia in tropical forest soil via biomass-derived black C, also known as charcoal or wood-char. Our objective is to quantify this slow-turnover pool of soil C in mature forests at Yasuni, Ecuador and in the vicinity of Iquitos, Peru in western Amazonia, and place this information in the context of forest disturbance. We measured charcoal buried in soils to 1 m depth on two ridges. Soils were sampled randomly within 100 m<sup>2</sup> plots to 1 m depth using a tubiform soil corer and extracted 10 cm increments. Soil charcoal was encountered at every depth in at least one of the 18 cores, but was found most frequently (>70%) at 10-50 cm. The total amount of soil charcoal (to 1 m depth) varied widely, ranging from 0 to 98.10 g/m<sup>2</sup> per core while the average soil charcoal mass for forest sites in Peru was 10.06 g/m<sup>2</sup> and 18.09 g/m<sup>2</sup> in Peru and Ecuador respectively. At both sites most of the soil charcoal was in the uppermost 50 cm. Because of proximity (0.5 km) to the Yasuni forest dynamics plot in Ecuador, evidence of frequent forest burning may be important for interpreting the extremely high tree diversity in that plot.

#### **V-16-10: Low-intensity, Landscape-scale Disturbance Pulses in a Seasonal Tropical Forested Landscape**

Patrick J. Baker<sup>1</sup>, Sarayudh Bunyavejchewin; *1. Monash University*

The formation of canopy gaps has long been considered a key component of tropical forest dynamics. Across tropical landscapes canopy gaps are typically assumed to be distributed randomly in time and space. In the absence of annual growth rings in most tropical tree species, it has been difficult to assess the temporal distribution of canopy gap establishment dates. We conducted a dendroecological reconstruction of disturbance events in seasonal tropical forests in western Thailand to evaluate the temporal distribution of gap formation across a large landscape. We found that small-scale

disturbances (e.g., gap formation) occurred in every decade of the 20th century. However, the frequency of canopy gap establishment was not random over that period. During certain periods there are large pulses of gap formation across the entire landscape. This pulsed disturbance regime is often associated with widespread, low-intensity fires which occur infrequently across the region, but are often associated with intense regional drought events. This simultaneous establishment of hundreds to thousands of gaps across the landscape synchronizes gap-scale dynamics at much large spatial scales.

## Human health, food security and forests (#17)

(July 20 pm; Wantilan wing)

Organized by: **Bronwen Powell and Patricia Shanley**

*During this decade, an increasing amount of evidence has been accumulated linking human health and food security to biodiversity and forest maintenance. Clear links on the positive side include the provisioning services of forests such as foods, medicines and shelter, the cultural implications of forest lifeways (emotional and cognitive connections that give meaning to forest people's lives), and cultural services such as indigenous knowledge and traditional health care systems. On the negative side, forested areas tend to be home to many diseases, some of which derive from habitats that favour disease or disease vectors, and some related to the remoteness and resulting lack of health services in such areas.*

*The Human Health, Food Security and Forests Panel will focus on research highlighting the importance of forests for health and especially food security of local populations. Research on forests and food security is particularly timely as increasing international attention to climate change fuels increasing interest in climate change mitigation. While many forest and biodiversity researchers focus on the role of "mitigation," the role of forests in "adaptation" – the maintenance of human well-being and livelihood security in the face of climate and other environmental and socioeconomic changes, is equally important. This panel will expand awareness of the links among human health, food security, biodiversity, and forest maintenance among scientists, strengthening inter-disciplinary communication and thereby helping to bridge epistemological gaps.*

### V-17-1: Food Security: Why is Biodiversity Important?

Terry Sunderland; *CIFOR*

Since agriculture began some 12,000 years ago, approximately 7,000 plant species and several thousand animal species have been used for human nutrition. Today, although certain traditional and indigenous communities continue to use a multitude of species in their diets, the general global trend has been towards diet simplification, with consequent negative impacts on human food security, nutritional balance and health. It is estimated that about three-quarters of the varietal genetic diversity of agricultural crops have been lost over the last century. Just twelve crops and fourteen animal species now provide the majority of the world's food. As biodiversity used in food and agriculture declines, the food supply becomes more vulnerable and unsustainable and agriculture becomes less able to adapt to environmental challenges, such as climate change or water scarcity. However, biological diversity comprises countless plants that feed and heal people, many crop varieties and aquatic species with specific nutritional characteristics, livestock species adapted to harsh environments, insects that pollinate fields and micro-organisms that regenerate agricultural soils. Less genetic diversity means fewer opportunities for the growth and innovation needed to provide food security, boost agriculture at a time of soaring food prices and competition for biofuels.

Biodiversity, food and nutrition intersect on a number of key issues. Biodiversity contributes directly to food security, nutrition and well-being by providing a variety of plant and animal foods from domesticated and wild sources. Biodiversity can also serve as a safety-net to vulnerable households during times of crisis, present income opportunities to the rural poor, and sustain productive

agricultural ecosystems. The conservation and sustainable use of biodiversity is pivotal to feeding the estimated 800 million malnourished people in developing countries. This presentation will discuss the linkages between biodiversity and food security and will provide an overview of why biodiversity conservation is an important component for securing rural livelihoods.

#### **V-17-2: Women, Health and Forest Conservation**

Meilinda Wan; *CIFOR*

Gender issues have acquired the attention of many sectors, including conservation in the forest domain. Women who live in and around the forests of developing countries, predominantly from marginalized groups, should not be ignored. This paper reviews existing literature on women, health and forest conservation. Forests provide women with positive and negative aspects. Fuel wood and fodder are important forest products for their livelihoods. With frequent use they have gained considerable knowledge of these species, which could be useful for forest conservation. With minimal availability of health services and the burden of household activities, their forest dependence causes health and safety concerns. Of most concern are smoke from using fuel wood for cooking and heating and the heavy burden of carrying fuel wood. Besides, health and safety issues, including working in the forest, the burden of unintended childbearing and the family add to their problems. Some research and development organizations have already identified the connection between women, health and conservation. However, generalizations that forest women are forest conservationist should be avoided. Not all forest women are pro forest conservation, some would like to escape from forest and land related work.

#### **V-17-3: Hunter-gatherers' Health in the Northern Sierra Madre Natural Park, the Philippines**

Tessa Minter, Terry Sunderland, Gerard Persoon, Reimar Schefold; *CIFOR*

The Agta are a forest dwelling hunter-gatherer people living in Northeast Luzon, the Philippines. The total population numbers around 10,000 individuals, spread across small, kin-based communities in the Sierra Madre Mountain Range. This paper focuses on around 1,800 Agta, residing in the country's largest protected area, the Northern Sierra Madre Natural Park (NSMNP). The park was established in 1997 and covers 360,000 hectares of forest and marine habitats. Due to both their indigenous status, and their dependence on the park's forest and aquatic resources, the Agta are allowed to extract resources from the protected area under certain conditions. However, because of weak law enforcement, the Agta's hunting and fishing grounds are under continued and increasing external pressures. Agricultural expansion and uncontrolled resource extraction by immigrant communities is causing the forest to become both smaller and less productive. This paper presents data on the Agta's high morbidity and mortality rates, nutrition, and hunting and fishing success rates. It explores the link between the Agta's poor health conditions and resource degradation. The results are based on ten months of ethnographic field work conducted between 2002 and 2007.

#### **V-17-4: Effect of Forest Cover and Access on Dietary Intake in the East Usambara Mountains, Tanzania**

Bronwen Powell<sup>1</sup>, Jaclyn Hall<sup>2</sup>; *1. McGill University, Canada, 2. The University of Louvain la Neuve, Belgium*

The East Usambara Mountains lie at the heart of one of the world's richest biodiversity hot-spots, where high human population density and extensive logging activities threaten the forest. Poverty, food insecurity and under-nutrition in local populations are both in part due to and a driver of continuing deforestation. In the East Usambaras both the forests and the local people are extremely vulnerable. This paper seeks to examine the role forests play in local diets by examining relationships between dietary patterns and intake and measures of forest cover, forest use, and rights to forest access. Information on dietary patterns, diversity and intake was collected for children and their

mothers in 270 households (HHs). GIS was used to generate information on amount of forest canopy cover and surface area of open water resources in 0.5 to 2.0 km radius areas around each HH. HH reporting consumption of foods from wild or non-agricultural land were compared to those not reporting use of such foods. A strong positive relationship between forest cover and diversity of fruits consumed was found, however the relationship was confounded by elevation. HH reporting use of foods from wild or non-agricultural lands did not have different wealth or education but had greater canopy cover and higher total dietary diversity (a marker of diet quality). Open water within 1 km from the house was associated with consumption of higher fish diversity. Other aspects of dietary intake were not related to proximity of forest cover in this study. HH reporting trips to the forest had lower canopy cover within the proximity, suggesting that HH in areas with greater canopy cover are obtaining substance products from land use types with canopy cover but not considered “forest” by local people (such as agroforests, farms and fallows). Despite long-term efforts to include communities in conservation of forests, in the East Usambaras there is limited use of protected government forests for food resources by local people, contributing to local peoples’ perceived lack of benefits from forests. Empirical evidence of the importance of forest ecosystems in the provision of adequate dietary intake will provide local populations with novel impetus for conservation and will support efforts to decentralize forests management, giving communities greater control over resources necessary for their subsistence.

#### **V-17-5: A Comparison Study of Plants Used as Traditional Medicine in Kampung Naga and Kampung Pulo, West Java**

Rina Ratnasih R. Irwanto; *Institut Teknologi Bandung, School of Life Sciences & Technology*

Humans depend on plant products for their daily life such as for lumber, fabric, paper, food, and industrial chemicals. Relation between plants and people, emphasizing many branches of human knowledge such as history, anthropology, botany, ecology and ethnobotany. Etnobotany gives value to peoples in traditional knowledge and understanding of their cultures, and also the practical use of plants. A comparison study of plants used as medicinal herbs in Kampung Naga and Kampung Pulo have been done to analysis how the modernisation affect traditional people use plants as medicine which have been used in generations. Kampung Naga and Kampung Pulo both located in West Java and have become a tourism destination. The methods for the study including open ended interviews with selected informant, and field observation. Plant identification was carried out in the Herbarium Bandungense, Institut Teknologi Bandung. The results showed that Kampung Naga’s community were still used more plant species for treating minor disease than that of Kampung Pulo’s community. More than 30% of plants identified in Kampung Naga, use as material medicine to treat minor disease such as fever, whereas in Kampung Pulo, people only use less than 20% of plant identified in the area. However, both communities used similar plants such as *Curcuma domestica*, *Cymbopogon nardus*, *Averrhoa carambola*, *Zingiber officinale*, *Imperata cylindrica*, *Musa paradisiaca*, *Ageratum conyzoides*, *Persea americana*, *Bambusa sp*, *Allium sativum*, *Oryza sativa* as medicinal plants.

#### **V-17-6: Conflict of Use in Tropical Forests: The Impacts of Logging on Non-timber Forest Product Availability**

Lucy Rist<sup>1</sup>, Terry Sunderland<sup>2</sup>, Douglas Sheil<sup>1</sup>, Ousseynou Ndoye<sup>1</sup>, Nining Liswanti, Julius Tieguhong and Patricia Shanley; *1. NONE, 2. CIFOR*

The potential for integrating timber and non-timber forest product extraction has been discussed in the context of diversified forest management. However, many tropical forests are exploited both commercially for timber and by forest-dependent communities for non-timber forest products, conflicts between these two uses may have significant implications for forest-dependant livelihoods. We draw on three case studies in Brazil, Cameroon and Indonesia to consider the livelihood consequences of commercial logging. Conflict of use, competition for resources, the facilitation of unsustainable NTFP harvesting and indirect impacts such as altered forest structure; all affect the availability of non-timber forest resources. Work in Brazil over a ten-year period of successive

logging events revealed marked changes in consumption of valuable NTFPs, a consequence of both logging itself and associated fire. In Cameroon communities reported declines in the majority of exploited NTFPs, with significant income implications. In Indonesia the value of logged forest to local communities was found to be significantly reduced in comparison to primary forest. Despite significant impacts on livelihoods including income and health, we found evidence in each case to indicate potential for making timber extraction more compatible with subsistence use of NTFPs. These findings have significant implications for current policy aimed at reconciling timber and non-timber uses of tropical forests.

#### **V-17-7: Contrasting Effects of a Legacy of Logging and Active Logging on Patterns of Parasitism in African Ape Populations**

Thomas R. Gillespie<sup>1</sup>, David Morgan<sup>2</sup>, Ken Cameron<sup>1</sup>, Patricia Reed<sup>1</sup>, Gonzalo Vazquez-Prokopec, Crickette Sanz; *1. Emory University, 2. Lincoln Park Zoo*

Many studies have examined the long-term effects of selective logging on the abundance and diversity of free-ranging primates. Logging is known to reduce the abundance of some primate species through associated hunting and the loss of food trees for frugivores; however, the potential role of pathogens in such primate population declines is largely unexplored. Selective logging results in a suite of alterations in host ecology and forest structure that may alter pathogen dynamics in resident wildlife populations. In addition, environmental pollution with human fecal material may present a risk for wildlife infections with zoonotic pathogens. How do patterns and risk of parasitism during the active logging process differ from those that are the product of a legacy of selective logging? To better understand this interplay, we compared patterns of gastrointestinal parasitism in sympatric western lowland gorillas (*Gorilla gorilla*) and chimpanzees (*Pan troglodytes*) in the undisturbed Goualougo Triangle of Nouabalé-Ndoki National Park and two adjacent logging concessions, one previously logged and the second actively undergoing logging in northern Republic of Congo. Patterns of parasitism did not differ between historically logged and undisturbed forest for chimpanzees or gorillas. However, ape fecal samples and vegetation plots (associated with tree species frequented by gorillas and chimpanzees) revealed the presence of *Strongyloides stercoralis* larvae at high prevalence in areas of active logging. This represents an unanticipated threat to ape health and conservation since *S. stercoralis* was not thought to occur in humans in this region and is associated with hyperinfections with the capacity for high mortality rates in apes and humans.

#### **V-17-8: Medicine on the Frontiers of Rain Forest Conservation: Healthcare to Heal the Planet**

Kinari E. Webb<sup>1</sup>, Ety Rahmawati<sup>2</sup>, Hotlin Ompussunggu<sup>1</sup>; *1. Health in Harmony, 2. Alam Sehat Lestari*

Our work is based on the philosophy that both human and environmental health are intimately intertwined. We present a unique pilot program that is attempting to stem the devastating loss of rain forest through a system that offers health care incentives to communities that become forest guardians. In July 2007 a clinic was opened on the border of Gunung Palung National Park in West Kalimantan, Indonesia and since then it has treated more than 15,000 patients. No one is ever denied care and everyone can pay with non-cash payment options but communities that are protecting the National Park during a given month are given extra discounted care either in the fixed clinic, mobile clinic, or for ambulance use. Included in our work is a tuberculosis control program, distribution of free birth control, reforestation work, goats-for-widows program and organic-farm training as an alternative to shifting agriculture. We present this model as potentially replicable around threatened biodiversity throughout Indonesia and the world.



## Managing invasive alien species (#19)

(July 23 am; Wantilan rear)

Organized by: Sri S. Tjitrosoedirdjo and Bambang Purwantara

*Indonesia has been benefiting greatly from foreign crop species in so many ways. Crops such as rubber (*Hevea brasiliensis*), oil palm (*Elaeis guineensis* Jacq.), coffee (*Coffea*), cacao (*Theobroma cacao*), and cassava (*Manihot utilisima*), to mention a few, have been fulfilling household and industrial needs for foods and feeds since they became domesticated. In the same way, some ornamental plants and exotic fishes and pets have been providing enjoyment and enhanced social life to various groups of people. However, the importation of these foreign beneficial species also carried with them unwanted species which have become nuisance such as *Crassocephalum crepidioides*, a weed from South America contaminating coffee seeds. Some imported species meant for beneficial purposes have unfortunately become a menace. For instance, *Mikania micrantha*, intended as medicinal plant, is now considered an invasive alien plant species threatening plantations and logged over forests. Iguana as a pet is now regarded as a pest since its release in some forests in Indonesia as it consumes eggs in the nests of local birds. *Widelia trilobata* (now recognized as *Sphagneticola trilobata*) used to be a beautiful garden plant but has become a difficult weed to control in rubber and coconut plantations and even in newly established forests. These species and several others, now aptly considered as invasive alien species (IAS), have already been recognized as causing reduction in biodiversity in terms of altering nutrient cycle and posing competition with other crops, and becoming pests in some production systems.*

*In most cases, areas that are susceptible to invasive alien species are those considered disturbed areas which can be of natural origin though the greater fraction of them is man-made. These areas are prevalent in Indonesia such as logged over forests aside from overgrazed pasture lands, various inland aquatic ecosystems, and agricultural plantations. The challenge for Indonesia is to manage these areas well to prevent the introduction and proliferation of IAS, if not to control or totally eradicate them whenever appropriate. Are there best practices in managing IAS that are already documented? What management aspects need improvement? Do we have the necessary manpower and infrastructure to sustain such practices? How could all these be integrated toward developing a national regulatory framework for managing IAS?*

### V-19-1: Native Latitudinal Range, and Growth Habit Predict Progression Through the Plant Invasion Continuum on a Tropical Island

Xingli Giam<sup>1</sup>, Kwek Yan Chong<sup>2</sup>, Richard T. Corlett<sup>1</sup>, Hugh T.W. Tan<sup>1</sup>; *1. Princeton University, 2. National University of Singapore*

The invasion of exotic plant species is a major threat to persistence of native biodiversity. To understand the mechanisms of plant invasions, previous studies identified species traits that correlate with invasion or naturalization success. However, no study investigated correlates of successful transitions along the invasion continuum in the tropics. Here, we identify ecological and life history traits that correlate with successful transitions from being introduced to casual, and casual to naturalized, in the exotic vascular flora of Singapore, and if the same traits predict transitions across both stages. We use generalized linear mixed-effect models to identify traits that distinguish (i) introduced species that escaped cultivation from those that have not, and (ii) species that established reproducing populations after escaping cultivation from those that have not, while controlling for within-superorder phylogenetic relationships using the random-effect structure. We found that the probability of a species successfully escaping cultivation increases with native latitudinal range, native longitudinal range, and when the species is an herb and native to the tropics. These same traits increase the probability of a species establishing reproducing populations but only native latitudinal range and an herbaceous growth habit were included in the top Bayesian Information Criterion-ranked model. This study, to the best of our knowledge, is the first to show that native latitudinal range and growth habit determines naturalization success of exotic plants in the tropics. Our results also show

that correlates of naturalization success are likely to be locality-specific as comparable studies in temperate regions identified different traits. Lastly, our results highlight the importance of adopting a stage-wise approach in studying biological invasions in the tropics as different but overlapping suites of traits drive transitions through different stages of invasion.

### **V-19-2: Invasion by Native Tree Species Prevents Biotic Homogenization in Novel Forests of Puerto Rico**

Oscar J. Abelleira Martinez; *International Institute of Tropical Forestry*

In Puerto Rico and other tropical islands, agricultural abandonment has facilitated the expansion of novel forests dominated by the introduced African tulip tree *Spathodea campanulata* Beauv. (Bignoniaceae). In this study, I characterized the substrate, land use history, spatial attributes and tree species composition of *S. campanulata* forests in northcentral Puerto Rico as means to evaluate if biotic homogenization is occurring. Non-metric multidimensional scaling was used to examine what variables were related to the large and small ( $\geq 2.5$  cm diameter at breast height [DBH]), and juvenile ( $< 2.5$  cm DBH) tree species composition of twenty *S. campanulata* forests. Species composition, especially that of juvenile trees, was strongly related to geological substrate, slope and soil, and less related to land use history and spatial attributes. The introduced species component was low (mean = 17%, S.E. = 1.8) and compositional differences were mostly due to native tree species of secondary to old growth forests on equivalent geological substrates. Animals seem to disperse most tree species into these forests yet because of this some introduced species are likely to persist. Although uncommon native tree species were mostly absent, recent species establishment is shaped by substrate type making homogenization in these forests unlikely. The *S. campanulata* forests of Puerto Rico facilitate the recovery of native tree species in deforested lands where poor land use practices extirpated original forest. These results are relevant to the management of agricultural landscapes where anthropogenic changes have or could result in the growth of novel forests dominated by this species.

### **V-19-3: Alien Plant Invasions in Tropical and Sub-tropical Savannas: Patterns, Processes and Prospects**

Marcel Rejmánek<sup>1</sup>, Foxcroft<sup>2</sup>, Llewellyn C.1, David M.1; *1. University of California, Davis, 2. South African National Parks*

Although alien plant species are invading virtually all landscapes on earth, the degree to which different regions and biomes are invaded, and the quality of information from different regions, varies greatly. A large body of literature exists on the invasion of savannas in the Neotropics and northern Australia where plant invasions, especially by African grasses, have had major impacts. Less has been published on plant invasions in African savannas, except for those in South Africa. Negative impacts due to plant invasions in African savannas appear relatively minor at present. As savannas cover about 60% of the African continent, with tens of millions of people relying on the services they provide, it is timely to assess the current status of invasions as a threat to these ecosystems. We review the available data, contrasting the African situation with that of the Neotropical and Australian savannas. The conclusions that follow from our studies of the literature and observations in South Africa, Botswana, and Uganda indicate that in African savannas invasive alien plants are not yet very widespread or common, and are a relatively minor cause of habitat degradation and biodiversity loss. We suggest that lower extent of alien plant invasions in African savannas is largely attributable to: (1) (until recently) significantly lower rates of intentional plant introductions, and widespread planting thereof, (2) the role of large mammalian herbivores in these ecosystems, and (3) the adaptation of African savanna systems to fire. We discuss how changing conditions in the three regions are likely to affect plant invasions in the future.

### **V-19-4: Grass as Human Footprints**

Alex Sumadijaya; *Herbarium Bogoriense - Research Center for Biology*

Grass as one of the distinctive vegetation component is closely related with human life. The cradle of our civilization was caused by domestication of wheat, maize, and rice in certain places on earth. At present, approximately 20 percent of land surfaces covered by grassland, and the percentage is going higher due to human influences. Human intervention to natural ecosystems could dramatically change the landscape. Secondary ecosystem components being heavily affected by human presence.

Numerous grass species around the world are supported by specialized features such as pollination (mostly by wind), dispersal mechanism (wind, animals, even water), and diaspores. The diaspores itself consist of generative part (small and numerous spikelets) and durable vegetative parts (rhizomes and stolons). Moreover, the metabolic pathways support different type of colonization. Wide area of gap in forest easily covered by sun loving species which mainly C4. At different conditions, C3 grass form green fence on side of track on shaded place as well as place with relatively high humidity.

Moreover, those dwellers can be divided into two groups based on origin, which are alien, (the outsiders of natural distribution) and native, as the indigenous species. Both groups could be invasive to environment and colonizing easily. *Poa annua*, as example of one now widespread grass species in the world, originated from Mediterranean area. It called white man's foot since it occupying all habitats where the white man spreading it accidentally. As climate change plays crucial factor and affecting the whole ecosystems on earth, i predict on near future, there will be significant changes on natural land cover. Contribution of plantation, mining, tourism activities with human as dispersal agent is significant. The impact is declining biodiversity of particular area, parallels with the increasing of grass biomasses rapidly.

#### **V-19-5: High Potential for Seed Dispersal by an Introduced Predator (*Rattus rattus*) in Hawaiian Montane Forest**

Aaron B. Shiels, Donald D. Drake; *University of Hawaii*

Rats (*Rattus* spp.) are omnivorous predators that have been introduced to many ecosystems worldwide and are among the most widespread and problematic invasive animals affecting islands. Rats may affect plant recruitment through seed dispersal and predation. Vulnerability of fruits and seeds to rats was tested in Hawaii by combining field trials in mesic forest with laboratory trials (captive feeding) with the most common rat (*R. rattus*). In the field, fruits of 12 woody plant species (eight native and four non-native) were arranged on the forest floor individually in four, camera-monitored treatments that excluded different-sized vertebrates (N = 8 for each treatment). Eleven of the 12 species had a portion (3% to 100%) of their fruit removed from vertebrate-accessible treatments, and *R. rattus* was the only animal photographed removing fruit. In the laboratory, captive *R. rattus* were offered fruits of the same 12 species to assess consumption of the pericarp and seed mass and to assess seed survival. Eight species had > 50% of their seed masses eaten by rats, and six of these eight species were usually killed when eaten by rats. Two of these eight species (the non-native *Clidemia hirta* and the native *Kadua affinis*) are likely dispersed when consumed because their seeds were small enough to pass intact through the rats. For 10 of the species (including both single- and multi-seeded species) a portion of the seeds offered were undamaged or partially (< 50%) damaged with the embryos left intact. Combining the laboratory findings with evidence of fruit removal by rats in the field indicates that many of the interactions between *R. rattus* and seeds of native and non-native species potentially result in dispersal rather than predation. Forest composition may be altered by introduced rats through their roles as both seed predators and seed dispersers.

#### **V-19-6: History Matters: Divergent Ecological Correlates of Abundance of the Exotic African Grass *Andropogon gayanus* in Early- and Late- Stages of Invasion,**

Aaron M. Petty, Samantha S. Setterfield, Keith Ferdinands; *Charles Darwin University*

Gamba grass (*Andropogon gayanus*) is a highly invasive pasture grass that was first introduced to Australia in 1931. It has recently been declared a Key Threatening Process in Australia for modifying

nutrient and water cycling, increasing fire fuel loads, modifying understory composition, decreasing tree canopy cover and increasing tree mortality in the tropical savannas of northern Australia. We compare and contrast gamba grass abundance and environmental correlates of abundance across two invaded savanna regions in the outer Darwin region, Northern Territory, Australia. One region, Litchfield National Park, is recently invaded and Gamba grass has only become locally widespread in the last ten years. The second region, the Adelaide River Site, is an abandoned cattle property that has a longer-established population of Gamba grass. In Litchfield National Park, Gamba grass abundance was strongly correlated with proximity to drainage lines and high-nutrient soils, and was affiliated with native woody vegetation that also occurs in relatively moist, fertile locations. By contrast, in the Adelaide River Site, Gamba grass abundance was not correlated with any measured environmental variables and was widespread across many vegetation communities. We conclude that Gamba grass spreads initially within highly suitable environments however eventually will colonize most upland communities in northern Australia. Our results will aid in predicting patterns of gamba grass spread and inform management strategies to slow and mitigate the invasion of Gamba grass. However, our results strongly suggest that studies to determine habitat suitability during the early stages of biological invasions are not indicative of the entire range of suitable habitats of an invasive species.

### **V-19-7: Role of Phenotypic Plasticity in the Invasiveness of a Grass Species of Global Importance**

Alexandre B. Sampaio, Curtis Daehler, Vania Pivello, Agno Damasceno; *University of Hawaii*

Introduced species may face very different environmental conditions in their new habitat compared to their original distribution. Phenotypic plasticity is one trait that may allow introduced species to spread into new habitats and outcompete native plants. This study assessed the role of phenotypic plasticity in the invasiveness of *Melinis minutiflora* (molasses grass). It is a stoloniferous Poaceae native to sub-Saharan Africa currently spread across the tropics, displacing native species and changing fire regimes. Seedlings of *M. minutiflora* and native grass species were grown in pots with different irrigation, fertilization, light and competition regimes; biomass allocation was used as a phenotypic plasticity measurement. We did the experiment in Brazil by planting *M. minutiflora* with three native *Aristida* spp. and in Hawaii by planting it with three native *Eragrostis* spp. The potential distribution of *M. minutiflora* was evaluated in Brazil (Goiás state), Hawaii (Hawaii Island) and Tanzania (native habitat) as a measurement of environmental breadth. *M. minutiflora* populations may have low genetic diversity due to reproductive traits, in which case a wide environmental breadth could be attributed to phenotypic plasticity. The experiment in Brazil showed an impressive variation on root:shoot biomass ratio for *M. minutiflora* in two contrasting light conditions (0% and 50% shade,  $F(1,142)=323.4$ ,  $P<<0.001$ ), with *M. minutiflora* always outcompeting the native species. The estimated potential distribution (BIOMOD ensemble model) showed that *M. minutiflora* may be able to occur in more than 60% of the climate space (1950 to 2000 averages for temperature in the coolest month, annual rainfall and rainfall in the driest quarter, WORLDCLIM) found in each one of the studied regions. *M. minutiflora*'s ability to vary its phenotype according to the environment and sustain a competitive superiority in all experimented situations may explain its wide distribution.

### **V-19-8: The Uses and Limits of Habitat Suitability Models for Invasive Species: A Case Study of an Exotic Grass Invading a Tropical Australia Floodplain**

Dongwook Ko, Setterfield Samantha, Buckley Yvonne, Ferdinands Keith, Aaron Petty, Michael Douglas; *School of Environmental and Life Sciences, Charles Darwin University*

Habitat suitability models (HSMs) have been widely used to predict or explain the spatial distribution of species in a range of ecosystems. There has been increasing interest in the application of HSMs to prioritise management by identifying vulnerable habitats to invasive plants. From a management perspective, such models are most useful in the early stages of invasion. However, this can violate some of the key assumptions of HSM: the invasive species has not occupied the full potential range of sites, which also leads to the limited spatial and temporal range of environmental variables being

sampled. The objective of this study is to evaluate the uses and limits of HSM in light of these concerns. Our target species is *Urochloa mutica* (para grass), a tropical invasive grass that is rapidly expanding in the tropical wetlands of Magela Creek in Kakadu National Park of north Australia. We used a combination of ground and aerial survey data collected between 2006 and 2009 to generate habitat suitability maps based on MAXENT approach, and analysed the similarities and differences. We evaluated the impact of several datasets on model performance, habitat preference, and management recommendations. Our results suggest that: (1) model performance was not sensitive to changes in the type of dataset used; (2) in contrast, models were strongly sensitive to different sets of environmental variables; (3) habitats identified as most susceptible to invasion differed depending on the type of survey data used. While our results highlight the importance of well-designed surveys for reliable HSM results, especially to capture the dynamics of the underlying ecological regime, we also present the use of various ensemble maps as a useful way to improve the utility of HSM for landscape-scale management of invasive species in its early phase.

#### **V-19-9: Invasive Plant Species Posed a Great Problem to Forest Rehabilitation**

Soekisman Tjitrosoedirdjo<sup>1</sup>, Sri S. Tjitrosoedirdjo<sup>2</sup>, Soekotjo<sup>1</sup>, A. Subiako<sup>1</sup>; 1. *WSSI*, 2. *BIOTROP*

**ABSTRACT** Since 2001 the Indonesian Government, through the Department of Forestry has been launching a forest rehabilitation technique called INTENSIVE SILVICULTURE. This technique relies on 3 principles, i.e. planting high yielding local species especially those from the family of Dipterocarpaceae such *Shorea leprosula*, *S. parvifolia*, *S. platyclados*, *S. macrophylla*, *S. selanica*, *Dryobalanops lanceolata* etc., environmental manipulation to ensure an optimum growth of planted material and integrated pest management, including weeds, insect pests and pathogens to minimize the negative biological interaction in the forest ecosystems. Selected seedlings were planted in rows of 3 m wide, at 1.5 m distance. The space between rows was 20 m wide. Weeds encountered in the fields were local lianas and invasive exotic plant species, mainly *Mikania micrantha*, *Chomolaena odorata*, and *Piper aduncum*. The local liana species were numerous, especially from the family of Annonaceae, Leguminosae, Euphobiaceae, Menispermaceae, Rubiaceae, Rosaceae. Weed control was done manually at 6 weeks interval for the first year, 4 monthly interval in the 2nd year, twice in the 3rd year and once annually thereafter up to 6th year of growth, after which the young trees were expected able to look after themselves. Biological and chemical control using herbicides was still at primary stage  
Key words : Intensive Silviculture, Dipterocarps, *Mikania micrantha*

#### **V-19-10: Data Base Development of Indonesian Invasive Alien Plants Species**

Tjitrosoedirdjo Sri S.<sup>1</sup>, Tjitrosoedirdjo S.<sup>2</sup>, Suminah N.<sup>3</sup>, Pujantoro<sup>4</sup>; 1. *WSSI*, 2. *BIOTROP*, 3. *Univ. of Gajahmada*, 4. *C.R.D Forest & Nature Cns*

The interactive Indonesian Invasive Alien Plant Species data base project aims to collate, organize and make available on the internet all published information on relevant aspect of biology, ecology, invaded habitat, control, and references on Invasive Alien Plant Species. The project was started in 2006 through the funding of SEAMEO BIOTROP DIPA project. This project was based on the inventory of Invasive Alien Plant Species in Indonesia which was published in 2003 and revised in 2006. Subsequently, an interactive program was developed for data entry and simple & multiple search functions, using software program called My SQL, which is based on SQL language. The database is appeared at the SEAMEO BIOTROP website: <http://www.biotrop.org> in 2008. The on going update of the database is developed for improving the data. Several fields has been added such as distribution maps, risk analysis etc. The update version hopefully can replace the old version soon.

## Engaging local people for conservation in South-East Asia (#21)

(July 23 pm; Wantilan wing)

Organized by: **Manuel Boissière and Douglas Sheil**

*Despite decades of conservation projects, the best way to engage local people remains one of the most controversial topics in conservation. To what extent can this debate be resolved by research? What is the way to move forward? This symposium will explore a range of experiences and viewpoints in the hope of casting light on this apparently intractable set of issues.*

*Numerous approaches have been developed to clarify and facilitate the role local people play in landscapes managed, in part, for conservation. By sharing experiences from participatory to more protectionist approaches, the symposium will initiate a debate between research institutions and conservation NGOs.*

*Two contrasting views are generally highlighted regarding the possible role of local communities in conservation: the devolutionists, favoring the full involvement of local communities in conservation management and the protectionists, which consider the communities a threat to be controlled. We shall explore the possibilities for a middle way that includes local people but does not necessarily give them full control. What requirements does this imply in terms of bridging the link between those in charge of the conservation and those who live in or near a protected area? How to improve – or even to initiate – communication between stakeholders with different agendas?*

*The symposium will address conservation inside and outside protected areas, and in fragmented landscapes, where human activities represent the main driver of changes. What are the most promising ways to ensure local people the sustainable use of biodiversity in these landscapes?*

### **V-21-1: The Importance of the Right Process: Community Participation and Conservation in Kayan Mentarang National Park (Indonesia)**

Cristina Eghenter; *WWF Indonesia*

The long history of shaping community-based management in the KMNP reflects, in part, the shifting paradigm in conservation to allow participation of local and indigenous peoples in the management of conservation areas. More importantly, it reveals the importance of a process where participation and trust are increasingly built and made more meaningful, the value of securing a deep understanding of local conditions and needs, and the significance of applying a more right-based and economic-based approach to sustainable management of conservation areas. The case of Kayan Mentarang National Park, the first park in Indonesia to be granted collaborative management status, may have not yet realized the full vision of effective and sustainable community-based management of the large conservation area, which is also and foremost the customary land of several Dayak ethnic groups. However, it shows how the current process and approach can help secure a more meaningful role for local people, and support the management of conservation, as long as involvements, equity, respect, and openness among stakeholders are sustained.

### **V-21-2: Participatory Mapping, Biodiversity Conservation and Local Partnerships in Mamberamo, West Papua, Indonesia**

Nining Liswanti<sup>1</sup>, Boissière Manuel<sup>2,1</sup>; *1. CIFOR, 2. CIRAD*

Biodiversity conservation in the tropics is often unsuccessful when decision-makers do not involve local people in the zoning and management of protected areas. Local communities, as the traditional users of natural resources, have a key role to play in conservation. We show how involving local people in the zoning of protected areas can help to address both local and conservation institutions' concerns. The Mamberamo Basin in Papua, covering nearly 8,000,000 hectares of forest, has a high biodiversity, which is an important source of livelihood products for local people. Forest is valued for

a wide range of uses and functions but unlogged forest is the most important. Traditional rules are still largely followed and play a key role in protecting important sites and resources. In collaboration with local communities, we characterized the most important species, habitats and sites, and their significance. The communities have a strong sense of land ownership. We also developed participatory maps of land use, land ownership, and natural resources. These maps have been used to negotiate Community Conservation Agreements (CCAs) with communities. CCAs are voluntary statements by villagers on how forestlands should be used and conserved. These CCAs are the first step in the development of village-based regulations and regional spatial planning that could be recognised by local government institutions and conservation agencies. Key words: biodiversity conservation, participatory approach, zoning map, Community Conservation Agreements, Mamberamo, Papua.

### **V-21-3: Building Links between National Park Managers and Local Communities in the Lorentz National Park**

Peter N. Wood<sup>1</sup>, Yunus Rumbarar<sup>2</sup>; 1. *Samdhana Institute*, 2. *Lorentz National Park Management Unit*

The 2.5 million Ha Lorentz National Park in Papua province, Indonesia, is the largest protected area in South-east Asia. It is the only protected area in the world with an intact transition from permanent snow fields to tropical lowland forests. The Park overlaps the densely populated highland valley of Baliem, where harvesting of wildlife and forest resources by customary land owners may be unsustainable and conflicts with conservation objectives. The Park management unit is charged with developing a management plan which must address these issues. Understanding how natural resources are being used is an essential pre-requisite for such a plan. The Multi-disciplinary Landscape Assessment (MLA) methodology developed by the International Centre for Forestry Research (CIFOR) is a participatory approach which uses simple quantitative methods to gather information on forest resource use and livelihoods. During 2009 the method was applied in 3 customary territories. As a result, the management team has improved knowledge of resource use by communities, and barriers to communications between park staff and communities have been reduced. There are challenges in moving from the MLA to plan interventions to address resource management problems. Resource management decisions are made at a small scale (extended family), and there are no existing institutions which would enable the Park to negotiate with a large number of land owners simultaneously. Local land and resource rights are not legally recognised. National laws are prescriptive and limit the authority of the park management team to agree to some forms of resource exploitation. There are virtually no funds for monitoring of resource use. MLA offers a rapid and efficient means to compile data in resources and management issues. It needs to be implemented as part of a larger program with funding for work on local rights, Park policies, and management interventions.

### **V-21-4: Biodiversity Conservation and Indigenous Peoples: Case Studies from UNESCO Sites**

Robert Lee, Koen Meyers; *UNESCO*

In recent decades, there has been much debate about the role of indigenous peoples in natural resource and ecosystems management. Strict protectionists note the severe loss of biodiversity and intact ecosystems, and call for removal of human presence in conservation areas including indigenous peoples while proponents of indigenous peoples' rights note the historical marginalization of indigenous peoples and maintain that locally-based knowledge by indigenous peoples enables them to sustainably maintain their ecosystems and resources, and the cultural practices to enact this knowledge into tractable actions. We feel that neither is completely accurate nor productive, and oversimplifies an ever-changing scenario that reflect the dynamic backdrop in which indigenous peoples and conservation engage. We draw on examples from UNESCO's experience with natural resource and ecosystems management and indigenous peoples in the Asia-Pacific region through UNESCO two programs on managing and protecting ecosystems and biodiversity – the Man and the Biosphere

(MAB) Programme, and the World Heritage Programme. We call on a practical and balanced approach that emphasizes engagement with indigenous communities while, at the same time, guides policies and practices that ensure sustainability of ecosystems and species. Such an approach needs to be adaptive and fully take into account the specific social, historical, political, economic and cultural context, as well as the needs, capacities and operational conditions of conservation sites.

#### **V-21-5: The Biology of Community Conserved Areas: A Contextual Review from India**

Ghazala Shahabuddin<sup>1</sup>, Rao Madhu<sup>2</sup>, 1. *School of Human Ecology, Dr. B.R. Ambedkar University*, 2. *Wildlife Conservation Society*

The view that biodiversity-rich areas partially or largely managed by local residents, sometimes referred to as community-conserved areas (CCAs), can be effective in biological conservation has gained considerable ground over the past decade. In this paper, we review available scientific information on the conservation effectiveness of such areas globally. We compiled studies undertaken during the last 5 years (2004-2009) that use specific, quantifiable ecological attributes to (1) compare CCAs with strictly protected areas (SPAs); (2) compare CCAs with open-access situations and (3) study trends in biological attributes of CCAs over time. CCAs harbour a species complement distinct from that of SPAs in many cases and may not effectively conserve endemic, habitat-selective and area-sensitive taxa that are of conservation importance. However, there were no consistent differences in diversity/species richness of flora or fauna protected under the two types of management or in deforestation rates. CCAs tend to conserve biological values more effectively than open access areas. Biological values declined in CCAs over time. We conclude that CCAs could represent a significant improvement over open access areas, yet fall short of the needs of comprehensive biological conservation. Overall, this review, based on a limited sample size is only a beginning, and reported trends are expected to serve as an invitation for more comprehensive interdisciplinary research to address the question of biological effectiveness of diverse governance regimes.

#### **V-21-6: The Asian Crocodile Crisis**

Jan van der Ploeg, Merlijn van Weerd; *Cultural Anthropology, Leiden University*

Crocodiles are a conservation success-story. In most parts of the world crocodylian populations have rapidly recovered in response to regulation of harvesting, captive breeding and the creation of protected areas. But not in Southeast Asia... Of the seven endangered crocodylians in the world, five occur in Southeast Asia: the Philippine crocodile (*Crocodylus mindorensis*), the Siamese crocodile (*Crocodylus siamensis*), the Malay Gharial (*Tomistoma schlegelii*), the Chinese alligator (*Alligator chinensis*) and the Indian Gharial (*Gavialis gangeticus*). Crocodile populations in Southeast Asia continue to decline in the wild as a result of hunting, the use of destructive fishing methods and the degradation of freshwater wetland habitat, which is fuelled by rapid economic growth, changing consumption and production patterns and a growing human population. Southeast Asia poses a specific set of challenges that demand innovative solutions. The classic conservation model focused on sustainable use and protected areas, which has been successful in other parts of the world, is clearly failing. An alternative community-based approach to conserve crocodiles in human-dominated landscapes is beginning to take shape in several countries in Southeast Asia, most notably in the Philippines and Cambodia. These grassroots initiatives highlight the cultural and aesthetic values of crocodiles through education and public awareness campaigns, and aim to strengthen the capacity of rural communities to conserve freshwater wetlands on which they depend. These small-scale projects counter 'the use it or lose it' narrative that has shaped crocodile conservation policy and practices, and provide hope for the survival of Asia's dragons.

#### **V-21-7: Engaging Local People in Orangutan Habitat Conservation in Borneo**



Andrew Teixeira de SSousa<sup>1</sup>, Cheryl Knott<sup>2</sup>, Tito P. Indrawan<sup>1</sup>, Mariamah Achmad<sup>1</sup>; *1. Gunung Palung Orangutan Conservation Program, 2. Boston University, GPOCP*

Gunung Palung National Park contains one of the world's last sizeable populations of endangered wild orangutans living in the lowland Bornean rain forest. In 1999, primatologists working in Gunung Palung began efforts to share their knowledge through educational activities with local school children. Over time, this has grown into a multi-faceted program in southwestern Borneo (West Kalimantan). A key factor in the success of the program has been to engage local people, by working closely with the communities that are most affected by changes to local habitat. This has been done by working with formal structures, such as local government education and conservation departments, but also by building civil society and engaging local communities to develop sustainable relationships with their ecosystems. Technical trainings, staff exchanges, in-kind support, joint field work and inter-agency cooperation agreements have been used to develop government capacity and commitment. Education and awareness efforts include rain forest field trips, our educational field camp, teacher workshops, an environmental education center, lesson plans, educational booklets, volunteer and ranger training, billboards, radio programs, newspaper articles, films, puppet shows and theatre presentations. In response to these efforts, some local leaders have sought ways to protect local habitats, particularly by developing green lifestyles and sustainable management of their customary lands. Thus, we highlight our work assisting local villages to obtain legal protection for their forests and introducing environmentally friendly income-generating activities that will help them increase the productivity of their land, thereby preventing the need for more rain forest encroachment. In this presentation we outline the success and challenges of our program (Yayasan Palung/Gunung Palung Orangutan Conservation Program) and lessons learned that can be applied to animal and habitat protection more broadly.

#### **V-21-8: Why Should Coffee Planters be Interested in Conservation?**

Yulia Rahma Fitriana<sup>1</sup>, Patrice Levang<sup>2</sup>; *1. Cifor, 2. Cifor/IRD*

Listed as one of UNESCO's World Heritage sites, the Bukit Barisan Selatan National Park (BBSNP) is a renowned biodiversity hotspot and the natural habitat of many endangered species. But the Park is also host to an increasing number of squatters, with approximately 20% of its surface area converted into illegal smallholder coffee plantations. Numerous international NGOs, the local government, and the private sector convened stakeholder meetings and negotiations in order to protect the Park and to sustain local development. In all cases stakeholders seemed genuinely concerned by conservation matters, but agreements never translated in a decrease in encroachments. A survey of 600 households in 20 villages around the Park concludes that the vast majority of the families living close to Park totally depends on coffee cultivation for their livelihoods. A large part of the coffee produced comes from plots inside the Park. Thus, any attempt at promoting conservation through the prohibition of cultivation inside the Park directly opposes the economic interest of local smallholders and is as such deemed to failure.

#### **V-21-9: Promoting Local Perception to Achieve Conservation Outside Protected Area in Malinau**

Michael Padmanaba, Imam Basuki, Douglas Sheil; *Center for International Forestry Research*

The views of local people concerning tropical forests are frequently neglected in decision making process that impact these forests. Our surveys carried out in Malinau, East Kalimantan (Indonesian Borneo) since 1999 have explicitly asked indigenous communities what they find important in terms of biodiversity and forested landscape. During the surveys, locally valued land types, species and their uses were illustrated among people representing two major ethnic groups in seven villages along Malinau River. As people are concerned about their culture and resources, they accept and support some types of forest conservation in the region. In addition, people agreed that biodiversity conservation and local views are vital in land use planning. Results from our surveys show how

biological evaluations too are practical and more efficient with local guidance. It also indicates potential opportunities for collaboration between indigenous communities and conservation practitioners to safeguard biodiversity outside formal protected area.

### **V-21-10: Participatory Land Use Planning for Conservation and Development: Is There Life after Planning?**

Jean-Laurent Pfund, Yves Laumonier, Castella, Ayat, van Noordwijk Meine, Lao-based colleagues (still tbd); *CIFOR*

Collaborative natural resource management requires decisions based on various needs for resources and ecosystem services. Complexity and dynamism of tropical social-ecological systems make unlikely that decisions will be agreeable to all actors in the long term; therefore adaptive mechanisms are needed. In biodiversity-rich areas, land use planning is used as a policy instrument to set spatially-explicit priorities for conservation and development. But practical planning often originates from projects limited in time, and strategic decisions are made according to specific political contexts. Life after planning, as important as the planning process itself, is often neglected. Based on examples from Indonesia and Laos, the paper identifies information and processes that helped or hampered enforcing and adapting land use plans. Local leaders supported by boundary organizations as well as regular communication between different hierarchical levels were crucial to capture windows of opportunities for joint decisions. To be adapted to ecological contexts and pragmatic with regard to possible outcomes, planning processes need to consider past trends, possible abrupt changes linked to new market opportunities and ecological processes occurring at multiple scales and pace. Scientists need to design multiple partnerships with communities, practitioners, NGOs, donor agencies and policy-makers so that collaborative management systems can support not only knowledge capitalization but also communication between governance levels. If participation of local communities is a clear ethical condition in any decision-making process affecting local resources, it has to be supported by transparent information on the potential and limits of local management, and by communication channels maintained over time with stakeholders linked to higher-level "power games". Research supporting outcome monitoring and knowledge networks can help maintaining the planning process alive.

## **Ecology and conservation of mangrove ecosystems along changing coastlines in Asia (#22)**

**(July 22 pm; Jauk)**

Organized by: **Edward L. Webb**

*Loss of tropical habitats may have severe consequences for the ecology of plant and animal species. This is especially true for mangrove ecosystems along coastlines that are undergoing changes from urban development, aquaculture, mining and overexploitation for natural resources. Furthermore, mangroves may be subjected to novel threats or opportunities not seen in terrestrial ecosystems, such as coastal squeeze, increased sediment loading, and sea level rise.*

*In this session, oral presentations will focus on the relationship between human-produced coastal landscape change and predicted / observed alterations in mangrove ecology. Topics may include reproductive ecology, conservation genetics, propagule dispersal, biogeography, and degradation and restoration. Linkages with biophysical changes of deforestation, land use change and fragmentation, and associated conservation implications, are necessary to maintain thematic continuity.*

### **V-22-1: Large-scale Threats and Mangrove Dynamics in SE Asia**

Daniel A. Friess, Edward L. Webb; *National University of Singapore*

Mangrove forests at the interface of land and sea provide a number of crucial ecosystem and socio-economic services, though are some of the most threatened of all environmental resources. Mangroves are vulnerable to multiple pressures, which may come from seaward (e.g. erosion and sea level rise) or by the impact of terrestrial land use such as coastal development, reclamation, agriculture and aquaculture. The monitoring of such large scale forcing and ecosystem change can only be achieved by the GIS analysis of remotely sensed imagery. This study used a combination of Landsat (United States Geological Survey/University of Maryland Global Land Cover Facility) and ASTER (NASA) imagery at 30 – 60 m pixel resolution to quantify areal change in mangrove cover in Peninsular Malaysia and NE Sumatra (Indonesia) up to the present day. This presentation will discuss a) potential methods and the accuracy of mangrove delineation, b) the magnitude of mangrove change derived from this analysis, and c) and how it is related to a number of socio-economic factors modelled for this study, including terrestrial land use and protected area status. These results will identify regional-scale drivers of mangrove loss and their spatial distribution, and are important to highlight areas in need of greater protection. This study also proposes a standardised methodology that can allow the comparison of mangrove forest change between countries.

### **V-22-2: Surface Elevation Change and Susceptibility of Different Mangrove Zones to Sea-level Rise on Pacific Islands: Insights for Changing Coastlines in Asia**

Ken W. Krauss<sup>1</sup>, Donald R. Cahoon<sup>2</sup>, Thomas W. Doyle<sup>1</sup>, Nicole Cormier<sup>1</sup>; *1. U.S. Geological Survey, Nat. Wetlands Res. Center, 2. U.S. Geological Survey, Patuxent Research Center*

Pacific high islands are subjected to constant erosion over geologic time, which establishes an important source of terrigenous sediment for nearby marine communities. Many of these sediments are deposited in mangrove forests and offer mangroves a potentially important means for adjusting surface elevation with rising sea level. We investigated sedimentation and elevation dynamics of mangrove forests in three hydrogeomorphic settings on the islands of Kosrae and Pohnpei, Federated States of Micronesia (FSM). Surface accretion rates ranged from 2.9 to 20.8 mm per year, and are high for naturally occurring mangroves. While mangrove forests on Micronesian high islands appear to have a strong capacity to offset elevation losses by way of sedimentation, elevation change over 6.5 years ranged from -3.2 to 4.1 mm per year, depending on location. Mangrove surface elevation change also varied by hydrogeomorphic setting and river, and suggested differential susceptibilities among Pacific high island mangroves to sea-level rise. Results of these studies have application to management throughout the Asia-Pacific region where mangrove forests vary widely in processes for maintaining surface elevation. Natural and anthropogenic disturbances are also important in mediating elevation dynamics, and while we found that constant allochthonous sediment deposition probably matters most on the Pacific high islands we studied, the relative importance of sedimentation processes versus biotic contributions (e.g., root growth) is expected to change widely on the diversity of substrates available to mangrove development in the Asia-Pacific region. We will discuss application of conducting similar studies to those on Pacific islands for predicting coastal inundation of Asian mangrove communities under climate change and projected sea-level rise.

### **V-22-3: Global Phylogeography of Mangroves**

Tadashi Kajita, Koji Takayama, Mariko Tamura, Yoichi Tateishi; *Chiba University*

Mangrove is a major ecological habitat that spreads throughout tropical and subtropical coastlines of the world. To reveal the global phylogeographic pattern of mangroves, we investigated the genus *Rhizophora* that is one of the most representative mangrove plants. Phylogenetic analysis using about 4 kbp of cpDNA sequences showed that the presence of the two distinct clades. One of them was composed of three species of the Indo-West Pacific region (IWP), *R. apiculata*, *R. mucronata* and *R. stylosa*. The other one was composed of the two species of the Atlantic-East Pacific region (AEP), *R. mangle* and *R. racemosa*, and surprisingly *R. samoensis* that is one of IWP species. Analysis of

geographic distribution of haplotypes clearly showed the distinctive genetic diversification between the Pacific and Atlantic populations in both *R. mangle* and *R. racemosa* in the AEP. This result suggests that the American continent is a strong geographic barrier that prevents gene flow by sea-dispersal for *Rhizophora* species. On the other hand, an identical haplotype was found among the Atlantic populations of the AEP species, and another identical one was shared among populations of the Pacific *R. mangle* and *R. samoensis* from South Pacific. These results suggest that recent transoceanic long distance seed dispersal would be responsible for maintaining the wide distribution range of *R. mangle*, and that *R. samoensis* may not be distinguished from *R. mangle*. In the analyses using microsatellite markers, genetically differentiated populations of *R. mangle* were further detected in the South Atlantic. Although there are no known land barriers, the bifurcating South Equatorial Current at the northeastern horn of Brazil might be a potential barrier to gene flow and may promote the genetic differentiation of these populations. Other recent results obtained from IWP species will also be introduced in the presentation.

#### **V-22-4: The Effects of Nutrient Enrichment on Mangrove Macrofauna**

Shuhaida S., Greg Skilleter, Catherine Lovelock; *University of Queensland*

Mangroves are prominent features of tropical and subtropical coastlines of the Asia Pacific region. They provide significant socio-economic and ecological goods and services that originate from ecosystem functions maintained in part by macrofauna such as crabs and molluscs. However, increasing human disturbances through coastal development such as aquaculture, land reclamation and urbanization have introduced excessive inorganic nutrients into mangroves, posing a direct threat to biodiversity. Despite the extent of the threat, there is a lack of information on how nutrient enrichment affects the distribution of mangrove macrofauna. We found that in the mangrove forests of Moreton Bay, Australia the composition of macrofaunal assemblages was strongly linked to ambient nutrient concentrations. However, habitat characteristics such as sediment type, pneumatophore density and macroalgal density were also found to have a direct influence on the composition of assemblages throughout the sites. To investigate further the effects of nutrient enrichment on the abundance and diversity of macrofauna, we experimentally manipulated nutrient concentrations by artificially fertilizing different types of mangrove forests. Throughout the enrichment period, macrofaunal assemblages were sampled simultaneously with sediment cores (to determine nutrient concentrations) and other habitat characteristics. Based on observational data derived from time based capture of crabs, there was a change in faunal composition due to an increase in species abundance and richness suggesting a direct response to nutrients in fertilized sites compared with unfertilized sites; although distinct assemblages were found to inhabit different sediment types. The results obtained from this study suggest an experimental approach combined with the assessment of habitat characteristics are required to identify and understand the effect of nutrient enrichment on important macrofaunal groups in mangroves.

#### **V-22-5: Gene Flow of *Avicennia alba* and *Bruguiera gymnorhiza* in a Fragmented Landscape**

Alison K. S. Wee, See Yan Low, Edward L. Webb; *National University of Singapore*

Singapore has lost more than 90% of its original mangrove cover due to coastal development and land reclamation. Our study investigated the effects of fragmentation on mangrove gene flow in Singapore to understand whether current trends of coastal development may be leading to genetic consequences for mangroves. We examined the genetic diversity and genetic structure of two mangrove species commonly found in remnant fragments, *Avicennia alba* and *Bruguiera gymnorhiza*, by using microsatellite markers. In particular, we compared the outcrossing rates of these two species in five mangrove populations in Singapore. Both species have very distinct reproductive characteristics and represent two extremes among mangrove plants in terms of fecundity and plant-pollinator specificity. Therefore, comparison between these two species will enable us to understand whether differences in reproductive characteristics, which might result in different levels of gene flow, contributes to species-specific response to fragmentation. This study is an initial effort in understanding genetic

consequences of fragmentation in mangroves and thus would be able to reveal significant insights for mangrove conservation and management.

#### **V-22-6: The Abundance of Forest Floor Fauna in Segara Anakan Mangrove: Indication of the Disturbed Ecosystem**

Tjut S. Djohan; *Gadjah Mada University*

The mangrove ecosystem of Segara Anakan, due to the heavy sedimentation, was in the process of changing to freshwater wetland. This sedimentation created a lot of shoals and newly-formed lands. Beside, this ecosystem was also experienced heavy mangrove tree-cutting, and 80-90% of the forest were colonized by mangrove shrubs *Acanthus ilicifolius* and *Derris heterophylla*. There were no mangrove zones but only topographical zones. The purpose of this research was to study the response of mangrove forest floor fauna to the mangrove-vegetation covers. This study was carried out at three locations, Bondan-Wates, Monggor, and Kali Gatal. In each location, a transect was established perpendicular to the shoreline, and crossed the area in 3 to 4 topographical zones. In each zone, the quadrat plots of 0.5m x 0.5m were used in collecting data of floor fauna with 10 to 20 replicates. I also measured the physico-chemistry of NO<sub>3</sub>, PO<sub>4</sub>, C organic, pH and soil textures. The results showed that distribution and the abundance of the fiddler crabs, burrowing fish, Gastropods, and Bivalves responded to the mangrove vegetation covers and the soils textures. There were 11 species of forest floor crabs, 10 species of mollusks, and 2 species of burrowing fishes. The *Neochiromantes* sp. (Grapsidae) was dominated the mangrove shrubs, *Acanthus ilicifolius* and *Derris heterophylla*. The *Camptandrium sexdentatum* (Ocypodidae) was found under the mangrove-tree canopies. *Melanoides requeti* (Gastropods) was only found at the mudflat of Bondan. *Periopthalmodon schollosseri* was present only in the very soft sediment. Thus the abundance of the *Neochiromantes* indicated that the mangrove-tree species of Segara Anakan was really as the endangered community. Key words: Fidler crabs, *Neochiromantes*, mangrove-tree disturbance

#### **V-22-7: Human Impacts on a Mangrove-fringed Lagoon in Java: Consequences for Tree and Macrobenthic Biodiversity**

Inga Nordhaus; *Leibniz Center for Tropical Marine Ecology*

The Segara Anakan Lagoon is the last large mangrove-fringed estuarine system in Java, Indonesia. It is affected by natural environmental change and human activities for decades. Deforestation, high riverine sediment input, fishing and effluents from industry and villages are the main causes for habitat changes. Indonesia's largest oil refinery releases effluents in the lagoon. Macrobenthic invertebrates and mangrove vegetation were investigated in the frame of the multidisciplinary German-Indonesian SPICE (Science for the Protection of Indonesian Coastal Marine Ecosystems) program since 2004. Twenty-one tree species were recorded; however, densities were generally low. Seedling density and tree diameter have declined and tree community composition has changed in the past decades. Pioneer species and understorey plants nowadays dominate parts of the lagoon as a result of tree cutting. Macrobenthic densities and community composition showed a high spatio-temporal variation mainly related to sediment properties salinity,  $\delta^{13}\text{C}_{\text{org}}$ ,  $\delta^{15}\text{N}$  and  $\text{C}_{\text{org}}/\text{N}$ . Despite human activities, benthic species richness, in particular that of crabs and gastropods was high compared to other Indo-West Pacific mangroves. However, diversity indices were low to medium and opportunistic species dominated the communities which may be attributed to continuous tree logging and high riverine sediment input. Persistent organic pollutants were detected in water, sediment and biota. Concentrations of polycyclic aromatic hydrocarbons in water and sediment reached toxic levels close to the oil refinery, but were generally below toxicity thresholds in other areas. A total of 54 organic contaminants were identified in five dominant benthic species and one economically important fish species. Possible biomagnification of pollutants in the food chain and their impact on benthic biodiversity and community structure are the subject of future studies.

### **V-22-8: Mangroves as Indicators of Coastal Condition and Vulnerability to Sea Level Rise: Results of Assessment Surveys in Kiang Giang Province, SW Vietnam**

Norman C. Duke, Nick Wilson, Jock Mackenzie, Hai Hoa Nguyen, Sharon Brown; *University of Queensland*

During 2009 and early 2010, around 250 km of coastline and 30 plus forest plots in Kiang Giang Province, SW Vietnam, were surveyed using small boats and other means. Our field assessments, coupled with analyses of vegetation units from SPOT5 satellite imagery, were used to identify the extent and status of mangrove habitat in the area, along with shoreline condition. These assessments comprised investigations assessing: mangrove biodiversity; mangrove plant distributions; shoreline condition; forest biomass as sequestered carbon; rehabilitation of eroded shoreline; use of payment for mangrove environmental services; and, related livelihood projects. Backed by a number of case studies, we report the revised extent of mangroves and shoreline status, with: 27 mangrove species present; at least 50% of coastline is severely impacted; a marked reduction in mangrove area observed in high resolution imagery; and, significantly low levels of forest biomass with mangrove stands fragmented from over-exploitation, replacement and disturbance. These indicators of coastal habitat condition identify sites of current high vulnerability to seawater incursion. We report on sites where mitigation and rehabilitation projects are needed urgently to bolster shoreline resilience in the face of imminent sea level rise along this low-lying and highly vulnerable part of the Mekong shoreline.

## **Experimental approaches in tropical marine biology and ecology (#23)**

**(July 20 am; Jauk)**

Organized by: **Karen von Juterzenka**

*Biological diversity generally describes the variety of living organisms and their environment in a defined area at a given time, in the sense of genetic, species and habitat diversity. In tropical countries which host unique marine communities and rely on diverse marine ecosystems for sustainable living and human development, it will be crucial to understand the driving forces for marine community and biodiversity shifts. Local anthropogenic influence and global climate change have countless implications for marine ecosystems as well as related resources and ecosystem services in general. Although changes of abiotic parameters and biological consequences will be complex, there are indications that climate-driven impacts on specific species, like substrate providers or significant predators, might cause substantial changes on the community level.*

*Experimental approaches help to understand organism responses to natural factors as well as anthropogenic stressors and to explain and predict changes in community compositions. Different level of sensitivity towards various stressors may lead to the survival or decline of a species, and to biological invasions causing a cascade of subsequent shifts in species interactions. Global comparisons can provide insights in the ecological capacity of marine organisms and their readiness to adapt to changes.*

*The symposium will focus on experimental approaches in tropical marine biology and ecology related to organism or community responses to environmental factors, as well as marine species interactions. Contributions addressing capacities of marine organisms towards temperature change, ocean acidification, marine pollution, current flow and current patterns, light regime and sedimentation are especially welcome.*

### **V-23-1: Benthic Recycling in the Mangrove Fringed Segara Anakan Lagoon, Java, Indonesia**

Regine Moll, Tim Jennerjahn; *Center for Tropical Marine Ecology*

Mangrove soils can act as a source and a sink for inorganic nutrients and organic carbon, therefore water-sediment interactions are of ecological importance. Experiments on nutrient recycling and benthic oxygen uptakes are important to understand elemental cycles which affect primary production and therefore the whole food web. Benthic recycling can be an important source of nutrients in shallow coastal waters, but little is known from tropical regions. We determined benthic fluxes of dissolved inorganic nutrients (nitrate, nitrite, ammonium, phosphate, silicate) from pore water profiles and incubation experiments in the mangrove-fringed Segara Anakan Lagoon (SAL). The lagoon's nutrient inventory is dominated by riverine input from the agriculture-dominated hinterland throughout most times of the year except for the dry season (July – September). We hypothesize that recycling in mangroves is an important source of nutrients during that time. During two expeditions in the rainy (February 2009, RS) and dry (September 2009; DS) seasons sediment cores were obtained and core incubation experiments were carried out at three mangrove sites. Pore water profiles showed differences between seasons and sites. Nitrite concentrations were low during both seasons (DS: 0.2 to 7.4  $\mu\text{M}$ ; RS: 0.0 to 0.6  $\mu\text{M}$ ) whereas nitrate (DS: 1.0 to 106.0  $\mu\text{M}$ ; RS: 1.9 to 24.7  $\mu\text{M}$ ) and ammonium concentrations (DS: 21.7 to 408.0  $\mu\text{M}$ ; RS: 2.4 to 229.3  $\mu\text{M}$ ) were higher. Phosphate displayed higher values during the dry season (DS: 0.4 to 16.7  $\mu\text{M}$ ; RS: 0.1 to 13.9  $\mu\text{M}$ ). No significant differences were found for silicate concentrations between seasons and stations (DS: 84.2 to 625.1  $\mu\text{M}$ ; RS: 82.9 to 365.1  $\mu\text{M}$ ). Diffusive fluxes calculated from pore water profiles and total fluxes from the incubation experiment will be presented. It is conceivable that benthic recycling in the mangroves contributes significantly to the nutrient pool of the Segara Anakan Lagoon, particularly during the dry season when river discharge is low.

### **V-23-2: Latitudinal Comparisons as a Tool for Measuring the Sensitivity of Tropical Marine Fauna**

Simon A. Morley<sup>1</sup>, Koh-Siang Tan<sup>2</sup>, Miles Lamare<sup>1</sup>, Robert W. Day<sup>1</sup>, Martin, S.M., Lai C.H., Ericson, J., Peck, L.S.; *1. British Antarctic Survey, 2. National University of Singapore*

Policy and conservation decisions aimed at protecting biodiversity can be guided by research into which animals and communities are most at risk. One way in which scientists can provide this information is through assessing the vulnerability of marine species and communities to climate change and identifying the mechanisms underlying this sensitivity. Temperature is a fundamental physical factor affecting ectotherms as it affects the rates of all biochemical reactions within organs and cells. Latitudinal comparisons of terrestrial ectotherms have shown tropical species to be among the most sensitive to increased temperature as they are already living close to their limits. We present two case studies comparing the temperature tolerance of both activity and mortality for two groups of intertidal marine species, Nacellid limpets and the clam genus *Laternula* from Antarctica to the tropics. Thermal limits followed the predicted pattern with upper limits becoming more sensitive towards warmer environments; however the warmest environment was in temperate Australia not in the tropics. Lower limits across environments were parallel to upper limits and therefore more sensitive in colder environments. Thermal niche for tenacity was wider in more variable environments but wider spread species had wider thermal limits for survival than predicted from this pattern.

### **V-23-3: Population Differences in Susceptibility to Salinity Stress in the Green Mussel *Perna Viridis* from Contaminated and Uncontaminated Sites in West-Java**

Carolin C. Wendling<sup>1</sup>, Rhamadian Bachtiar<sup>2</sup>, Mark Lenz<sup>1</sup>, Karen von Juterzenka<sup>1</sup>, Martin Wahl; *1. University of Mainz, 2. Institut Pertanian Bogor*

An increasing frequency of extreme weather events will lead to pronounced short-term fluctuations in environmental parameters such as temperature, salinity and sedimentation in coastal ecosystems. At the same time, human populations are growing and coastal waters are increasingly loaded with nutrients and heavy metals. Direct effects of and interactions among these stressors will alter the structure and functioning of ecosystems with negative consequences for the economical and social systems that depend upon them. In this context, we investigated the stress tolerance of populations of

the Indopacific green mussel (*Perna viridis*) stemming from two coastal locations in West Java. The two study sites differ in their abiotic conditions: Jakarta Bay is highly impacted by organic matter input and pollution, while Tanjung Lesung represents a benign environment with low turbidity and almost no pollution. In laboratory experiments, we determined the mean tolerance of the two populations towards reduced salinity by 13 and 18 units, by measuring fluctuations in oxygen consumption and survival rates. Our results reveal that under reduced ambient salinity both responses were significantly different between populations. Mussels stemming from Jakarta Bay showed no mortality under reduced salinity levels within 21 days, whereas individuals from the benign site exhibited a mortality of 50 % at 15 psu and 20 % at 20 psu, respectively. Furthermore, the deviation in oxygen consumption under salinity stress from the normal performance was significantly smaller in mussels from Jakarta Bay than in mussels from Tanjung Lesung. Significant differences in survival and metabolic rates in the face of salinity stress suggest that the origin of a population contributes substantially to its tolerance towards increasing environmental stress. We discuss possible mechanisms that could underlie these differences in stress tolerance of two populations stemming from two different coastal habitats.

#### **V-23-4: Spatio-temporal Variation and the Effect of Human Disturbance upon Scleractinian Coral Recruitment in the Coral Triangle**

Pelayo Salinas-de Leon<sup>1</sup>, David J. Smith<sup>2</sup>, James J. Bell<sup>1</sup>; *1. Victoria University of Wellington, 2. University of Essex*

Recruitment is a key factor driving the population dynamics of scleractinian corals, but despite its importance, we still have a poor understanding of recruitment processes in the Coral triangle region, which contains the most biodiverse marine ecosystems in the world. The aim of this study was determine the influence of inter-annual and seasonal variations upon coral recruitment rates to artificial settlement panels and cleared areas of natural reef and the influence of human disturbance upon recruitment rates. We examined recruitment rates at four sites in the Wakatobi National Marine Park, south east Sulawesi, Indonesia; two reefs were light-limited, high sedimented regimes with low coral cover (<10%) and two had moderate coral cover (approx. 40%) and lower sedimentation rates. Panels were directly attached to the reef at 6-7 m depth. Coral recruitment was twofold higher during the 2008-2009 period than during 2007-2008 and a seasonal coral recruitment peak was recorded during the November 2008-March 2009 period, with more than five and three times the numbers recorded in July 2008- November 2008 and March 2009- July 2009 periods respectively. We also report a significant difference in the recruitment rates between sites, with higher recruitment rates at higher live coral cover sites. Here we confirmed the presence of a seasonal recruitment peak for the Wakatobi NMP during the wet North West monsoon season that matched the yearly increased in sea surface temperature (SSI). We also hypothesize that the lower recruitment rates recorded at the degraded sites are a consequence of the lower locally available larvae due to the small number of alive coral colonies and the heavy sedimentation rates derived form human disturbance. Our research provides essential information to managers on coral population dynamics and highlights the importance of reef protection to ensure the future preservation of coral reefs within the coral triangle.

#### **V-23-5: On the Move, but just How and Why?: The Dynamics of a Mangrove Species *Rhizophora stylosa* at its Southern Limits in a Time of Warming Climate**

Nick Wilson; *Australian Catholic University*

The mangrove species *Rhizophora stylosa* Griff. is widely spread in the Indo-Pacific and is the ubiquitous mangrove of northern Australia. It reaches its southern limit on the Australian east coast where it is patchy in distribution and this study examined the species closely in distribution, growth, reproductive and genetic terms at its limit. A context for the research is a measurably warming climate in recent decades, making study of species at their limits particularly pertinent, albeit rare for a tree species. There is a longstanding view that the latitudinal extremes of both mangrove vegetation and its constituent species are limited by air and/or sea temperatures and thus it has been theorised that



mangrove species will migrate pole-ward with any warming. Key conclusions (and perhaps some speculation) about *R. stylosa*'s recent dynamics are reported here. Although climate cannot be completely discounted in recent dynamics, there appear other factors too. While there is clear evidence of recent and continuing expansion at scales from the patch to the inter-estuary over the last decades (including to the southern limits) a simple fit with recent warming climate does not easily emerge. Perhaps surprisingly, *Rhizophora stylosa* is not stressed at its limits in growth or reproduction and population inertia is clearly high. A general pattern of inter-estuary expansion is proposed and some conclusions (and perhaps speculation) about physiological limitation versus historical and chance factors in dispersal and establishment are presented. This work is timely in suggesting that simple assumptions about the response of species to climatic change may be somewhat dangerous.

#### **V-23-6: Patterns of Temperature Tolerance in the Tropical Marine Mussel *Perna viridis***

K.V. Juterzenka, S. Morley, M.K. Schmid, D.R. Widianari; *Department of Marine Science and Technology, Bogor Agricultural University*

Understanding organism response to environmental change is a major challenge to modelling the effect of climate change on species distributions and survival. Measuring organism's thermal capacities is key to these predictions as temperature is an important physical factor that influences all life functions through changes in the rates of biochemical and physiological processes. A variety of corals and coral-reef related organisms are likely to be stenothermal, indicated by their tropical distribution patterns and published heat stress effects under extreme conditions, (like ENSO-related temperature anomalies). However, studies in this field are still limited and thermal capacities in tropical marine invertebrates might differ, indicating potentials for colonisation of environments beyond shallow-water ambient temperature ranges of approx. 26 – 31°C. In this study we chose the Indo-pacific green mussel *Perna viridis* as a model organism of a widely distributed shallow water generalist. Mortality and activity in varying patterns of temperature change have been investigated in laboratory experiments. Starting point were ambient temperatures of the source population at the northern Javanese coast in Indonesia (about 26°C). Maximum mortality as well as survival and activity patterns differ with the velocity of temperature change, indicating the need for more complex information on the ecological strategy for short-term survival and medium-term acclimatisation capacity.

#### **V-23-7: Upper Temperature Limits of Tropical Marine Molluscs: Global Warming Implications**

Thi Khanh Dung Nguyen, C.H. Lai, S.M. Morley, K.S. Tan, M. Clark, L.S. Peck; *Tropical Marine Science Institute*

Temperature affects invertebrate physiology, ecology, evolution; and global warming could strongly influence marine community structure. This is particularly relevant in the tropical environment where organisms are expected to be most vulnerable to temperature rise, given that they are already living near their upper temperature limits. As molluscs are some of the most diverse and common invertebrates living in tropical shallow-water habitats, upper limits of 18 gastropod and bivalve species from both intertidal and subtidal habitats under different heating regimes were examined. The results showed that thermal tolerance and vertical distribution of the animals were correlated, i.e., upper shore animals have better thermal tolerance than lower shore and subtidal animals. When temperature was raised by 1°C per hour, lethal temperature range of intertidal molluscs was 41–52°C, while it was 37–41°C for those living in subtidal habitats. Thermal tolerance also decreased under longer-term exposure to thermal stress. Lethal limits declined to 38–40°C and 34–38°C for intertidal and subtidal animals respectively, under a 1°C per day heating regime. These limits decreased even further to between 35–42°C and 35–37°C under a 2.5°C per week regime respectively for intertidal and subtidal groups. However, it was also noticed that under long-term heating, upper thermal limits leaned towards a critical temperature, i.e. lethal ranges were narrower and habitat differences were less pronounced. This critical temperature was less than 8°C higher than currently experienced by the animals observed upon. Based on the range of animals examined, body size did not have a significant

effect on thermal tolerance. However, our result reinforced a prevailing hypothesis that active species, i.e. mobile and prey-capturing, appear to have a higher tolerance to elevated temperatures than sessile and filter-feeding species. Possible implications of global warming to tropical marine shallow-water communities will be discussed.

## **The Poseidon Adventure: climate change, marine biodiversity and food from the sea (#24)**

**(July 20 pm; Wantilan front)**

Organized by: **Agus Heri Purnomo, Ahmad Hezri bin Adnan, Natasha Stacey and Marion Glaser**

*Illegal, uncontrolled, unregulated exploitation of marine resources has continuously challenged the existence of species and shifted ecosystem balance. Climate change further threatens the ecosystems, thus placing human interests and overall sustainability of the natural resources at increased risk. The UN Intergovernmental Panel on Climate Change (IPCC) predicts that global warming will trigger enormous physical and social changes. Physical effects such as higher average surface and ocean temperatures and rising sea levels could trigger adverse socio-economic impacts such as famine and drought, shifts in economic output and migration patterns. Major sources of concern for developing countries associated with climate change are the anticipated negative effects on their marine resource biodiversity, economies and development prospects.*

*Specifically, significant impacts of climate change on global food system, and particularly on market prices, are possible. The potential impacts of climate change on food security must therefore be viewed within the larger framework of changing earth system dynamics and interrelated changes of multiple socio-economic and environmental variables, including climate change and biodiversity. Although generally perceived as having negative impacts only, climate change may also provide positive impetus to move towards sustainability. For example, development of technology for sustainable food supply or transformations in social values and associated behaviours towards the natural environment. Moreover, the resilience and adaptive capacities of aquatic resource ecosystems, fisheries and aquaculture production systems, and of the human communities dependent on them can be enhanced by principles and approaches such as good governance, social-ecological systems and resilience management, adaptive sustainable resources management, as well as careful application of biotechnological innovations.*

*Managing marine resources biodiversity normally include the ecosystem approach to fisheries (EAF) and the ecosystem approach to aquaculture (EAA). These include practices of adaptive and precautionary management based on appropriate social, economic, political and institutional incentives. In response to the global marine crisis, new approaches that focus on supporting and sustaining social-ecological system resilience have to be developed. Such approaches contest current management and metrics and stress the significance of multilevel adaptive governance systems for marine and aquaculture management. Such governance systems need features that can deal with cross-scale socio-economic drivers of globalisation that cause coastal and marine vulnerability. Only with such approaches can we anticipate unwanted regime shifts - (or, conversely, promote desirable ones) and improve understanding of the complex dynamics and processes that support or undermine social-ecological resilience and manage the socio-economic drivers and governance systems that shape the future of living marine resources and the services they provide to humanity.*

*Considering that challenges and solutions are multi-layered and multi-dimensional, the establishment of sustainability criteria for the conservation and use of marine biodiversity calls for multi-disciplinary empirical perspectives leading to holistic understanding that will enable the wise use of natural resources on one hand and an equitable and sustainable approach to human and societal interests on the other hand.*

### **V-24-1: Corals at Risk: Effectiveness of the Removal of a Keystone Coral-Predator *Acanthaster planci* in a Marine Park of Malaysia**

Clement P. Dumont<sup>1</sup>, Kee Alfian<sup>2</sup>; *1. The University of Hong Kong, 2. National University of Malaysia (UKM)*

Assessing and managing threats to the coral reef health is essential to devise appropriate conservation strategies. Destructive population explosions of the coral-eating predator crown-of-thorns (COT) sea star are responsible to large-scale disturbance of coral reefs throughout the Indo-Pacific. Invertebrate coral-eating predators are, however, one of the few threats that could potentially be directly managed through targeted predator removal. Volunteers remove thousands of sea stars every year in Malaysia in an attempt to control outbreaks in protected areas. The present study describes the status of the COT populations in the Pulau Tioman Marine Park and examines the impact of the manual removal of the sea stars on coral reefs. We therefore compared COT densities and coral communities at sites where COT have been removed every year since 1998 with sites where no sea stars removals were conducted. Our surveys revealed that COT densities are well above the critical density threshold suggesting active outbreaks at most sites, regardless of the removal effort. Up to 60% of corals were observed dead at sites with high sea star densities. Further, sea urchins occurred at much higher densities at removal sites, although not correlated with COT densities. Unthinking and unfocused programs to control coral predators' impact are generally unsuccessful and may even prolong the damage.

### **V-24-2: Tropical Marine Biodiversity Loss: Benthos, Land Use, and Heavy Metal Contamination Interplay**

Noverita D. Takarina, Andrio A. Wibowo, Yasman; *Department of Biology, FMIPA, Universitas Indonesia*

Alteration of land is continuing to increase inorganic matter to marine ecosystems and reduce marine biodiversity. Therefore, we investigated the interplay among land use and heavy metal (Cr, Cu, Pb, Zn) inputs from 8 rivers of Jakarta Bay to the benthic biodiversity. At current time, land uses surrounding Jakarta Bay are fulfilled with industrial activity, settlement, and agriculture. Total concentration of Cr, Cu, Pb, and Zn were determined using the Atomic Absorption Spectrometry in order to assess and compare contamination levels among land use types. Results showed that the average concentrations of heavy metals in sediment were generally higher in river-mouth received water from industrial than those in agriculture. Metals content measured in the benthos were also high and above standard from National Agency for Drugs and Food Control. Those land use related metal patterns were also reflected in the benthos community. Macrobenthic diversity decreased and species composition altered when inputs of organic matter increased. In industrial area, increases in abundance of specifically deposit-feeding polychaetes, were mainly linked to decreases in non deposit feeder species. Our finding confirmed that land use in the form of industrial areas were potential to produce toxic material into ecosystems, alter biodiversity and species composition. Therefore, we recommend that the development need to consider the allocation of physical infrastructures particularly near waterways.

### **V-24-3: The Unexpected Suddenly Water Change Lead to Disrupt the Life Cycle of Aquatic Living Resources**

Hajime Matsubara, Yuki Kubara, Daisuke Iwata, Masaharu Shimizu, Takamasa Suzuki, Hiroka Yoshikawa, Yoshifumi Horie, Ayaka Chiba, Takuto Imai and Masaki Ichimura; *Tokyo University of Agriculture*

The global warming poses a major threat to the future. The arctic and sub arctic zone are especially sensitive to current global warming. The global warming has a possibility of substantial impacts on

the material cycle and biological productivity. In the aquatic area, its main effect is the suddenly change of water conditions (i.e. high water temperature, low salinity and oxidization etc.). Moreover, it is suggested that these unsuitable water conditions lead to death or larval deformity of aquatic living resources. Here, we inform that the affect or influence of water temperature, pH and salinity on the survival rates in cultured some the aquatic living resources in sub arctic zone, in order to guess the effect of coming global warming.

#### **V-24-4: Australian Mud Crab Fisheries and Climate Change**

Jan-Olaf Meynecke<sup>1</sup>, Mark Grubert<sup>1</sup>, Lee<sup>2</sup>, Joe<sup>1</sup>; *1. Griffith University, 2. Northern Territory Fisheries*

Mud crabs (*Scylla serrata*) are a highly valued commercial species harvested throughout South-East Asia. They are an important food source for many coastal communities. A combination of overfishing and unexpected consequences of climate change can put this fishery at risk. The Australian mud crab fishery has been regulated from its early stages providing continuous catch records. Both the market demand and catch rate of mud crabs has increased substantially over the past decade but there has also been large variations in productivity, particularly in Northern Australia. Fluctuations in catch rates greater than a factor of eight is thought to be driven by climate parameters and may shift strongly with climate change with the lifecycle of *Scylla serrata* related to rainfall and temperature. In this study, we quantified the relationship/s for catches and climate parameters. Catch per unit effort (CPUE), freshwater flow, sea surface temperature, Southern Oscillation Index (SOI), Madden-Julian Oscillation (MJO) and catch time series for specific combinations of time intervals and river systems have been explored using correlation analysis, meta analysis and multi dimensional scaling. Measures of high productivity such as warm sea surface temperatures, high rainfall and increased fresh water flow were significantly correlated with mud crab catch between 1 and 2 years later and suggest that mud crab recruitment is enhanced under these conditions. A strong relationship was found between annual maximum SOI values (indicating a strong monsoon) and catch adjusted for effort for Northern Australia. A regression model that included a measure of annual maximum SOI values explained 30-40 % of the variance in catch. The findings suggests that rainfall and temperature thresholds exists and if exceeded can cause a significant drop in production. Hence, the fishery may be sensitive to effects of climate change.

#### **V-24-5: Effects of Warming Sea Temperatures on Survival of Juvenile Reef Fishes in Nursery Areas around Hoga Island in the Wakatobi Marine National Park**

Wayne A. Bennett, Theresa Dabruzzi, John Eme, Nann A. Fanguie, Jodi L Rummer; *University of West Florida*

More than 160 juvenile reef fishes inhabit shallow sea grass and mangrove forest habitats adjacent to patch and coral reefs around Hoga Island in the Wakatobi Marine National Park. These habitats are important nursery areas that provide juvenile fish with access to resources and refuge from larger predators. We found that temperatures in Hoga's nursery habitats routinely experience extreme shifts of 15°C or more depending on time of day and tidal stage, suggesting that even relatively modest increases in sea surface temperature could have serious consequences for fish survival and ultimately reef biodiversity. High temperature tolerances (measured as Critical Thermal Maxima, CTMax) were determined for 450 individual juvenile fish from 65 species collected from deep (40-10cm) as well as shallow (<10cm) nursery zones. Overall, fish CTMaxima ranged from 44.1 to 38.1°C with a grand mean CTMax (SD) of 40.4 (1.2)°C. Species collected exclusively from deeper, thermally stable sites exhibited the lowest collective CTMax of 39.1 (0.7) °C; whereas fishes found only in shallow thermally extreme sites had a collective CTMax value of 41.4 (0.8) °C. Fishes common to both habitats had an intermediate CTMax value of 40.8 (0.9) °C. Thermal niche analysis for selected fishes from each of the three groups show the highest levels of intrinsic heat tolerance in shallow dwelling fishes and lowest levels from species in deeper zones. Likewise, metabolic rate temperature sensitivity (Q<sub>10</sub>) approached unity in shallow water fish but increased (Q<sub>10</sub> between 2 and 3) for fish in deeper

more thermally zones. Our data argue that juvenile fishes inhabiting shallow Indo-Pacific nursery areas are well adapted to high temperatures and are more likely to be affected by the indirect consequences of global climate change (e.g., reef degradation or changes in trophic structure) than by direct temperature mortality.

#### **V-24-6: Resilience, Biodiversity and Food Security Issue**

Agus H. Purnomo; *DKP*

Segara Anakan Lagoon represents one of the nation's most rapidly changing natural resource base and environments and wherein ecological dynamics interact intensively with the social aspects. This makes the lagoon a perfect case for the scientific communities and development agents to draw lessons and synthesize policy recommendation related to social, resource and environmental issues, particularly those pertaining to the frequently raised issue of biodiversity, food security, and sustainable development. In line with it, a study which focuses on portraying the social-ecological interactions of the lagoon is carried out. This paper is a part of the study, presenting a result, which draws upon the social-ecological system methodological approach. Data were collected through a series of survey involving side visits to 3 dusuns and interviews with key respondents from the dusuns, carried out in 2009. The dusuns were selected to represent locations in the lagoon inhabited respectively by predominant farming communities (Dusun Bugel), aquaculture communities (Dusun Bondan), and mixed communities (Dusun Lempong Pucung). In general, the study shows that through social-ecological adaptive cycles, social adjustments mainly aimed to secure food supply / availability, have been taking place following the existing ecological dynamics. Livelihood types and structure are constantly developing to adjust to the changing environment. Meanwhile, people's visions are no longer the same; part of the communities obviously is transforming from 'maritime people' to 'terrestrial people'. On the other part, the study also shows strong indications that such changes in the social context is starting to impact on the ecological aspect of the lagoon; marine biodiversity and productivity is declining while terrestrial outputs are increasing. At this stage, we can make it clear that a number of public policy options are available, including some social and physical engineering approaches directed toward stopping further environmental degradation.

#### **V-24-7: The Role of Biotechnology for Sustaining Marine Biodiversity and Food Security**

Irianto, Hari Eko, Ekowati Chasanah; *DKP*

Indonesia has been well known as the second biggest marine biodiversity. As maritime country, Indonesia is blessed with marine biota richness known as one of coral triangle world ecosystem countries. Research Center for Marine and Fisheries Product Processing and Biotechnology has done several biotechnology researches pointing on developing sustainable technology on marine utilization for food and pharmaceutical industry. The research strategy, results as well as its opportunity and challenge in developing the marine product will be presented and discussed

#### **V-24-8: Production of Bioactive from Microbes Isolated from Marine Sponges**

Ekowati, Ariyanti, Nuning Mahmudah, Yenni Risjani

Microorganism has been known as bioactivity producers since years. Our previous research has isolated 2 microbes from marine sponges harvested from Lombok sp and *Exserohilum rostratum*, identified as *Streptomyces* sp.. The microbes produced anticancer compounds when cultured during 10 weeks. The *Exserohilum rostratum* extract was selectively active against MCF-7, while *Streptomyces* sp extract was active against H460, SF 268 and MCF-7 cells. Aims of this research was to optimize culture medium for other bioactive production, i.e antioxidant and antibacteria. Optimization was carried out using 3 liquid media previously used for screening, i.e Malt extract medium, minimal fungal medium and glucose peptone yeast extract medium. Sampling has been done every 2 weeks, and parameters studied were bioactivity, yield and biomass produced. Result showed

that the 2 isolates did not show significantly different in producing biomass and yield. The 2 isolates showed weak antioxidant activity, and relatively active against *Vibrio parahaemolyticus* and *Pseudomonas aurogenosa*. Preliminary identification of the active substances using NMR showed that the active extract might be from alkaloid and peptida. Fractionation and structure elucidation of the active compound is underway. Keywords : bioactive, microbes, marine sponge

## Geographical evolution, genetics and conservation of marine biodiversity (#25)

(July 21 am; Wantilan rear)

Organized by: **Paul Barber, Craig Starger and Eric Crandall**

*The Coral Triangle Biodiversity Hotspot is the most biologically diverse marine ecosystem in the world. It is also the most threatened. While conservation of this region is complex, two key issues must be considered in conservation planning to yield long-term preservation of this biodiversity hotspot. First, it is critical to understand patterns of connectivity among populations. Connectivity provides the demographic exchange required to promote population stability and genetic exchange required to maintain the genetic exchange needed to maintain the ability of populations to respond to environmental change. Knowledge of connectivity is essential for developing functional networks of marine reserves. Second, although often overlooked, preservation of the Coral Triangle Biodiversity Hotspot requires conserving the processes that are creating and preserving this pattern. Identifying the origins of high marine biodiversity in this region is important so that these processes can be considered in region-wide conservation planning.*

*Recent years have seen tremendous advances in genetic methods. These methods are increasingly being applied to the waters of the Coral Triangle, providing novel insights into the processes driving diversification in this region. Perhaps more significantly, these methods are increasingly able to bridge the gap between processes occurring on evolutionary time scales and those occurring on ecological time scales, providing the ability to inform both ecological and evolutionary components of marine conservation.*

*This symposium will focus on the application of genetic methods to marine conservation. Specifically it will 1) explore the progress in applying genetic methods to the understanding of genetic connectivity and the processes shaping that connectivity across the Coral Triangle, and 2) the insights from genetic studies on the processes contributing to the creation and maintenance of the Coral Triangle Biodiversity Hotspot, and 3) how this information can be applied to conservation planning.*

### **V-25-1: Vicariance and Dispersal across an Intermittent Barrier: Population Genetic Structure of Marine Animals across the Torres Strait Land Bridge**

Cynthia Riginos, Anna G.K. Mirams, Eric A. Treml; *The University of Queensland*

The Torres Strait land bridge connected Australia and Papua New Guinea through much of the Pleistocene, and represents a major historical barrier for marine taxa, which would have blocked the most direct route for marine animals and their larvae to move between the western /northern and eastern coasts of Australia. Intermittently, however, there has also been a seaway through this region, with the most recent marine inundation dating from 7000 years ago to present. We gauge the effects of this dynamic seascape on contemporary population genetic structure of marine animals distributed across the northern regions of Australia, and specifically investigate how variation in larval life histories can influence gene flow and thus erode historical signals of vicariance. Mitochondrial DNA sequence variation was examined from four co-distributed teleost fish species, *Acanthurus triostegus* (Acanthuridae), *Dascyllus trimaculatus* (Pomacentridae), *Pomacentrus coelestis* (Pomacentridae) and

*Apogon doederleini* (Apogonidae). We also re-analyzed previously published mtDNA data from six invertebrates and four non-teleost vertebrates with reference to the Torres Strait barrier. For fishes, we find that population structure varied greatly among species with regards to the Torres Strait historical barrier, but that divergence and gene flow matched a priori predictions of species dispersal potential based on egg type and pelagic larval duration. The strength of population structure was also variable among invertebrates and non-teleost vertebrates, but not clearly correlated with predicted dispersal ability.

### **V-25-2: Quantifying Patterns of Connectivity and Isolation across the Coral Triangle – a Process-based Modelling Approach**

Eric A. Treml, Hugh P. Possingham, Cynthia Riginos; *University of Queensland*

Population connectivity is fundamental to understanding the population dynamics of species, marine biodiversity, and the conservation of marine species. Developing spatially-explicit hypotheses quantifying the patterns in marine population connectivity has been challenging, and requires a multidisciplinary approach. Although underutilized, biophysical modelling can be a powerful tool for quantifying the relative importance of, and interplay between, the environment and life histories. To better understand the scale and spatial patterns of marine connectivity, we constructed marine dispersal networks using a spatially explicit model to simulate dispersal between the reefs of the entire Coral Triangle. This dispersal model incorporates realistic and high-resolution ocean current data, reef habitat configuration, pelagic larval duration, mortality, larval behaviour, and settlement probability estimates. Network path analysis and community structure algorithms identified probable dispersal routes, persistent barriers, and isolated island clusters. The biophysical modelling, network analysis, and spatial context provide a robust examination of coral reef connectivity and valuable data source for interpreting marine population genetic patterns. We also illustrate how these connectivity estimates may be integrated into the regional conservation planning process.

### **V-25-3: Population Genetic Structure of Selected Shark and Shark-like Ray Species in the Tropical Indo-West Pacific**

Jenny L. Giles<sup>1</sup>, Jennifer Ovenden<sup>2</sup>, Cynthia Riginos<sup>1</sup>; *1. Schl Biological Sciences, University of Queensland, 2. Queensland Department of Employment, Economic Deve*

The tropical Indo-West Pacific region has the most diverse shark and ray fauna and highest rates of harvest globally, yet sharks and rays have been underrepresented in studies of population structure across this biogeographically complex region. This study describes mtDNA population structure for a number of co-distributed tropical Indo-West Pacific shark and shark-like ray species. This multispecies approach allows us to identify shared barriers to dispersal and compare patterns of genetic differentiation among selected species with differing dispersal potentials. Specimens for this work have been collected from fisheries landings in seven Central Indo-West Pacific nations. This study aims to contribute important regional-scale connectivity data for fisheries management and conservation applications in this comparatively data-poor group of fishes.

### **V-25-4: Preserving the Process: Phylogeny and Conservation in the Coral Triangle**

Matthew T. Craig; *University of Puerto Rico*

The Coral Triangle represents an area of extreme marine biodiversity superimposed upon an area of extreme human influence. Coupled with large scale changes in the dynamics of global climate, effects of human-induced alterations to habitats, increases in exploitation of marine species, and a lack of enforced harvest regulations have severely impacted this area, causing rapid loss of biodiversity. This realization has made the Coral Triangle a priority area for research aimed towards abating this reduction in species, populations and individuals. Empirical studies focussing on demographic parameters are common, as are studies of connectivity among populations, both of which aim to assist

in stemming the tide against present-day loss. The Coral Triangle, however, may serve an important evolutionary function as a “speciation engine”, serving as a geographic locality where new species may form rapidly. This presentation will review recent advances in our understanding of the phylogenetic relationships among marine fishes with representatives in the Coral Triangle, and will describe considerations that must be made to preserve the process by which biodiversity is created in the marine realm.

**V-25-5: Ecology, Evolution, and Speciation in the Coral Reef Fish *Dascyllus trimaculatus***

Giacomo Bernardi<sup>1</sup>, Matthieu Leray<sup>2</sup>, Ricardo Beldade<sup>1</sup>, Sally Holbrook<sup>1</sup>, Russell Schmitt; *1. University of California Santa Cruz, 2. EPHE*

Long pelagic larval phases and the absence of physical barriers counter rapid speciation and contrast the high diversity observed in marine ecosystems such as coral reefs. In this study, we used the three-spot dascyllus (*Dascyllus trimaculatus*) species complex to evaluate speciation modes at the scale of the Indo-Pacific. The complex includes 4 recognized species that differ in distribution and coloration morphs. Previous studies of the group using mitochondrial DNA revealed a disconnect between color morphs and genetic groupings; two of the color morphs grouped together, and one color morph separated into three clades. Using extensive geographic sampling of 591 individuals and a combination of mitochondrial DNA sequences and 13 nuclear microsatellites, we defined population/species boundaries and inferred different speciation modes. The complex is composed of 7 genetically distinct entities, not all of which are distinct morphologically. Ecological speciation was likely not the primary factor involved in the diversification of the complex, and despite extensive dispersal abilities, observed genetic partitions are consistent with allopatric speciation. However, ecological pressure, assortative mating, and sexual selection, likely acted significantly during periods of geographical isolation. This study suggests that historical factors may be the primary cause for divergence in this group.

**V-25-6: Reticulate Evolution in Corals**

Charlie Veron; *Coral Reef Research*

Taxonomy has changed from being a science in its own right to being a servant of other disciplines. It must now reflect natural order, incorporating changes in space (biogeography) as well as time (evolution). Environmental and geographic variations in corals form continuities that override concepts of taxonomically-defined species being natural units. Natural order is seen in the existence of syngameons, a highly intuitive genetic concept that replaces traditional Darwinian order. Evolution of this order produces reticulate patterns in both geographic space and evolutionary time. These patterns are molded by environmental mechanisms, not natural selection. Relevant evolutionary theories are compared in historical context and the mechanisms that links reticulate evolution with Darwinian concepts are discussed.

**V-25-7: Identification and Conservation of Evolutionary Processes in the Coral Triangle Biodiversity Hotspot**

Paul H. Barber<sup>1</sup>, Ambariyanto<sup>2</sup>, Hamid Toha<sup>1</sup>, I. Gusti Ngurah Mahardika<sup>1</sup>, Mark V. Erdmann, Timery DeBoer, Elizabeth Jones, Eric Crandall, Craig Starger, Samantha Cheng, Alexis Jackson, Kim Tenggardjaja, Krystle Chavarria ; *1. UCLA, 2. Universitas Diponegoro*

The reefs of the Coral Triangle are the most diverse in the World. While the origins of pattern have long attracted the attention of evolutionary biologists, answering this question has largely been considered of purely academic interest. However, given the increasing threats facing the reefs of the Coral Triangle, it is becoming increasingly clear that understanding the processes generating high biodiversity in this region is critical for preserving this diversity, including the processes that create it. In this study we compare phylogeography and genetic connectivity of over 30 fish and invertebrate



taxa that are codistributed across the Coral Triangle, representing multiple reef functional groups ranging from corals to pelagic fish. Results indicate a broad array of evolutionary patterns in this shared physical environment. Some taxa exhibit the classic pattern of differentiation between Pacific and Indian Ocean populations, suggesting Pleistocene vicariance. Others show fine-scale genetic differentiation, suggesting a common history of regional geographic isolation. Still others show no genetic structure at all. Although patterns fell into these three basic classes, there were few commonalities among taxa with similar patterns of genetic structure. The unique responses of multiple taxa to a shared environment suggest a multiplicity of physical and ecological processes contributing to the evolution of high biodiversity in the Coral Triangle. While the commonalities seen among some taxa suggests some support for regional seascape conservation initiatives, the idiosyncrasies among taxa demonstrate the challenges facing marine managers in designing reserve systems that will effectively protect a broad array of biodiversity.

#### **V-25-8: Integrating Methods from Spatial Ecology and Phylogeography to Understand Past and Future Climate Impacts on Marine Communities in the Coral Triangle**

Elizabeth J. Sbrocco<sup>1</sup>, Paul H. Barber<sup>2</sup>; *1. Boston University, 2. University of California, Los Angeles*

Understanding the extent to which climate variability over time and space shapes the diversity and distribution of wild populations is a common goal of evolutionary and conservation biologists. This is particularly true within biodiversity hotspots like the Coral Triangle, where similar physical and environmental pressures can lead to either rapid radiations or mass extinctions, two radically different consequences of living on a dynamic planet. Whether a species will flourish or face extinction under such pressure is largely determined by its dispersal ability, its adaptive capacity, or some combination of these two processes. Both processes have played important roles in the evolutionary histories of species, ultimately shaping their contemporary distributions and physiological preferences; as such, conservationists can gain valuable insight into the fate of species in the future by examining past and present interactions between dispersal, adaptation, and the environment. Utilizing a newly developed climatological database for use in marine spatial ecology (MARSPEC), we demonstrate how species distributional models can be used to infer the Pleistocene history of Coral Triangle anemone fish, creating phylogeographic hypotheses that we further test with multi-locus genetic data. Furthermore, using empirical estimates of genetic connectivity to inform assumptions about dispersal, we use these same spatial ecology methods to forecast the effects of future climate change on species diversity over the next century and assess the potential for dispersal to mitigate biodiversity loss across this region. Our results demonstrate how integrating genetic data with spatial models of species distributions over time can help to identify and preserve the diversifying processes that have contributed to the formation of this marine biodiversity hotspot.

#### **V-25-9: The Origins of Marine Biodiversity in the Coral Triangle: A Phylogeographic Perspective**

Brian W. Bowen<sup>1</sup>, Luiz A. Rocha<sup>2</sup>, Jeff A. Eble<sup>1</sup>, Robert J. Toonen<sup>1</sup>; *1. University of Hawaii, 2. University of Texas*

Two biogeographic theories have been proposed to explain the high biodiversity in the coral triangle. The Center of Origin theory maintains that successful species originate in the highly competitive environment of the coral triangle, and radiate out to peripheral areas. The Center of Accumulation theory maintains that the coral triangle is a region of overlap between Indian and Pacific faunas, and that species originate in peripheral areas. Recent phylogeographic surveys of Indo-Pacific reef fauna provide evidence for both patterns. Most of the coral reef fauna in the Central Pacific has origins at or near the coral triangle. In contrast, several recent cases have demonstrated species originating in the peripheral Central Pacific and colonizing in towards the coral triangle. We propose that both processes are operating in concert. Successful species forged in the highly competitive ecosystems of the coral triangle can radiate out to depauperate peripheral habitats, where they undergo ecological release and are able to develop novel functions. These peripheral species can subsequently expand

their range back into the center of biodiversity. A similar process is operating for the Caribbean biodiversity hotspot, which provides species to the South Atlantic. These Brazilian species may develop novel morphology, behavior, or feeding strategies and then recolonize the Caribbean. Under this process of biodiversity feedback, both hotspots and peripheral areas contribute to the production and maintenance of reef biodiversity.

#### **V-25-10: Concordant Marine Phylogeographic Pattern in the Philippines**

Kent E. Carpenter<sup>1</sup>, Paul Barber<sup>2</sup>, Carmen Ablan-Lagman<sup>1</sup>, Marie Antonette Juinio-Meñez<sup>1</sup>, Eric Crandall, Craig Starger, Amanda Ackiss, Timery DeBoer, Maria Lourdes Docoy, Inggat Laya Casilagan, Adam Hanson, Elizabeth Jones-Sbrocco, Mia Olivares, Rachel Ravago-Gotanco, Jeremy Raynal; *1. Old Dominion University, 2. University of California Los Angeles*

The extreme concentration of marine biodiversity in the Coral Triangle reaches an apex in the Philippines. Numerous hypotheses have been proposed to explain the pattern of species richness in the Coral Triangle. One of these, the area of origin hypothesis, assumes that conditions that promote lineage diversification are concentrated there both spatially and temporally. The building blocks of lineage diversification, population-level barriers to gene flow, have already been detected in concordant pattern across Indonesia, the largest component country of the Coral Triangle. Phylogeographic studies reveal that while some species show broad patterns of connectivity across the Philippines, others show concordant barriers to gene flow. This suggests that conditions that promote lineage diversification are also taking place in the apex of the Coral Triangle.

## **Evaluating economic incentives for conservation: from case-studies to process understanding (#26)**

**(July 22 am; Garuda)**

Organized by: **Claudia Romero**

*Economics are one of the pillars on which decisions affecting the present and future of tropical ecosystems and their resources are based. Thus, it is a discipline that can offer several insights to the community of tropical conservationists. It is thanks to the efforts of researchers willing to recognize the contributions of economic thinking, and to the integration of economics to work of other disciplines more traditionally linked to conservation, that conservation initiatives have increased potential of changing the characteristic path of destruction of tropical ecosystems.*

*This Symposium represents a first step, within the realm of ATBC, to bringing economists and their perspectives together with conservationists and researchers, to enhance the growing but still scarce experiences of collaboration and mutual learning towards tropical conservation. The underlying objective is to start a discussion of frameworks for evaluation of the ecological, social, and economic impacts of PES and economic-based incentives for conservation (e.g., tradable development rights, biodiversity offsets, environmental subsidies and taxes, performance-determined transfers between different levels of government).*

*Through the presentation of case-studies, attendees interested in understanding the opportunities offered by these incentives will be better able to grasp the numerous and often complex impacts of the implementation of economic-based initiatives. This Symposium will conclude with a panel during which the speakers and attendees will explore ways forward on the important tasks of progress monitoring and problem detection, processes on which ecologists and social scientists increasingly need to be involved.*

*The specific focus of this Symposium will be on the methods used to evaluate the progress and impacts, intended and not, of economic incentives-based conservation initiatives. Impacts considered will include ecological, economic, and more narrow financial benefits and costs for the parties*

*involved, as well as for the particular ecosystem services being marketed, and those that are not (e.g., biodiversity costs associated with carbon gains). Likewise, impacts to be assessed will include the cascade of effects above and below the levels of the participating institutions, as well as at various time scales. Finally, the political impacts on decision-making, information transfer, and accountability related to resource allocation and control will be examined. By emphasizing the methods used to quantify impacts, participants will be able to advance towards a more analytical framework that will allow identification of those 'ingredients' needed for the success of economic incentives initiatives, and of those characteristics of failures that should be avoided in the future.*

### **V-26-1: Typology and Checklist for Evaluation in Conservation, Environmental and Resource Settings**

Andy Rowe; *ARCeconomics*

Requirements for credible evaluations of resource, conservation and environmental interventions are growing rapidly. These settings are always challenging for evaluation and require the best evaluation knowledge. However evaluation thinking about these settings is still very nascent and a large proportion of the evaluations are undertaken by domain specialists from the natural and physical sciences with little or no evaluation training or experience. This presentation offers a checklist of key elements for evaluation in these settings designed to provide guidance for both evaluation consumers and providers. The hallmark of evaluation in conservation, resource and environmental settings is that it always occurs at the intersection of complex and linked natural and human systems. This intertwining of complex systems presents very serious challenges for standard evaluation techniques, especially the requirement for evaluation to assess and value the changes attributable to the interventions being evaluated. The presentation will discuss other challenges including appropriately specifying time, location and scale, balancing rigor and use of evaluation, promoting utilization of evaluations and culturally appropriate evaluation approaches. The checklist will identify the distinguishing characteristics of evaluation in these settings, and options to address the main challenges.

### **V-26-2: Cost-Benefit Analysis of Scenarios Versus Options: Application to Natural Resource Management in Morocco**

Romain Pirard; *Project Institute of Sustainable Development and International Relations (IDDRI)*

Cost benefit analyses for the environment usually refer to a limited number of static and contrasting situations (e.g. construction of a dam, mining in a protected area). Two or more courses of action are defined ex ante and assessed in relative economic terms. However, when the situations to be compared are not particularly contrasting (e.g. low forest degradation or conservation) and involve feedback effects, then it may be justified to adapt the methodology. One refinement would be to give more prominence to interactions between economic sectors, production practices and land uses, with some of them changing endogenously over time. Consequently we argue that it would be useful in many cases to prioritize the elaboration of long-term scenarios that incorporate these interactions in addition to the usual exogenously defined trends and economic profits per activity. This could enable better informed decisions on natural resource management by providing more realistic estimations of costs and benefits.

This line of thought was applied to the case of the Moroccan province of Ifrane in the Middle Atlas, where remaining cedar forests are indirectly threatened by a "tragedy of the commons" through overgrazing by sheep. We performed a cost benefit analysis that goes beyond the strict comparison of scenarios with/without straightforward conservation activities (e.g. stopping herding activities or forbidding the use of remaining forests). Emphasis has been put on the understanding of local practices in several key sectors – herding, forestry, agriculture, tourism, water – to identify the nature of interactions between sectors but also their impacts on the condition of the main natural resources. Long-term scenarios with associated economic evaluations were thus produced to stress the dynamic aspects (i.e. changing over time in response to external factors) of decisions and practices in these

sectors. While acknowledging the uncertainties regarding the interactions between sectors, natural resources and environmental services, the results show that it makes more economic sense to act in a manner that is ambitious enough to allow for the resolution of the most problematic issues. A contrario, if decision-makers design public policies that do not address the severe social and political problems identified in the area, the conservation strategy would then bear a significant risk of being a losing strategy for both the environment and the economic development of the province in the long term.

### **V-26-3: Designing Policies for Successful Tropical Forest Carbon Credit Programs: A Brazilian Amazon Case Study**

Claudia M. Stickler, Daniel C. Nepstad, Andre Lima, Britaldo S. Soares-Filho; *Woods Hole Research Center*

In an effort to reduce global greenhouse gas emissions from tropical forest conversion by tapping into emerging forest carbon markets, federal and state governments of tropical nations are developing programs to achieve reductions in deforestation and forest degradation. Brazil's evolving program to reduce emissions from deforestation in the Amazon is among the most advanced and has the potential to serve as a model for other nations. Under the Brazilian National Climate Policy—which created a target of 80% reduction in deforestation in the Amazon region by 2020—state governments are expected to establish deforestation reduction targets that, combined, provide the requisite reductions for the entire region. Although historically responsible for the highest deforestation rates in the Amazon, Mato Grosso state now accounts for 59% of deforestation reduction already achieved under the BNCP goals over the last 4 years. Here, we attempt to provide input to the policy framework design of the state's emissions reductions program, specifically to the design of the programs to reduce deforestation on private and indigenous lands. We examine the extent to which existing forest and land-use policies (including economic instruments) might be used for effectively applying carbon credits in the upper Xingu River basin in northeastern Mato Grosso—one of 3 pilot sites for designing and testing the state level program. We estimate the emissions reductions below (a) a historical baseline and (b) 3 business-as-usual scenarios that could be achieved on private lands in the region under 3 alternative policy frameworks. We also estimate the price of carbon that would be needed to offset the opportunity costs incurred by private landholders of complying with each alternative framework used to achieve the state target. Finally, we compare the alternative scenarios in terms of several ecological indicators to evaluate the performance of each in providing co-benefits beyond carbon stocks.

### **V-26-4: Challenges and Opportunities for Public Funded Restoration: Lessons Learnt from South Africa's Working-for-Water Programme**

Matthew M. McConnachie<sup>1</sup>, Richard M. Cowling<sup>2</sup>, Andrew T. Knight<sup>1</sup>, Christo Marais<sup>1</sup>, Mark Difford; *1. Rhodes University, 2. Nelson Mandela Metropolitan University*

South Africa is a mega-diverse country consisting of over three biodiversity hotspots. One of the major threats to this biodiversity are alien invasive plants. Woody alien plants are also attributed to reducing stream-flow of rivers. In response the South African government initiated what is the developing world's largest ecological restoration project: Working for Water (WfW). Restoration, however, is not the primary reason why the project receives state funding. Instead restoration is seen as a vehicle for job creation. On private land, where the bulk of restoration takes place, the programme relies on a combination of subsidisation and enforcement of restoration. This poses unique challenges for linking of effective restoration with job creation targets and ultimately the co-operation of landowners. A major short coming thus far is that ecological monitoring and evaluation of WfW operations have been relatively scarce. This information is integral without which it is difficult for the programme to know how to confront and learn from the challenges it faces. This paper draws from findings from a recent ecological monitoring and evaluation study conducted on the programme in the Eastern Cape Province. A feature of the study was to incorporate and compare the

tacit knowledge of the programme's managers with the empirical findings of the assessment. Building on this, the paper explores potential incentive and enforcement options that the programme is considering.

### **V-26-5: Fiscal Incentives for Conservation at the Local Level: The Case of REDD Implementation in Indonesia**

Silvia Irawan; *Australian National University (ANU)*

Reducing Emissions from Deforestation and Degradation (REDD-plus) has been adopted in the Copenhagen Accord to provide incentives for developing countries to pursue forest protection and conservation. Indonesia is now developing an implementation framework to implement REDD-plus scheme. Following decentralization in public administration, local governments in Indonesia now play an important role in forest protection and conservation. However, local governments often are not interested in pursuing conservation at the local level, because they are not compensated properly for the local costs. These include such costs as those accrued due to the restrictions on land use to generate local taxes and charges. This study proposes an intergovernmental fiscal transfer as an economic instrument that encourages local public actors to support forest protection and conservation. Using REDD-plus as the case study, this study conducts a cost analysis and fiscal simulation to calculate the amount of fiscal transfers to distribute REDD-plus payment to the district and provincial governments in Riau and Papua provinces. These provinces vary in terms of the autonomy status granted by the national government, the rates of deforestation, and the fiscal capacity, which reflects the dependency of local governments on fiscal support from the national government. Local governments are expected to be interested to pursue REDD-plus when the benefits generated from the scheme are higher than total costs of REDD implementation (including opportunity costs, management costs, and transaction costs). However, governance factors as well as political and administrative circumstances also influence the willingness of local governments to participate in the scheme.

### **V-26-6: The Pathway to a Market for Compliance-Grade REDD Credits**

Daniel C. Nepstad<sup>1</sup>, Andre Lima<sup>2</sup>, Paulo Moutinho<sup>1</sup>, Osvaldo Stella<sup>1</sup>; *1. Woods Hole Research Center, 2. Instituto de Pesquisa Ambiental da Amazonia*

Since the Bali conference of the parties of the UNFCCC, in 2007, important steps have been taken towards development of an architecture for linking state-/province-level REDD programs with cap-and-trade policies in developed nations. The greatest progress has been achieved in the "Governors' Climate Forest" task force (GCFT), initiated by California in 2008, and with the participation of Wisconsin, Illinois, five states of the Brazilian Amazon (Amazonas, Acre, Mato Grosso, Pará, Amapá), four Indonesian provinces (Aceh, West and East Kalimantan, Papua), and provinces in Nigeria and Mexico. In the context of this partnership, states have made formal commitments to lower deforestation, implemented land use zoning plans, and launched programs for regularizing land holdings and monitoring their performance, among several other programs. Investors are at the design table, together with NGOs, agro-industry, ranching, and smallholders. Here, we discuss the potential of this initiative to increase the scale of tropical forest conservation because it heralds the beginning of a broad, global scale market for the storage and sequestration of carbon by tropical forests. We discuss the prospects for the GCFT to set the standard for tropical forest carbon trading, presenting an analysis of the opportunities and challenges for achieving fungible tropical forest carbon credits in a formal market. We discuss the outlook for this initiative to gain in scale, using a case study of how states are integrating their efforts to meet national-level targets in the Brazilian Amazon to highlight the major challenges and priorities for achieving broad-scale emissions reductions and for raising "readiness" levels throughout the tropics.

### **V-26-7: The Australian Experience with Market-based Instruments for Environmental Stewardship**

Hugh P. Possingham; *The University of Queensland*

Over the past decade Australia's governments have embarked on several trials that use market-based instruments to deliver environmental outcomes. In this talk I will review these experiences focussing on biodiversity conservation. (I was Chair of the National Market-based Instruments Committee for Natural Resource Management for five years that trialled about 40 projects.) Of all the styles of market-based instrument – there are two common approaches in Australia: “reverse auctions” and “cap and trade”. Other market-based approaches, like green marketing and insurance mechanisms, are rare. Reverse auctions were championed first and very successfully in the state of Victoria and are now widespread. I will review the conditions under which they are seen to be most successful and criticisms of the approach. Cap and trade mechanisms in Australia are often used as an alternative to legislation for land clearing, threatened species or other biodiversity-related protection. Both approaches rely on the creation of a biodiversity metric that allows us to evaluate a bid (in the case of auctions) or trade. I will review the pros and cons of different metrics. The details of these metrics are stabilising and the Australian experience is relevant to many other countries. The approaches will be contrasted with more traditional direct economic incentives which, at present, are not that widely used in Australia.

### **V-26-8: Efficiency and Distributional Impacts of Protected Area Planning using PES Schemes in the Biosphere Reserve “Podocarpus-El Cónдор”, Ecuador**

Byron Maza, Jan Barkmann, Frank Von Walter, Rainer Marggraf; *Georg-August Universität Göttingen*

Ecuador is one of the countries with the richest biodiversity globally. 18% of the national territory are protected areas. Still, Ecuador has the highest annual deforestation rate in South America (1.7%; 198 000 ha) with much land being converted to pastures and crop land. Payment for Ecosystem Services schemes (PES) are an incentive-based alternative to a "command and control"-type establishment of protected areas. They are voluntary transactions between a buyer and a seller referring to a well defined ecosystem service. PES have been applied in Latin America to biodiversity protection, water supply protection, and carbon sequestration.

This paper investigates the effects of differing conservation instruments fostering a forest conversion ban in mountainous southern Ecuador (including PES schemes) on cost-efficiency and poverty alleviation. The instruments differ with respect to being either mandatory or voluntary, and if all farmers are compensated by the same fixed payment rate per hectare or if the compensation equals opportunity cost stipulated to be known by the analyst. Such schemes can be approximated by the auctioning of PES contracts. Additionally, a dedicated 'pro-poor' PES was designed restricting payments at a fixed rate to the poorest households. In all cases a fixed budget of ~25,000 USD/yr is dispensed. Empirical opportunity cost data stem from a sample of 130 local farming households living at the northern edge of the Biosphere Reserve “Podocarpus-El Cónдор” in southern Ecuador.

As expected, a voluntary PES paying just the opportunity costs can cover most of the relevant forest area (305 ha; 36%). In contrast, a mandatory approach covering all farms and compensating at an average opportunity cost of 156 USD/ha/yr only secures 136 ha. This approach also fares worst with respect to poverty alleviation with most payments being dispensed to the relatively least poor farmers and even the GINI coefficient rising slightly to 0.488. Voluntary approaches fare better in this respect with a maximum contribution to household incomes of about 10% for the three poorest household quintiles and GINI coefficients of ~0.477. If payments are restricted to these quintiles at rates between 150 and 300 USD/ha/yr, only 168 to 84 ha forest are covered but the GINI coefficients drops to 0.47-0.462. While mandatory approaches appear worst, we conclude that severe trade-offs between cost efficiency and poverty alleviation are likely to impact PES application in the study area.

**V-26-9: Pathways of Reforestation and Socio-agrarian Change in Panama, 1980-2008**Sean Sloan; *University of Melbourne*

Recent studies from Latin America suggest that forest regeneration occurs where rural depopulation, agricultural intensification, urbanization and 'development' increased off-farm economic activity and/or reduced agricultural extent. However, empirical models of this so-called 'forest transition' are crude and have failed to adequately define its dynamic.

This paper defines the major pathways of social and agrarian change resulting in regeneration in Panama. Upon integrating ~11 million census records of 1980, 1990 and 2000 with satellite observations of forest cover for 1990, 2000 and 2008 for 388 counties (81% Panama's rural counties), a canonical correlation analysis distils the complexity of change since 1980 into two pathways of change.

The first pathway describes deforestation (1990s) giving way to regeneration (2000s) as a function of agricultural expansion (1980s) followed by marked rural affluence (1990s). The second pathway describes intensifying regeneration (1990s and 2000s) as a function of sustained declines in agricultural employment rates and increases in female employment rates in improving economic conditions. Canonical correlations of social and forest-cover change are moderate, at 0.31 and 0.28 respectively, albeit significant ( $p < 0.001$ ) and appreciable considering the scale of observation. Both pathways concentrate along highways in the Interior provinces and are unified by a shift away from agricultural employment, though not necessarily agricultural contraction. Results recommend that economic development underlie policy to foster regeneration via social change. However, policy must acknowledge that such efforts may achieve only limited success, and may potentially be offset by deforestation 'leakage' elsewhere.

**V-26-10: of Public and Private Authority in Forest Governance in Southeast Asia**Benjamin Cashore; *Yale University*

The phenomenon of illegal logging has attracted widespread attention from private actors such as NGOs and international development agencies as well as public authorities such as national governments and international governmental organizations. However, the multiplication of these actors has not limited or complicated the use of domestic authority, but instead enhanced it. Because "legal" timber can only exist as a construction of domestic policy makers, the international conception of "legal" timber multiplies the number of relevant actors with overlapping authority. Through "Multi-Stakeholder Consultation Processes" there has been a growing recognition of overlapping authority and the need to create durable institutions. The growing synergy of private and public authority in illegal logging is an interesting empirical example of Gunningham's concept of policy baskets. Currently, three related efforts are interacting: timber legality tracking, EU procurement policy for this, EU-Indonesia bilateral agreements on legality. These different activities are enhancing each other by providing new logics for compliance to domestic laws. Because the notion of legal timber production can only be established locally, these interactions have proven to enhance the power of domestic policy makers by creating new opportunities for enforcement at each stop in the chain of custody for a timber product. If a timber supplier has obtained legal timber they will need to be able to prove "due diligence" in ensuring compliance to all relevant countries laws on timber trade. This would suggest that if sufficient policy making willpower appears in the end consumer nations, then companies will be driven to pursue strong methods of verifying the legal compliance of their product. This could then result in companies pushing for strong methods to certify their chain of custody.

## Exploration of tropical microbial diversity and their role in overcoming food, energy and climate crisis (#27)

(July 21 pm; Jauk)

Organized by: **I Made Sudiana and Kyria Boundy-Mills**

*Tropical microorganisms are vital to maintaining global ecosystem health and ecosystem services. The vast metabolic diversity of tropical microorganisms enable them to play key roles in terrestrial and marine food webs, and they are responsible for the cycling nutrients. This diversity is underpinned by novel enzymatic functions and metabolites or pigments, or stress tolerance, while microorganisms have already proven to be a rich source of biologically active compounds. Recently a large scale microbial survey indicated the existence of phylogenetically distinct microorganisms. Both culture-dependent and independent studies have provided an opportunity to also access the seemingly microbial diversity of microbial communities associated with plants, and animals.*

*From the biotechnological prospective, the productions of toxins, signaling molecules and other secondary metabolites as effective competition and defense strategies by endophytic microorganism constitute an unparalleled reservoir for the discovery of renewable energy sources, new drugs, therapeutic agents, and bioactive molecules, with application across medical, industrial and environmental settings.*

*In agricultural sectors, microorganisms have great potential for increasing crop productivity, drought tolerance, pest resistance and thus exploitation of beneficial microorganism for sustainable agricultural practices are interest for both developed and developing countries. On a global scale, microorganism can even influence climate change, and they are importance actors of green house gas emission, and reduction.*

*To enhance research on microbial resources, microbial culture collections are an important asset for facilitating research on taxonomy, ecology and bioprospecting. Despite the significant importance of tropical microorganism in sustaining ecosystem services, and maintaining global ecosystem health, and key actors in bio-industrial processes, our understanding on the species and metabolic, and ecological diversity is still limited. Thus intensive and integrated researches on global scale are required. The goal of the proposed symposium is to explore tropical microbial diversity, metabolic diversity and its applications, as well as understanding ecological and functional diversity in relation with climate crises.*

### **V-27-1: Bacterial systematics and identification methods**

Akira Yokota; *Institute of Molecular and Cellular Biosciences, The University of Tokyo*

The current classification of bacteria is based on the so-called polyphasic approach, comprised of phenotypic, chemotaxonomic, genotypic and phylogenetic analyses. Phenotypic approach is based on similarities of morphological, physiological and chemotaxonomical properties. Genotypic approach is based on genetic relatedness, deduced from DNA-DNA hybridization studies and comparative gene sequence analyses. Comparative sequence analysis of 16S rRNA gene sequence is useful for the characterization of higher taxa, whereas various character genes, so-called house-keeping genes, may be suitable as phylogenetic markers for the delineation of lower taxa. 16S rRNA gene sequence comparisons are currently considered as the gold standard for deducing the phylogenetic relationships of bacteria. However, species definition using rRNA sequence is often not possible because of the molecule is too conserved to distinguish between closely related species. Bacteria with 98.7% or lower 16S rRNA gene sequence identity can be considered as members of different species, because such differences in 16S rRNA gene sequence correlate well with DNA-DNA hybridization relatedness values of less than 70%. Bacterial species are defined as groups of strains that show more than 70% DNA-DNA similarity are considered to belong to the same species. For species delineation, DNA-DNA hybridization cannot be replaced until a better method becomes available. Thus,



genotypic and phenotypic characteristics are sufficient for reliable classification and identification of bacteria.

### **V-27-2: Tapping Biodiversity in Indonesia and in the Phaff Yeast Culture Collection**

Kyria L. Boundy-Mills; *University of California Davis*

Microbes play important roles in nature such as degradation and nutrient cycling, and can also be harnessed for a variety of applications. We report on microbial ecology research and linked bioprospecting projects, that tap two sources of microbes: an existing culture collection, and an ongoing bioprospecting survey in Indonesia. The Phaff Yeast Culture Collection at the University of California Davis contains over 7,000 yeast cultures belonging to over 700 different species. The collection offers contract screening service, which has been utilized by biotechnology companies to identify strains with superior properties. Screening results include, for example, identification of strains that can better tolerate conditions associated with production of cellulosic ethanol. The collection is growing through an international collaboration between researchers at the University of California and LIPI, the Indonesian Ministry of Forestry, and ITB, funded through the NIH International Cooperative Biodiversity Groups program. Microbes (bacteria, filamentous fungi and yeasts) are being isolated from soil, leaf litter, plant surfaces, and insects at a field site in Sulawesi. Microbes isolated in this project are being screened for lignocellulolytic activities, high lipid content, and therapeutic activities. To date, we have isolated 339 bacteria, 154 actinomycetes, 112 filamentous fungi, and 140 yeasts. Utilizing growth on CMC agar followed by staining with Gram's iodine, we have identified microbes with potential cellulolytic activity. Microbes are being screened for high lipid content by staining with Nile red, followed by GC analysis to identify lipid molecules. High lipid microbes identified in this project are candidates for use in production of biodiesel and other oleochemicals.

### **V-27-3: Fungal Diversity: Soil Fungi in Indonesia and Japan**

Katsuhiko Ando<sup>1</sup>, Yantyati Widyastuti<sup>2</sup>; *1. National Institute of Technology and Evaluation (NITE) Japan, 2. Indonesian Institute of Sciences (LIPI)*

From soil samples collected at 1) Eka Karya Botanical Garden in Bali (18 soil samples), and 2) Cibodas Botanical Garden in West Java (24) in 2003, 3) Purwodadi Botanical Garden in East Java (20), and 4) Bukit Sari Botanical Garden in Jambi, Sumatera (21) in 2004, 5) Cibinong Science Center in West Java (23) in 2004, 2005 and 2006, 6) Kupang Research Station in West Timor (20), and 7) Enrekang Botanical Garden in South Sulawesi (24) in 2005, 8) Kutai National Park in East Kalimantan (30), and 9) Lombok Research Station in West Nusa Tenggara (14) in 2006, 10) Sungai Wain Botanical Garden in East Kalimantan (20) in 2007, and 11) Pucak Botanical Garden in South Sulawesi (16), and 13) Liwa Botanical Garden in Lampung, Sumatera (13) in 2008 in Indonesia, 148, 200, 106, 71, 201, 291, 290, 185, 91, 179, 63, and 46 filamentous fungi were isolated by a soil dilution method. In the total 1871 isolates, 150 genera were identified. The genera identified with high frequency were *Penicillium* (frequency = number of sampling sites observed the fungal genus / number of sampling sites (12) = 100%), *Aspergillus* (100%), *Paecilomyces* (92%), *Cladosporium* (92%), *Acremonium* (92%), *Ochroconis* (83%), *Trichoderma* (75%), *Fusarium* (75%), *Verticillium* (75%), *Metarhizium* (75%), and *Cunninghamella* (75%). The biological diversity of soil fungi in Indonesia was a little bit different from the results of 113 soil samples collected in Japan; *Penicillium* (82%), *Acremonium* (54%), *Trichoderma* (48%), *Mortierella* (43%), *Verticillium* (29%), *Gliocladium* (25%), *Humicola* (24%), *Aspergillus* (23%), *Cladosporium* (22%), *Paecilomyces* (21%) and *Fusarium* (21%). This work was conducted under the Joint Research Project on Taxonomic and Ecological Studies of Fungi and Actinomycetes in Indonesia and Japan between LIPI, representing the Government Research Centres of Indonesia and NITE of Japan.

#### **V-27-4: Exploration of Tropical Microbial Diversity and Its Role in Overcoming Food, Energy and Climate Crisis**

I Made Sudiana<sup>1</sup>, Shigeto Otsuka<sup>2</sup>, Atit Kanti<sup>1</sup>, Heddy Julistiono<sup>1</sup>; *1. Research Center for Biology-LIPI, 2. The University of Tokyo*

Research Center for Biology is one of the research centers in the front line of biodiversity conservations. The cultivation of mycorrhiza in 1887 in Threub Bogor Botanical garden was the important starting point of Microbial Collection in LIPI. The culture collection has been enriched every year through a special program on exploration of tropical microorganism. The ecosystem type explored was quite varied. To study the effect of environmental changes (especially forest fire) on microbial activities, analyses were also carried out on amoA gene that is responsible for N-cycle. The importance of methanotrophic bacteria in rice field ecosystems in reducing methane emission was verified by gene functional analyses especially on the particulate methane monooxygenase gene and the soluble methane monooxygenase gene. To explore the role of microorganisms in overcoming food and energy crises physiological and ecological studies were conducted. About 500 fungi, 400 bacteria including 200 actinobacteria, 200 yeasts were so far deposited in LIPI, and available for further bioprospecting studies. Culture-independent techniques showed numerous diversity of bacteria including actinobacteria in forest soil. There was no much difference in soil bacterial community structure between burnt and unburnt areas 5 years after a series of forest fire. Analyses on diversity of amoA gene were able to show the effect of forest fire on diversity of ammonium oxidizing bacteria. Aeration or oxygenation was needed to stimulate cell growth and activities of methanotrophic communities. Present study clearly showed that forest ecosystem is not only important for maintaining global ecosystem health but also valuable genetic resources for overcoming energy, food and climate crisis, and clearly this is the added biodiversity value of forest conservation. Key words: exploration, microbial diversity, plant growth promoter, energy, and climate

#### **V-27-5: Metagenome Analysis of Tempeh, Indonesia's Indigenous Fermented Food**

Antonius Suwanto; *Department of Biology, Institut Pertanian Bogor*

Tempeh is an Indonesian indigenous fermented soybean that has been an integral part of rural Javanese and Balinese cuisine for centuries. Despite its excellent nutritional value, tempeh has not yet developed or penetrated into mainstream popular food. One of the main reasons is due to the high variability of tempeh quality which could be traced back to the lack of our knowledge on critical bacterial population and function during tempeh fermentation. Consistent tempeh quality will not only facilitate its development into highly accepted healthy food ingredients nationally, but also will help to promote this unique Indonesian product internationally. We attempt to systematically analyze bacteriological determinants essentials for consistent tempeh quality and to explore the diversity of local tempeh inoculants for their sustainable industrial utilization.

#### **V-27-6: Saeh Plant (*Broussonetia Papyrifera* Vent.): A Link Between the Yeast Diversity and Daluang (Dluwang) Paper**

Ariyanti Oetari<sup>1</sup>, Wellyzar Sjamsuridzal<sup>1</sup>, Tamara A. Susetyo-Salim<sup>2</sup>, Mega Atria<sup>1</sup>, Dian Hendrayanti<sup>1</sup>, Dalia Sukmawati<sup>1</sup>, Nanny Sri Lestari<sup>2</sup>, Eko Wijayanto<sup>2</sup>, Arie Toursino Hadi<sup>2</sup>, H. Sandi Pratama<sup>2</sup>, Titi Soedjiarti<sup>1</sup>, Atiek Soemiati<sup>1</sup>, Katrin<sup>1</sup>; *1. Faculty of Mathematics & Natural Sciences, University of Indonesia, 2. Faculty of Humanities, University of Indonesia*

Saeh plant in the past was commonly found and used by the Indonesians for making daluang (dluwang) paper. Nowadays, the plant is in scarcity and the traditional knowledge for daluang paper making is not known anymore. The UI Indigenous Studies research group investigated the distribution of saeh plant, yeast diversity on saeh plant, and the condition of daluang manuscripts. Plant samples were collected from Bandung, Garut and Trowulan in year 2009. Plant specimens were identified as *Broussonetia papyrifera* Vent. A total of 2,706 yeast isolates were collected from saeh leaf surfaces, and 340 isolates were selected for identification. Thirteen yeast isolates were identified by molecular

method based on the sequence analysis of ITS region of rDNA. Nine isolates were identified as *Cryptococcus rajasthanensis*, *Debaryomyces nepalensis*, *Geotrichum candidum*, *Pichia anomala*, *Pseudozyma antarctica*, *Rhodotorula dairenensis*, *Rhodotorula mucilaginosa*, and *Trichosporon asahii*. Four isolates were candidates for new species (*Saccharomycetales* sp., *Basidiomycete* sp., *Pichia* sp.). Physical condition and quality of 20 daluang paper manuscripts and 7 European paper manuscripts held in Sonobudoyo Museum in Yogyakarta was investigated in year 2009. Daluang manuscripts were mostly dated from 18th century, whilst European manuscripts were mostly dated from 19th century. Only 50% of daluang manuscripts showed fungi attacks compared to European manuscripts (85.7%). Only 25% of daluang manuscripts showed insect attacks compared to European manuscripts (42.8%). Daluang manuscripts contained less water (10.4 to 17%) compared to European manuscripts (10 to 15%). Only 10% of daluang manuscripts were illustrated in red colour compared to European manuscripts (28.5% in red, violet, gold, brown, blue). Investigation is still being carried out on finding saeh plant from other locations, identification of 327 isolates, and conditions of daluang manuscripts from other libraries.

#### **V-27-7: The Potential of Microbial Resources for Biofuel Development in Overcoming Energy Crises**

Nathan Schiff<sup>1</sup>, Atit Kanti<sup>2</sup>, Irmayuli Sitepu<sup>2</sup>, Kyria Boundy-Mills<sup>3</sup>, Elizabeth Widjaja<sup>2</sup> and Dan Potter; *1. USDA Forest Service, Stoneville, MS, USA, 2. Research Center for Biology, LIPI, 3. Food Science and Technology, University of California Davis*

In a world with a finite supply of fossil fuels and an ever increasing demand for energy, it has become necessary to develop sources of renewable fuels. Although opinion is divided on the best way to develop new energy sources, the conversion of cellulose to alcohol is a likely mechanism depending on the efficiency of the process. To increase efficiency we examined the biodiversity of Sulawesi particularly the lignivorous beetles for novel cellulases. Although many insect species feed on the wood of trees, most of them do not make their own cellulases but have symbiotic relationships with cellulase producing microorganisms. In this study, we isolated easily culturable species from the digestive tracts of lignivorous beetles, identified them using DNA bar-coding and stored them in culture collections until they can be tested for cellulolytic activity. We have also started an ecosystem level approach to wood degradation where we associate complexes of beetles and their microbial symbionts with their tree hosts. We hope to compare these associations with the lignivore complexes of congeneric host trees, in North America.

#### **V-27-8: Exploring the Diversity of Marine Bacterial Symbionts for Sustainable Source of Marine Natural Products**

Ocky Karna Radjasa; *Department of Marine Science, Diponegoro University*

The importance of terrestrial bacteria and fungi as sources of valuable bioactive metabolites has been very well established for more than half a century. As a result, most important medicines in use today are obtained from terrestrial microorganisms. On the other hand, the oceans are the source of a large group of structurally unique natural products that are mainly accumulated in invertebrates that are common to coral reef ecosystems, such as sponges, tunicates, bryozoans, soft corals and molluscs. Several of these secondary metabolites showed pronounced pharmacological activities and are interesting candidates for new drugs. The supply problem with regard to drug development and sustainable production lies in the limited amounts of biomass of most marine invertebrates available from wild stocks. Thus, most pharmacologically active marine natural products can only be isolated in minute yields. Total synthesis of pharmacologically active natural products has been successfully established but is in many cases economically not feasible due to the complexity of the molecular structures and the low yields. A growing number of marine microorganisms are the sources of novel and potentially bioactive secondary metabolites. It has been suggested that natural products from marine invertebrates have striking similarities to metabolites of their associated microorganisms. Thus, it is important to highlight the possible role of bacterial symbionts of marine invertebrates and

plants as alternative sources of biologically active substances. Most marine bacterial symbionts have eluded cultivation attempts, combined methodologies from microbial ecology, molecular genetics, metagenomics, and natural products chemistry have laid a valuable foundation for work on biosynthetic origin studies, allowing the symbiotic sources of a handful of marine natural products to be identified. As a result, molecular-based approaches on bacterial symbionts have become of great interest as a way to overcome the problem of natural levels of supply.

Here, it is discussed some prospects of bioactive compounds isolated from marine-derived microbes and their possible roles in providing drugs from the sea. It is also discussed the future commercial exploitation of these compounds for possible drug development using modern biological techniques.

#### **V-27-9: Nitrogen (N<sub>2</sub>) Fixation Activity and Molecular Identification of Methanotrophic Bacteria Isolated from Rice Fields**

Iman Rusmana<sup>1</sup>, Alina Akhdiya<sup>2</sup>; *1. Bogor Agricultural University, 2. Litbang Pertanian*

Methane is a greenhouse gas and has potency to deplete ozone layer. Rice fields are a significantly sources of atmospheric methane. Methanotrophic bacteria are unique in their ability to utilize methane as a sole carbon and energy source and their ability to fix N<sub>2</sub>. This research was successfully characterizing N<sub>2</sub> fixation activity and indentifying of methanotrophic bacteria from rice fields. From 19 tested isolated, four isolates performed high acitivity to fix N<sub>2</sub>. They could fix N<sub>2</sub> on different concentration of air saturation (10 % up to 100%). Molecular identification based on 16S rRNA gene sequences indicated that BGM 1 isolate had 74% similarity with *Methylocystis rosea* SV97T, isolates BGM 2 had 83% similarity wit *Methylococcus capsulatus* Texas, BGM 3 isolates had 69% similarity with *Parvus Methylocystis*, BGM 9 isolate had 85% similarity with *sMethylococcus capsulatus* and SKM 14 isolate had 63% similarity with *Methylobacter* sp.

#### **V-27-10: The Roles of Biological Resource Centers: Conservation and Sustainable Utilization of High Quality Microbial Resources for International Cooperation in Biotechnology**

Ken-ichiro Suzuki; *NITE Biological Resource Center (NBRC), National Institute of Technology and Evaluation (NITE) Japan*

Biological Resource Center (BRC) is an essential infrastructure for the life sciences and biotechnology to provide biological materials and accompanying information. NBRC was established to facilitate the biotechnological research and development in academia and industry. The essential roles of a biological resource center for microbiology are collection, preservation and supply of (1) reference organisms specified for quality control and standardized tests, (2) taxonomic type strains of prokaryotes and yeasts, and (3) wide variety of microorganisms with potential for utilization. In 2006, NBRC was certified by ISO 9001 and renewed in 2009 in the quality management system. Genomic DNAs of some microorganisms are available from NBRC for molecular biological research using the genomic data. NITE has been analyzing the whole genome sequences of various important microorganisms for industry and taxonomy available from the website. BRCs have to assist the users by supplying materials derived from correctly identified microorganisms in compliance with laws and regulations relevant to biosecurity, Convention on Biological Diversity (CBD), quarantine, and intellectual properties in addition to scientific interest. NITE also has a function of patent microorganism depositary as an international depositary authority (IDA) under the Budapest Treaty. International cooperation is important for the microbial resources in the collection. However, we have to pay attention to the national regulations for international transfer of biological materials in consideration of CBD. BRCs should be the focal points for transfer of biological resources to assist users. Asian Consortium for Conservation and Sustainable Utilization of Microbial Resources (ACM) was established by culture collection curators and microbiologists of twelve Asian countries in 2004 to construct the framework of the international cooperation and to improve the quality of BRC in each country.

## Phylogenetics in the Tropics: building trees to understand community structure and tropical biodiversity (#30)

(July 22 am; Wantilan rear)

Organized by: Nathan Swenson, Vinita Gowda and W. J. Kress

*The question of how so many species coexist in tropical latitudes is one of the largest unresolved questions in ecology and evolution. For decades ecologists have examined local-scale species diversity and coexistence with mixed results. Often the shared, or unique, evolutionary histories of the species within and across communities has been left unexplored. Phylogenetic hypotheses that describe the evolutionary relationships between species have been increasingly employed to inform studies of tropical community structure and biodiversity. The goal of the present symposium is to highlight novel conceptual and methodological approaches for analyzing how phylogenetic relationships influence present day patterns of community structure and biodiversity. Specific topics will include phylogenetic beta diversity, succession and phylogenetic structure, comparing the phylogenetic and functional structure of diverse communities, detecting cryptic species, the phylogeography of mutualisms, and the effects of phylogenetic age on sensitivity to ecological disturbance. As the number of phylogenetic analyses of tropical species continues to grow, it will become increasingly critical to develop and test novel conceptual and methodological approaches to determine when, where and why phylogenetic relatedness influences observed ecological patterns. It is expected that the present symposium will help provide answers to these pressing questions.*

### V-30-1: Phylogenetic Diversity in Community Assembly Across a New Guinea Lowland Rainforest Light Gradient

Timothy J.S. Whitfeld, George D. Weiblen; *University of Minnesota*

Identifying mechanisms that maintain high plant species diversity in tropical forests has long been a challenge for community ecologists. The application of phylogenetic methods to this ongoing conundrum is a relatively recent approach that has been greatly facilitated by the increasing availability of DNA sequences and a rapid increase in computing power. Here we apply a phylogenetic approach to the question of species coexistence in a diverse New Guinea lowland rainforest including 382 vascular plant species (at least 5 cm dbh) in 4¾ hectares. Two chloroplast DNA markers were used: the *rbcL* gene and the non-coding *trnH-psbA* spacer region. In combination these markers provide phylogenetic resolution at deep and shallow nodes of the tree. The result is a well-resolved community phylogeny, with branch lengths, that can be used to assess the degree of phylogenetic clustering or evenness in the highly diverse lowland rainforest of New Guinea. Results from this analysis can be used to identify patterns of diversity and test hypotheses of mechanisms of species coexistence.

### V-30-2: Hyper-Diversity without Niche-partitioning: Examples from Neotropical Fruit Flies

Marty Condon<sup>1</sup>, Sonja Scheffer<sup>2</sup>, Matthew Lewis<sup>1</sup>, Isaac Winkler<sup>1</sup>; *1. Cornell College, 2. Systematic Entomology Laboratory USDA*

In community ecology, principles of resource partitioning predict that assemblages of species minimize niche overlap. Resource partitioning principles also underlie current discussions of ecological speciation: niche overlap can result in disruptive selection leading to specialization, which can lead to speciation. Our observations, however, suggest that niche-partitioning may play a minor role in diversification. Our studies of hyper-diverse neotropical communities of herbivorous insects and their parasitoids reveal high levels of specialization; however, we find very high levels of niche-overlap. Multiple cryptic species of herbivores in sympatry occupy the same, very specific niches: e.g., male flowers of a single species of host. We suggest that selection for niche-partitioning plays a minor role in the diversification of the herbivores, most of which probably diverge in allopatry during

periods of habitat fragmentation. Hyper-diverse communities of specialists occupying the same niches may form via neutral processes accompanying repeated fragmentation and expansion of host-plant habitats.

### **V-30-3: Phylogenetic Beta Diversity in Tropical Forest Plots: An Examination of Alternative Approaches**

Nathan G. Swenson; *Michigan State University*

In the last decade community ecologists have increasingly incorporated phylogenetic information into their analyses of community structure and diversity. The vast majority of this work has focused on measures of phylogenetic alpha diversity and dispersion. This approach is now beginning to be expanded into analyses of phylogenetic beta diversity and dispersion with the number of metrics utilized rapidly growing. The relative merits of these metrics is unclear and whether analyses of phylogenetic beta diversity provide useful information is even less clear. Here I examine the phylogenetic beta diversity in two Neotropical long-term forest dynamics plots using several metrics. The goal of the work is to determine the relative independence of different metrics, the role of abundance-weighting and to examine when and where phylogenetic beta diversity is higher or lower than species beta diversity in these forests.

### **V-30-4: Divergence in Anti-Herbivore Defense among Sympatric Psychotria Shrubs and Implications for Herbivory in Phylogenetically-Clustered Assemblages**

Brian E. Sedio<sup>1</sup>, Jared W. Westbrook<sup>2</sup>, Christopher W. Dick<sup>1</sup>, S. Joseph Wright<sup>1</sup>; *1. University of Michigan, 2. University of Florida*

Many tropical forests contain diverse assemblages of congeneric trees, which raises the question of how ecologically similar species can avoid competitive exclusion. Negative density-dependent fitness imposed by specialized natural enemies (i.e. the Janzen-Connell hypothesis) is a broadly accepted mechanism of species coexistence. Specialist herbivores, however, often specialize on a particular genus, not species, of plants. On the other hand, plant defenses can be quite divergent among closely related sympatric species. Herbivore-driven spatial overdispersion of such defense traits might allow a Janzen-Connell-like mechanism to facilitate coexistence within local assemblages. We examine the specificity of interactions between herbivorous insects and their host-plants among 21 sympatric species of the diverse tropical shrub genus *Psychotria* (Rubiaceae) on Barro Colorado Island (BCI), Panama. Data on plant-insect associations based on DNA barcode analysis of insect gut contents are combined with profiles of host plant defense traits to address three principal questions: i) how specialized are the insect herbivores of a single, diverse plant genus? ii) do *Psychotria* defenses show evidence of evolutionary divergence? and iii) do *Psychotria* species assemblages reveal limited similarity in defense traits? Results indicate that the insect herbivores of *Psychotria* on BCI are not strict specialists. Phylogenetic signal with regards to particular defensive traits appears driven by divergence between the two *Psychotria* subgenera, though phylogeny is a poor predictor of multivariate defense syndromes within each subgenus. Previous results indicate that species of *Psychotria* that co-occur within 28 m<sup>2</sup> plots are more closely related than by chance relative to the BCI species pool (i.e. are phylogenetically clustered). Evolutionary divergence in defense may facilitate coexistence within such assemblages by reducing herbivore overlap between close relatives.

### **V-30-5: Comparative Phylogenetics of Tropical Asian Taxa Reveals a Phylogenetic Break in the Indomalayan Region Corresponding to the Brahmaputra Valley**

K. Praveen Karanth; *CES, IISc, India*

The biota of tropical Asia has been placed in the Oriental realm by Wallace in 1876 and in more recent times this biogeographic zone is called the Indomalayan region. The Indomalayan region has been subdivided into various subregions. For example mainland tropical Asia is further divided into

Indian and Indochines subregions with the borderline between these subregions passing through Bangladesh and Northeast India. Here I have reviewed recent phylogenetics and phylogeography studies on a range of taxa from the Indomalayan region to test this biogeographical scenario. These studies suggest that species from Indian and Indochines subregions constitute separate and independent radiations. Additionally the river Brahmaputra in Bangladesh and Northeast India appears to form the Eastern and Western boundaries of Indian and Indochines subregions respectively. Northeast India, particularly the state of Assam forms the transition zone between these two subregions and harbors species from both the subregions. Interestingly, in some cases hybridization between taxa from Indian and Indochines subregions have been reported in Assam. Thus molecular studies are largely concordant with the subregion designation proposed in the past with some hybrid forms appearing in the transition zone.

**V-30-6: Increased Phylogenetic Clustering along Gradients of Increasingly Harsh Conditions- Examples from a Plant and a Bird Family.**

Eliot T. Miller, Amy E. Zanne; *University of Missouri, St. Louis*

The ability of an organism to survive and reproduce in the face of environmental extremes such as aridity and low temperatures requires physiological adaptations. These adaptations may be costly to maintain (e.g. high metabolic rates or dense wood), and may arise infrequently over evolutionary timescales; as a result, few lineages are expected to possess tolerances to such environmental extremes. For these reasons, we predicted that continent-wide distributed lineages, for example the Meliphagidae honeyeaters and the Proteaceae of Australia, should exhibit increased phylogenetic clustering along gradients of increasing extremeness. We tested this prediction in a series of such gradients in both families: increasing latitude (and decreasing overnight temperatures) from northeast Australia to Tasmania and from North-central Australia to South-central Australia; and decreasing precipitation, from Sydney west into the arid interior, and Perth east into the same region. Because some of these gradients confound latitude, temperature, and precipitation, we used multivariate analyses to partition the variance and tease apart the relationships. We found that the predicted increase in phylogenetic clustering with increasing gradients of extremeness was indeed largely supported, though the relationship was not always strong. When available, we incorporated abundances, which improved the fit of the relationship. We present our results and discuss implications for the radiation of clades along such gradients.

**V-30-7: Trait Neighborhoods, Phylogenetic History, and Variation in Growth and Mortality through Time in Neotropical Forests**

Nathan J.B. Kraft; *University of British Columbia*

Advances in functional ecology and phylogenetics have produced a boom in recent years in the analyses of tropical plant communities in the context of ecophysiological function and evolutionary history. Analyses have documented patterns of species co-occurrence that are non-random with respect to phylogenetic distance, and, more recently, with respect to key functional traits (e.g. Kraft and Ackerly 2010, *Ecological Monographs*). These patterns have often been interpreted in the context of niche-based community assembly processes such as habitat filtering and within-habitat niche differentiation. However, more work is needed to link these patterns to ecological processes. I present analyses focused on two relatively poorly understood areas- the temporal changes in the functional structure of forests through time, and the intersection between functional-trait patterns and evolutionary relatedness patterns. Many initial analyses of tropical forests focused on a single census of the forest. However, if niche-based processes are indeed operating it follows that variation in the growth and mortality of trees through time should be related to the functional and/ or phylogenetic identity of neighboring trees. I will address this temporal question in two ways- first by considering patterns of co-occurrence within different size classes in the forest, and second by testing if the growth and mortality of individuals through repeat censuses are related to the functional and phylogenetic “neighborhood” in which they are found. Finally, I will explicitly make comparisons

between the results of phylogenetic and functional trait based approaches. Preliminary results suggest that mortality is correlated with the functional similarity of neighboring trees and that phylogenetic analyses integrate the results of trait-based tests, as opposed to capturing distinct information.

### **V-30-8: Phylogenetic and Trait Structure of Communities across >600 Tree Species in French Guiana**

Kyle G. Dexter<sup>1</sup>, Christopher Baraloto<sup>2</sup>, Tim Paine<sup>1</sup>, Jerome Chave<sup>1</sup>, Olivier Hardy; *1. Centre National de la Recherche-France, 2. UMR-Ecofog-Guyane*

Many recent studies have examined the phylogenetic structure of communities in order to assess the relative influence of competition, habitat filtering, and other ecological processes on community assembly. For example, if closely related species co-occur less often than expected by chance, this can suggest that there is competitive exclusion among ecologically similar species. In general, this research program depends on the assumption that there is a strong correlation between species' relatedness and ecological similarity. Measuring functional traits of species may offer a more direct means of assessing species' ecological roles, determining their ecological similarity, and assessing the relative influence of different processes on community assembly. In one of the largest-scale studies to date, we integrate phylogenetic, trait, and community composition data for >600 tree species sampled in the rainforests of French Guiana. We measured a diverse set of traits from the leaf and wood economics spectra across multiple individuals per species per community. We constructed a phylogeny for all species using the *rbcL* and *matK* chloroplast markers. We then examined patterns of phylogenetic and trait structure in communities across varying phylogenetic and spatial scales. We find little pattern in the phylogenetic structure of communities, while nearly all traits show significant clustering in communities. This indicates that there is not competitive exclusion based on traits we have measured, and that the trait values of co-occurring species may depend more on the local environment. Furthermore, preliminary analyses of intraspecific variation and patterns of trait evolution suggest that traits are highly evolutionarily labile. Thus, the pattern of trait clustering within communities may reflect plasticity or genetic variation within species rather than habitat filtering.

### **V-30-9: Phylogeographic and Population Genetics of Two Eastern Caribbean Heliconias – a Molecular Perspective of Ecological Interactions**

Gowda Vinita, W. John Kress; *Smithsonian Institution*

Islands are nature's best natural laboratories for the study of ecological and evolutionary patterns of speciation. Here, we provide a phylogeographic study of two native heliconias (Heliconiaceae) from the Eastern Caribbean Islands: *H. bihai* and *H. caribaea*. The two species of heliconias have been known to be primarily pollinated by the dimorphic Purple-throated Carib Hummingbird (*Eulampis jugularis*), with which a strong sex-specific coevolutionary interaction has been recorded. The two heliconias are distributed throughout the archipelago from Dominican Republic in the North to Trinidad & Tobago in the South. However, *H. caribaea* is a dominant species on the northern islands (north of Guadeloupe except Dominican Republic) while *H. bihai* is a dominant species in the southern islands (south of St. Vincent), and both can be found in comparable densities in the central islands (Guadeloupe, Dominica, and Martinique). Here, we used highly variable microsatellite markers and standard molecular markers (*trnH-psbA* spacer region and coding *rbcL*) to investigate phylogeographic patterns within the two species of heliconias to answer key questions about species radiation, colonization patterns and inter- and intra-island genetic divergences. Results from the phylogeographic and genetic network analyses show that populations from the geographically closer islands indeed share more alleles with each other than distant islands. Further, preliminary results from concurrent analyses of ecological interactions and the phylogeographic studies show that islands where the heliconias are pollinated by diverse species of pollinators show higher genetic diversity than islands where strong species-specific interaction have been observed. In conclusion, ecological observations supported most phylogeographic patterns and we discuss the need to integrate ecological and phylogeographic studies to understand plant-pollinator interactions from new perspectives.



### **V-30-10: Phylogenetic Structure and Functional Traits: Factors Contributing to Rainforest Community Assembly at Regional to Local Scales**

Robert Kooyman<sup>1</sup>, Maurizio Rossetto<sup>2</sup>, William Cornwell<sup>1</sup>, Mark Westoby<sup>1</sup>; *1. Macquarie University, 2. National Herbarium of New South Wales*

Measures of phylogenetic relatedness of co-occurring species can be used to infer the importance of processes that influence community assembly. Phylogenetic clustering and/or evenness are thought to be created by the interaction of factors such as habitat filtering, dispersal limitation and limiting similarity, combined with different scenarios of trait evolution. We used empirical rainforest data to assess the capacity of various methods to detect the sign of individual processes in relation to different pool sizes and null models across continental, regional and local scales. Trait variation within and across communities, trait conservatism relative to environmental gradients, and species turnover relative to spatial and temporal scales were used to model aspects of rainforest community assembly. Phylobetadiversity showed that species were replaced by less related taxa across regions at the continental scale, and more related taxa at local scales. NRI and NTI showed that species were less related in more stable locations (indicating possible refugia) and more related where stronger environmental filtering acted on conserved traits. Trait dispersion metrics (SES MPD and SES MNTD) provided additional insights into key processes such as dispersal and recolonisation. Model outputs showed that rainforest community assembly differed across scales relative to both trait and niche conservatism. Overall the results highlighted the efficacy of the methods and the benefit of linking multiple measures of phylogenetic structure and trait variation to elucidate community assembly across scales. They also provided a framework for additional genetic sampling aimed at testing the results and associated evolutionary, biogeographic and ecological hypotheses at a range of scales.

### **Conserving primates through research and habitat protection (#31)**

**(July 22 am + 22 pm; Wantilan front)**

Organized by: **Cheryl D. Knott and Djuwantoko**

*The global pressures of food shortage, increasing energy demands and climate change have severely impacted primates worldwide as their habitats shrink from the human-generated activities of logging, mining, poaching and conversion of natural habitat to meet human needs. Because of their relatively large ranges and often specific habitat requirements, primates are particularly vulnerable to such environmental changes and their populations are dwindling. Over 50% of primates are now classified as vulnerable, endangered or critically endangered in the wild. Indonesian primates exemplify this conflict. With over 30 species of primates, Indonesia hosts a wealth of primate diversity, yet many of these are threatened or endangered, with three being on the most endangered list. Indonesia thus serves as a particularly appropriate venue for this symposium that brings together primatologists and biologists from around the globe who are studying primate ecology and behavior and engaging in efforts to save primate habitats. Through sharing of research results and conservation applications we hope to create synergy within the primate research and conservation community for further advancements in the protection and study of the world's primates. Scientists play a critical role in preserving these populations. Only by understanding the ecology and biodiversity of primates can successful conservation efforts be implemented. Different methods for securing natural primate habitats, such as the establishment of protected areas, sanctuaries, national parks, eco-parks, and conserving non-protected areas, (e.g. production forests or private land) critically rely on an understanding of the primates themselves. This symposium brings together scientists working on primate ecology, behavior and conservation to share the results of their research and conservation efforts with the goal of achieving a greater understanding of primates as members of tropical ecosystems and furthering efforts to decrease the degradation of primate habitats. The objective of the*

*symposium will be to share new results from tropical areas across the globe with a special emphasis on studies that emphasize the intersection of primary research and on the ground conservation actions. One of the goals of the symposium will be to inspire and formulate new ways of studying primates and to highlight the role that primate researchers can play in protecting and conserving primates and their natural habitats. With a number of primate species facing the very real possibility of extinction in the wild, sharing of this expertise will make a real contribution to combating the tropical biodiversity crisis.*

**V-31-1: Conservation Impacts of Co-mgt on Western Chimpanzee (*Pan troglodytes verus*) Habitat and Chimpanzee consv. in Nialama Classified Forest, Rep.of Guinea**

J.L. Sunderland<sup>1</sup>, Dan Slayback<sup>2</sup>, Michael Balinga<sup>1</sup>, T.C.H. Sunderland<sup>1</sup>; 1. *CIFOR*, 2. *Science Systems and Applications, Inc.*

Across the globe a multiplicity of efforts to protect remaining wild ape populations are underway and these vary in their approach towards the involvement of local people. One approach recently engaged in Republic of Guinea is that of co-management which involves government and local community groups developing and implementing effective strategies for sustainable utilization and conservation across a multitude of sites. The first site identified for co-management was the Nialama Classified Forest, and a decade financial support was provided to develop local natural resource management capacity. Long-term local chimpanzee monitoring provided the basis for delimiting the boundaries of core protection areas which continue to provide refuge to the resident chimpanzee population. Employing the use of satellite imagery, we reviewed the impacts of co-management on key chimpanzee habitat. Degradation statistics show that land cover change within critical chimpanzee habitat within the Classified Forest is far less than within the Classified Forest as a whole, or within a 5 km buffer zone. However, critical chimpanzee habitat located outside of the Nialama Classified Forest suffered the most degradation (126 ha). Within this manuscript we discuss the impacts of co-management on chimpanzee habitat and causal factors surrounding the continued survival of chimpanzee at this site.

**V-31-2: Assessing the Health and Energetic Status of Wild Orangutans in Gunung Palung National Park**

Cheryl D. Knott, Melissa Emery Thompson; *Anthropology, Boston University*

Disease load is a critical factor effecting the long term viability of wild primate populations. Here we present data on non-invasive measures used to assess health, energetic and reproductive status of wild orangutans in Gunung Palung National Park, West Kalimantan, Indonesia. Data come from over 2500 urine samples collected from 1994 - 2010 on over 100 individual orangutans. Urinary dip-sticks were used to measure specific gravity and pH and to detect the presence of leukocytes, nitrite, ketones, protein, glucose, urobilinogen, bilirubin and blood in the urine. Urine was assayed for C-peptide, a measure of energy expenditure, and cortisol, a measure of metabolic stress. Results indicate high levels of leukocytes, particularly in males with visible signs of wounding, and in some females pre- and post-partum. The presence of nitrite in urine can also be indicative of infection and was seen in 15% of samples. Glucose, urobilinogen and bilirubin were detected in just 1-3% of samples. Ketones, reflecting the breakdown of fatty tissues, were found in 6% of urine samples and were correlated with periods of low fruit availability. Additionally, 24% of urine samples showed trace levels of protein, concentrated during the period of lowest food availability. Blood was detected in 10% of urine samples, sometimes indicting menstruation. C-peptide levels were significantly correlated with the presence of ketones, caloric intake and food availability. Non-invasive methods such as these promise to provide new ways to evaluate the health of wild primate populations and interpret individual behavior. Detecting infection can be used to evaluate the seriousness of wounds and to quantify the costs associated with particular behaviors. It may also reveal the presence of infection not otherwise apparent. These results provide a baseline for future orangutan health evaluations at this site and a comparative sample from a relatively undisturbed population.

**V-31-3: Is Kin-Network Realistic in Monogamous Gibbons?**Tommaso Savini; *King Mongkut's University of Technology Thonburi*

Over 29 years (1978-2006; 137.5 group years) of published demographic data on white-handed gibbon, *Hylobates lar*, population of Khao Yai National Park (Thailand) have been used to investigate natal dispersing pattern in monogamous primate. Beside the dispersing dynamic, I will be looking at the long term consequence in the spatial shaping of gibbon society. Firstly a strong sex difference was observed both 1) on the time period when dispersion occurred and 2) on the dispersing distance from the natal group. Female leave the natal group on average 9.4 months (n=7) after reaching sexual maturity (estimated at 8 years of age for the species) while males extended dispersion on average after 33 months (n=13) after reaching sexual maturity showing a long post-maturity residence in the natal group. As a possible direct consequence female disperse on average at 2.2 home ranges away from their natal range while males mainly (50% of the reported cases) move to the neighboring home range. Following those results we can hypothesize that this dispersing pattern might be responsible for the formation of a male kin-network which could provide three major advantages to breeding males: 1) low encounter intensity, 2) limit the effect of take over by opening polyandrous options for secondary dispersion and 3) buffering the effect of EPC.

**V-31-4: The Locomotor Behaviour of Wild Orang-utans (*P. p. wurmbii*) in Disturbed Peat Swamp Forest, Sabangau, Central Kalimantan, Indonesia**Kirsten L. Manduell, Helen C Morrogh-Bernard, Thorpe; *University of Birmingham*

The study of orangutan positional behaviour contributes to our understanding of the complex relationship between the largest arboreal primate and its environment. This study examined the locomotor behaviour of a population of wild Bornean orangutans (*P.p.wurmbii*) in disturbed peat swamp forest in the Sabangau Catchment, Indonesia. The main objectives were to identify key associations between orangutan locomotion and support use and to assess whether support use mirrors support availability within the environment. A total of 18,220 instantaneous observations of positional behaviour were obtained, with 2,874 of locomotion. Twenty two individuals were observed, including all age-sex classes. Log-linear modelling was used to identify key associations between orangutan locomotion, body size, height in the canopy and support use. Whilst all variables in the model were found to influence locomotion to varying degree, support type and support diameter were found to have the strongest associations with locomotor repertoire. This supports the hypothesis by Thorpe and Crompton (2005) that orangutans have evolved specific modes of locomotion in order to solve problems associated with traversing a complex arboreal environment. Torso orthograde suspensory locomotion, where the body is held in an upright position, dominates orangutan locomotion concurring with studies in mixed dipterocarp forest. Data indicate that orangutans in disturbed peat swamp forest employ higher frequencies of tree-sway which is an energetically efficient means of traversing the arboreal environment. This mode of travel is easily exploitable in the Sabangau given the high density of small, and by the nature of their size, compliant trees. Habitat data indicate that orangutans use trees for travel in similar proportions to what is available within the environment with regard to crown shape, crown position relative to the neighbouring canopy and presence of lianas within the tree crown.

**V-31-5: Protected Area Establishment and Cross River Gorilla Ecology (*Gorilla gorilla diehli*) at Kagwene Mountain, Cameroon**J.L. Sunderland-Groves; *CIFOR*

The critically endangered subspecies of gorilla (*Gorilla gorilla diehli*) surviving in the Nigeria-Cameroon border region continues to persist in small numbers despite continuing habitat degradation, fragmentation and hunting. Ape focused research established in the mid-1990s in both Cameroon and

Nigeria has provided current state of knowledge on ape abundance and distribution throughout this range and led to the formation of a broad program of conservation, research and outreach education. Within the scope of long-term conservation action two new protected areas in southwestern Cameroon were proposed in 2004 and created in 2008, the Takamanda National Park and Kagwene Gorilla Sanctuary. Long-term Cross River gorilla ecological data recorded at the Kagwene Mountain in Cameroon were employed to propose the boundaries of the Kagwene protected area and gorilla monitoring continues to date. This paper serves to provide results on feeding ecology and range behavior of the Kagwene gorillas and the process for continued protection at this recently recognized protected area.

**V-31-6: Orang-utan Feeding Ecology in the Sabangau Peat-Swamp Forest, Central Kalimantan, Indonesia: Implications for Captive Management**

Mark E. Harrison, Helen C. Morrogh-Bernard; *Wildlife Research Group, University of Cambridge*

Maintaining a suitable diet is important for the health and wellbeing of captive primates, both in collections and rescue/rehabilitation centres, and includes both the avoidance detrimental nutritional shortfalls and excesses. Among other reasons, studies of wild primates are needed to shed light on the nutritional quality of diets appropriate for captive populations. We present the results of a two-year study on orang-utan (*Pongo pygmaeus wurmbii*) feeding ecology in the non-masting peat-swamp forest of Sabangau, Indonesian Borneo. Orang-utans were followed and continuous observations of feeding behaviour (species and food part eaten, feeding rates) collected. Samples of foods eaten were collected and analysed for nutritional content in a laboratory, using standard methods. These data were then compared to those from mast-fruiting habitats in the region, which experience much wider fluctuations in fruit availability and quality than peat-swamp forests. It is evident that wild orang-utans regularly face energetic shortfalls in both masting and non-masting habitats, and that orang-utans are very well adapted towards coping with these shortfalls. A key mechanism facilitating this is fat storage and subsequent metabolism during periods of energetic shortfall. Furthermore, given an adequate range of differences in nutritional quality between food items in a site, orang-utans actively select those foods that are richest in energy. These two observations indicate that care is needed when devising diets for captive (and largely inactive) orang-utans to avoid obesity, which is a frequent problem in captive orang-utans. Specifically, careful attention should be paid to the nutritional quality of diets provided (with large amounts of high-energy foods avoided and regular provision of low-energy foodstuffs) and the weight of captive orang-utans, and keepers should not be fearful of occasionally allowing their animals to experience periods of negative energy balance.

**V-31-7: Population Status and Conservation of Javan Gibbon (*Hylobates moloch*), in Central Java, Indonesia**

Arif Setiawan, Tejo S.Nugroho, Yohannes Wibisono, Vera Ikawati, Djuwantoko; *Faculty of Forestry, Gadjah Mada University*

Javan gibbon (*Hylobates moloch*) threatened extinction in the unprotected and fragmented forest in Central Java, Indonesia. This study is intended to estimate population density, habitats and threats for the survival of the gibbon in their eastern most range distribution.

We used line transect method, based on maximum animal to transect perpendicular distance to estimate population density of the gibbon. Landsat 2006 satellite imagery also used to determine the forested habitat.

We found 56 groups of gibbon in 16 localities, total 132 individuals in 173.421 km total length of the transect i.e in Dieng Mountain : Sigugur (33.88 km<sup>2</sup>), Sokokembang ( 65.69 km<sup>2</sup>), Sikesod (48.38km<sup>2</sup>), Linggo (18.95km<sup>2</sup>) and Mt.Slamet (103.41 km<sup>2</sup>) the gibbon densities were (4.4 indv/km<sup>2</sup>;7.57 indv/km<sup>2</sup> ;3.33 indv/km<sup>2</sup>; 6.12 indv/km<sup>2</sup> and 1.7 indv/km<sup>2</sup>

If we use average density of gibbon is 5.36 indv/km<sup>2</sup> in Dieng Mountain areas and 1.7 indv /km<sup>2</sup> in Mt.Slamet , population estimation will be 896 individuals and 176 individuals. These largest fragment forest habitats is on the top of conservation priorities in central java, home for all javan endemic primates and other unique wildlife and flora.

Keywords: gibbon, java, fragmented, habitat, population, conservation

### **V-31-8: The Development of Gap Crossing Behaviour in Bornean Orangutans (*Pongo pygmaeus*)**

Abigail C. Phillips<sup>1</sup>, Maria A. van Noordwijk<sup>2</sup>, Susannah K. Thorpe<sup>1</sup>; *1. University of Birmingham, 2. University of Zurich*

As the largest predominantly arboreal animal, gaps in the canopy present a particular problem for orangutans (*Pongo* spp). The shortest routes between trees often lie between thin flexible branches and orangutans have a diverse repertoire of locomotor behaviour to travel across discontinuous canopy. As flexible branches deform in response to the weight of the animal using them, ontogenetic changes in body size are likely to influence the gap crossing behaviour of orangutans. Orangutan gap crossing locomotion often involves manipulation of compliant vegetation and these skills can be both cognitively and physically challenging for young orangutans to learn, which makes them a key area to focus on when investigating the development of independent travel. Orangutans have a long immature phase and spend the first six to nine years in exclusive association with their mother. Previous observations of Bornean orangutans indicate that mothers facilitate their offspring's travel until they are around 6 years old often by making a bridge or allowing them to ride as they bend a tree, younger infants are usually carried between trees. However, the extent to which immature orangutans of different ages rely on assistance from their mother during travel has not been fully investigated. During a one year study at Tuanan Research Station in Central Kalimantan, Indonesia, data on locomotor behaviour, support use and distance travelled were collected for orangutan gap crossing events. Both immature and adult orangutans were sampled and the ages of the immature subjects ranged from one to ten years. Over 1000 hours of focal data were collected from 18 individuals. Here we demonstrate the ontogenetic changes in gap crossing behaviour and maternal assistance during gap crossing events and discuss the results with respect to orangutan life history and conservation.

### **V-31-9: Forest Characteristics, Habitat Disturbance, and Population Density of Pileated Gibbons *Hylobates pileatus* in Southeast Thailand**

Rungnapa Phoonjampa<sup>1</sup>, Andreas Koenig<sup>2</sup>, Warren Y. Brockelman<sup>1</sup>, Carola Borries<sup>1</sup>, George A. Gale, John P. Carroll, and Tommaso Savini; *1. King Mongkut's University of Technology Thonburi, 2. Stony Brook University*

Assessing the factors which affect population density is an essential tool in conservation planning. For many species, general effects of habitat quality and human disturbance are known although effects for individual species may vary tremendously. In this study, we determined how forest characteristics and habitat disturbance correlate with the abundance of pileated gibbons (*Hylobates pileatus*), an endangered primate species with a very restricted distribution. We studied the population in Khao Ang Rue Nai Wildlife Sanctuary, southeast Thailand, and assessed the density using an auditory method (with distance sampling) at 24 sites randomly placed throughout the sanctuary. At each site 100 circular 0.01-ha plots were established to determine the forest characteristics and the level of disturbance. In addition, we determined the time since protection was initiated (1977 vs 1992) and used satellite imagery to assess the amount of evergreen forest and distance to the sanctuary boundary for each site. For the whole sanctuary population density was estimated to be  $1.02 \pm 0.16$  (SE) groups/km<sup>2</sup>. Bivariate analyses showed that densities depended on food tree biomass, level of disturbance, evergreen forest cover, time since protection, and distance to the sanctuary boundary ( $P < 0.05$ ). A stepwise multiple regression analysis suggested that percentage of evergreen forest cover ( $P = 0.027$ ) and distance to the boundary ( $P = 0.098$ ) were the most influential factors. Because percentage of

evergreen forest cover, time since protection, and habitat disturbance are significantly correlated, these results suggest a direct dependence of pileated gibbon densities on mature undisturbed evergreen forest. While pileated gibbons can persist in disturbed areas where forest is subsequently protected, recovery to previous densities may take decades. We suggest that this is due to the slow pace of forest regeneration and/or poor recovery potential of pileated gibbons.

### **V-31-10: Orangutan Habitat Conservation in Sumatra, Indonesia; Challenges and Opportunities**

Ian Singleton; *PanEco Foundation*

The Sumatran orangutan (*Pongo abelii*) survives in much fewer numbers (ca. 6,600) than its Bornean cousin (*P. pygmaeus*) and the wild population is restricted to the northernmost provinces of North Sumatra and Aceh, since the 1990's the site of a novel approach to conservation in Indonesia known as the Leuser Ecosystem. Furthermore, since 2005, after the devastating tsunami and the end of civil conflict, the Province of Aceh has also enjoyed a special autonomy status, giving greater regional authority over conservation and environmental management to the provincial government. This paper will provide a brief overview of the challenges and opportunities this unique situation presents, with special mention of two key orangutan habitat case studies, the Tripa coastal peat swamp forests on the West coast of Aceh province and the Batang Toru Forest Block, in North Sumatra Province. The former is a coastal peat swamp forests with among the highest densities of orangutans in the world, and which also sits within the Leuser Ecosystem, and forms the largest single as yet un-protected carbon stock in the entire province. The latter represents the southernmost remaining wild Sumatran orangutan population in hill forest that serves as a critical watershed for 3 government districts, their agriculture and key industries. Research and a diverse range of other activities, have contributed to the battle to save these important orangutan populations. These activities and their results and outcomes will also be discussed.

### **V-31-11: Dispersal Limitation, Ecological Niche Differentiation, and Primate Community Structure in Four Tropical Metacommunities**

Andrew J. Marshall, Lydia H. Beaudrot; *University of California at Davis*

A major goal in community ecology is to identify mechanisms that govern the assembly and maintenance of ecological communities. In the absence of strong habitat or resource-based niche partitioning, dispersal limitation is a central feature of theories concerning the maintenance of species coexistence in ecological time. We present a test of dispersal limitation in residential terrestrial vertebrates using data on primate communities from Africa, South America, Madagascar and Borneo. If dispersal limitation is important in structuring metacommunities, then community similarity should depend on geographic proximity (controlling for ecological similarity), whereas if metacommunities are assembled primarily through niche processes, then community similarity should be determined by ecological similarity (controlling for geographic proximity). We performed Mantel and partial Mantel tests to investigate correlations between primate community similarity, ecological distance and geographic distance. Results showed a significant and strong negative relationship between diurnal primate community similarity and ecological distance only in Madagascar, but significant and stronger negative relationships between community similarity and geographic distance in African, South American and Bornean metacommunities. We conclude that dispersal limitation is an important determinant of primate community structure and may play a stronger role in shaping the structure of some terrestrial vertebrate communities than niche differentiation. These patterns are consistent with patch dynamic and neutral models. We recommend tests of functional equivalence to determine the extent to which neutral theory may explain primate community composition.

### **V-31-12: Density and Population Estimate of Agile Gibbon in Degraded Lowland Sumatran Rainforest: An Assessment of Survey Techniques and Analytical Approaches**

Victoria J. Powell, M. Jeri Imansyah, David C. Lee; *Harapan Rainforest*

A population assessment of the globally threatened Agile Gibbon (*Hylobates agilis*) was conducted in a unique ecosystem restoration initiative in southern Sumatra, called Harapan Rainforest. This area, covering 98,554 hectares of previously logged dry lowland forest, is managed and protected for restoration, with a view to returning the forest to its original condition. Gibbons were surveyed in the same general areas using two methods: triangulation of calling groups from sets of three listening posts (LPs) positioned 300-500m apart, in an L shape and manned simultaneously; and variable width line transects of 2.8km in length using distance sampling. Daily calling activity of known gibbon groups suggested that each LP be surveyed for four consecutive days to maximise the chances of recording all groups present, while field trials showed that gibbons could be reliably heard calling up to 1.2km away. Sampling effort was divided proportionally amongst three main habitat types: high, medium and low canopy cover secondary forest. Surveys took place over a 10-month period in 2009 and 2010. The positions of all distinct gibbon groups heard calling within 1.2km of LPs, over the four days, were triangulated and mapped. These data were analysed using three approaches to estimate density: cumulative total counts of distinct calling groups, fixed width plots and distance sampling. Group size data were collected independently of surveys to convert group density to individual density. Here we compare density estimates generated from these different methods and make recommendations for the application of survey techniques and analytical approaches for improving hylobatid surveys and their conservation assessments. This study suggests Harapan Rainforest, as one of the last and largest remaining tracts of dry lowland forest in Sumatra, remains an important site for Agile Gibbon despite being heavily logged, and that gibbons can persist even in some of the more degraded areas.

### **V-31-13: Spider Monkeys (*Ateles geoffroyi*) as Seed Dispersers in Continuous and Fragmented Rainforests in Southern Mexico**

Kathryn E. Stoner, Oscar M. Chaves, Víctor Arroyo-Rodríguez, Julieta Benítez-Malvido; *Centro de Investigaciones en Ecosistemas, UNAM*

The reduction of seed dispersers in fragmented landscapes is an important theme in conservation biology because of the impact the disappearance of dispersers has on forest structure and diversity. Given the importance of vertebrates in seed dispersal, and in particular the role of primates, studies focusing on these key dispersers and their role in the regeneration of forest fragments are crucial for understanding the dynamics of tropical ecosystems. Our objective was to evaluate the efficiency of spider monkeys as seed dispersers in continuous and fragmented forests in Lacandona, Chiapas. During 15 months we assessed fruit and seed handling, diversity and composition of defecated seeds, and seed germination. Foraging data were collected using focal animal observations and fecal samples were collected to identify seeds dispersed and to perform germination experiments. Spider monkeys consumed 73 species in continuous forest, whereas in fragments they fed from 61. At least 10 of these were primarily dispersed by primates. Approximately 95% of the seeds consumed were swallowed, but seed spitting was observed and was more common in fragments than continuous forest. Similar numbers of seed species were found in feces from continuous forest (37) and forest fragments (38). More than 90 % of the fecal samples (N= 865 out of 957) contained seeds, but the average percentage of feces without seeds was greater in fragments (17%) than in continuous forest (4%). Defecated seeds had greater germination percentages than control ones from mature fruits. Our results indicate that spider monkeys are efficient seed dispersers based on seed handling behavior, the number of species dispersed, and germination success. Nevertheless our study also suggests that this efficiency may be limited in small forest fragments, wherein the percentage of seeds swallowed decreases and fruit shortage can force them to use proportionally higher amounts of leaves and other food items.

### **V-31-14: Food for Thought: Using Tonkean macaque (*Macaca tonkeana*) Feeding Ecology to Inform Conservation Management in Sulawesi, Indonesia**

Erin P. Riley, Barbara Tolbert, Jeffrey V. Peterson, Wartika Rosa Farida, Rusmanto Lakareba; *San Diego State University*

Understanding a primate's feeding ecology and the factors that influence food choice are critical for the development of conservation management efforts for nonhuman primates and their habitats. We collected data on food availability and diet of two groups of Tonkean macaques (*Macaca tonkeana*) in Lore Lindu National Park, Sulawesi, Indonesia. We also examined the nutritional composition of a set of Tonkean macaque foods, including 13 forest fruit species and one cultivated resource, cacao (*Theobroma cacao*). Food choice was independent of the frequency of plant species in the habitat, indicating that Tonkean macaques are selective feeders. The group living in undisturbed habitat had a greater percentage of highly preferred foods (selection index >10) than the anthropogenic habitat group. Fruit choice was negatively related to fiber levels for the anthropogenic group and positively related to protein content for the undisturbed group. The fruits sampled had, on average, significantly lower protein levels (5.9%) and higher fiber (NDF) levels (36.3%) than the National Research Council's recommended values (8% and 20%, respectively). The greater digestibility of cacao pod pulp compared to forest fruits may explain why Tonkean macaques are attracted to this crop. The planting of *Arenga pinnata* palms at the forest edge to deter cacao crop raiding may be an appropriate conservation strategy for three reasons. First, the palm fruit is a highly preferred food; it comprised almost 50% of the feeding records of the anthropogenic habitat group. Second, in addition to being of relatively good nutritional quality in terms of macronutrients, this fruit is an important source of calcium for Tonkean macaques; calcium levels were significantly higher than all other species sampled, including figs. Third, ethnographic research has found that the *Arenga pinnata* palm also has considerable cultural and economic importance to local human communities.

#### **V-31-15: Adaptations of an Arboreal Seed Predator to Seasonal Scarcity Periods**

Suzanne Palminteri; *University of East Anglia*

The abundance and distribution of food resources is considered to be the primary factor influencing the use of space by frugivores: when availability of ripe fruit decreases seasonally in the Neotropics, frugivores have been documented to move greater or shorter distances, select different habitat types, or modify the composition of their diets. Availability of ripe fruit is more variable than that of immature fruit, so seed predators, frugivores that specialize on unripe fruits, could show less seasonal change in movement and behavior patterns than species that consume primarily ripe fruit pulp. We tested this hypothesis by monitoring the movement patterns, habitat use, and diet of five groups of bald-faced saki monkey (*Pithecia irrorata*), an arboreal seed predator, in southeastern Peru and compared these to the seasonal availability of both ripe and unripe fruit. Sakis showed no significant seasonal change in the size of their ranging area or activity budget. They did, however, vary seasonally in their habitat selection, daily travel path length, and diet, showing high inter-group variability for each of these parameters. This suggests that sakis minimize the potential impacts of seasonal food scarcity through the flexible exploitation of a relatively aseasonal food supply for which they face little competition.

#### **V-31-16: Pigtailed macaques (*Macaca nemestrina leonina*) the Pest and the Gardener**

Marie Claude J. Huynen, Albert Aurelie, Savini Tomaso; *University of Liege*

Many primate species are classified as "vulnerable" by the IUCN, meaning the species persistence could be endangered should its habitat continue to shrink, fragment and deteriorate. This is however the case in many places over the world. To save the remaining primary forest and rehabilitate degraded areas, managers have to examine strategies of natural or artificial reforestation. In this matter, the role of seed dispersers is still insufficiently known, or ignored. Accumulating data on seed dispersers' role and on factors that could facilitate their action could lead managers to promote their protection and conservation. Our study focuses on pigtailed macaques (*Macaca nemestrina leonina*) in the Khao Yai National Park (Thailand), a species little studied until now, ordinarily considered as



prolific and often as a pest for its well known crop raiding habits. Collected data in a wild population of Khao Yai give evidence of pigtailed macaques role in seed dispersal of a large variety of plant species, particularly those inaccessible to smaller frugivores. The process of seed dispersal by these macaques' can be described as follows: numerous seed species, of all kind of sizes, across all forest types, in particular from primary to secondary forest, edges' zones and grasslands. Various handling techniques (ingestion and defecation at distance of the parent trees, or storage in cheek pouches, latter processing and spitting at distance of the parent tree) are associated with the use of rather large homer ranges selectively visited. Our observations also suggest that macaques adjust their daily travel across seasons according to the resources availability. The knowledge about these sophisticated foraging strategies could prove useful in establishing management plans for species maintenance or recolonization in wild environment as well as in human managed landscape.

### **V-31-17: The Effects of Low Impact Spiritual Tourism on Javan Gibbons (*Hylobates moloch*)**

Melissa A. Reisland<sup>1</sup>, Joanna Lambert<sup>2</sup>; 1. *University of Wisconsin, Madison*, 2. *University of Texas, San Antonio*

Human/non-human primate interactions are increasing as human population continue to grow near and in primate habitats, making research on primate response to human presence increasingly critical. Behaviors that prey species exhibit towards predators – including humans – such as increased vigilance, reduced time feeding, and reduced time in risky areas, are known to limit population size, even when predator caused mortality is low. This suggests that these behaviors may be used as indicators of potential human impact on primate populations. In this study, I investigated how one population of Javan gibbons (*Hylobates moloch*) living in the human-impacted sacred forest, Cagar Alam Leuweung Sancang, located in West Java, adjusts to varying levels of human exposure. Indonesian spiritual tourists enter this reserve daily, and sacred areas are located within the ranges of several gibbon groups. Results indicate that the majority of gibbons (4/5) showed a significant trend ( $p=0.0010-0.0112$ ) of reduced time spent feeding and increase time spent resting (remaining still) as the number of people (1-30) they were exposed to increased. As number of humans and intensity of behavior increase, male gibbons (2/2) showed a trend ( $p=0.0013-0.0565$ ) of increased being vigilant and female and juvenile gibbons (3/3) were more likely to be found high in the canopy ( $p=0.0001-0.0702$ ). One of two study groups of gibbons was significantly ( $p<0.0001$ ) less likely to be seen in areas of its range with more humans. These results suggest that gibbons alter their behavior in the presence of increasing numbers of humans in ways that are consistent with anti-predator behaviors. Assessing how this critically endangered species responds to human presence is a vital part of their ultimate conservation.

### **V-31-18: Habitat Characterisation, Use and Conservation for the Critically-Endangered Margarita capuchin in the Venezuelan Caribbean Sea**

Natalia Ceballos-Mago, David J. Chivers; *University of Cambridge*

The Margarita capuchin *Cebus apella margaritae*, one of the three monkeys on the Caribbean Islands, is found in the evergreen and the dry forests on Isla de Margarita (1,071 km<sup>2</sup>), but its relative abundance is much higher in the evergreen forest when this is available. We aimed to explore the differences in the main types of vegetation found in the habitat of these capuchins and how they use this habitat. In 2008 we conducted a vegetation survey in 16 sites across the protected and unprotected forest fragments inhabited by capuchins. The cloud, dry and gallery forests and fruit plantation were sampled. A total area of 0.7 ha was sampled in 100 plots. Data about habitat use were collected during systematic line-transect surveys conducted from November 2006 to April 2008 (total transect length of 102 km walked on 122 transects) and also ad libitum. We measured and identified 1,532 trees. There were significant differences in vegetation structure and composition between types of vegetation. The cloud forest had the highest richness and was the most diverse. The dry forest had the lowest species diversity. Diversity, richness and evenness were very low for all vegetation types. Capuchins were found from 40 to 830 m asl. They were mainly in the medium strata (5 to 10 m), but

also used the ground heavily. Bromeliads, pith and cacti were eaten by capuchins and they also ate fruits and corn from plantations. They are hunted for this reason. Hunting must be stopped and the size of protected areas increased to include and connect, through ecological corridors, two currently- unprotected forest fragments. The Margarita capuchin is a potential flagship for the conservation of the Caribbean Islands, which is one of the six "hottest" hotspots, and represents a global priority for conservation.

## **REDD-Plus: Beyond the Hype (#32)**

**(July 21 am + 21 pm; Wantilan middle)**

Organized by: **David Neidel and Nur Masripatin**

*Reducing Emissions from Deforestation and Forest Degradation and other related approaches (REDD-Plus), which assign a price to forests based on their ability to sequester and store carbon, have emerged as a prominent strategy for mitigating climate change. Poised for inclusion in international and national regulatory frameworks, and already in effect through voluntary, non-compliance transactions, REDD-Plus holds the promise of providing affordable offsets to carbon-intensive industries in the developed world, channeling needed funds for economic development to developing countries, and significantly increasing the amount of money available for tropical forest conservation and sustainable management. Although the exact nature of this mechanism is still being worked out, groups concerned with the plight of tropical biodiversity have started implementing demonstration REDD-Plus projects on the ground using designated funds and voluntary carbon market standards, while scholars have begun to pursue multiple lines of research to support, evaluate and/or influence the development of the REDD-Plus mechanism.*

*This symposium, which is pantropical in scope with a significant focus on Indonesia, brings together the latest findings from both pure and applied research on a number of REDD-Plus-related topics, including carbon accounting, opportunity-cost valuation, safeguarding biodiversity, improved resource management practices, and working with communities. Each presentation has its own emphasis, but the symposium as a whole is driven by the concern that conservation and development approaches are often over-hyped with the actual results failing to live up to initial, high expectations. Past experience has shown that in the excitement surrounding new conservation and development 'fads', lessons from past experiences are often forgotten, technical issues are emphasized over fundamental political ones, and critical voices are ignored. Looking back ten years in the future, will the same be said about REDD-Plus? With this critical perspective in mind, the hope is that this symposium will serve as a forum for evaluating the opportunities, challenges, and obstacles to using REDD-Plus to mitigate climate change impacts and conserve tropical biodiversity.*

### **V-32-1: Effects of Oil Palm Plantation Expansion on Land Use and Carbon Emissions in West Kalimantan, Indonesia: Past Change and Future Scenarios**

Kimberly M. Carlson<sup>1</sup>, Lisa M. Curran<sup>2</sup>, Alice McDonald Pittman<sup>1</sup>, Dessy Ratnasari<sup>1</sup>, Dwi Astiani, Gregory P. Asner, Britaldo Soares-Filho; 1. Yale University, 2. Stanford University

Global demand for palm oil has stimulated a 7-fold expansion in oil palm (*Elaeis spp.*) plantation area in Indonesia since 1990. Yet, studies are lacking that empirically measure the specific land cover, including degraded forests, secondary forest regrowth, and smallholder agriculture, converted to oil palm. Similarly, carbon sequestration rates post-logging have rarely been incorporated in emissions estimates from tropical land cover change. Here, we assess the effects of this massive agribusiness expansion on land cover and associated carbon emissions across 12,000 km<sup>2</sup> in Ketapang District, West Kalimantan. CLASLite software was applied to a time series (1989-2008) of raw Landsat data to derive fractional cover (live vegetation, dead vegetation, soil) for each pixel. We used nearest neighbor classification to develop land cover classes including primary forest, logged forest (low and

high intensity), forest regrowth post-logging, smallholder agriculture (0-10 yrs, >10 yrs), burned areas, and oil palm. Post-classification change detection was then applied to track the history of each pixel and detect areas of secondary forest regrowth, undetectable in a single-date satellite image. Above-ground carbon density (Mg C ha<sup>-1</sup>) and annual carbon increment (Mg C ha<sup>-1</sup> yr<sup>-1</sup>) for each land cover type were measured in this region and used to calculate carbon emissions from oil palm expansion. In annual time steps through 2020, we modeled several plausible scenarios of land cover change and associated emissions with Dinamica Ego, a modeling platform that simulates spatially-explicit landscape dynamics. Preliminary analysis reveals that mean deforestation rate throughout the time series was ~2% yr<sup>-1</sup>. Oil palm has become an increasingly important contributor to deforestation, with 57% of oil palm converted from forests over the 20-yr period, including oil palm establishment in peat swamps in 2008. We discuss the implications of these findings for REDD and community livelihoods.

### **V-32-2: Ready for REDD: High Resolution Carbon Stocks and Emissions in the Amazon**

Gregory P. Asner, 1, George Powell<sup>2</sup>, Joe Mascaro<sup>1</sup>; 1. *Carnegie Institution*, 2. *World Wildlife Fund*

The United Nations program to Reduce Emissions from Deforestation and Degradation (REDD) requires high-resolution mapping of tropical forest carbon to support climate change mitigation. With a new integrated use of satellite imaging, airborne Light Detection and Ranging, and field plots, we mapped aboveground carbon stocks and emissions at 0.1-ha resolution over 4.3 million ha of the Peruvian Amazon, revealing variation at multiple scales due to geologic substrate, forest type and land use. From 1999-2009, land use emissions totaled 1.1% of the standing carbon throughout the region. Carbon emissions from forest degradation increased gross regional emissions by 47% over deforestation alone, but secondary regrowth provided an 18% offset. High-resolution monitoring reduces uncertainty in carbon emissions for REDD, and uncovers fundamental controls over forest carbon storage.

### **V-32-3: Hierarchical Bayesian Modeling of Aboveground Forest Carbon in Papua New Guinea; Isolating the Influence of Selective-Harvesting and El Niño**

Julian C. Fox<sup>1</sup>, Ghislain Vieilledent<sup>2</sup>, Rodney J. Keenan<sup>1</sup>; 1. *The University of Melbourne*, 2. *CIRAD*

Here we report on a spatially and temporally extensive Permanent Sample Plot (PSP) network in Papua New Guinea (PNG) and examine the impact of selective-harvesting and the El Niño-Southern Oscillation (ENSO) on aboveground forest C and C sequestration. To achieve this we develop a hierarchical Bayesian modeling (HBM) framework capable of explicitly accounting for spatial and temporal variability whilst isolating the influence of anthropogenic and climatic drivers of C stock and C sequestration. We modelled the evolution of the C stock in AGLB with time assuming a starting date corresponding to the last disturbance for each plot (selective-harvesting, ENSO fire, or first census for primary plots). We used a hierarchical state-space Bayesian model. We include spatial and temporal random effects in our model facilitating more accurate parameter estimates, valid inference and the quantification of plot and inter-annual variability. Most importantly the model allows us to isolate the influence on selective-harvesting and ENSO on C stocks and C sequestration. The HBM model indicated; average C stock in AGLB was 112 and 65 MgC ha<sup>-1</sup> in primary and selectively-harvested forest respectively (50 MgC ha<sup>-1</sup> difference); C sequestration in AGLB was 0.45, 1.12, and -7.1 MgC ha<sup>-1</sup> yr<sup>-1</sup> in primary, selectively-harvested, and ENSO burnt forest respectively; There is high plot to plot variability in C stock and C sequestration that cannot be attributed to bioclimatic influences. When applied to permanent sample plot data, HBMs can be used to improve understanding of the global carbon cycle and support negotiations for climate change mitigation initiatives such as REDD, as well as elucidating the impact of anthropogenic drivers and climatic influences on forest structure and functioning.

### **V-32-4: Assessing Biologically Diverse Carbon Stocks: A Review and Synthesis**

Jonathan R. Sweeney; *University of Missouri-St. Louis*

Within the United Nations' REDD ('reducing emissions from deforestation and forest degradation') framework, determining the value of forest resources for carbon trading relies on an effective assessment strategy. Recently, a carbon assessment protocol was proposed using remote sensing (LiDAR) and field plots for calibration. Such technologies are becoming globally available, at increasingly lower costs, and are potentially the best solution for assessing carbon stocks. Yet before adopting a protocol, several questions should be considered: (1) Who will be the practitioners for assessing carbon resources? (2) Should there be a standardized protocol for global carbon assessment? (3) Will that protocol effectively address biological, economic, and social interests? Here, I will review a selection of the published studies to date, and suggest that a standardized protocol designed with an eye to blending conservation and economics will serve both local and foreign interests. Although remote sensing offers a potentially rapid and effective form of assessment, I will argue that only through the involvement of those people living closest to the forest acting as curators of the carbon assessment process, can we ensure the conservation, growth, and security of carbon resources through time, as well as equitable and fair monetary exchange.

### **V-32-5: Real Costs of REDD – from Underestimating Opportunity Costs to Understanding Replacement Costs in Biodiversity Hotspots**

Brendan Fisher<sup>1</sup>, David P. Edwards<sup>2</sup>, David S. Wilcove<sup>1</sup>; *1. Princeton University, 2. University of Leeds*

Much hope for increased biodiversity conservation has been pinned to the future of carbon markets and REDD. While caution about potential 'win-wins' for carbon and species exists, several analyses show that in many high biodiversity areas the opportunity costs, which a REDD mechanism would have to cover are quite low, as low as \$5/tCO<sub>2</sub> in some areas. Here we look at two distinct tropical systems and use spatially explicit data on carbon storage and the opportunity costs of conservation to understand how close a payments system can come to offsetting incurred costs of conservation. First we use actual logging records for primary dipterocarp forests in Borneo and show that the best case scenario payments for carbon and other ecosystem services could meet only about ½ the opportunity costs of conservation - leaving a conservation shortfall of \$8,400/ha. Second, using spatially-explicit data from Tanzania (Eastern Afromontane hotspot), we show that current REDD calculations underestimate the true costs by ignoring major benefits of forest conversion, which do not flow through markets, but rather accrue from small-scale agricultural expansion and resource extraction. Focus here needs to be on the cost of replacing the demand from conversion – i.e increasing agricultural yields on existing lands and increasing efficiency of biomass fuel use. Taken together these studies suggest 1) funding for conservation will have to increase dramatically if we are to conserve biodiversity in two of the world's hottest hotspots 2) estimating costs in different parts of the world under different conversion regimes will require site specific analyses and different economic approaches 3) interventions in many places should be targeted to meet the replacement costs of lost benefits, not simply the market-based opportunity costs.

### **V-32-6: REDD: Reckoning Environment and Development Demands**

Jaboury Ghazoul, Lian Pin Koh, Rhett A. Butler; *ETH Zurich*

Reducing Emissions from Deforestation (REDD) aims to curb carbon emissions from deforestation by financially compensating forest owners. However, compensation based on the opportunity costs of REDD might underestimate true costs by failing to account for downstream economic benefits of current land uses, including employment and wealth generated by processing and service industries. A comprehensive analysis of REDD impacts should also include sociopolitical impacts. REDD might exclude people from forest land, causing demographic shifts, and declining tax revenues from commodity production and associated industries might disincentivise government investment in forested regions to the detriment of communities and regional development. Furthermore, effective

implementation of REDD will bar large areas of land from development, possibly curtailing the feasibility of extensive 'wildlife friendly farming' to meet increasing agricultural demands. Indeed, rising demand for food is likely to drive intensification of farming practices and raise opportunity costs for REDD. An alternative land sparing approach, which implicitly emphasises land use intensification to spare land elsewhere from agricultural development, may offer greater hope for optimism, so long as unit area yield increases are able to keep up with rises in demand for commodities. As the productivity of land under intensive agriculture is high, the opportunity costs of a competing REDD land use would rise, in effect also serving to undermine REDD. We argue for the need to recognise and appropriately compensate the full range of economic, social and political costs of REDD.

### **V-32-7: Generic REDD+ Model: Scenarios to Conserve Landscape and Reward Actors**

Herry Purnomo, Desi Suyanto

Man created a worldwide tragedy to their common atmosphere and forests. Forest and land use change contribute to 18% of greenhouse gas (GHG) emissions, which cause global warming. Conference of Parties 15th in Copenhagen have agreed among others on increasing political commitment to reduce emission from deforestation and forest degradation including maintaining and enhancement carbon stocks in conservation areas (REDD+). However, government, political actors, business groups, civil societies, conservation managers and various interest groups may support or reject REDD+ in their true life. This paper describes REDD+ dynamics through agent-based modeling approach with the following steps: identify key actors, categorize their objectives, types of rationality and policy preferences and simulate their activities. This study took (a) a generic landscape pattern which consist of forest core, forest margin and mosaicland as explained by Chomits (2007) and (b) Jambi, Indonesia as a case study. The model will be useful for other countries because it is generic and has a case for implementation. The model will explore REDD+ scenarios on effectivity and efficiency in reducing GHG emissions and conserving landscape and biodiversity as well as cost and benefit equity among different actors. The model result will be able to explain why REDD+ will and won't work, who will win and lose and its plausible institutional arrangement.

### **V-32-8: Community Forest Management as Building Block of REDD Madagascar: Risk and Opportunity for Community Livelihood**

Lalaina Cynthia Ratsimbazafy, Harada Kazuhiro, Yamamura Mitsuru, *Hyogo University*

Madagascar is one of the developing countries beneficiaries of FCPF to develop REDD mechanism. The study intends to bring an outcome understanding of how REDD mechanism is implemented in Madagascar, particularly the policy issue of protected area under REDD, the possibilities of local community's participation in the project and their livelihood implication. Data were collected from stake holders involved in the REDD mechanism; interviews and surveys were also conducted within households in 3 villages in the adjacent part of the protected area. Up to now, 5 pilot projects have been implemented by the government with international NGOs. The country finalized its readiness preparation plan already and intends to be ready for REDD in two years to come. The main policy for forest conservation under REDD is the management transfer into local community however the local level is still far from ready. Those local communities are relying on forests for their livelihood in different level according to their socio economical backgrounds. Comparing with the period anterior to the establishment of protected area, accesses to forest resources are limited, there is a notable decrease of gathered food product (yawn, honey, eel...) an average decrease up to 60% within households. As a compensation measure, 50% of total revenue from REDD project in Madagascar will be allocated to local community's livelihood improvement and considerable job on forest conservation activities are also expected to be created. However, up to now, patrolling is the only job that has been created for local people. These situations discourage some groups of local people to participate actively into conservation. For a community based forest conservation under REDD to be efficient: it is recommended that compensation and incentive measures should go in parallel with

conservation measure and during the project design, particular attention should be paid to the differentiation of the impact that the project has into the local community member's livelihood.

### **V-32-9: Developing Community-Managed REDD+ Demonstration Activities Based on Village Forest (Hutan Desa) Designation and Management**

Ahmad Kusworo, Frank Momberg, Andjar Rafiastanto; *FFI Indonesia Programme*

A unique feature of the policy framework for REDD in Indonesia has been the use of forest management licensing mechanisms for government, the private sector, and community institutions to develop REDD demonstration activities. For forests managed by indigenous/local communities, village forest licenses (izin hutan desa) are seen as appropriate, as it provides sufficient legal grounds for developing a REDD+ project. As a performance-based reward mechanism to reduce GHG emissions from the forestry sector, REDD+ project development requires solid scientific (and technocratic) approaches in carbon accounting, as well as the identification and formulation of plans to cope with the drivers of deforestation and degradation. In hutan desa, with indigenous/local communities as the main project proponent, scientific knowledge needs to be combined with local/indigenous ecological knowledge in a fully participatory approach. This central role of indigenous/local communities raises the question of the relative effectiveness, efficiency, and equitability of this project type in achieving carbon benefits, as well as biodiversity and community co-benefits, compared to other project types. This paper reports on our progress in developing REDD demonstration activities in hutan desa in West Kalimantan. Project activities have been promising, but are far from complete. Securing forest tenure, in particular, has proven challenging. Our field experience indicates that compared to purely scientific knowledge, local/indigenous knowledge will prove equally effective in delivering emission reductions (carbon benefits) and are efficient in forest protection/conservation (i.e. biodiversity co-benefits). Moreover, this model of community-managed REDD holds the promise of a more equitable sharing of benefits (i.e. community/social co-benefits).

### **V-32-10: REDD+ in Papua New Guinea: Is Anybody Ready?**

David K. Mitchell, Roger James

Are the traditional Papua New Guinea rainforest custodians ready for REDD(+) or are the compliance requirements too complex for it to work where it counts, at the community implementation level? This paper outlines the disconnect between the GovPNG which internationally has been proactive in seeking an agreement and mechanism for carbon offsets from its tropical rainforest resource, yet locally has left communities in the dark. How can this gap be bridged in actionable ways? Local NGOs have outlined general principles to guide the process of REDD(+) and to inform policy development, from a pro-resource owners perspective, but the gap even at this level between the NGOs and the GovPNG has not yet been bridged. Getting messages right down to communities not just on REDD(+), but in the realization of the ecosystem values of their dynamic environment in relation to emerging and future climate change impacts is the crux of the matter. For a community or clan to drive the required REDD(+) process requires, decision, to formally manage their environmental capital, based on communal understanding of what their future resource base (and if it contains REDD(+)) would look like and how it will fulfill their needs. In order to achieve community driven REDD(+) in the PNG contextural mosaic, is the answer as simple as progressing through a checklist of requirements as set out in the Climate, Community & Biodiversity Alliance (CCBA) standards or does it require local community empowerment through awareness raising and community participatory investigation of the dynamic issues beyond their traditional view of their environment?

### **V-32-11: Biodiversity and Climate Change**

R.T.M. Sutamihardja, Mar Eko Mulyani; *Indonesian Biological Society*

Biodiversity is an important resource for the socio-economic and cultural life of the Indonesian people as well as for the entire nation. Some 40 million Indonesians depend directly upon biodiversity for their livelihood, relying on forests, marine and coastal resources, and agriculture. The existing data confirms that Indonesia's biodiversity has been continually degraded. For example tropical forest, a main resource of biodiversity, has diminished by half and the tendency for environmental abuse to decrease biodiversity warrants serious management. The environmental abuse of protected forest by illegal logging, forest fires, illegal mining, the illegal trade of endangered species, and the introduction of new species, and its conversion to palm oil plantation, all threaten the existing biodiversity. Ecosystem diversity serves the survival of the existing species and facilitates its further diversity. Although Indonesia occupies 1.3% of the earth's surface it has 17% of the total species of the world. In terms of fauna, Indonesia has fauna from the Indo-Malayan (Asia) region, such as the placental mammals, and from the Australasia region such as the marsupials in Irian Jaya. It also has at least 12% of the world's mammals, 15% of amphibians and reptiles, 17% of all birds, and 37% of the world's fishes. Indonesia's flora are included in the Malesia region and has at least 11% of the world's known flowering plants. Its endemism level is high, particularly in Sulawesi, Irian Jaya and Mentawai Indonesia is known to have among the richest biological diversity in the world. Biological diversity or biodiversity is the term used to describe the variety of ecosystems, as well as various forms and variability of plants, animals and micro-organisms. Thus, biodiversity includes the diversity of ecosystems (habitat), species and genes (cultivar/race) (MNLH, 1993). More recently, climate change caused by the accumulation of greenhouse gases to the atmosphere, creating global warming and rising temperature of the globe, will affect the ecosystem that supports human and biological life, and threatens the existing biodiversity for the whole 21st century. Without sustainable development this will affect all future generations.

#### **V-32-12: Biodiversity and REDD**

Stuart L. Pimm<sup>1</sup>, Alan Grainger<sup>2</sup>; *1. Duke University, 2. Leeds University*

REDD should have multiple benefits, yet might safeguard carbon stocks but fall short on protect biodiversity. We recommend: 1. Rules to conserve biodiversity should be included in any agreement. National implementation standards for REDD should include biodiversity-inclusive environmental impact assessments. UNFCCC does not have a mandate to protect biodiversity, but mitigating climate change should not harm biodiversity. The Parties could include financial support to sustain existing protected areas or establish new ones as part of the overall financial package for reducing emissions. 2. UNFCCC's Subsidiary Body for Scientific and Technological Advice should ask the IPCC to include explicit assessment of the biodiversity and ecosystem service impacts of mitigation alternatives in all future reports of Working Group III. They should convene conservation biologists and 'carbon ecologists' to describe feasible methods for optimal co-management of carbon and biodiversity ecosystem services. 3. UNFCCC and CBD should make cooperation on the biodiversity impacts of climate-change mitigation a priority. 4. IPCC should report any transnational leakage. If it occurs on the scale some models suggests, it would undercut the carbon as well as the biodiversity benefits of REDD. The U.S. Waxman-Markey bill, the European Commission, and other countries propose to use non-market funds to conserve forests in countries with large forests and low deforestation rates ineligible for REDD funds under guidelines now proposed. This would be an important counterweight to international leakage. REDD cannot address all biodiversity funding priorities. Private funds could be focused on high biodiversity forests that would not otherwise be eligible for REDD funding. Biodiversity is essential to ecosystem adaptation. Ensuring that REDD policies not only reduce carbon emissions but conserve biodiversity will ensure that the biosphere can be as resilient as possible to climate disruptions.

#### **V-32-13: Will REDD-Labelled Protected Areas Conserve Indonesia's Lowland Forests?**

David L.A. Gaveau<sup>1</sup>, Ketut Muliastira<sup>2</sup>, Lisa M. Curran; *1. Stanford Univ. c/o SIMPUR SEKALA, 2. SEKALA*

Governments have historically established networks of protected areas (PAs) to conserve the biodiversity of tropical forests. These PA networks have largely been established in remote highland areas with few alternative land uses. It has been harder to conserve lowland forests where agricultural plantations are typically sited, even though lowland tropical forests contain more biological diversity than the highlands. It may become easier to conserve lowland forests, where there is more carbon through carbon payments such as reducing carbon emissions from deforestation and degradation (REDD). The greatest challenge for REDD is increasing demand for agricultural land. In south-east Asia, an important threat to lowland forests is the expansion of high-revenue oil-palm plantations. In Indonesia, there is a contradiction between the establishment of a new generation of REDD-labelled PAs and the continuing expansion of oil palm plantations. Here, we question whether Indonesia's REDD-labelled PAs will be primarily established in lowland forests, where there is more carbon, or whether REDD will simply end up resembling other types of conservation project that promote the establishment of PAs in remote highlands. Like existing PAs, REDD-labelled PAs will be primarily sited on forests located on steeper slopes and at higher elevations. By contrast, Forests located on flatter areas of land, at lower elevations, and on peat soils will likely be left unprotected and converted into oil palm plantations. REDD resembles other types of conservation project that promote the establishment of PAs in remote highlands, while lowland forests continue to be converted into agricultural land, notably oil palm. Biodiversity conservation has lacked support political elites when faced with near-term opportunities to engage in high-revenue extractive industries. Carbon conservation will suffer the same fate. REDD in its current form

#### **V-32-14: Harnessing REDD to Conserve the Sumatran Tiger: An Update of REDD Implementation at the Project Level**

Tom Maddox, Agus Suratno; *Zoological Society of London*

The key limitation to biodiversity conservation, as with most ecosystem services, has been its economic invisibility during key decision making processes. However, recent developments with REDD mean that one ecosystem service – the role of forests in the carbon cycle - is now being recognized financially, creating a firm financial incentive for forest conservation. This has important implications for biodiversity, both because biodiversity is an integral requirement for forest resilience and because forests represent a key habitat for many species. The Berbak Carbon Value Initiative (BCVI) is an REDD-based project located within the mixed-use peat swamp forests of Sumatra. These forests represent one of the largest sources of carbon emissions in Indonesia and one of the largest remaining populations of the critically endangered Sumatran tiger. The aim of the BCVI is to harness the REDD potential of the area to drive the development of a multidisciplinary development project in which not only are greenhouse gas emissions through making the forests self sufficient, but also drive the conservation of local biodiversity and community development. Many REDD project updates focus on the global and national challenges of establishment. In this presentation we will describe the challenges faced working at project level together with an update of current progress.

#### **V-32-15: Multi-Level Planning to Maximize Biodiversity Benefits from Forest Carbon Investments: Berau Forest Carbon Program**

Alexander Hovani; *The Nature Conservancy*

Sustainable management of terrestrial carbon will be a crucial part of the strategy for fighting climate change, and the next 20 years are expected to bring unprecedented investment in conservation and sustainable management of forests in tropical countries. Though international policy frameworks are not yet established, including regarding the role and scale of offset crediting or public funding, it is still possible to lay the foundations for future REDD decision-making that will maximize sustainable development benefits from REDD, including biodiversity benefits. Experiences from the Berau Forest Carbon Program will be presented, addressing a multi-level planning approach for a) spatial plan development at the district-scale, b) planning approaches for allocation of license areas (e.g. timber plantations, oil palm plantations) within spatial plan zones, and c) planning of productive zones and



set asides within license areas. Planning tools and methods will be presented in the context of conservation strategies and incentive mechanisms aimed at decision-makers at different scales.

### **V-32-16: REDD in Berau, Indonesia: Systematic Prioritization of Strategies and Locations to Reduce Forest Carbon Emissions**

Oscar Venter, Possingham, Hugh P., Kerrie, A., Hovani, Lex; *University of Queensland*

International efforts to reduce emissions from deforestation and forest degradation (REDD) have the potential to slow deforestation, contribute to sustainable livelihoods and help safeguard the biologically diverse forests of developing countries. REDD provides financial incentives for voluntary efforts to reduce forest carbon emissions below a reference level. In Indonesia, as in other developing countries, a suite of on and off reserve strategies are available to reduce forest loss, and these strategies may be applied in any number of locations with variable costs and benefits. We draw on systematic conservation planning to develop an approach to prioritize strategies and locations for REDD. The approach incorporates multiple strategies, multiple goals, socio-economic concerns and landscape configuration. We apply this approach to a large REDD program run by The Nature Conservancy in the Berau regency of East Kalimantan, one of the few remaining areas on either Sumatra or Borneo that still contain substantial expanses of relatively undisturbed lowland dipterocarp forest. We find that our approach can be used to help maximize the carbon and biodiversity benefits from REDD while minimizing costs to stakeholders.

### **V-32-17: Improved Forest Management in East Kalimantan, Indonesia: An Opportunity for Emissions Reductions and Biodiversity Conservation**

Griscom Bronson; *The Nature Conservancy*

At least 20% of the tropical forests are designated as logging concessions. Prior studies have found that (i) conventional logging in tropical forests generates emissions ranging from less than 5% to more than 50% of forest carbon stocks, and (ii) reduced impact logging techniques can reduce these emissions by about 30-50%. We assess the potential for emissions reductions in East Kalimantan concessions with data from four conventionally logged concessions, one FSC-certified concession, and one concession using a low-impact skidding technique. We find that a combination of (i) traditional reduced impact logging practices, (ii) avoidance of logging in sensitive areas, and (iii) adoption of additional low carbon skidding practices, can reduce conventional logging emissions by more than 50%. This strategy, referred to here as “improved forest management” (IFM), can achieve emissions reductions with little to no leakage or risk of non-permanence while increasing jobs in the forest sector. Further, by establishing sustainable livelihoods from standing native forests, improved forest management is a long-term strategy for avoiding deforestation. However, safeguards will be essential to developing IFM as a successful REDD strategy. We also consider the opportunity for IFM to achieve biodiversity conservation goals in East Kalimantan by (1) considering the distribution of logging concessions with respect to The Nature Conservancy’s portfolio conservation sites, and (2) reviewing the impacts of logging on biological diversity in this and other tropical forest systems.

### **V-32-18: Biodiversity Benefits and Costs from Mitigating Climate Change by Reducing Emissions From Ecosystem Destruction and Degradation, and Increased Carbon**

Putz Francis; *Biology. U. of Florida*

REDD programs have potential to mitigate the impacts of global climate change while securing the co-benefit of increased biodiversity retention. While the “arborealization” of the global conservation agenda is worrisome, that biodiversity is only a “co-benefit” of REDD engenders fundamental concerns insofar as there are circumstances under which what is good for carbon (and hence climate change mitigation) is bad for biodiversity. Concerns about biodiversity-carbon tradeoffs only loom large where forests are intensively managed to the verge of being converted into plantations. In

natural forests throughout the tropics the problem is degradation by too little, not too much management. Among the most widespread and carbon-costly causes of tropical forest degradation is selective uncontrolled logging. If REDD is extended to capture the carbon benefits of improved forest management (REDD+), carbon money could be efficiently used to reward timber miners that transform themselves into timber stand managers. Where this transformation is indicated by certification by the Forest Stewardship Council, the biodiversity and other co-benefits are more assured. If REDD is further extended to include other ecosystems as well as improved management (REEDIM), then further benefits will accrue. Just as for any other natural resource, if carbon is the sole focus of management, then species other than those that sequester large quantities of carbon can be disregarded or even perceived as weeds/pests if they reduce the carbon uptake and storage functions of focal species. Given that most forest biomass carbon is fixed and stored by large trees, the risks of a carbon focus is akin to the familiar dangers of trying to maximize timber yields. Moving out towards the production possibility frontier at which carbon retention, timber production, and biodiversity protection are all maximized requires novel insights into the nature and extent of avoidable and unavoidable tradeoffs.

### **V-32-19: Forest Management and REDD: The Role of Silvicultural Treatments for Enhancing Carbon Stocks after Logging**

Marielos Pena-Claros; *Wageningen University*

Forest degradation due to poor management can result in large carbon losses. Recent studies have shown that the use of reduced-impact logging (RIL) techniques during logging operations results in a reduction of carbon emissions because there is less collateral damage. Additionally areas logged with RIL techniques have a higher carbon stock at the end of the cutting cycle than areas conventionally logged, mostly because forests recover faster after logging. One way to further enhance this recovery is the application of silvicultural treatments to promote tree growth. In this study I compare areas logged using RIL techniques with areas logged using RIL plus silvicultural treatments in terms of both timber volume production and carbon sequestration. For doing so I used the experimental plots of the Long-term Silvicultural Research Program in a tropical moist forest in Bolivia. Trees receiving the liana-cutting treatment grew faster than control trees. These data were used to estimate at the logging compartment level the costs and benefits of silvicultural treatment application in terms of timber volume and carbon sequestration at the end of the cutting cycle.

### **V-32-20: Forest Restoration for Carbon Sequestration: Opportunities and Challenges**

Robyn Sakkara, Stephen Elliott; *Forest Restoration Research Unit (FORRU)*

Climate change is one of the most prominent and important topics of the 21st century, and many strategies are being implemented worldwide in an attempt to halt or reverse climate change forecasts. Tree planting is effective at sequestering atmospheric carbon, but information on carbon accumulation in restored forests is limited, particularly in developing countries. The Forest Restoration Research Unit (FORRU), located in Chiang Mai, northern Thailand, has been conducting research into the restoration of native forests on degraded sites in northern Thailand and beyond, since 1994. FORRU's initial research concentrated on restoring forests for biodiversity conservation. Now, the unit has begun to assess how alternative funding mechanisms, including carbon trading schemes, could encourage communities to restore forests for multiple benefits. For a successful carbon trading program, the accumulation of carbon in restored forests over time must be known and compared with that of alternative land uses such as natural forests, single species plantations, agriculture and degraded land. It is essential to select appropriate parameters and develop suitable measurement techniques, which may be applied within the Southeast Asia region. Therefore, this paper will examine the measurement techniques appropriate for accurately measuring carbon in restored forests, the incentives and rewards which may encourage or hinder forest restoration for climate change, and discuss the opportunities and challenges of implementing carbon trading mechanisms in restored

forests, particularly in relation to equitable distribution of benefits to communities involved in activities.

## **Land reforestation with native species: Case studies in experimental trials and community based initiatives (#34)**

**(July 23 am; Wantilan middle)**

Organized by: **Mark S. Ashton and Jefferson Hall**

*Deforestation for agriculture accounts for an estimated 17.3% of global greenhouse gas emissions. Reforestation is therefore receiving significant attention in climate change policy and management discussions. As a society industrializes and urbanizes, marginal lands are abandoned and agriculture is concentrated on the most productive sites. As marginal agricultural lands are abandoned, they often transfer to pasture and then to forest, or directly to forest. If land has been degraded, natural regeneration is often impossible or impractically slow. Currently most reforestation in the tropics occur at large industrial scales with a few well known exotics which have well accepted markets and known and secure silvicultural technologies. There is a need for reforestation with native species that can provide greater ecological and social values. However, silvicultural and social knowledge of planting native species on lands is lacking. This symposium will focus on degraded tropical lands and reforestation with native species. It can be divided in three parts. The first will be presentations of current experimental and applied ecological work being conducted in Latin America and Asia. The second part will be a series of case studies demonstrating lessons learned in the implementation of community restoration and agroforestry planting programs. The third part will be a panel discussion on how to integrate experimental science within reforestation programs.*

### **V-34-1: Major Issues in Establishing Mixed-species Stands in Subtropical and Tropical Environments: Examples from Costa Rica and Australia**

J. Doland Nichols<sup>1</sup>, F. Lynn Carpenter<sup>2</sup>, Kevin Glencross<sup>1</sup>, John Grant<sup>1</sup>; *1. Southern Cross University, 2. University of California at Irvine*

Re-establishing forest cover in tropical and subtropical areas, often on degraded cleared land, presents a number of challenges and poses many complex questions. An initial issue involves understanding and characterising the current site conditions. Can sites be adequately characterised with simple verbal descriptions or are some detailed analyses of soil warranted to avoid poor results? What types of labour, machinery, materials, and nursery stock are available? What specific techniques are most appropriate to use? Will there be any commercial component to the planting – will some trees eventually be harvested and sold? Will exotic tree species be used for a first rotation? Forest growers who aim to establish mixed-species plantings will need to consider extra layers of opportunity and complexity regarding the use of nitrogen fixing-trees and-or pioneer species and managing for a range of timber and/or non-timber forest products.

### **V-34-2: Overcoming Knowledge Gaps in the Use of Native Species for Reforestation: Lessons from PRORENA**

Jefferson S. Hall, Michiel van Breugel, Ashton; *Smithsonian Tropical Research Institute*

One of the basic premises of the PRORENA project has been that a major barrier to the use of a diverse set of native species in reforestation efforts has been lack of knowledge on growth, mortality, and management. The PRORENA project is screening a large number of species (75) for survivorship and growth performance (in comparison with popular exotic species) between four sites along rainfall and soil fertility gradients. These data are now being used to inform further experiments and

reforestation projects. Species selected for screening include those believed potentially important for restoration (62%), promising native timber species (54%), and species providing a variety of products to local farmers (49%). Approximately 60% of the species screened had mean two year survivorship across sites of 80% or greater while 25% of the species had mean survivorship of less than 60% for this period. Many native timber species, including *Anacardium excelsum*, *Dalbergia retusa*, *Pachira quinata*, *Tabebuia rosea*, and *Terminalia amazonia*, survive and perform well under specific conditions but no species performs well under all conditions. Data from the PRORENA screening trials, including up to six years of growth, will be presented and discussed in the context of site specific reforestation objectives. Specific examples include 1) PRORENA research in the context of restoring a native mixed species forest on a site occupied by *Saccharum spontaneum*, an exotic and highly invasive grass, 2) plantations owned and managed by local farmers at two sites varying in climate and culture, and 3) plantations established to maximize timber production in association with environmental services.

### **V-34-3: Degradation and Restoration Processes of Seasonal Dry Tropical Forests in Central America**

Heather Griscom; *Biology, James Madison University*

Seasonal dry tropical forests on the Pacific side of Central America are one of the most threatened ecosystems in the world. Most of the forested land was initially harvested for timber and then cleared for cattle in the last century. In the 21st century, these areas are again in a state of transition due to the combination of decreasing land productivity and increasing land prices. Cattle pasture land has been sold to new landowners, some of whom are interested in reforesting to increase biodiversity, forest cover and long-term economic value. However, habitat fragmentation is also a threat from development of second homes and tourism. Attempts have been made to restore these forests with intensive native species plantations, enrichment planting, or protection from fire. Experimental studies have shown that these ecosystems are surprisingly resilient due to the ability of many tree species to stump-sprout and the diverse forested riparian zones which serve as a source of seeds and habitat for seed dispersers. However, species diversity will remain low in the successional recovery processes unless some active management occurs. Intensive plantation systems are recommended when there are no arboreal elements in the landscape (e.g., live fences, shade trees, forested riparian zones). Less intensive management, such as enrichment planting, is recommended when forested riparian zones are not nearby but relic species still have the ability to stump-sprout and shade trees and/or live fences are present. Many areas, however, will have the natural capacity to regenerate when in close proximity to forested riparian zones. In all cases, restoration areas should be protected from fire, competition from exotic grasses should be eliminated, and tree seedlings should be protected from cattle.

### **V-34-4: The Culture of Tree Planting and Protecting by Landholders in Rural Panama and Their Experiences with PRORENA: Implications for Designing Reforestatio**

E. Garen, Saltonstall, Kristin, Jacob, Mark S. Ashton, Jefferson Hall; *Smithsonian Tropical Research Institute*

Many reforestation projects in Panama focus only on the planting of a handful of fast-growing exotic timber species and rural landholders tend not to participate in these initiatives. These trends have been attributed to two widespread beliefs: (1) Panamanian cattle ranchers and agriculturalists often are perceived as not wanting to plant trees because they interfere with their agricultural practices; and (2) if rural landholders are interested in tree planting then they want to plant fast-growing exotic timber species only. However, an analysis of the tree planting and protection practices of landholders in two regions of rural Panama (n=68) and their experiences participating in a native species reforestation initiative revealed the contrary. The farmers in this analysis had a wealth of knowledge about native trees, planted and protected numerous native trees in many ways for different reasons, and had positive experiences planting native trees with PRORENA. In fact, native trees and forests often provided critical ecosystem services for farmers and were an integral component of their farming and

livelihood practices. Moreover, most of the farmers recognized and wanted to plant a variety of native trees in the future in many ways for different reasons. These results indicate widespread interest in, and success with, planting native species by rural landholders in Panama and underscore the need to systematically examine farmers' tree planting practices, knowledge, and interests when planning and implementing reforestation projects. This study also suggests that rural landholders in Panama do not participate in tree planting efforts not because they lack an interest in planting trees, but instead because reforestation projects are not designed to account for their existing, and highly diverse, tree planting practices and interests.

#### **V-34-5: Pathways Toward Restoration for Cleared and Selectively Logged Lands in the Hill Mixed Dipterocarp Forest Region of Southeast Asia**

Mark S. Ashton<sup>1</sup>, Savithri Gunatilleke<sup>2</sup>, B.M.P. Singhakumara<sup>1</sup>, Nimal Gunatilleke<sup>1</sup>; *1. Yale University, 2. University of Peradeniya*

We provide a review of reforestation methods and associated financial analyses for deforested or degraded lands of the hill mixed dipterocarp forest (mdf) regions of SE Asia. For deforested lands most has been cleared for permanent agriculture systems. A significant proportion of these lands cannot sustain agriculture and have subsequently been abandoned. Such lands have reverted to fire-dependent grasses and ferns that inhibit regeneration of the original rain forest. Plantations of certain fast-growing, fire-tolerant tree species have been established on such sites. Many of these plantations have been reported to promote establishment of native forest vegetation by shading out the grasses and ferns. Other studies have reported that tree plantations can improve soil structure and fertility. We review these studies and provide enrichment and conversion strategies for plantation systems with alternative comparisons using mixed species plantations and second growth accompanied by comparative financial analyses. In other circumstances, over cutting through selective logging practices have degraded composition and structure of mixed dipterocarp forests to an extent that there is no further economic value. Such lands are now being cleared for plantation agriculture and industrial forestry. We provide a review of different enrichment and restoration techniques for mixed dipterocarp forests, with analyses of economic benefits compared to their conversion to industrial agricultural and forestry plantations.

#### **V-34-6: Restoring Tropical Forest Ecosystems: from Research to Practice**

Stephen D. Elliott, Sutthathorn Chairunagsri, Cherdasak Kuaraksa, Kwankhao Sinhaseni; *FORRU, Chiang Mai University*

This paper describes a forest restoration research project in Doi Suthep-Pui National Park, N. Thailand, which combined the needs of science with those of villagers and is now being replicated in several Asian countries. Chiang Mai University's Forest Restoration Research Unit (FORRU-CMU) was established in 1994 to test the framework species method of forest restoration. A phenology study determined optimal seed collection times of native forest tree species. In the research nursery, optimal propagation methods for >400 tree species were devised. Field trials were established in collaboration with a Hmong hill tribe community, Ban Mae Sa Mai, within the national park. Villagers were fully involved in project planning, growing and planting the trees, and caring for them after planting. Field trials i) identified which tree species perform as framework species (high survival/growth, attraction of seed-dispersing animals to promote biodiversity recovery), ii) tested different silvicultural treatments and iii) monitored biodiversity recovery. This work resulted in i) a successful method to restore upland evergreen forest, and ii) insights into factors that influence villagers' participation in forest restoration. Canopy closure was achieved 3 years after planting 20-30 framework tree species. Within 6 years, plots were colonized by 61 recruit tree species and bird species richness increased from 30 to 88. Benefits most appreciated by villagers, were intangible, such as "reduced conflicts" over resources and "improved public image", which strengthened their right to live in a national park. Of the utilitarian benefits, increased water quantity and quality were most appreciated, whereas income from forest products and eco-tourists, was ranked lower. The research program is now being

replicated to develop suitable restoration protocols for lowland deciduous forest in N. Thailand and lowland evergreen forest in S. Thailand. The Ban Mae Sa Mai site is now a valuable demonstration facility, for teaching both technical and social aspects of forest restoration throughout SE Asia. Outreach includes education and training programs and publication of practical manuals in 6 SE Asian languages. A global guide (French and Spanish) is in prep. The FORRU model is now being tested in China, Cambodia and Indonesia.

#### **V-34-7: The Use of Fig Trees (*Ficus spp.*) in Forest Restoration Plantings**

Cherdsak Kuaraksa, Stephen Elliott, Martine Hossaert-Mckey; *Chiang Mai University*

Fig (*Ficus spp.*) trees have been promoted as framework species for tropical forest restoration because they are considered to be keystone species. Here, I report on a study of the seasonality of fig development, as well as fig tree propagation and planting techniques for six dioecious *Ficus* species, in Doi Suthep-Pui National Park, Northern Thailand, that will enable their inclusion in forest restoration plantings: *Ficus auriculata*, *F. fulva*, *F. hispida*, *F. oligodon*, *F. semicordata* and *F. variegata*. At the population-level, most species produced figs all year round, but fig abundance varied seasonally. Ripe figs, bearing fruits, were most abundant in the rainy season (June-September). A critical bottleneck for wasp dispersal was discovered in the rainy season. The most successful method for the production of fig tree planting stock was using seed, germinated on a mixture of sand and charcoalized rice husk, with a fungicide applied to the surface of the germination medium when seeds are sown and applications of fertilizer 1 month after germination and after pricking out. Seedlings were placed in full sunlight, so that most were ready for planting within a year after seed collection. This treatment also resulted in the highest growth rates and seedling survival after planting out in disturbed areas. The study generated scientifically based recommendations that will enable propagation and planting of fig trees in forest restoration projects such as i) optimum time for seed collection, ii) forest restoration plans to sustain the fig wasp population, and iii) optimum propagation and planting techniques, to maintain keystone resources in tropical forest ecosystems.

#### **V-34-8: Comparison of Site Preparations Approach for Forest Restoration in Alang-alang Grassland in West Kalimantan**

Romadoni Anggoro<sup>1</sup>, Campbell O. Webb<sup>2</sup>, A. Andrew M. MacDonald, Kari S. Malen<sup>1</sup>; *1. Yayasan ASRI 2. Arnold Arboretum, Harvard University*

This research project takes place in Gunung Palung National Park in West Kalimantan, Indonesia. This area was damaged because of the illegal operation of a logging company, that was forced to close by the community. After the operation the land was burned for agriculture and abandoned after few years. Then the area was invaded by an exotic grass called alang-alang (*Imperata cylindrica*). The grass has a strong network of roots and can burn easily preventing natural regeneration of native plants. This restoration research began in October 2009, regrowing rain forest trees on four hectares of alang-alang land within the park. Our approach balances three distinct goals: to improve the natural habitat, to provide work to local people, and to increase knowledge about tropical rain forest restoration. The questions that we want to answer are which restoration methods are most effective and efficient? We focus on planting methods and community outreach by making combinations of land preparation, weeding treatment, cardboard mulch, fertilizer and involving community during all phases of the project. We have planted 81 plots of 102 plots, 20x20m square and surrounded by a firebreak. Each plot is a single experimental unit and planted with 177 trees at approximately 1.5m spacing. We systematically arrange the positions of individual trees to avoid a linear, artificial planting arrangement. In each plot, 64 trees (36% of the total) remains a constant mix of the five most abundant species in our nursery. We are avoiding treatment combinations that, based on the literature and our experience, are unlikely to succeed. For all experiments, our response variables are survival and growth for each individual plant, measured at regular intervals.

### **V-34-9: Restoration of Ecological and Economic Diversity in Monoculture Forest Plantations: A Case Study from Sri Lanka**

Nimal I.A.U. Gunatilleke, Inoka Ambagahaduwa, Savitri Gunatilleke, Mark Ashton; *University of Peradeniya*

Natural regeneration of site-specific and shade-tolerant tree species is poor in mixed-dipterocarp forestlands that have been cleared for agriculture and subsequently abandoned in Sri Lanka as elsewhere in South-east Asia. *Pinus caribaea* plantations established in such areas have only limited economic value to rural communities while the ecological significance of such monocultures remains controversial. We established an experiment to enrich a *P. caribaea* stand in Hantana in Kandy District with four indigenous/naturalized tree species viz. *Artocarpus nobilis* Thw., *Madhuca longifolia* (L.) Macbride, *Michelia champaca* L. and *Terminalia bellirica* (Geartn.) Roxb. along with several understory herbaceous species with known rural economic value. The performance of the above tree species was compared under partial and complete shade of *Pinus* trees with those grown without *Pinus* trees under full light conditions as the control. The incremental mean plant height and root collar diameter showed significant variations among species in treatment and control plots indicating their species specific responses to different environment created. Experiments of this nature hold promise in systematic conversion of exotic monocultures into multiple-species stands of enhanced ecological and economic value to rural communities.

### **V-34-10: Peat Swamp Forest Rehabilitation in South-East Asia**

Peter Van Der Meer<sup>1</sup>, Demies<sup>2</sup>, Giesen<sup>1</sup>, Verwer<sup>1</sup>; *1. Alterra - WUR, 2. Malcom*

Tropical peat swamp forests cover between 30 and 40 million hectares worldwide, of which 70% is found in Southeast Asia. The forest which originally covers these peat areas contains a large number of endemic species. Also, these forests are important sinks of carbon, sequestering between 100-200 megatonnes of carbon per year under natural conditions. These forests have been under increasing pressure, both for economic exploitation of commercial timber species such as Ramin (*Gonystylus bancanus*), as well as for oil-palm development. We focus on technical aspects of peat swamp forest restoration/rehabilitation related to forestry and ecology. We give a summary of degradation types & natural regeneration studies in Indonesia and Malaysia, followed by an overview of restoration/rehabilitation attempts in the region. Field trials from Malaysia (Sarawak) show mixed results for replanting and liberation of the locally abundant PSF species Ramin (*Gonystylus bancanus*). Our results confirm that ramin is regenerating very poorly in natural forest because of low seed production and high mortality among seedlings. Tree growth was extremely variable with an average dbh increment of 0.28cm yr<sup>-1</sup>. Liberation of saplings showed to enhance growth rates in both gaps and understory but growth of liberated individuals did not differ significantly between gap and understory, suggesting that light is not the most important growth determinant. Planting of ramin seedlings in Maludam NP showed a wide range of mortality 1.5 years after planting. We conclude with some guiding principles for restoration and rehabilitation followed by technical guidelines for PSF restoration and rehabilitation

## **Tropical forest road impacts and mitigation (#35)**

**(July 22 pm; Wantilan wing)**

Organized by: **Miriam Goosem**

*Clearings for linear infrastructures, especially roads, are a burgeoning feature of the tropical forest landscape. Roads, powerlines and other linear clearings provide a means of ingress to mostly unmodified forest for a variety of organisms which can result in differing scales of forest alterations. These range from invasions by native species adapted to habitats other than rainforest, through*

*invasions of weeds, pests and diseases imported from other tropical areas, to human hunting and potentially forest clearing, colonisation and land development. Roads also have the potential to increase forest changes resulting from natural disturbances and from climate change.*

*Tropical rainforest fauna and flora often are particularly susceptible to road impacts. Many species are ecological specialists adapted to the complex architecture, and low light, high humidity and relatively stable temperature regimes found below the rainforest canopy. These may avoid clearings and forest edges or fail to survive in the altered conditions found there, causing both edge and barrier effects. In contrast, many long-lived, large animals may not necessarily avoid edges but can be vulnerable to vehicle collisions, hunting and forest clearing encouraged by road development. The goal of this symposium is to explore what is known of road impacts in tropical rainforest regions and how we currently assess these impacts. We aim to identify gaps in knowledge regarding linear infrastructure impacts, particularly where studies are lacking regarding particular taxonomic groups or geographical regions. We will discuss means of mitigating both small- and landscape-scale impacts and how far we have progressed in the evaluation of these mitigatory measures.*

### **V-35-1: The Perils of Roads in Tropical Frontiers**

William Laurance

I will provide an overview of the environmental impacts of roads in tropical forests, emphasizing research in the Amazon, Congo Basin, and Asia-Pacific region. Roads and highways are omnipresent features of human activity and are rapidly expanding in the tropics. Tropical biota are especially vulnerable to such infrastructure because they include many ecological specialists that avoid even narrow (<30-m wide) clearings and forest edges, as well as various other species susceptible to elevated road-kill, predation, or human hunting near roads. In addition, roads are playing a major role in opening up forested tropical regions to destructive colonization and exploitation. I will synthesize existing research on the impacts of roads on tropical rainforests, and will assert that such impacts are often qualitatively and quantitatively different in tropical forests than in other ecosystems.

### **V-35-2: Interactions of Climate Change and Impacts of Rainforest Linear Infrastructure on Microclimates at and Near Tropical Forest Edges**

Stephen M. Turton; *School of Earth & Environ. Sci., James Cook Univ.*

Anthropogenic climate change is predicted to have a range of impacts across the humid tropics over coming decades. Most of the tropics can expect mean temperatures to increase by 2-3 degrees C by 2070, while rainfall changes show a higher degree of uncertainty. Some regions may expect higher rainfall than present, while others may expect less rainfall or greater seasonal changes in rainfall. Both increases in mean maximum and minimum temperatures coupled with significant changes in total and seasonal rainfall are likely to result in profound impacts on tropical forest biota and ecosystem processes. Some attention has been given to how climate change might interact with forest clearing in the tropics but this work has largely focussed on synergies between climate change and large-scale forest fragmentation. There has been little attention given to interactions between linear clearing fragmentation and climate change in tropical forests. I shall examine the likely impacts of climate change on forest microclimates at and near tropical forest edges in a range of regional contexts, including regions like northeast Australia where rainfall and temperature regimes are strongly seasonal and compared with more equatorial regions where climate patterns are more aseasonal but may become more seasonal under anthropogenic climate change.

### **V-35-3: 'Killer roads' Threatening Endangered Mammals in Southeast Asia**

Reuben Clements, Miriam Goosem, Susan Laurance, William Laurance; *James Cook University*

Tropical forests are being cleared for timber, agriculture, infrastructure and human settlements at unprecedented scales - roads are known to expedite this process. In Southeast Asia, roads are known



to plough through forests in close proximity to endangered mammal habitats. We term these as ‘killer roads’, or roads that contribute to the decline of IUCN threatened mammals by accelerating deforestation, promoting frontier colonization and/or increasing hunting pressure and roadkills. However, the extent to which current and proposed killer roads threaten mammal habitats in this region has hardly been quantified. We sent questionnaires to 112 regional experts involved in research and conservation of mammals in order to solicit their opinion on the top three existing and proposed killer roads in their respective countries. Apart from highlighting environmental issues associated with existing killer roads, we used Maximum Entropy (MaxEnt) modelling to illustrate the extent to which some of these roads bisect predicted suitable habitats for certain IUCN threatened mammal species. We propose strategies to mitigate the impacts of existing killer roads on the region’s embattled mammal populations. Most importantly, we call on NGOs and research institutions to lobby for the suspension of potential killer road projects identified in this study through their respective road authorities, which are important stakeholders that have largely been ignored in conservation planning throughout the region.

#### **V-35-4: Edge Effects of Roads and Powerlines on Rainforest and Savanna Plant Communities**

Catherine L. Pohlman; *James Cook University*

Human activities have led to the loss and fragmentation of tropical forests around the world. Linear clearings for human infrastructure, including roads and powerlines, may further subdivide remaining areas of forest. Such clearings are widespread within the rainforests and tropical woodlands of north-eastern Queensland and the edge effects (alterations in the physical environment and biological community of the forest near the forest edge) of these clearings have the potential to substantially increase the disturbed area within existing tracts of forest. I will present the results of a study on the impacts of road and powerline clearings on the vegetation structure and understorey microclimate of rainforest and dry sclerophyll woodlands in the Wet Tropics World Heritage Area of north-eastern Queensland and explore the differences and similarities in these impacts between these two ecosystem types.

#### **V-35-5: Evaluating Road Impacts on Vertebrates**

Susan Laurance; *School of Marine and Tropical Biology, James Cook University*

From a conservation perspective, roads are without a doubt one of the most insidious human activities in tropical forests. They facilitate widespread habitat loss and disturbance, as well as causing highly localized impacts on populations through insularization and road mortality. We are able to quantify road mortality with a high degree of confidence (we have the road kill evidence) but road avoidance is a far more complex issue. One of the problems is that road avoidance is confounded by a number of behaviors: territoriality, edge avoidance and gap avoidance. What are the best techniques to address these problems? In this talk I will review studies that have examined the barrier effects of roads and highlight some problems with the methodologies, assumptions and interpretations. I will discuss some new experimental approaches that should be considered in future studies.

#### **V-35-6: Roads as Barriers for the Movement of Understorey Birds in the Tropical Semi-deciduous Forest of Cozumel Island, Mexico**

Héctor Perdomo, Ellen Andresen; *CIECO-UNAM*

Roads constitute important and necessary infrastructure for the development of a country. When roads are built in wildlife habitat, they also constitute linear openings in that habitat, and are known to have negative effects on the ecology and conservation of animal populations. In this study we quantified the proportion of understorey bird movements involving road crossing, and compared it to the proportion of movements, of the same distance, without road crossing (control movements). The study was carried out in the tropical semi-deciduous forest of Cozumel Island, in the Mexican

Caribbean. Roads of three widths were used in this study: 3, 9 and 19 m. Two sites per road width were used, and all sites had negligible traffic. Three parallel lines of mist nets were set out, inside the forest, at each site: the first and second lines at 5 m from both road edges, and the third line in such a way that the distance between the second and third lines was equal to the distance between the first two lines. Using the ratio of crossings vs. control movements, a barrier effect was found for all three road widths. This effect increased as road width increased, such that a reduction of 9, 12 and 55% in observed crossings, with respect to the expected number of crossings, was found for roads that were 3, 9 and 19 m wide, respectively. Also, there was a negative relationship between the average distance of bird movement and road width. The average distance of movements decreased from 40 m in the case of 3m-wide roads, to almost half that distance (23m) in the widest roads. At least 42 species use the understory of this forest. Nevertheless, only 12 species (28%) were recorded crossing roads. Also, resident species tended to be more negatively affected by roads than migratory species. The roads in Cozumel act as barriers for the movement of the understory forest birds. The barrier effect increases as the road width increases.

### **V-35-7: Traffic Noise: What Impact does it have on Non-vocalising Species?**

Peter J. Byrnes, Miriam Goosem; *James Cook University*

Traffic noise can be detected through dense habitat, such as tropical rainforest, at distances greater than 200m from a road. This results in greatly increased areas of disturbance. For example, along a 20m wide road the area of impact may be increased by at least twenty times the road clearing area. Studies in other habitats have found impacts attributed to traffic noise at much greater distances including road avoidance and changes to frequencies and amplitudes of calls. Most noise research has focused on vocal species that are vulnerable when attempting to communicate (birds and amphibians). What impact does traffic noise have on species which do not rely on vocalisation? The potential for impact on such species means that this largely unstudied area should be examined. This paper overviews research into traffic noise, and outlines results from my study on impacts of traffic noise on rainforest mammals in north Queensland, Australia. Four target species- two bandicoots (*Perameles nasuta*, *Isodon macrourus*), one rodent (*Uromys caudimaculatus*) and one macropod (*Hypsiprymnodon moschatus*)- were spool-and-line tracked in rainforest away from roads. These animals were followed with and without traffic noise being played through a row of speakers to assess responses in movement and behavior. Traffic noise had little impact on these species, with none exhibiting avoidance behavior or large modifications to their general movement patterns. Similarly, traffic noise did not affect path tortuosity or cause a movement barrier. This may mean that these animals quickly habituate to noise and suggest that traffic noise may not cause a large disturbance to species whose main impact from traffic noise is auditory, rather than vocal. It is likely that the physical presence of the road and vehicles, and alterations to the biophysical environment as a result (changes to flora, other fauna, microclimate, soils, etc.), would cause greater impacts on these species.

### **V-35-8: Minimising the Impacts of Roads: Strategies and Their Evaluation**

Miriam W. Goosem; *James Cook University*

Clearing for linear infrastructure causes impacts on both small- and landscape-scales. Landscape-scale impacts include incursions by non-indigenous peoples for hunting and settlement. Careful planning that avoids the penetration of roads into intact forest habitat is the best option to minimize such impacts. Where roads are unavoidable, the creation of protected areas along the route prior to construction can reduce human incursions. Small-scale impacts of roads in tropical forests include loss of habitat connectivity, edge effects, road mortality and invasions by alien species. I will suggest a range of inexpensive options for mitigating these impacts including maintaining canopy above roads, minimising road and verge width and maintaining rainforest habitat up to the road surface. Inexpensive bridges across streams can also provide habitat connectivity. Data from Australia shows that such strategies can be successful for a number of rainforest species. I will also show some of the more expensive engineering strategies currently incorporated into tropical forest road designs.

Unfortunately, in many cases, the success of expensive structures remains unevaluated with information available in only a few cases. This general lack of evaluation is a feature worldwide but particularly in tropical regions. Scientific evaluation of the success of such strategies is desperately necessary to encourage the best environmental designs and ensure wise use of funds allocated for mitigation. I will present data from tropical Australia regarding animal movements and road mortality in the vicinity of several types of structures. Further in-depth evaluation of animal population and genetic structure is necessary to ascertain levels of success for engineered solutions.

## **Fire ecology and management in tropical savannas (#36)**

**(July 22 am; Wantilan wing)**

Organized by: **Anna E Richards and Alan N Andersen**

*Tropical savannas make up one sixth of the globe and are one of the most flammable biomes on the planet with ca. 20 % of savanna landscapes burnt annually. In recent times, modification of historical fire regimes in savannas, through changes in landscape fire management or fragmentation, have resulted in more intense and frequent fire in some areas, or the exclusion of fire in others. The modification of fire regimes in savannas has had significant impacts on their biodiversity and ecosystem function. Savannas also play an important role in the global carbon cycle by contributing 30 % to net primary productivity. Therefore, modification of historical fire regimes impacts global climate through changes to emissions and sequestration of greenhouse gases. The impact of fire on savanna ecosystems poses significant challenges for the maintenance of biodiversity and ecosystem services. This symposium will address these issues by assembling many of the world's leading savanna ecologists. The symposium will cover a range of topics including fuel dynamics and fire behaviour, and the impacts of different fire regimes on savanna vegetation dynamics, fauna and flora diversity, nutrient cycling and greenhouse gas emissions.*

### **V-36-1: When is a Forest a Savanna?**

William J. Bond<sup>1</sup>, Jayshree Ratnam<sup>2</sup>, Rod J. Fensham<sup>1</sup>, William A. Hoffmann<sup>1</sup>, and members of WG 49-2 ; 1. Botany Department University of Cape Town, 2. Ecology Evolution Group, NCBS

The archetypal view of a savanna is one of vast African plains, dotted with trees and teeming with animals. This is far removed from the archetypal tropical forest where trees are densely packed and a sparse understorey struggles to survive in dense shade. However trees vary greatly in density in savannas and, at the high density end, appear to grade into forests. We propose that forests and savannas differ fundamentally in functional attributes following from the defining feature of savannas – the presence of a near continuous, usually C<sub>4</sub>, grass layer. C<sub>4</sub> grasses are shade-intolerant and highly productive in humid climates but also highly flammable in the dry season. We suggest these features of the grassy understorey select for very different woody and herbaceous traits than those characteristic of closed forest communities. Failure to recognise the functional differences between forests and savannas seems often to have led to a policy of fire exclusion from savannas which negatively impacts the savanna community while also promoting invasion of woody weeds. We suggest pointers to distinguishing between forests and savannas based on hypotheses on the functional differences between plants growing in these two biomes.

### **V-36-2: Biological and Physical Controls over Fire Feedbacks at Savanna-forest Boundaries: Implications for the Origin of Tropical Savannas**

William A. Hoffmann, Susan Y. Jaconis, Kristen McKinley, Erika L. Geiger, Augusto C. Franco, M. Haridasan; North Carolina State University

Fire-vegetation feedbacks are widely recognized to play an important role in the dynamics of

savanna-forest boundaries. The low flammability of forest is commonly attributed to the cooler, more humid microclimate under the closed canopy. Recent evidence, however, suggests that fire became frequent in the tropics as a result of the spread of C4 grasses, suggesting a critical role of grasses for fire-vegetation feedbacks. To understand the relative importance of microclimate versus grasses in governing fire regimes in savanna, we measured air temperature, relative humidity, wind speed, fuel load, fuel packing ratio, and fuel moisture at eight savanna-forest boundaries in Brazil. We then used BehavePlus4 to model fire behavior in response these variables. We found abrupt changes across the boundary in all variables, with savanna having greater wind speed, air temperature, and fuel loads but lower relative humidity, fuel moisture, and fuel packing ratio. Predicted flame lengths and rates of fire spread were greater in savanna than forest, and roughly half of the difference was due to the presence of grasses. Of the other variables, wind speed had the greatest effect in determining fire characteristics. Structural and ecological differences between savanna and forest tree species further contribute to these feedbacks by mediating rates of canopy closure and vegetation responses to fire. These results emphasize the importance of species traits in governing feedbacks between vegetation and the physical environment.

### **V-36-3: Fire Resistance of Savanna Trees: Escape Diameter vs. Escape Height vs. Bark Thickness**

Michael J. Lawes<sup>1</sup>, Jeremy J. Midgley<sup>2</sup>, Hylton R. Adie<sup>1</sup>, Jeremy Russell-Smith<sup>1</sup>, Brett Murphy; *1. Charles Darwin University, 2. University of Cape Town*

We examine the role of bark traits in fire resistance and persistence of trees in the tropical savanna of north Australia. In fire-prone environments, such as tropical savannas, possessing traits that facilitate the survival of stems has obvious adaptive value. In this paper we examine the following hypotheses for how trees might escape the fire trap: i) growing a thicker stem (escape diameter) and thus being buffered against the heat of fire; ii) growing quickly and tall (escape height), enabling the terminal buds to escape being scorched; and/or (3) having thick bark (bark thickness) and/or other bud protection. While the escape diameter and escape height hypotheses are popular explanations for how trees escape the fire trap, they are insufficient on their own because if either height or diameter growth rate was strongly implicated we would expect forest species to invade savanna - they do not. We suggest that escape height is not the height at which the canopy is damaged or scorched but is the height at which bark protects the stem. We further point out that bark traits (bark thickness, bark thickness growth rates) are central to fire resistance among fire-prone savanna trees and to their resprouting capacity, which in turn ensures that most trees survive repeated fires (persistence niche). Furthermore, we suggest that topkill, at least in Australian savannas, may have a lesser role in determining tree demography and structure, compared to African and Central American savannas.

### **V-36-4: Fire, Savannas and Forest/Savanna Dynamics in New Caledonia**

Christelle Hély, Thomas Ibanez, Laurent Borgniet, Thomas Curt, Cédric Gaucherel, Marc Despinoy, Morgan Mangeas, and Hubert Géaux; *CNRS*

New Caledonia is one of the world's biodiversity hot spots. However, anthropogenic fires are becoming more threatening to ecosystems and human populations as they increase in number, frequency, and area. The overall objective of the French ANR INC project is to analyze the interactions between ecosystems, cultural and social practices, climate, and fire, and to develop a Geographic Information System (GIS) for the integrated monitoring of these components through time and space. An analysis of aerial photographs over the last fifty years in the Northern Province (Aoupinié mountain and the surroundings of the Gohapin tribe) showed significant changes in the savanna/forest landscape mosaic of 24 km<sup>2</sup> with a first period of forest expansion until 1976 followed by a regression whose maximum rate was observed during the last three years period (1997-2000). We characterized all fuels found in forest stands and savannas and performed fire simulations at the stand level using BEHAVE [Andrews, 1986; Burgan and Rothermel, 1984] to calibrate fuel models and then at the landscape level using the FlamMap model [Stratton, 2004]. We present savannas and

forest fuel characteristics, as well as fire simulation results using several weather conditions extracted from the dry season weather typology. We finally discuss the environmental factors that likely enhance fire propagation in such savanna/forest landscape mosaic.

### **V-36-5: Savanna Fires in Eastern Indonesia: Factors Influencing Changes to Fire Management Practices**

Bronwyn A. Myers, Rohan P. Fisher, Sam J. Pickering; *Charles Darwin University*

Large areas of eastern Indonesia are dominated by fire-prone savannas. Livelihoods here rely largely on subsistence agriculture where fire is commonly used as a land management tool despite official national fire policy prohibiting burning. A project in 2002-2005 described the fire history of savannas in two districts in Nusa Tenggara Timur province. Fire mapping revealed: fires annually burnt 29% of East Sumba district and 11% of the central Flores district of Ngada; most fire occurred in savanna grasslands, with some in cultivated lands and small remnant patches of forest; most fire activity occurred under harsh, late dry season conditions; and while the great majority of individual fires were less than 5 ha, some individual fires in the late dry season burnt hundreds of hectares. The project built capacity in the district governments and NGOs to map and monitor fires, and in local communities to establish agroforestry plots and to use strategic burning to protect assets. Development projects aim to have positive outcomes that are sustained beyond the period of funding, but ongoing impacts are rarely measured, especially by independent third parties with an understanding of the culture. The outcomes of the fire project were assessed in 2008, based largely on interviews by a local researcher. It was found that the district governments continued to use satellite based mapping and monitoring for natural resource management. The maintenance of agroforestry plots and community fire management groups varied between villages. Sustainability was supported where local networks and links with external agencies (social capital) was strong. Cessation of outcomes occurred where a village leader had died and disputes occurred over land tenure. The engagement by the research team with multiple stakeholder levels (i.e. district and village leadership, NGOs and universities) was essential to the uptake of the project approaches and continuity of the outcomes.

### **V-36-6: Seasonality of Fire and Fuels in Tropical Savannas**

Richard J. Williams; *CSIRO*

Fuel beds in savanna fires are dominated by fine fuels – grasses, herbs and tree leaf litter – and, where tree density is relatively high, coarse woody debris (CWD). In this paper the seasonal and annual variation in fuels, fire behaviour and fuel consumption are presented for a number of study sites in the greater Darwin region of the NT, Australia. Experimental fires were lit, using line ignitions, in the early dry season (June), and the late dry season (September), over the period 2004-2010. Fine fuels were determined by direct harvest; CWD by line intercept; and fire rate of spread by electronic timers, stop watches and triangulation. All study sites were ca. 1ha, situated in *Eucalyptus tetrodonta* – *E. miniata* mesic savanna. Fine and coarse fuel loads were each in the range of 2-5 t/ha. Rates of spread varied from ca. 0.01 - 0.3 m/s. Flame residence times were 30-180 seconds, and head fire intensity 100 – 3000 kW/m. Late dry season fires were generally more intense than early dry season fires. Consumption of CWD was generally 5-50%, averaging between 0.5 and 1 t biomass per hectare per fire over multiple fires. There was no significant relationship between CWD consumption and either standing tree basal area, or fire intensity. All measured values for fire behavioural variables are within the range of previously reported values, albeit at the low-middle end of the range. Measuring rate of spread with simple hand held stop watches was accurate (as judged by comparison with the standard method of electronic timers) for fires up to about 3000 kW/m. The lack of a predictive relationship between CWD consumption and the major environmental and fire behaviour variables implies that, for carbon accounting purposes, in the absence of detailed site-specific measures, a mean value of CWD consumed by savanna fires must be assumed.

### **V-36-7: Burning for Biodiversity in Tropical Savannas: A Critique of the Pyrodiversity Paradigm**

Alan N. Andersen<sup>1</sup>, Kate L. Parr<sup>2</sup>; *1. CSIRO Sustainable Ecosystems, 2. University of Oxford*

Tropical savannas are the world's most fire-prone biome, with most savanna landscapes burnt every 1-3 years. Fire management is a key issue for savanna conservation managers worldwide, and there is widespread concern that inappropriate fire regimes are threatening savanna biodiversity values. In this presentation we critically analyse the variation in fire regimes ('pyrodiversity') required to maintain savanna biodiversity values. In doing so we make an important distinction between what different elements of the biota prefer and what they need. The published literature shows that most savanna species are remarkably resilient in relation to fire, and that much pyrodiversity is ecologically meaningless. This indicates that relatively little pyrodiversity is required to maintain savanna biodiversity. We argue that attention should shift from implementing pyrodiversity as a matter of principle, to focussing on meeting the needs of species known to be threatened by prevailing fire regimes. The situation with small mammals in northern Australia is presented as an example, where there is a need to increase the representation of less frequently burnt habitat. We identify two key research priorities. The first is identifying components of the savanna biota that are not so resilient to high fire frequency and therefore in need of special attention. The second is identifying trade-offs that might occur between managing savannas for carbon sequestration and maintaining savanna biodiversity values, given the growing interest in savannas from the perspective of greenhouse gas abatement.

### **V-36-8: The Greenhouse Gas and Carbon Implications of the Management of Fire Regimes in Savannas**

Garry D. Cook, Mick Meyer; *CSIRO Australia*

Burning of savannas and grasslands consumes more than one third of the total annual biomass burning globally while in Australia, savanna burning comprises 2 to 4 % of national greenhouse gas (GHG) emissions. This national significance of this has led to efforts to reduce savanna burning emissions by better managing the extensive fires that burn across northern Australia each year. The approach is to use early dry season fires to create burnt fire breaks and reduce the frequency of late dry season fire and fires overall. In this paper we describe how fire management can be used to manage greenhouse gas emissions and carbon stocks in northern Australian savannas.

### **V-36-9: Optimal Fire Regimes for Soil C Storage in Tropical Savannas**

Richards, Anna E., Garry D. Cook; *CSIRO Sustainable Ecosystems*

Modification of fire regimes in tropical savannas can have significant impacts on the global carbon cycle and the climate system. In Australian tropical savannas there has been recent, large-scale implementation of fire management that aims to decrease Kyoto-compliant non-CO<sub>2</sub> greenhouse gas emissions by reducing late season intense fires through strategic early season burning. However, there is no accounting for changes to above or belowground carbon stocks resulting from changes to savanna fire management, although impacts on these pools may be considerable. We present a hypothesis that soil C storage is greatest under low intensity fires with a frequency of 5 y compared to annual burning, severe fires and long unburnt savanna. Century Soil Organic Matter Model simulations confirmed this hypothesis, although predictions for long unburnt stands were not consistent. However, soil carbon stocks measured in the field under annual, 3 y and unburnt fire treatments did not vary (41–58 t/ha). Further Century modelling suggests that changes in fire management will take up to 100 y to have a detectable impact (+5 t/ha) on soil carbon stocks. However, implementation of fire management that reduces fire frequency within the large area of intact savanna landscapes in Northern Australia could still convert this figure to a saving of 0.2 tCO<sub>2</sub>-

e/ha/y, five times greater than reductions of non-CO<sub>2</sub> emissions. These findings have implications for savanna fire management as a greenhouse gas abatement tool and livelihood opportunity for remote indigenous communities in Northern Australia.

### **V-36-10: Turning up the Heat: The Impact of an Invasive African Grass on Savanna Fire Behaviour in Northern Australia**

Samantha A. Setterfield, Rossiter-Rachor, Natalie A., Lindsay B., M.M. Douglas, K. Ferdinands;  
*Charles Darwin University*

Fire is an important feature of Australia's tropical savannas, which cover the northern quarter of the continent. The region is characterised by frequent fire, with approximately 50% burnt each year by relatively low intensity fires. During the 20th Century, hundreds of grass cultivars were introduced to northern Australia for the purpose of improving agricultural potential. Many of these species are now major weeds with some species of particular concern due to their effects on fire behaviour. Arguably the most serious is *Andropogon gayanus* Kunth. (gamba grass), which was introduced for pastoral production but has now invaded extensive areas of the Australian savanna region, including land managed for conservation, rural/residential purposes, agriculture, defence and mining. Compared with native grasses, gamba grass forms substantially taller and denser stands that cure later in the dry season. The large fuel loads resulting from gamba grass invasion support fires 5 to 10 times more intense than those fuelled by native grasses. The change in fire fuel properties means that flame height is significantly increased and we have recorded the first passive crown fires in the region in the gamba invaded areas. The change in fire regime has a major effect on the vegetation, with up to 50% loss of tree cover occurring in just six years following invasion. This reflects a major loss of carbon store which has implications for regional carbon accounting. Fire risk to life and property has also increased dramatically and we have documented the subsequent changes in fire and land management practices, and increases in resources, required to mitigate this threat. This paper will describe the dramatic changes in fire regime following gamba grass invasion and its environmental, social and economic consequences.

## **Understanding the dynamics of secondary tropical forests (#37)**

**(July 21 am; Garuda)**

Organized by: **Robin L. Chazdon and María Uriarte**

*Of the many land-cover changes affecting tropical forests today, one of most significant to ecosystem service provisioning and human wellbeing is the large increase in the extent of secondary forests. The area of degraded and secondary forests in the tropics was recently estimated at 850 million hectares, and this amount is likely to increase dramatically in the future. These secondary forests provide many of the ecosystem services attributed to primary forests including regulation of water flow and quality, erosion control, carbon sequestration, restoration of nutrients and soil properties in former agricultural lands, timber and non-timber forest products, and biodiversity conservation through relief of pressure from primary forests and enhanced connectivity of fragmented landscapes. In spite of their increasing extent, dominance, and prevalence in tropical countries, the processes that affect the structure and composition of secondary tropical forests are only beginning to be understood. These processes include animal-mediated seed dispersal from remnant forest patches in the surrounding landscape and effects of prior land use on soils and the soil seed bank. More information is needed not only on the status and extent of secondary forests but also on the drivers of transitions among different types of land uses, rates of forest recovery following different land uses, and the potential for secondary forests to conserve biodiversity threatened by deforestation and forest fragmentation.*

*This symposium explores the interactive effects of landscape and stand level processes on secondary forest regeneration, structure, composition, and ecosystem services. Addressing these interactive effects requires a comprehensive, comparative, multi-investigator approach across different regions and landscapes. To this end, we bring together scientists working at landscape and stand scales in wet and dry forest regions distributed throughout the tropics. A series of ten presentations will examine (1) drivers of forest recovery at the landscape scale; (2) effects of human legacies on forest structure, composition, and ecological interactions; (3) roles of animal-mediated seed dispersal and tree habitat specialization in community assembly; and (4) recovery of ecosystem services in secondary forests. The symposium presents a global panorama of research on secondary forest regeneration, with presentations based on field studies conducted in Mexico, Costa Rica, Puerto Rico, Borneo, Australia, Papua New Guinea, Remote Oceania, Ecuador, and Brazil. This symposium is sponsored by the neoSelvas International Network on Tropical Forest Regeneration and Restoration.*

### **V-37-1: Influence of Matrix and Land Use History on Forest Regeneration in Old Fields in Humid and Dry Tropical Areas**

Miguel Martinez-Ramos, Patricia Balvanera, Frans Bongers, Ximena Garcia-Orth, Jocelyn Duran, Beatriz Fuentealba, Susana Maza-Villalobos, Jenny Renteria; *Centro de Investigaciones en Ecosistemas, UNAM*

Forest regeneration rates in old-fields may be enhanced as more propagule sources exist in the surrounding matrix. Such effect, however, is mediated by filtering factors such as the land use history (LUH), which determines the environmental conditions found in old fields. We used permanent plots in chonosequences (1-27 fallow years) to assess matrix and LUH effects on forest regeneration rates in humid and dry tropical areas. Matrix was characterized as the relative area covered by secondary and remnant old-growth forests in a radius of 75- 500 m around old fields, where regeneration rates were monitored during 2 to 10 years. Land use history of each studied old field was characterized considering intensity (level of environmental change due to forest conversion to agriculture), extension (old field area), and duration (years of agriculture use) of the agricultural activities before field abandonment. Our results show evidences that LUH plays a more important role than matrix in determining forest regeneration rates (basal area, species diversity). In particular, pasture cattle raising have higher negative effects on forest regeneration than corn cultivation, independently of matrix. Even in pastures with similar matrices, forest regeneration rates differed depending on land use histories.

### **V-37-2: Pervasive Effects of Human Legacies on the Dynamics of Small Island Tropical Forest Communities**

Janet Franklin<sup>1</sup>, David W. Steadmant<sup>2</sup>; *1. Arizona State University, 2. University of Florida*

Historical land use legacies affect forest ecosystems worldwide. We have studied forest dynamics on oceanic tropical islands because much can be learned by studying ecosystems that are relatively simple compared to the mainland tropics. Further, the archipelagos of Remote Oceania were settled by agricultural peoples and the time of human arrival in the mid- to late Holocene is known. This has allowed us to investigate the impact of prehistoric and historic resource use and land cover change on small island forests. Some generalizations have emerged, primarily from studies in Tonga. Pathways of forest succession following land clearing for shifting cultivation differ from those following “natural” disturbance. A severe natural disturbance (hurricane) showed little impact on remnant “old growth” forest; even an old growth forest area that subsequently was subjected to an escaped, human-set fire that removed two thirds of the canopy showed recruitment of late-successional, shade-tolerant tree species after only 4 years. This recovery was facilitated by the presence of “biological legacies” in the form of large surviving trees. In contrast, secondary forest (30-40 year-old) showed no recruitment of late-successional trees in spite of the proximity of remnant forest patches. Documented prehistoric and historic losses of vertebrate frugivores (birds and bats) and introduction of seed predators (rats) probably has reduced secondary forest resilience. Human-caused extirpations and



extinctions of vertebrate frugivores have disproportionately affected the dispersers of large-seeded, late-successional trees, and extant vertebrate frugivores are more diverse and abundant in late-successional than in secondary forest. Active dispersal by vertebrate frugivores contributes as much as 50% to seedling species richness. Conservation of vertebrate seed-dispersers and legacy old-growth patches is essential to secondary forest recovery on tropical islands.

### **V-37-3: The Role of Fauna-mediated Plant Dispersal in Regeneration and Biodiversity Recovery of Australian Rainforest**

Carla P. Catterall, John Kanowski, Catherine Moran, Wendy Neilan, Wesley Silva, Kylie Freebody, Amanda Freeman; *Griffith University*

The regeneration dynamics of many tropical forests in former agricultural landscapes depend strongly on processes of fauna-mediated plant dispersal, because most rainforest trees bear fleshy fruits which are dispersed primarily by birds and mammals. While plant-frugivore interactions have been extensively studied within remnant old growth forest, there has been little systematic research into the recovery of this ecological process after retirement of land from agriculture. Post-agricultural forest regeneration should be most effectively catalysed in situations where: (1) the landscape contains disperser species; (2) initial plant colonisers provide resources used by disperser species; (3) other habitat attributes of regenerating sites are sufficient to attract or support these dispersers; (4) there is an adequate source(s) of plant propagules within the dispersers' movement range; and (5) other constraints to regeneration (grass growth, fire, etc have been overcome). Regeneration patterns should be more finely shaped by the form of the interaction matrix between the plant species and disperser frugivore species coupled with the latter's species-specific sensitivities to habitat loss and fragmentation. For example, studies in remnant and regrowth forests have demonstrated a differential sensitivity of larger frugivores that may compromise the recruitment of larger-seeded plant species for which they are the main dispersers. Conversely, novel ecosystems with fleshy-fruited invasive tree species are facilitated by habitat-generalist frugivores. We present data from four different landscape-scale observational experiments within mixed agricultural/rainforest regions in the eastern Australian tropics and subtropics. These processes are explored through measurements of the diversity and abundance of birds and plants in replicate sites in old-growth forest, regrowth and different types of replanted forest, together with information on bird diets and functional traits.

### **V-37-4: Experimental Evidence that Dispersal Limits Succession in Tropical Secondary Forest**

Amy E. Rogers<sup>1</sup>, Jonathan L. Levine<sup>2</sup>, Lisa M. Vogler<sup>1</sup>, Thomas B. Smith,<sup>1</sup>; *1. Center for Tropical Research, UCLA, 2. University of California, Santa Barbara*

Limiting ecological processes in the succession of tropical secondary forests have been widely theorized but are rarely empirically tested. An understanding of how these processes may shape the divergent compositional trajectories commonly observed in different secondary forests (variations in 'subsets' of mature forest taxa) is critical to reforestation design, as it forms the basis for counteracting natural limits to the restoration of diversity. Using a fully-crossed factorial experiment, we tested the effects of mature forest proximity, seed availability, understory competition, and predator access on patterns of seedling recruitment over ~2.5 annual cycles in a 15 year-old secondary forest of the Ecuadorian Chocó. Stage-specific dynamics from seed to seedling were further elucidated using several auxiliary methods. We found that constraints to mature forest species recruitment operated almost exclusively at the seed stage via dispersal limitations and predation pressures, while understory competition and source population proximity were not limiting factors. Seed addition benefits, stronger than the limiting influence of predation, generated highly significant increases in both the stem and species density of mature forest seedlings. We suggest that recruitment niches in secondary forest are largely unoccupied, and that mature forest taxa are well-adapted to fill them provided that they arrive.

### V-37-5: What are Secondary Forests Made of? The Composition of Successional Specialists and Generalists in Neotropical Forests

Robin L. Chazdon<sup>1</sup>, Susan G. Letcher<sup>2</sup>, Natalia Norden<sup>1</sup>, Anne Chao<sup>1</sup>, Shang-Yi Lin; *1. University of Connecticut, 2. Organization for Tropical Studies*

We assessed the ecological affinities of tree species composing tree, sapling, and seedling assemblages in second-growth and old-growth forests in the Caribbean lowlands of NE Costa Rica. Using a multinomial model based on relative abundance data and an extensive landscape-level survey of trees  $\geq 10$  cm in 18.3 ha of old-growth (OG) and 11.3 ha of second-growth (SG) forests, we classified 359 tree species into six groups based on their degree of forest specialization: (1) generalists; (2) OG specialists; (3) SG specialists; (4) exclusive to OG; (5) exclusive to SG; and (6) too rare to classify. We then compared the relative abundance of generalist and specialists in three vegetation size classes in SG and OG forests. Thirty species of trees  $\geq 10$  cm were classified as second-growth (SG) specialists, and 8 species were exclusive to SG. These 38 species contributed, on average, 56% of the trees  $> 10$  cm in second-growth forests of NE Costa Rica. On average, 34% of the trees in SG forests (54 species) were classified as successional generalists, with similar relative abundance in SG and OG forests. Less than 2% of the trees in young secondary forests ( $< 15$  yr old) were species classified as OG specialists, but this percentage increased substantially in SG plots  $> 30$  yr old. Generalist tree species contributed 53% of the saplings in young SG, with OG specialists contributing only 9%. The contribution of OG specialist tree species in the sapling pool increased to 40% in intermediate SG. A similar pattern was observed in the composition of the tree seedling pool. Sapling and seedling assemblages in secondary forests are dominated by generalist tree species, with increasing relative abundance of OG specialists with increasing forest age.

### V-37-6: Whole Forest Leaf Biomass and Leaf Area in Old- and Second-growth Tropical Lowland Papua New Guinea

Rebecca A. Montgomery, Timothy Whitfeld, Vojtech Novotny, George D. Weiblen; *University of Minnesota*

Structural complexity of forests plays an important role in forest function contributing to resource variation, habitat diversity, and species interactions (e.g. food web structure). We explored horizontal and vertical structure of secondary and old-growth forest in the tropical lowlands of Papua New Guinea by harvesting all vegetation in 1 ha plots. In addition to traditional stem analysis (height, dbh, crown depth and width), we weighed fresh leaf biomass and estimated leaf area for each tree  $> 5$  cm dbh, for plants  $< 2$  m in height (understory) and for plants  $> 2$  m in height but  $< 5$  cm dbh (low-story). The latter (under- and low-story) were bulk sampled in 20 x 20 m plots. Standing leaf biomass was separated by age (mature, young). Mature and young leaf biomass of the understory layer did not differ with forest age (average mature understory = 1,647 kg ha<sup>-1</sup>; young understory = 9.55 kg/ha). Young leaf biomass in low-story did not differ with forest age but was twice as high as young understory biomass (average = 21.4 kg/ha). In contrast, there was more than twice the biomass of mature leaves in the low-story of the secondary forest (2,843 kg/ha) compared to old growth (1,155 kg/ha). We found reverse trends for young and mature leaf biomass in trees. Old-growth had nearly twice the mature leaf biomass compared to secondary forest (12,013 kg/ha vs. 6,474 kg/ha), with a per tree average of 234 kg vs. 133 kg. Second-growth had more young leaf biomass (227 kg ha<sup>-1</sup>) than old-growth (151 kg/ha), with a per tree average of 5.9 vs. 4.5 kg. Difference in the distribution of leaf area and standing levels of young versus mature leaves may influence herbivore interactions and food web structure in these forests. In addition, overall differences in structure and biomass also influence forest carbon storage.

### V-37-7: Tree Diversity, Composition, Forest Structure and aboveground Biomass Dynamics after Single and Repeated Fire in a Bornean Rain Forest

J.W. Ferry Slik<sup>1</sup>, Caroline Bernard<sup>2</sup>, Marloes van Beek<sup>1</sup>, Floris Breman<sup>1</sup>, Karl Eichhorn; *1. Xishuangbanna Tropical Botanical Garden, China, 2. Nationaal Herbarium Nederland, Netherlands*

Forest fires remain a devastating phenomenon in the tropics that not only affect forest structure and biodiversity, but also contribute significantly to atmospheric CO<sub>2</sub>. Fire used to be extremely rare in tropical forests, leaving ample time for forests to regenerate to pre-fire conditions. In recent decades, however, tropical forest fires occur more frequently and at larger spatial scales than they used to. We studied forest structure, tree species diversity, tree species composition, and aboveground biomass during the first seven years since fire in unburned, once burned and twice burned forest of eastern Borneo to determine the rate of recovery of these forests. We paid special attention to changes in the tree species composition during burned forest regeneration because we expect the long term recovery of aboveground biomass and ecosystem functions in burned forests to largely depend on the successful regeneration of the pre-fire, heavy wooded, species composition. We found that forest structure (canopy openness, leaf area index, herb cover, and stem density) is strongly affected by fire but shows quick recovery. However, species composition shows no or limited recovery and aboveground biomass, which is greatly reduced by fire, continues to be low or decline up to seven years after fire. Consequently, large amounts of the carbon released to the atmosphere by fire will not be recaptured by the burned forest ecosystem in the near future. We also observed that repeated fire, with an inter-fire interval of 15 years, does not necessarily lead to a huge deterioration in the regeneration potential of tropical forest. We conclude that burned forests are valuable and should be conserved and that long term monitoring programs in secondary forests are necessary to determine their recovery rates, especially in relation to aboveground biomass accumulation.

#### **V-37-9: Effects of Forest Regeneration and Climate Variability on Freshwater Quality and Flow in a Tropical Landscape**

Maria Uriarte, Charles Yackulic, Elizabeth Lim; *Ecology, Evolution, Env. Biology, Columbia University*

Watershed ecosystem services such as water provision are essential for most societies so there is a pressing need to understand the ecological and social processes that can safeguard these services. Puerto Rico is a densely populated island with little history of land use planning. Socioeconomic changes in the island during the past 50 years have resulted in dynamic landscape transformation, including dramatic increases in forest and urban cover. It is unclear whether and how the pattern and scale of land use change have affected water delivery in the island. Using USGS water quality and flow data from dozens of stations throughout the island together with detailed precipitation data, and land cover maps, we link climate variability and changes in land use/cover from 1977 through 2001 to water quality and quantity. In general, turbidity increased with discharge and decreased with percent of forest in the watershed. Concentrations of nutrients were greater in watersheds with urban and pasture cover in the stream buffer relative to those with forested buffers. The presence of fecal coliforms was also positively associated with pastures and urban development. These findings suggest that the reforestation that often accompanies agricultural abandonment and economic development can improve water provision but only if urban development is managed to do so.

#### **V-37-10: Time to Recovery of Ecosystem Services in Secondary Forests: Patterns and Unknowns**

Rebecca Ostertag<sup>1</sup>, Erika Marin-Spiotta, Nathan Swenson, Jimena Forero Montana; *1. University of Hawaii at Hilo*

Tropical secondary forests have the potential to provide important ecosystem goods and services, including carbon sequestration, habitat for biodiversity, soil nutrient conservation, erosion protection, timber and non-timber forest products. While a large body of chronosequence work has now been developed on how secondary forest structure changes with stand age during succession, very few studies have examined ecosystem services using this approach. Secondary succession is particularly

complex due to interactions between two processes that are changing simultaneously: species replacement and alterations of abiotic conditions. The study of functional traits and functional diversity during succession has been proposed as a way to link species to ecosystem functions. However, numerous challenges remain with this approach due to an incomplete understanding of the feedback of variables such as phenotypic plasticity and growth and reproduction rates on ecosystem processes. This talk will examine ecological processes related to secondary forest ecosystem function, particularly biomass accumulation and nutrient cycling, using data from the literature and an 80-yr successional chronosequence in Puerto Rico. Although we see an increase in species richness and a concomitant increase in functional trait diversity with reforestation, measured ecosystem functions (aboveground C accumulation, litterfall rates, and litter decomposition) did not differ during succession. These results suggest that secondary forest function may recover much faster than species composition, often in the first few decades of succession. The implication of these trends for secondary forest management and restoration will be discussed, as will future research needs.

## **The future of rainforests in a changing landscape and climate (#39)**

**(July 20 am + 20 pm; Wantilan middle)**

Organized by: **Rory P. D. Walsh and Glen Reynolds**

*This symposium focuses on the future of rainforests in the contexts of both a rapidly changing landscape and climate. The goals of the symposium are to demonstrate (1) how current rainforest science can tackle the new challenges and issues posed by the rainforests of the future being found increasingly as embedded patches within agricultural landscapes, and (2) how studies can provide the science to underpin the practice of forest rehabilitation and restoration and the design and targeting of conservational strategies.*

*Although the focus is on findings from projects within the Royal Society SEARRP, the symposium also includes invited papers drawing upon findings from elsewhere in the tropics. Four principal themes are covered by sections of the full-day symposium. The first theme focuses on the influence which different land-uses (forest and non-forest) have on carbon dioxide, reactive trace gas emissions and particulates. The second theme focuses on the impacts which logging, different land uses, forest fragmentation and forest restoration techniques have on ecosystems and their functioning. The third theme encompasses the influence which climatic change (past, present and future) and land-use change have on the rainforest and its hydrological and erosional systems. The final theme examines the use of scientific findings in conservation and forest management in the SE Asia region.*

### **V-39-1: Effects of Land use on Trace Gas Emissions and Deposition in Borneo**

David Fowler, Eiko Nemitz, Pawel Misztal, Chiara Di Marco, James Rider, Carole Helfter, Neil Cape, Sue Owen, M Coyle, Gavin Phillips, Nick Hewitt, Brian Davison, Ben Langford, Jennifer Muller, Jambery Siong; *CEH*

Interactions between forests and the atmosphere create the potential for efficient surface–atmosphere exchange of heat, momentum and mass. However, in the case of mass, the chemical form exerts a controlling influence and, in general, many factors in addition to the rates of turbulent exchange influence the emission and deposition fluxes. In particular the species composition and structure of the canopy profoundly influence emissions of volatile organic compounds. In this paper recent measurements of emission fluxes of volatile organic compounds (VOC) and deposition of ozone over a rain forest and over oil palm plantation in the same region of Sabah in Borneo allow the effects of land use on these fluxes to be characterised. Emissions of VOCs over the two contrasting canopies showed very different fluxes of isoprene, a reactive VOC which has the potential to create substantial quantities of ozone through photochemical reactions in the presence of oxides of nitrogen. Emissions of isoprene over the oil palm canopy represented 80 % of the VOC emissions and exceeded those over

the rain forest in similar light and temperature condition by on average a factor of 5. Isoprene emissions over the rain forest also dominated VOC emissions, again representing 80% of the VOC flux, with monoterpenes accounting for 18% of the remainder. Some compounds emitted by oil palm appear entirely unique to this surface relative to rain forest. Substantial emissions of estragole (1-allyl-4-methoxybenzene) from the oil palm plantation were detected whereas no trace of this VOC was detected in or above the rainforest. It is clear therefore that unique chemical signatures of land use may be generated by land use changes. Ozone deposition to the rainforest represents an important sink for boundary layer ozone, and draws down the ambient ozone mixing ratios to very small values as the air is advected over the forest.

### **V-39-2: The Atmospheric Chemistry of Trace Gases and Particulate Matter Emitted by Different Land Uses in Borneo**

A. Robert MacKenzie, the OP3-Danum-08 team; *1. Lancaster University*

We report early results from the OP3-Danum-08 field campaign, which took place between April and July 2008, in Sabah, Malaysian Borneo. The OP3-Danum-08 consortium consists of eight research groups from the UK, with Malaysian, Italian, US and other collaborators. OP3 objectives are to better understand how emissions of reactive trace gases from tropical land surfaces affect local, regional and global scale atmospheric composition, chemistry and climate. Ground-based measurements were made at the Bukit Atur Global Atmospheric Watch station in the Danum Valley forest conservation area. Measurements using the FAAM BAe146 were made over northern Borneo at typical altitudes of ~150, 1500, 3000 and 6000 m above ground, over rainforest and extensive areas of agro-industrialised oil palm landscape. Measurements of fluxes of trace gases and particles to and from the forest canopy were made, coupled with ground, tower and aircraft-based atmospheric composition measurements and complementary modelling activities. We believe the coupled ground-based and aircraft chemistry measurements to be the most comprehensive accomplished to date by the UK atmospheric composition community. Early results point to, amongst other things, subtle atmospheric responses to land-use change in the region and deficiencies in our understanding of isoprene and OH chemistry over both landscapes.

### **V-39-3: Integrating the Effects of Tropical Land Use on Atmospheric Composition and Chemistry at Regional and Global Scales**

John A. Pyle, the OP3 team; *1. University of Cambridge*

An important aim of the OP3 (Oxidant and Particle Photochemical Processes above a South-East Asian tropical rain forest) project was to relate the local measurements of emission and transformation of chemical species made in 2008 at the Danum Valley field site in Sabah, and in aircraft flights over Sabah, to chemical and meteorological processes at the regional and larger scales. In this paper we will first examine how well chemical schemes, appropriate in their complexity for inclusion in global atmospheric models, can reproduce local observations. Case studies of data from Danum Valley and from the aircraft are presented. Comparison with local composition measurements is challenging, made more difficult by uncertainty surrounding local emissions, but generally the model behaviour is, at least, adequate. We will then use our global models to address a number of important issues. How might changes in biogenic emissions, associated with land use change (or climate change), impact local air quality and regional oxidizing capacity? We will focus on isoprene emissions, contrasting low emissions from agricultural land, with moderate emissions from the rain forest and high emissions from palm oil plantations.

### **V-39-4: Sampling and Studying Ants in the High Canopy of a Tropical Rainforest**

Kalsum M. Yusah, Tom M. Fayle, William A. Foster; *Dept of Zoology, University of Cambridge*

Although research in the past few decades has established that the rainforest canopy harbors an exceptionally rich diversity of arthropods, we still know very little about the ecology of these important animals. This is principally because it is difficult to sample and study animals that live so high above the ground. We report here on methods that we have developed for studying ants, the dominant arthropod taxon, in the canopy of the dipterocarp forest of the Danum Valley Conservation Area in Sabah, Malaysia. We show that methods that work well on the ground need to be significantly modified before they can be applied in the challenging conditions of the high canopy.

The most flexible method of accessing tree crowns is to use double-rope (rope access) techniques. It is also essential that the scientist becomes competent in using branch-walking techniques such that they are able to move freely and make direct observations in all parts of the canopy. For efficient sampling of canopy ants, fogging is a useful general method, but needs to be modified by raising the fogging trays high into the tree-crown. This is necessary in order to produce a focused sample with little loss of crown ant species or contamination by ants from lower in the canopy. Traditional baits work well in the canopy, but in order to efficiently collect ants at baits away from the main trunk it is necessary to use a modified trap that can be closed without the disturbance caused by walking on the branch supporting the trap. We show in detail how this purse-string trap works. Baited pitfall traps can also be used in the canopy but are quite poor at collecting ants. For observing ant behavior, we used video cameras, which both reduces disturbance and maximizes the possible observation period.

We present quantitative data on the effectiveness of these different sampling methods, and show that a combination of baiting and fogging captures approximately 90% of the ant species in the crowns of emergent trees.

#### **V-39-5: Impacts of Logging on Density Dependent Predation of Dipterocarp Seeds in a Southeast Asian Rainforest**

Robert Bagchi<sup>1</sup>, Chris Philipson<sup>2</sup>, Eleanor Slade<sup>1</sup>, Andy Hector<sup>1</sup>, Sam Phillips, Jerome Villeneuve, Owen T. Lewis, Reuben Nilus, Adzley Madran, Julie D. Scholes, Malcolm C. Press; *1. Durham University, 2. University of Zurich*

Tropical forests are being heavily exploited worldwide and logging of Southeast Asian forests has been particularly intense. Unexploited forest is scarce in the region, but large expanses of selectively logged forest remain within logging concessions. Can the tree diversity in these forests recover? Key to answering this question is determining whether the processes involved in maintaining species coexistence in tropical forests (such as the Janzen-Connell mechanism) are affected by this kind of disturbance. Studies in Neotropical forests suggest that some forms of human-caused disturbance can disrupt the Janzen-Connell mechanism, but similar data are unavailable for Southeast Asian rain forests. We examined the impact of conspecific density and distance from parent trees on seed and seedling survival of *Parashorea malaanonan* in logged and unlogged forest round Danum Valley, Sabah, Malaysia. Seed production was higher in unlogged forest, perhaps because high densities of adult trees allowed greater pollination success or satiated predispersal seed predators. Manipulative experiments and observational data collected over two months in both forest types suggest that post-dispersal survival was reduced by conspecific density, but not proximity to parent trees. The magnitude of the negative density dependence was similar in logged and unlogged forest. While average survival did not differ between forest types, the variation between parent trees was much higher in the unlogged forest. Thus nearly all the recruits at the end of the study period were in unlogged forest, although these were concentrated around a small number of parent trees. These results suggest that the Janzen-Connell mechanism might not be affected by logging as practised around Danum Valley, but recruitment of *P. malaanonan* might be reduced due to poor seed crops.

#### **V-39-6: Managing Forest for Multiple Ecosystem Services: Impacts of Logging on Biodiversity and Carbon in a Tropical Lowland Dipterocarp Rainforest**

Philippe Saner<sup>1</sup>, Yen Loh<sup>2</sup>, Robert C. Ong<sup>1</sup>, Andy Hector<sup>1</sup>; *1. Evolutionary Biology and Environmental Studies, 2. School of International Tropical Forestry*

REDD (Reduced Emissions from Avoided Deforestation and Degradation) aims to be simultaneously beneficial to both carbon storage and biodiversity. We examined how biodiversity and carbon storage are related in areas of primary and logged secondary lowland tropical rainforest of Sabah (Malaysian North Borneo). We found that the extraction of desirable timber species of the dipterocarp family led to substantial reductions of carbon rich canopy trees and altered the stand composition so that pioneer trees, with lower wood density, occupied the basal area that was previously dominated by dipterocarps. We compared a new carbon budget for 30 year old logged forest with previous estimates for primary forest. Six major carbon pools contributed to the total stores of 237.2 Mg C ha<sup>-1</sup>  $35 \pm 8.4$  (SD): Above-ground tree biomass (57%), above-ground non-tree biomass (2%), below-ground roots (10%), forest floor litter (<1%), deadwood (6%) and soil (25%). Indicators of nutrient and carbon turnover rates (dead standing wood, fine roots and litterfall) were not noticeably degraded in secondary logged forest. Our results show that tree functional diversity related to carbon storage remained degraded even after 30 years of recovery following logging and therefore the potential for rehabilitative measures to increase their carbon storage. We conclude that if the aim is a win-win scenario for biodiversity and carbon then it is critical to consider not just overall taxonomic diversity but also the functional aspects of tree diversity that are related to carbon storage.

#### **V-39-7: Are Highly Degraded Rainforests Worth Protecting?**

David P. Edwards, Paul Woodcock, Keith C. Hamer, Rob J. Newton, Simon H. Bottrell, Abdul H. Ahmad, Chey Vu Khen; *University of Leeds*

Southeast Asia is a hotspot of imperiled biodiversity, due to extensive logging and forest conversion to agriculture, especially oil palm. The degraded forests that remain after repeated rounds of intensive logging are often assumed to have little value for conservation by governments and some NGOs, and consequently, there has been no concerted effort to prevent them from being turned into oil palm. However, no study has quantified the biodiversity of repeatedly-logged forests. We investigate the biodiversity value of these forests using birds, dung beetles, and ants, which are key indicator taxonomic groups. We find that in even the most intensively logged sites, which have undergone two rotations of logging, species richness and diversity is maintained at unlogged levels. Furthermore, whilst there are shifts in species composition following forest degradation, in the case of birds, a large proportion of IUCN-listed species are still present within the repeatedly-logged rainforest. Remarkably, over 75% of species found in unlogged forest persisted within twice-logged forests, and although these forests have less biological value than primary forests, they provide important habitat for numerous species. Preventing degraded forests from being converted to oil palm and other crops should be a priority of policy makers and conservationists.

#### **V-39-8: Ecological Impacts of Tropical Forest Fragmentation: Are Remnants Worth Conserving?**

Jane K. Hill<sup>1</sup>, Keith Hamer<sup>2</sup>, Suzan Benedick<sup>1</sup>, Chey Vun Khen<sup>1</sup>; *1. University of York, 2. University of Leeds*

Large areas of tropical forest are increasingly being fragmented and isolated within inhospitable agricultural and urban landscapes. This is particularly true of Borneo where many natural forest fragments are surrounded by oil palm plantations. We will present data to show that large fragments can support levels of species diversity (focussing specifically on insects), although the most range-restricted species of highest conservation concern often disappear from fragments. We will discuss the degree to which fragments can support high levels of genetic diversity, and the time periods over which genetic erosion effects might become evident. Our paper will draw attention to the role that fragments have in maintaining regional diversity. We will focus on Sabah, and discuss which remaining forest remnants are crucial for promoting regional landscape connectivity. We will also

present findings showing where reforestation/forest rehabilitation might be most effective for enhancing habitat connectivity.

### **V-39-9: Spillover Effects Across Rainforest-Oil Palm Ecotones: Responses of Two Contrasting Insect Groups in Sabah, Malaysia**

Jennifer M. Lucey, Jane K. Hill; *University of York*

Across the tropics, biodiversity is threatened by conversion of natural forest habitat to agriculture. In Malaysia, rapid growth of the oil palm industry has resulted in the loss and fragmentation of hyperdiverse lowland rainforest. Within this agricultural mosaic, habitat “edges” are becoming an increasingly common feature and act as important mediators of species movement and dispersal across the landscape. Insects perform vital roles in ecosystem processes, therefore understanding the response of these taxa to man-made ecotones can give valuable insight into aspects of ecosystem functioning as well as direct impacts on biodiversity. From an agricultural perspective, nearby forest could provide a source of beneficial insects, while from a conservation perspective, the extent of plantation permeability could have important implications for improving habitat connectivity. Here I compare the responses of two insect groups; ants and butterflies, to the forest-plantation ecotone. I show that butterflies demonstrate a clear spillover effect, with the forest affecting plantation diversity over distances of several hundred metres. By contrast, the response of ants at the ecotone is far more abrupt with little evidence that the forest affects diversity of ants in oil palm. I conclude that while broad similarities maybe drawn, such as an overall decrease in diversity in oil palm, the differences between taxa in response to the forest-oil palm ecotone may be striking.

### **V-39-10: The Role of Habitat Complexity in Maintaining Arthropod Diversity and Ecosystem Function in the Emerging Agricultural Landscapes of South East Asia**

William A. Foster<sup>1</sup>, Gavin R. Broad<sup>2</sup>, Arthur Y.C. Chung<sup>1</sup>, Timothy D. Cockerill<sup>1</sup>, Paul Eggleton, M.D.Farnon Ellwood, Tom M.Fayle, Jake L.Snaddon, Edgar C.Turner, Chey Vun Khen, Kalsum M.Yusah; *1. University of Cambridge, 2. The Natural History Museum*

The expansion and intensification of agriculture is the major current threat to tropical rainforests. It is vital therefore that we understand how the conversion of rainforest to an agricultural landscape affects biodiversity and the services provided by biodiversity in these new managed ecosystems. But we have exceptionally little reliable information on the nature and extent of these changes in biodiversity and about how these changes might affect the functioning of the agricultural ecosystem. Oil palm plantations are our model system. Oil palm provides food for millions of people and is grown in precisely those areas where much of the world's remaining biodiversity is located. We will provide a rigorous account of what is known about arthropod diversity in oil-palm landscapes. Based on work conducted at Danum Valley and in oil palm plantations in Sabah, Malaysia, we will discuss the nature of the major drivers of this change in biodiversity: these will include both microclimatic and biotic factors. We will examine what the effects of changes in biodiversity might be on ecosystem services. We will suggest how the management of the complexity of the habitat (e.g. epiphytes and understorey vegetation) and the landscape (e.g. by maintenance of forest fragments) might encourage arthropod biodiversity and the maintenance of ecosystem functions (e.g. pest control and decomposition) within the oil-palm ecosystem. We aim to show that the development of rational policies relating to the management of the oil palm landscape requires detailed scientific understanding of how ecosystems function both when intact and when suffering from changes in species richness and abundance.

### **V-39-11: SAFE: The Stability of Altered Forest Ecosystems Project**

Robert M. Ewers, Glen Reynolds, Edgar Turner; *Imperial College London*

Opportunities to conduct whole-ecosystem experiments are rare, but provide a unique prospect to reveal the complex processes and interactions that operate within natural ecosystems. Here, we



present the design for the Stability of Altered Forest Ecosystems (SAFE) Project, a new forest fragmentation experiment to be located in the lowland tropical forests of Borneo (Sabah, Malaysia). SAFE represents an advance on existing experiments in that it: (1) allows for independent tests of the effects of landscape forest cover patch-level processes at multiple spatial scales; (2) is designed to facilitate the unification of data collected on ecological patterns and processes that operate over a wide range of spatial scales; (3) has greater replication than existing experiments; and (4) embeds the experimentally fragmented landscape within a wider gradient of land use intensity than existing projects. It mimics the real-world progression of land use change from (i) old growth forest, to (ii) logged forest, to (iii) logged and experimentally fragmented forest, and finally to (iv) intensive agriculture in the form of oil palm plantation. Within this experiment, our interdisciplinary science programme is tracking changes to biodiversity (invertebrates, birds and mammals), carbon dynamics, hydrology, microclimate, and earth-atmosphere linkages. The SAFE Project represents an opportunity for ecologists across disciplines to participate in a large initiative designed to generate a broad understanding of the ecological and biological impacts of tropical forest modification.

### **V-39-12: Tropical Trees as Archives of Environmental Change: Recent Developments and Future Potential of Rainforest Dendroclimatology**

N.J. Loader, Walsh, R.P.D., McCarroll, D., Robertson, I., Gagen, M.H., Bidin, K., Newberry, D.M., Grudd, H., Ong, R.C.; *Swansea University*

A diverse and powerful range of analytical techniques has been developed within the discipline of dendrochronology for the study of tree response to environmental change. The potential for applying such methods to tropical tree species is significant, but scientific and practical challenges relating to the development of robust chronology and the characterisation of signal preservation need to be addressed before the advances made in temperate regions can be applied to trees growing in the tropics. These challenges are reviewed in relation to recent studies and progress made in the development of new approaches in Tropical dendroecology.

### **V-39-13: Rainforest Hydrological and Erosional Systems and Their Long-term Responses to Forest Disturbance and Climatic Change**

Rory P.D. Walsh<sup>1</sup>, William H. Blake<sup>2</sup>, Kawi Bidin<sup>1</sup>, Nick Chappell<sup>1</sup>, Michelle A. Clarke, Ian Douglas, Rosmadi Ghazali, Aimee Sayer, Kogila V. Annammala; *1. Swansea University, 2. Plymouth University*

This paper explores the long-term impacts of actual and predicted future climatic and land-use change on erosion and hydrology within the large Segama river catchment in Sabah, Malaysian Borneo. The upper part of the catchment has been rotationally selectively logged since the 1970s and the lower section has been mainly converted to oil palm plantation. A dual approach is adopted: (1) analysis of instrumented nested catchment records from the mid-1980s to date and (2) analysis of current bed-sediment and lateral bench and floodplain deposits of the main river and its principal tributaries using isotope dating and multi-proxy sediment fingerprinting. The complex recovery of a small catchment since selective logging in 1989 is explored via analysis of streamflow, sediment and solute behaviour in storm events and slope erosion records and comparison a primary forest control catchment. At a larger scale, changes in the relative contributions of tributary catchments to downstream sediment transport (in floodplain cores) from pre-logging times are explored. In the upper catchment, massive differences in sedimentation rate responses to three distinct phases of upstream logging are linked to differences in steepness of terrain being logged. Impacts of current and predicted future climatic change are then explored. Since 1998 there has been a rise in annual rainfall of 16 % and increased frequency of large rainstorms - features also predicted by IPCC 2007. If sustained, the consequence is likely to be a landsliding phase in steeper terrain areas, leading to increased downstream flooding, sedimentation and channel shifting. Landslide frequency data derived from aerial photographic and

satellite imagery evidence demonstrate that these impacts can be greatly reduced if (1) slopes greater than 25° are protected by adherence to Reduced Impact Logging protocols in natural forest management and (2) conversion to plantation is confined to lower slope terrain.

### **V-39-14: Balancing Conservation, Protection and Production in a Changing Landscape and Climate: Applying Science to Land-use Management Policy and Practice**

Ruth E. Nussbaum<sup>1</sup>, Tom Maddox<sup>2</sup>, Sophie Persey<sup>1</sup>; 1. ProForest, 2. ZSL

There is an intense debate about the benefits and challenges of forest and plantation production systems within the rainforest landscapes of SE Asia. Production of timber, pulp, palm oil and other products is an essential source of income and development opportunities, but at the same time the conversion of natural rainforest landscapes to managed forest or exotic plantations has impacts on biodiversity, ecosystem services and the climate. Developing land-use policies and implementing practices which combine production with conservation and protection is essential to future sustainability, and science has a crucial role to play in informing both the policy debate and the development of practical solutions on the ground. This paper summarises progress made to date and highlights outstanding issues.

## **Frontiers in marine conservation planning (#40)**

**(July 22 pm; Wantilan rear)**

Organized by: **Carissa Klein and Hugh Possingham**

*Systematic conservation planning identifies configurations of complementary areas that achieve explicit, quantitative objectives. Since its origin in the early 1980s, the field has influenced conservation decisions and policy around the world. For example, systematic conservation planning methods and tools were used to inform the rezoning of the Great Barrier Reef Marine Park.*

*Most approaches to solving complex problems start simply and evolve; systematic conservation planning is no exception. The approach was originally used for simple problems, that is, to identify potential new reserves that meet a set of conservation targets for minimum expenditure. It is continually evolving to address complex and more realistic factors better, such as considering multiple actions, species persistence requirements, threats, spatial connectivity, and socioeconomics.*

*The increasing influence of systematic methods on conservation spending and actions underlines the importance and urgency of further advances. The aim of our symposium is to highlight new ideas and techniques in the field with a focus on marine ecosystems. Marine conservation has captured the interest of regional, national, and international agencies and, as a result, many initiatives are being established to protect marine biodiversity (e.g., Coral Triangle Initiative, Australia's Environmental Protection and Biodiversity Conservation Act, World Commission on Protected Areas).*

*We will discuss theoretical advances in marine systematic conservation planning and feature applications of these ideas to on-the-ground conservation decisions, including case-studies from the Coral Triangle (i.e. East Timor, Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands). We will focus on three main topics:*

*1) Integrated land and sea planning: Marine ecosystems are threatened by local-scale human activities (e.g. over-fishing, deforestation) whose reduction may help increase the resilience of marine ecosystems to global threats such as climate change (e.g. warming water and ocean acidification). Both land- and sea-based human activities are threatening marine ecosystems, thus conservation strategies should address both.*

2) *Zoning inclusive of socioeconomic factors: A major challenge in mitigating threats to biodiversity are primarily socioeconomic in origin. As such, successful marine planning processes involve stakeholders and consider socioeconomic information to select conservation areas.*

3) *Incorporating ecosystem dynamics: Most marine conservation plans are concerned with biodiversity pattern – that is, the elements of biodiversity that can be mapped and regarded as static. Planners have done less well at promoting the persistence of dynamic ecological and evolutionary processes that maintain and generate biodiversity.*

#### **V-40-1: New Directions for Marine Planning in the Coral Triangle: Patch Dynamics, Connectivity, Catchment Management, and Applying Local-scale Actions**

Bob Pressey, Glenn Almany, Jorge Alvarez-Romero, Natalie Ban, Debora de Freitas, Vera Horigue, Johnathan Kool, Morena Mills, Rebecca Weeks; *James Cook University*

Marine conservation planning in the Coral Triangle is faced with challenges that are both particular to the region and common to all regions around the world. Among the common challenges are the need to extend spatial planning for biodiversity beyond representation of pattern (e.g. marine habitats, maps of species distributions) to regulate or promote the persistence of coastal and offshore processes of interest. We describe research to address three kinds of processes. We refer to the first group of processes as “patch dynamics”: spatio-temporal dynamics of disturbances such as coral bleaching or resources such as pelagic productivity and outline our research on planning for patch-related objectives in the region. The second sets of processes are broadly defined as “connectivity”. We describe modelling of connectivity for the whole Coral Triangle and work being planned at local and regional scales that links modelling to empirical field data. The third area of research on processes concerns integrated planning for coastal catchments and near-shore marine waters, considering multiple objectives for catchment managers and the need for marine planning to respond to threats from catchments that cannot be abated. Our work also addresses socio-economic aspects of marine conservation in the Coral Triangle. A particular challenge in this region is the need to move effectively from regional-scale conservation designs to local-scale conservation actions in the context of customary tenure, high dependence on marine resources, and devolved responsibility for management. We describe work directed at better understanding the mismatches of scale and information between regional and local perspectives and ways of better connecting “top-down” and “bottom-up” initiatives.

#### **V-40-3: Prioritizing Investments to Protect Coral Triangle Reefs**

Carissa J. Klein<sup>1</sup>, Natalie C. Ban<sup>2</sup>, Ben Halpern<sup>1</sup>, Maria Beger<sup>1</sup>, Edward T. Game, Hedley Grantham, Alison Green, Travis Klein, Stuart Kininmonth, Eric Treml, Kerrie Wilson and Hugh P. Possingham; *1. University of Queensland, 2. James Cook University*

Coral reefs have exceptional biodiversity, support the livelihoods of millions of people, and are threatened by multiple human activities on land and in the sea. We develop a prioritization approach to guide regional-scale conservation investment in marine and land-based conservation actions that mitigate threats to coral reefs and apply it to the Coral Triangle, an area of significant global attention and funding. Although marine conservation almost always trumps terrestrial conservation within any ecoregion, terrestrial conservation in one ecoregion can be a better investment than marine conservation in another. We show how these results could inform the allocation of a limited budget for coral reef conservation in the Coral Triangle.

#### **V-40-4: Balancing the Interests of Individual Fishing Communities and Biodiversity Conservation in the Zoning of a Marine Protected Area Network**

Hedley S. Grantham<sup>1</sup>, Vera Agostini<sup>2</sup>, Joanne Wilson<sup>1</sup>, Sangeeta Mungubhai<sup>1</sup>, Mike Beck, Hugh Possingham, Nur Hidayat, Andreas Muljadi, Muhajir; *1. University of Queensland, 2. The Nature Conservancy*

Marine protected areas have been implemented around the world but many are proving unsuccessful because they ignore the needs of local communities. Raja Ampat in Indonesia is one of the most biodiverse marine regions in the world. Expanding fisheries, tourism and oil and gas extraction could have negative impacts on the regions biodiversity. Given the cocktail of remarkable biodiversity, increasing threats and reliance on marine resources by local communities, zoning the network of existing marine protected areas demands a balance between competing human-uses and biodiversity conservation. We developed a decision support system and zoning approach that enables stakeholders to explore different zoning configurations that achieve multiple objectives for conservation, local community fisheries and other human-uses. We present the results of this project and demonstrate techniques for exploring trade-offs between conflicting objectives and how to incorporate feedback from conservation practitioners and stakeholders in an adaptive cyclical fashion.

#### **V-40-5: Coral Reef Conservation Planning with Connectivity in the Coral Triangle**

Maria Beger, Matthew Watts, Eric Treml, Hugh P. Possingham; *The University of Queensland*

Connectivity is a crucial process underpinning the persistence of coral reefs. Yet, contemporary conservation planning and reserve design theory and practice has been largely incapable to deal systematically (i.e. spatially explicit, repeatable, and mathematically sound) with connectivity. This talk explores a new method incorporating connectivity into the systematic design of conservation area networks. First, we present the newly developed capability of the decision support system MARXAN to incorporate connectivity, and demonstrate the improvement of potential reserve networks with connectivity above reserve systems without for a Great Barrier Reef case study. A remaining challenge for connectivity in conservation is its likely changeability for species with different life history traits. Using the coral triangle region as a case study, we explore the implications of integrating multiple connectivity characteristics into reserve networks.

#### **V-40-6: Mapping the Resilience of Coral Reefs to Climate Change**

Peter J. Mumby; *School of Biological Sciences, University of Queensland*

Recent progress modelling the dynamics of coral reefs now allows their resilience to be mapped across entire seascapes. Here, resilience is defined as the probability that a reef avoids shifting towards a stable, coral-depleted state. Mapping resilience begins by creating a spatially-explicit model of the ecosystem and giving it the flexibility to represent different physical environments. For example, a model was created for the dominant reef habitat of the Caribbean, the *Montastraea* reef. The effects of physical wave exposure on macroalgal dynamics were included and enable the model to be parameterised for different locations around a reef system. The equilibrium dynamics of the model are then explored in the absence of acute disturbance regimes. This allows critical thresholds of the ecosystem to be identified for each physical environment. If such thresholds are exceeded then the reef is attracted to a coral-depleted stable state, which is highly undesirable from the perspective of biodiversity and ecosystem services. To determine resilience, the model is initialised with the current ecological state of each reef and then subjected to a spatially and temporally-realistic disturbance regime that includes hurricanes and coral bleaching. Repeated stochastic simulations enable a probability to be calculated for the risk that the reef will be pushed beyond thresholds and towards a coral-depleted state. The approach has the advantage in that it integrates many available datasets and provides a single metric of resilience that is directly relevant to management. Further, the approach can be used to identify the relative rewards of different conservation actions. For example, the approach can be used to identify areas that benefit the most from marine reserve designation.

### **V-40-8: An Overview of Spatial Prioritization of Coral Reef Conservation Actions**

Hugh P. Possingham; *The Ecology Centre, University of Queensland*

For most of twenty years traditional systematic conservation planning focussed on one very simple problem – conserve a representative sample of the mappable biodiversity features of a region for the minimum cost (where area was invariably used as a surrogate for cost). In the past decade there have been rapid advances in both theory and tools for conservation planning – especially in marine systems. Indeed, the application of systematic conservation planning tools, like Marxan, in marine systems has emerged as one of the most high impact and influential applications of conservation science. In this paper I will briefly review some of the recent advances in marine conservation planning that enable us to deal with complexities such as: complex assessments of opportunity costs, connectivity (including asymmetric connectivity), land-sea interactions, catastrophes and patch dynamics, and multiple use marine zoning. The issue of marine zoning, placing any parcel of sea into one of many kinds of zones, raises new opportunities and challenges that will take much of the next decade to resolve. Furthermore, new prioritisation tools are emerging that allow more broad-scale strategic allocation of conservation effort in dynamic systems. Suffice it to say – now that systematic conservation planning tools and principles are being widely applied in marine sectors progress will be rapid. Probably the greatest remaining challenge is the wise integration of social and economic values into these prioritisation tools. Despite an apparent dearth of ecological data – good socio-economic data is even harder to obtain and wisely use in prioritisation. Ultimately the success of marine prioritisation will rely on building relationships between the people that need to set priorities and the scientists, mathematicians and social scientists who can help them.

### **Small-scale fisheries and the tragedy of the commons revisited (#42)**

**(July 20 am; Wantilan front)**

Organized by: **Suseno Sukoyono and Elvira C. Ablaza**

*Unlimited entry to common property resources constitutes a huge challenge to resource conservation and sustainable development. As different interest groups have their respective perspectives, which are likely to be biased and self-serving, it is important to seek a common understanding of why there is a need for resource conservation, protection, and management, and when limited (rather than common) access to the resources needs to be enforced. Due to gaps between science/knowledge, governance, and policy making, the common property resource (CPR) regime has long been a stumbling block to the development of basic trust and harmony, which are essential to the avoidance of conflicts and which are vital prerequisites to successful conservation and sustainable development.*

*Through this Symposium, a holistic understanding of common property resources will be sought to improve the crucial links between science and policy, leading to coastal community welfare based on the attainment of a consensus as to when limited access to common property resources should be implemented.*

*The Symposium will aim to foster multidisciplinary reflection, assessment, and dialogue on the management of common property resources as a tool for fisheries conservation and sustainable development in the tropics. More specifically, the Symposium will (i) explore array of interlinked among various disciplines of ecology, economics, and social sciences, as they apply to the empirical perspectives of small- scale fisheries; and (ii) assess the policy implications of various strategies in different geographic locations.*

### **V-42-1: Transplantation of Soft Coral Sarcophyton sp and Nephthea sp at Badul Island, Ujung Kulon**

Lily Surayya Eka Putri, F. Fahrudin, P. Sukandar; *State Islamic University*

Coral transplantation had been conducted to soft coral *Sarcophyton* sp. dan *Nephthea* sp. using rack and substrate method at Badul Island, Ujung Kulon. The research aimed at comparing survival rate and growth rate by both transplanted soft corals. It was found that both soft coral had 100% survival rate, but *Nephthea* sp grew faster than *Sarcophyton* sp. *Nephthea* sp had 11,33 mm of width growth and 15,16 mm of length growth. For *Sarcophyton* sp showed less width and length growth, that was 9,76 mm and 7,37 mm. Therefore it can be concluded that *Nephthea* sp tend to vertically growth while *Sarcophyton* sp tend to grow horizontally. Keywords: soft coral transplantation, survival rate, growth rate, *Sarcophyton* sp., *Nephthea* sp

#### **V-42-2: Estimation of Fish Abundance in a Seagrass Marine Protected area in Central Philippines Using Delta-Type Two-Steps Model**

Erwin O. Brunio; *Tokyo University of Marine Science and Technology*

Fish abundance estimates serve as a useful indicator on the status of the fishery and hence is important for fisheries management. To understand the status of parrotfish, we investigated its abundance in Jagoliao, central Philippines from underwater visual census data. However, data from underwater visual census are typically highly skewed and contains many zeroes. The objective of this paper is to estimate abundance of parrotfishes in Jagoliao using Delta-Type Two-Step model which take into account the zero-inflated characteristics of the data. Our result shows that the presence of parrotfish is a function of season and period of MPA implementation; different from those that affects its non-zero abundance which was a function of the site covariate. Given similar season and period, the over-all mean abundance of parrotfishes in Jagoliao was similar in both the reserve and non-reserve sites. Our estimates suggest that the number of fish per 250 square meters ranges from a low of 2.41 (95% CI: 0.89 – 7.22) in the current reserve site before the MPA was implemented in the wet season, to a high of 36.48 (95% CI: 18.78 - 69.18) in the non-reserve site during the implementation of MPA in the dry season.

#### **V-42-3: The Distribution of Captured Freshwater and Marine Crustacea in Bali, Indonesia**

Pande G. Sasmita, A.A.G. Raka Dalem; *Udayana University*

Some studies show that Indonesia's capture fisheries are either full or over-exploited. However the capture fisheries sector still expected to contribute to the increase of Indonesia's total fisheries production. Crustacea is one of favourite Indonesia's capture fisheries, especially in Bali. In this province, crustacea requirements is important as seafood material for culinary tourism purposes. Due to its important value, the concern about crustacea sustainability is increased. In order to reveal the distribution of capture crustacea in Bali, a series of these data were collected from several location around Bali from 2001 - 2008. The capture production was distinguish by marine capture, inland openwater capture and lake capture. Two parameters of distribution pattern were selected, namely by spesies and by regency. Result of data analysis showed that there were 12 common spesies obtained as marine crustacea capture dominated by Rock Lobster (*Panulirus homarus* L.), 3 spesies inland openwater crustacea capture dominated by common freshwater shrimp (*Macrobrachium lanchesteri* de Man), and 2 spesies lake crustacea capture dominated by other common freshwater shrimp (*Macrobrachium* sp.). The highest volume of marine crustacea were captured in Tabanan regency, while highest volume of inland openwater crustacea were captured in Gianyar regency and the highest volume of lake crustacea were captured in Bangli regency. This information may be useful for Bali's capture fishery management and we conclude that Bali has a potential for production development of capture crustacea contributing the increase of Indonesia's capture fisheries sector.

#### **V-42-4: Succeeded in Larva Rearing of Coral Trout *Plectropomus leopardus* as Supporting its Conservation**

Regina Melianawati Sudjono, Ketut Suwirya, Retno Andamari; *Research Institute of Mariculture*

Coral trout, *Plectropomus leopardus* is known as one of grouper high economically value. The fish culture has been started to prevent it's over exploitation and to conserve its existence in nature. Rearing larvae of coral trout has been succeeded in research institute of mariculture since 2005 by using 8000 L tank. A larvae rearing period until juvenile stage is forty days in average. The live feeds are used including rotifers, artemia and mysid. Rotifers is given started at day two, while artemia and mysid are given at about days seventeen and twenty four, respectively. Artificial micro diet started to give at about day ten. The amount and kinds of feeds that was given was depend on the condition and growth rate of larvae itself. Some innovations were done to improve larval growth and its survival rate, i.e. additional of boiled chicken yolk, giving different kinds of live feeds, live feeds enrichment, using pure oxygen and probiotic. Total length and specific growth rate of 7 days old larvae that fed combination between 3-4 g boiled chicken yolk emulsion and rotifers were bigger ( $2.75 \pm 0.12$  mm and 3.44%) than those fed rotifers only ( $2.69 \pm 0.27$  mm and 3.17%). The survival rate of larvae with addition of wild copepods was higher (1.19%) than using rotifers only. 10 days old larvae fed enriched rotifers with 0.2 g HUFA during 3 hours indicated better and faster growth,  $3.33 \pm 0.33$  mm in total length. Survival rate of 37 days old larvae by adding oxygen + probiotic (9.80%) was higher than those of by adding oxygen (3.51%) and probiotic (0.58%) only. The results indicated that survival rate of larvae has been increased from 2005 until 2009. Succeeded in larvae rearing of coral trout can decrease the fishing activity of this species, on the other words, this rearing can support its conservation in wild. Key words: conservation, coral trout, larvae rearing

#### **V-42-5: Estimation of Coral Fish Abundance Using the Combination of Field Survey Data and Satellite Imagery in the Shallow Water Coral Reef of Karang Lebar**

Vincentius P. Siregar, Sutrisno Sukimin, Sam Wouthuyzen, Sriati, Andriani, Samsul Bahri, M. Banda Selamat; *Seameo Biotrop*

As one of the shallow water ecosystem, coral reef has specific function in terms of its association with fish community. Ecologically, the function is as the shelter and habitat for fish. Thus, the abundance of coral fish depends on the coral reef condition. One important issue of the coral reef management is how to estimate fastly the abundance of coral fish. A conventional method to estimate the abundance of coral fish in the area is by visual fish census method in the field. This method is limited by access to the coral reef ecosystem and time consuming. This paper deals with the propose of method to use the high resolution satellite imagery combined with field survey data to estimate the abundance of coral fish in the coral reef ecosystem. The satellite data is classified using several schemes of classification of coral reef, and the scheme which has high correlation with the number of coral fish, then will be used to map the coral reef ecosystem providing coral fish abundance. Number of fish at each label of the classification provided is derived from visual fish census. The result of this then was applied to the other coral reef of the surrounding area which not covered by the field survey. The result of this study showed that the approach proposed to estimate the coral fish is promising

#### **V-42-6: Small-scale Fisheries; Capacity Building of the Panglima Laot**

Crispen Wilson, Suseno Sukoyono; *Ministry of Marine Affairs and Fisheries*

When the tsunami hit Banda Aceh, it killed 186,000 people; among those were many senior fishermen. One of the consequences of so many lives lost was that much of the fishing knowledge in the area was also lost, e.g. the location of navigational hazards, underwater sea mounts, fish location, and how to navigate. To help the fishermen regain this knowledge the Department of Fisheries (Ministry of Marine Affairs and Fisheries) and Syiah Kuala University partnered with the 400 year old traditional fishing authority, the Panglima Laot. The term "Panglima Laot" is both the name of the traditional fishermen's association as well as the title of the elder fishermen who is elected to lead them. His responsibilities include assigning fishing resources, arbitrating disputes, communicating changes in fishing regulations, organizing rescues as well as just maintaining general order. Captains

under the authority of the Panglima Laot, installed sounders fitted with global position systems (GPS) on 63 artisanal fishing boats. This equipment was then configured to automatically record location, depth and sea surface temperature every time a boat moved thirty meters. Data was collected from these boats along with catch data every few days. Over the next nine months, the fishermen recorded over eight million data points, and with assistance from Aceh Geospatial Data Centre, created maps identifying hazards, fishing grounds, EEZ boundaries and ocean currents. These waterproofed maps were then distributed back to the fishermen in a format they could easily understand and use. We show how, with simple operational techniques, community-based bathymetric mapping was successfully implemented by the stakeholders. Furthermore, that involving the traditional authorities from the beginning ensured a strong sense of ownership of the project and activities aimed at building their capacity to manage the project led to the program continuing after the project's completion.

#### **V-42-7: Small-scale Fisheries: a Challenge in Management**

Purwito Martosubroto; *National Committee on Fish Stock Assessment, Indonesia*

Important role of fisheries sector in food security in Indonesia is reflected by its contribution to protein intake to its population. In certain area the sector contributes up to 50%, in particular in some coastal communities where fish is the main protein intake in their daily food. Development of fisheries, in many instances, has resulted in increased pressure on coastal resources where small-scale fisheries depend.

Management of small-scale fisheries in archipelagic state where coastal communities spread in large number of small islands poses a challenge. Collection of data and information in coastal communities where landing facilities are not adequate causes constraints, and in turn it will also become hindrance in fish stock assessment. Devolution of management authority to local level through Governance Law 32/2004 does not necessarily improve the management and thus the well being of small-scale fishers.

Growth in fisheries sector as reflected by industrialization of fisheries in general put more pressure to the small-scale sector, especially when open access regime is still in place. Tragedy of the common has taken place in some areas, as a result small-scale fishers become poorer and poorer. In the absence of limited entry policy, subsidy will only temporarily benefit small-scale fisheries as new comers will put more pressure to the resources.

#### **V-42-8: Livelihood Strategies and Vulnerabilities in the Bajo Community of Wuring Laut, Flores Island, Nusa Tenggara Timor (NTT), Eastern Indonesia**

Frances Every; *Charles Darwin University*

Small scale coastal fishing communities throughout the developing world face increasing challenges to their livelihoods and food security. These stem from a range of influences including increasing population pressure in coastal areas as well as competition for, and scarcity of, marine resources. These communities also face a range of vulnerabilities related to climate change and exposure to natural disasters, particularly earthquakes and tsunamis. In Indonesia the open access approach to marine resources and the movement of highly mobile marine based cultures such as the Butonese, Bugis and Bajo of eastern Indonesia create and exacerbate local (and global) pressures on both marine resources and fishing communities. As these pressures increase so does dependence on the marine environment for livelihoods and food security. This paper will examine some current challenges to livelihoods and Bajo community well-being in the hamlet of Wuring Laut, a fishing community located in the regency of Sikka, eastern Flores in the province of NTT, among the poorest and least developed in Indonesia. It considers two important livelihood strategies (i) Purse Seine (artisanal small pelagic fish operations) and the circulation of marine produce from these operations and (ii) line fishing for Yellow Fin Tuna (*Thunnus albacares*) – a small scale industry both supplying the export market and having an important role in the local subsistence economy. The preliminary results of this



research indicate that for many households in Wuring Laut the future is uncertain in terms of economic and food security. Uneven distribution of benefits from marine pursuits, combined with a range of internal and external vulnerabilities perpetuate a cycle of resource dependence which includes unsustainable fishing methods and may inhibit livelihood diversification.

## Mutualism in a changing climate (#45)

(July 23 am; Wantilan wing)

Organized by: **Rhett D Harrison and Martine Hossaert-McKey**

*The release of greenhouse gases and the consequent changes in global temperature and rainfall distributions is changing tropical environments. In Amazonia, different authors have recorded directional changes in plant species composition, which they attribute to CO<sub>2</sub> fertilisation. In SE Asia the severity and frequency of El Niño-associated droughts appear to be increasing, and these have been associated with widespread fires, changes in plant composition, and local extinction of mutualists. Meanwhile, on tropical mountains, increased temperature has led to elevational shifts and extinction of species.*

*The aim of this symposium is to examine the consequences of these changes for mutualistic interactions. Climate change may affect the outcome of mutualistic interactions, through compositional changes in the partners involved or through other changes in the biotic environment, including the composition of competitors or organisms 'parasitic' on the mutualism. Moreover, the degree to which mutualistic interactions are affected will depend on levels of redundancy and evolutionary plasticity. Talks are invited on topics pertaining to the direct effects of climate change on mutualistic interactions or on their functional consequences.*

### **V-45-1: Phylogenetic Conservatism in Floral Odours Functioning as Pollinator-attractant Signals: A Case Study of Ficus / Agaonidae mutualisms**

Catherine Soler<sup>1</sup>, Nadir Alvarez<sup>2</sup>, Magali Proffit<sup>1</sup>, Jean-Marie Bessiere<sup>1</sup>, Bertrand Schatz, Martine Hossaert-McKey; 1. CEFÉ-CNRS, 2. Université Lausanne

Mutualisms are interspecies interactions in which each participant gains net benefits from interacting with its partner. The webs of interdependencies created by mutualisms play key roles in the maintenance of biodiversity and the functioning of ecosystems. Like many other interspecies interactions, mutualisms are mediated by chemical signals. Understanding how mutualisms function, and how they might evolve, depends on deciphering the chemical information transmitted between mutualists, for example, those that guide one partner to the resources offered by the other in exchange for services. Most studies on chemical mediation between plants and pollinators stress the impact on the message of selection by pollinators. Nevertheless, constraints on the message emission might also be important. We studied whether phylogenetic history constrains the composition of plant chemical signals that mediate interactions with pollinators, i.e., we tested whether the evolution of floral scents exhibits phylogenetic conservatism. We studied the chemicals that mediate a group of interactions which has become a model system for understanding the evolution of mutualisms: the interactions between figs (ca. 800 species of *Ficus*, found throughout the tropics) and their species-specific pollinating fig wasps. In this 'nursery pollination mutualism', the pollinators can breed only in receptive figs of their host tree, which depends in turn on the wasp as its sole pollinator. Encounter of the pollinator and the receptive fig is mediated by specific chemical signals. We used headspace adsorption/resorption methods to collect scents of several fig species in tropical forests from different tropical regions, and analyzed the composition of their volatile compounds using gas chromatography/mass spectrometry (GC-MS). We then built different chemograms, using both qualitative and quantitative traits of the bouquets of compounds, and compared them with phylogenies.

**V-45-2: Dietary Differences among Nectar-feeding Bats in a Lowland Forest in French Guiana**Cullen K. Geiselman; *Columbia University*

I studied the dietary differences among three glossophagine species (*Anoura geoffroyi*, *Lionycteris spurrelli*, *Lonchophylla thomasi*) coexisting in the lowland primary rainforest near the Nouragues research station in French Guiana. Over the course of one year I collected 325 fecal samples from 536 individuals captured in mist nets at dawn as they returned to their day roosts. Based on the pollen found in their feces, I identified 14 plant species from 7 families in the bats' diets. All three bat species showed evidence of feeding on insects and visiting flowers throughout the year, though the dominant life form of plants visited changed seasonally with epiphytes and lianas predominating in the wet and canopy trees in the dry season. Overall *A. geoffroyi* and *L. spurrelli*, the glossophagines commonly captured at the site, visited 12 species each, with ten in common, though the proportions in which these ten were visited differed between the two bat species. For example, *A. geoffroyi* had significantly higher proportions of samples with pollen from *Eperua rubiginosa*, *Marcgravia coriacea*, *Souroubea guianensis*, and *Psittacanthus acinarius*, while *L. spurrelli* had significantly higher proportions with pollen from *Caryocar glabrum* and *Bauhinia outimouta*. The results of a canonical discriminant analysis and a logistic regression analysis confirmed that *A. geoffroyi* and *L. spurrelli* had distinct diets. In some cases, their differences could be attributed to a lack of fit between flower and pollinator, such as the case of the smaller *L. spurrelli* being excluded from the flowers of *P. acinarius*. However, neither flower morphology nor energetics can explain why the two bat species differed significantly in their visitation to accessible flowers with large nectar rewards. I propose that repetitive interactions with certain flowers may illicit flower constancy in nectar-feeding bats.

**V-45-4: Microclimatic Conditions along Forest Edges Drive Changes in Biological Interactions and Phytotelm Communities in Tank-bromeliads**Celine Leroy<sup>1</sup>, Laurent Pelozuelo<sup>2</sup>, Jean-François Carrias<sup>1</sup>, Bruno Corbara<sup>1</sup>, Alain Dejean; Regis Cereghino; *1. CNRS, 2. Université Paul Sabatier*

Habitat fragmentation in rainforests leads to an increase in artificial forest edges, and microclimatic alterations provide a context in which to address the influence of greater light availability, temperature extremes, and moisture stress upon biological communities. *Aechmea mertensii* is a dominant tank-bromeliad found along man-made forest edges in French Guiana, where it only occurs in arboreal antgardens (AGs) initiated either by the ants *Camponotus femoratus* or *Pachycondyla goeldii*. Many specialized aquatic organisms (from prokaryotes to small vertebrates) complete their development in tank-bromeliads, as their leaves form wells that collect rainwater and leaf litter. We hypothesized that AGs bearing tank-bromeliads significantly increase habitat and food resources for opportunistic species. The prevalence of mosquito larvae, in particular, was examined. As dispersal agents, *P. goeldii* and *C. femoratus* influenced the shape and size of the bromeliad by determining the location of the seedling, from exposed (*P. goeldii* AGs) to shaded areas (*C. femoratus* AGs). The mean volumes of water, organic matter and detritus in *C. femoratus*-associated bromeliads were 3 to 5 times higher than in *P. goeldii*-associated bromeliads. Moreover, the highest invertebrate density and diversity were found in *C. femoratus*-associated bromeliads. For tank-bromeliads and their aquatic communities, the outcome of the ant-plant interaction is spatially conditioned, and the environment-dependant outcome in the mutualism is clearly linked to the ant partner. More importantly, we found that the density of mosquitoes hosted by tank-bromeliads was 2-3 times higher in *C. femoratus*-associated bromeliads, compared to other bromeliad species from primary forest. The creation of artificial forest edges has led to a juxtaposition of contrasting environments. The consequences were a lower plant species diversity, and a quantitative increase in the invertebrate communities in tank-forming bromeliads.

#### **V-45-5: Tritrophic Interactions in a Changing Climate: Potential Impact on Phoretic Nematodes in the Fig/fig Wasp Mutualism**

Renee M. Borges, Anusha Krishnan, Subhashini Muralidharan, Likhesh Sharma; *Indian Institute of Science*

Ephemeral, patchy or unpredictable habitats coupled with low vagility of the passenger select for the evolution of a passenger–vehicle relationship wherein passengers must be able to efficiently locate their phoretic vehicles for transmission. The ancient, co-evolved and highly species-specific nursery pollination mutualism between figs and fig wasps is host to species-specific plant-parasitic nematodes which use fig wasps to travel between figs. Since individual globular fig inflorescences, i.e. syconia, serve as incubators for hundreds of developing pollinating and parasitic wasps, a dispersal-stage nematode within such a chemically complex and physically crowded environment is faced with the dilemma of choosing the right vehicle for dispersal into a new fig. Such a system therefore affords excellent opportunities to investigate mechanisms that contribute to the evolution of specificity between the passenger and the vehicle, and their possible perturbations by climatic change. In this study of the chemical ecology of fig–wasp–nematode tritrophic interactions, we demonstrate using two-choice as well as cafeteria assays that plant-parasitic nematodes do not hitch rides randomly on available eclosing wasps within the fig syconium, but are specifically attracted, at close range to the right vector, i.e. the female pollinating wasp. How changes in temperature and carbon dioxide levels may perturb a system with such great specificity will be discussed.

#### **V-45-6: Host Traits Differentially Affect Plant-Herbivore and Plant-Pathogen Interactions in a Tropical Dry Forest Plant**

Braulio Santos, Julieta Benitez-Malvido; *CIECO, UNAM*

The interaction of plants with their natural enemies shapes the ecology and evolution of tropical communities, but few studies have evaluated how host traits may affect plant-herbivore and plant-pathogen interactions in tropical dry forests. We assessed the effect of leaf age, host height and phenology on the incidence and severity of damage by insects and pathogenic fungi on the woody perennial grass *Lasiacis ruscifolia*, in the dry forest of Chamela, Mexico. We also tested the hypothesis that herbivores facilitate leaf infection by pathogens. On average, culms presented half and a sixth of their leaves attacked by herbivores and pathogens, respectively. Herbivores damaged three times more leaf area than did pathogens (3.5% vs. 1.3%), but the low values of severity indicate high plant resistance against predators. Leaf age explained between 56% and 89% of the variation in herbivore attack, with old leaves being more attacked, while host height and phenology did not affect herbivore attack. Conversely, leaf age was a poor predictor of pathogen attack while host height and phenology explained a third of the variation, with smaller and fruiting culms being the most susceptible. Leaves damaged concurrently by herbivores and pathogens accounted for only 9.8% of the leaves and the relationship between herbivore and pathogen attack was not significant, suggesting that insects do not facilitate leaf infection in *Lasiacis*. The possible mechanisms underlying each of these findings are discussed.

#### **V-45-7: Asian Tapirs are no Elephants when it Comes to Seed Dispersal**

Ahimsa Campos-Arceiz<sup>1</sup>, Carl Traeholt<sup>2</sup>, Razak Jaffar<sup>1</sup>, Luis Santamaria<sup>1</sup>, Richard T. Corlett; *1. National University of Singapore, 2. Malay Tapir Conservation Project*

The loss of the largest herbivores (elephants and rhinoceroses) from many forests in Tropical East Asia disrupts important ecosystem processes like seed dispersal. We studied the capacity of Malayan tapirs *Tapirus indicus* -- the next largest non-ruminant herbivore in the region -- to disperse the seeds of nine (seven native and two exotic) megafaunal dispersal-syndrome plants (i.e. believed to depend on megafauna for their dispersal). We combined information from feeding trials, a germination test, and field telemetry to assess the effect of tapir consumption on seed viability and estimate the spatial scale at which tapirs disperse them. The tapirs (N = 7) swallowed few seeds (mean = 361; range = 2 -

2328 seeds per plant species). Seed survival was moderately high for small-seeded plants (36.9 % [N = 385 seeds] for *Dillenia indica* and 41.5 % [N = 2328] for *Carica papaya*) but very low for medium- (e.g. 7.6% [N = 224] for *Tamarindus indica*) and large-seeded (e.g. 2.8 % [N = 72 seeds] for *Artocarpus integer*) plants. Mean seed retention times were long (e.g. 87 h for *Garcinia mangostana* [N = 11] and 183 h for *Tamarindus indica* [N = 17]). In the germination test, only small seeds (< 1 cm) germinated. Using movement data from three wild tapirs in Krau Wildlife Reserve (Peninsular Malaysia) we estimated mean dispersal distances of 755 m (range = 12 - 3332) and 846 m (range = 12 - 3332) for *C. papaya* and *D. indica*, respectively. Malayan tapirs effectively disperse plants with small seeds over long distances but act as seed predators for the large-seeded plants included in our study and, therefore, cannot replace the role of larger herbivores in seed dispersal. In the absence of elephants and rhinos many megafaunal-syndrome plants in Tropical East Asia are expected to face severe dispersal limitation problems.

#### **V-45-8: Mutualisms in Changing Climates: Community Ficus Dispersal and Recruitment in Northern Australia**

Britta Denise Hardesty, Matt Bradford, David Westcott; *CSIRO*

Mutualisms play an important role in forest structure and community dynamics, particularly in tropical systems. Dispersal services provided by frugivores underlie plant species distributions multiple scales and figs are considered keystone resources for animal consumers at local, landscape and continental scales. How dispersal services may shift with changes in climate is an important consideration, particularly at species distribution edges and under extreme events. We assess community-wide dispersal and recruitment for *Ficus* species to infer dispersal services of frugivores and recruitment patterns and timing of fig reproduction and germination in an intact forest community across two years within a 25 ha Forest Dynamics Plot. Our interest was in assessing similarities and differences in dispersal patterns and recruitment for co-occurring fig species with different densities, microsite associations and fruiting patterns. Of twelve fig species arrived in traps, only seven species occur as reproductive adults within the study site. Fig germination shows two peaks which corresponds with optimal environmental conditions provided by seasonal rainfall and temperatures in the region. Overall, several of the fig species are well dispersed, with four species arriving in > 80% of seed traps during the two years of study. We discuss implications of our findings in light of mutualisms, community structure and potential climate change impacts on forest dynamics through space and time.

#### **V-45-9: Obligate Mutualisms, Genetic Co-structuring and Climatic Change**

Martine Hossaert-McKey, Finn Kjellberg, Noppol Kobmoo, Anthony Bain, Doyle Mckey; *1. Centre D'ecologie Fonctionnelle et Evolutive, UMR*

Species associated in obligate mutualisms may be expected to share the same history of population expansion and regression, reflected by similar structuring into populations. However, this prediction may be simplistic. Partners in obligate mutualisms generally present highly contrasted sizes, generation times and dispersal capacities. Therefore their populations may respond quite differently to climatic changes. Studies after a hurricane in Florida and a prolonged El Niño-induced drought in Borneo documented a history of regional disappearance of fig-pollinating wasps, survival of the host *Ficus* trees, and wasp recolonization a few months later. Hence despite strong interdependence, population histories at a regional scale may be quite different because contrasted generation times allow one partner to wait for the other's return. Does such a process result in strikingly different population structuring? Analysis of co-structuring between *Ficus racemosa* and its pollinating wasp showed that they present the same structuring into biogeographic genetic units. Frequent long-distance dispersal of wasps has led to genetically homogeneous populations of both *Ficus* and wasps. This association may be resilient to climatic change because dispersing wasps efficiently recolonize their more resilient habitat (= hosts). Another system, the association between an ant-plant (*Leonardoxa africana*), its mutualistic ant (*Petalomyrmex phylax*) and a parasitic ant (*Catantop*)

mckeyi), presents a low-dispersal situation. Following a climate shift, the plant colonized habitats extremely slowly, in a stepping-stone process with repeated foundation events by few colonizers. Lack of ant dispersal between highly local populations suggests that the association is fragile. These two examples illustrate that mutualistic systems may present highly contrasted responses to climatic change. However, predictions can be made based on biological knowledge about the functioning of individual associations.

## **Tropical fungi: an under-explored biodiversity frontier (#48)**

**(July 22 pm; Garuda)**

Organized by: **Atik Retnowati, Brian Perry and Anne Pringle**

*The fungi are a megadiverse group of eukaryotic microbes and function as mutualists, parasites, and decomposers. Fungi may drive the diversity of other groups of organisms, including plants: an increase in the numbers of symbiotic mycorrhizal species may increase the local diversity of plants, and fungal pathogens may mediate the Janzen-Connell model. Introductions of novel fungal pathogens may devastate native species of plants or animals. Saprotrophic fungi are also critical to biogeochemical cycles, as fungi are the primary decomposers in terrestrial soils. Most work on fungi has focused on species of temperate latitudes, and there is comparatively little information about tropical fungi. The scarcity of data is such that even basic trends remain a mystery, for example, there are no data to support or refute a latitudinal gradient in fungal diversity. In fact, it seems clear that some fungal groups demonstrate a reverse gradient, and are more diverse in temperate latitudes. This symposium will focus attention on an important but poorly studied kingdom, with the aim of generating excitement about unanswered questions, and fostering a community focused on tropical fungi.*

### **V-48-1: Assessing the Factors that Structure Soil Fungal Communities in a Tropical Rain Forest**

Krista L. McGuire<sup>1</sup>, Kathleen K. Treseder<sup>2</sup>, Noah Fierer<sup>1</sup>, Benjamin L. Turner<sup>1</sup>; *1. Barnard College, Columbia University, 2. University of California, Irvine*

Shifting frequency and intensity of precipitation events is expected to impact soil fungi through a variety of complex feedbacks, although the general patterns and mechanisms are not fully understood. Precipitation and plant diversity often co-vary, and disentangling the relative contribution of each is important for predicting changes in global C and N fluxes. In order to test the relative contributions of plant diversity and precipitation in shaping fungal community structure and function, soil samples (0-10cm) from six established 1-ha plots across a natural precipitation gradient on the isthmus of Panama were collected. These plots co-vary in mean annual precipitation and plant diversity. Fungal DNA was sequenced using general fungal primers for the 18S region and 454 pyrosequencing. We found that total fungal taxa significantly increased with increasing mean annual precipitation, but not with plant diversity. Activity for some extracellular enzymes increased, whereas as others decreased with mean annual precipitation, indicating that the effect of shifting precipitation on nutrient transformations may be process-specific. To directly test for effects of plant species richness on fungal diversity and function, we experimentally re-created litter diversity gradients in nylon, 2 mm screen litter bags with 1, 25, and 50 species of plant leaf litter. After six months, we found a significant effect of plant litter diversity on decomposition rate, but only after the increase from one to 25 species of leaf litter. Total fungal taxa and extracellular enzyme activity did not track plant species richness, suggesting that precipitation may be a more important factor than plant diversity in structuring soil fungal communities in tropical rain forests.

### V-48-2: Arbuscular Mycorrhizal Fungal Diversity and Spatiality among Three Leguminous Tree Species in Tropical Forests of French Guiana

Francis Q. Brearley, David R. Elliott, Robin Sen; *Manchester Metropolitan University*

Arbuscular mycorrhizal fungi (AMF) are keystone mutualistic fungi associated with plant roots in all terrestrial environments. Our knowledge of factors influencing their diversity and spatial community structure is increasing but there is little knowledge of this group from tropical forests. We examined AMF molecular diversity in the roots and rhizosphere of three legume tree species: *Dicorynia guianensis*, *Eperua falcata* and *Tachigali (Sclerolobium) melinonii* from the long-established Nouragues research station in French Guiana using a community fingerprinting (PCR-SSU, DGGE and cloning) and DNA sequencing approach. In this talk we will provide answers to the following questions: (i) How many AMF taxa are found at this site with a high above-ground diversity? (ii) How does the host tree species influence the AMF community structure? and (iii) Is there a difference between the root and rhizosphere AMF communities, indicating the level at which any selectivity occurs? Our results add significantly to the literature on molecular diversity of AMF in lowland tropical rain forests.

### V-48-3: Guignardia/Phyllosticta Species from Northern Thailand

Nilam F. Wulandari, Chaiwat To-Anun, Pedro W. Crous, Kevin D. Hyde; *Fac. of Agriculture, Chiang Mai Univ, Thailand*

Guignardia and its anamorph Phyllosticta are cosmopolitan ascomycetes causing important plant disease. The objective of this research is to provide information concerning the presence of Guignardia species from several host plants in Northern Thailand. Twenty four plant diseases with Guignardia infection and three saprobes were collected. Seven species are common and 17 species are new records for Northern Thailand. *G.musae* and *P.musarum* (freckle disease from *Musa paradisiaca*), *P.cordilenophila* (leaf spot and leaf blight on *Cordyline* spp), *P. capitalensis* (leaf spot and leaf blight on *Vanda* sp), *P. atrocarpina* (leaf spot on *Arthocarpus heterophyllus*), *G.dioscorea* and *P.dioscorea* (frog-eye spot and leaf blight on *Dioscorea bulbifera* and *D.penthaphylla*), *P.citricarpa* (leaf spot on *Citrus maxima*), *P. arecae* (leaf spot on *Caryota* sp.) are common in Northern Thailand. *G.mangiferae* (leaf blight on *M. nanae*), *Guignardia* sp. (leaf blight on *Spatholobus suberectus*), *G.sterculiae* (leaf blight on *Sterculia monosterna*), *G.morindae*-*P.morinda* (frog-eye spot on *Morinda citrifolia*), *P.dieffenbanchiae* (leaf blight on *Aglaonema* sp), *P.tinosporae* sp.nov. (leaf spot on *Tinospora craspa*), *P.nephrolepicola* sp.nov. (leaf spot on *Nephrolepis exaltata*), *P.pandanicola* sp. nov. (leaf blight on *Pandanus amaryllifolia*), *P.dracontomelonicola* sp. nov. (leaf spot on *Dracontomelon mangiferae*), *P.shoreae* sp.nov. (leaf blight on *Shorea* sp.), *P.thunbergiae* sp. nov. (leaf spot on *Thunbergia grandiflora*), *P.capitalensis* (leaf blight on *Dendrobium* sp.), *P.alpiniae* sp.nov. (leaf blight on *Alpinia purpurata*) as new record, *Phyllosticta* sp. (leaf blight on *Agavae* sp.) and *P.jasminicola* new record (leaf litter on *Jasminum* sp.), *P.samanea* a new record (leaf litter on *Samanea saman*), *P.cassiae* a new record (leaf litter on *Cassia agnes*) were also recorded in Northern Thailand. Morphology, micrographs for each species are provided. Key words: Guignardia, leaf blight, leaf spot, morphology, new record, new species, Phyllosticta, plant diseases.

### V-48-4: The Diversity of Fructicose Lichens in the Forest of Tahura R Soeryo, Batu, East Java

Miftahul Jannah, Dwi Anggorowati Rahayu, Devi Arifianti Mahadi, Ludmila Fitri Untari, D. Listyorini; *State University of Malang*

Lichen is an outstanding successful group of symbiotic organisms, which comprise the strand of algae partner (phycobiont) and fungal partner (mycobiont). According to the morphological forms, there are seven growth-forms of lichen, however, there are five common growth-forms, i.e.: foliose, fruticose, crustose, squamulose, and leprose. A taxonomic study of the fructicose lichens in the forest of Tahura R Soeryo had been conducted based on morphological, anatomical, and chemical characters. In this research involved a method of descriptive explorative and the aim of this research is to study the

diversity of fruticose lichens in the forest of Tahura R. Soeryo. Tahura R Soeryo is a natural forest located in Tulungrejo, Batu City, East Java. Its altitude is 1000-3000 m, the rainfall is about 2500-4500 mm per year, and the temperature is about 50C - 100C. This research was conducted from Desember – Januari 2010. Fifteen species of fruticose lichen is reported from the forest of Tahura R Soeryo. They are *Evernia prunastri*, *Ramalina calicaris*, *Teloschistes flavicans*, *Usnea esperantiana*, *U. strigosa*, *U. glabrescens*, *U. flammea*, *U. subfloridana*, *U. hirta*, *U. floridana* and *U. hirta*. The taxonomic, the current delimitation and description of the species; and the identification key to its species of the Tahura R Soeryo's foliose lichen are presented in the article. Key words: diversity, fruticose lichen, Forest of Tahura R. Soeryo

#### **V-48-5: The Diversity of Mushroom Genus *Marasmiellus* (Tricholomataceae) in Java and Bali Based on Morphological Data**

Atik Retnowati<sup>1</sup>, Indrawati Gandjar<sup>2</sup>, Mien A. Rifai<sup>1</sup>, Wellyzar Sjamsuridzal<sup>1</sup>; 1. *Herbarium Bogoriense, Indonesian Institute of Sciences*, 2. *Fac. Math and Science, University of Indonesia*

Until recently, only limited information on the mycota of Indonesia has been published. Over 500 species of Agaricales have been reported, mostly by foreign mycologists in 1844-1840. However, no report has been made on the diversity of genus *Marasmiellus* in Indonesia. Therefore this research focuses on obtaining data in order to fill the gap in understanding the diversity of Indonesian *Marasmiellus*. *Marasmiellus* is a cosmopolitan genus which has low variation in its characters. Many species are very important elements of the tropical and subtropical basidiomycete mycota, playing a significant ecological role in tropical forest. Most are saprophytic, degrading leafy or woody debris of monocotyledonous or dicotyledonous plants. A few species are parasitic and attack various economically important plants. Taxonomic study of Javanese and Balinese *Marasmiellus* species using morphological data has been carried out. Extensive fieldworks at a number of underexplored sites and at well known and historically important mycological collecting areas have been completed. Research sites of this study are in West Java (Bogor Botanical Garden, Cibodas Botanical Garden, Mt. Gede-Pangrango National Park, Mt. Halimun National Park, and artificial research area of Haurbentes), and East Java (Mt. Wilis). Collecting sites located in Bali include Ekakarya Botanical Garden, Mt. Pohen, Forest around Tamblingan Lake, and forest around Bratan Lake). Over 100 specimens have been collected and examined macro-microscopically, and the complete information on the number of described species of the Indonesian *Marasmiellus* will be presented along with habit, habitat, and their distribution. Keywords. Mycota, Agaricales, *Marasmiellus*, Java, Bali.

#### **V-48-6: Bioinduction Increased Agarwood (gaharu) Production of *Aquilaria* and *Gyrinops***

Maman Turjaman, Erdy Santoso, Ragil S.B. Irianto, Irnayuli R. Sitepu; *FORDA*

One tropical tree family currently a focus of international attention is Thymelaeaceae. This tree family is important as they provide agarwood (gaharu) for the forest community in South and Southeast Asia. Thymelaeaceae consists of 50 genera with *Aquilaria*, *Gyrinops*, *Aetoxylon*, *Enkleia*, *Gonystylus*, *Phaleria*, and *Wikstroemia* producing agarwood. Agarwood plays an important role in gaining foreign exchange and as a source of income for people living in around and inside the forest in Indonesia. However, at the mean time, its production has declined rapidly, due to lack of technology and limited dissemination of the bioinduction technology. If no serious action to be taken, agarwood production would not be sustained. As a consequence, pressure on the natural forest will increase significantly. Today *Aquilaria* and *Gyrinops* were placed on Appendix II of the Convention on the International Trade in Endangered Species (CITES) and considered to threaten according to the IUCN Red. Objective of the project is introducing bioinduction technology to forest communities living in and around on the forest area. Bioinduction of pathogen has been carried out intensively in forest area with specific purposes Carita, Banten and Kandungan District, South Kalimantan. For this purpose, four isolates that have shown efficient induction were used, namely isolate from Gorontalo, Jambi, Padang, and West Kalimantan. Additional induction was also conducted in Kotabaru (South Kalimantan), Jambi, Lombok (West Nusa Tenggara), Flores, Sanggau and Seram (Mollucca). Target

for tree induction is at least 500 trees. Agarwood products between 1, 2 and 3-year after bioinduction showed distinct differences by color and weight. Three year old induction has darker color and is heavier than that harvested from 1.2-year induction. Bioinduction of pathogen appears to be a promising way to increase the production of agarwood which are economically and ecologically important for forest community in Indonesia.

Key words : agarwood (gaharu), bioinduction, pathogen, Aquilaria, Gyrinops.

#### **V-48-7: Modification of Wood Characteristic of *Aquilaria crassna* by Application of Salicylic Acid in Comparison to *Acremonium* Inoculation**

Gayuh Rahayu; *Department of Biology, Faculty of Mathematics and Life Science*

The role of salicylic acid on the formation of resinous substance in agarwood tree (*Aquilaria crassna*) is not yet known, while *Acremonium* sp is known to induce resin formation. The indicator of the resin formation is the modification of the wood characteristic such as wood discoloration. This research was carried out to determine the role of salicylic acid on the modification of wood characteristic in term of discoloration and terpenoid accumulation, in comparison to those caused by *Acremonium*. The bark and cambial layers of branches of 8 years *A. crassna* tree were peeled off about 2 cm long, then either smeared with salicylic acid at 100mM (SA 100), 200mM (SA 200), 300mM (SA 300), 400mM (SA 400), 700mM (SA 700), or inoculated with *Acremonium* sp. The level of wood color intensity and the area of color formation, accumulation of terpenoid (histochemical and Lieberman-Burchard analyses) and fragrance level was observed at 10, 25 and 50 days after application (da). All treatments caused wood discoloration from white to brownish white, leaf chlorosis (SA 400 at 50 da and SA 700 at 10 da), wood brittleness until death of some branches (SA 700 at 25 da). Terpenoid was accumulated in parenchyma rays, included phloem, xylem vessel and pith of treated branches. For those treated with SA 700, terpenoid was found only in parenchyma rays and xylem vessel. Accumulation of lipid was found in parenchyma rays, included phloem and xylem vessel of all treated branches. Starch was accumulated in parenchyma rays and included phloem of all treated branches at 10 daa only. Sterol can be extracted from the treated wood. Salicylic acid cannot induce fragrance formation and in contrast to *Acremonium*.

## **Island biogeography and the Malay Archipelago: Krakatau and beyond (#51)**

**(July 23 am; Wantilan front)**

Organized by: **Christian H. Schulze, Damayanti Buchori, and Richard Field**

*The Malay Archipelago contains several globally important biodiversity hotspots and is characterized by a huge number of endemic species. It also represents an important transition zone between the Oriental and Australasian fauna and flora. It consists of thousands of islands, ranging from extremely big ones, such as Borneo and Sumatra, to many tiny islands. Since at least the time of Alfred Russel Wallace, this, the largest archipelago in the world, has been the focus of many important biogeographic studies. Examples include Wallace's seminal works on evolution by natural selection and on island life, MacArthur and Wilson's use of Krakatau data in developing their equilibrium theory of island biogeography, Diamond's assembly rules and Wilson's taxon cycle.*

*Given the conference's location right on Wallace's line, and the field trips to Krakatau and other highlights of this archipelago, this symposium focuses mainly on current research based on fieldwork in these islands, though some of the research involves tropical locations further afield. Because the islands of the Malay archipelago have tremendous biological value both in themselves and in informing theory and conservation more generally, issues addressed in the symposium relate to both conservation of the islands and development of biogeographic theory.*



*Topics to be covered include biogeographic and phylogeographic patterns in birds, moths and other volant animals in Krakatau, the Malay Archipelago and beyond; effects of island characteristics on habitat use and patterns of diversity and endemism; range dynamics in tropical mountains; effects of invasions on insular ant communities; and effects of plant and fruit morphology in the archipelago.*

### **V-51-1: Revisiting the Birds of Krakatau: it is Still Hard to Reject MacArthur and Wilson's theory**

Richard Field<sup>1</sup>, Albert B. Phillimore<sup>2</sup>, Olwen Williams<sup>1</sup>, Tukirin Partomihardjo<sup>1</sup>, Samuel Kemp; *1. University of Nottingham, 2. Imperial College*

The post-eruption colonization of Krakatau by birds was famously used by MacArthur and Wilson as evidence for their dynamic equilibrium theory of island biogeography (ETIB), and is prominent in subsequent discussion of island biogeography. We report a seventh post-1883 ornithological survey of Krakatau. We found 33 non-migratory, breeding land birds, one of which is new to the archipelago. Local knowledge and unconfirmed sightings suggested a further 12 breeding species might be present, of which seven would be new to the archipelago. Snapshot and cumulative species richness and turnover rates through time did not depart significantly from ETIB expectations, according to simulations of species colonization and extinction, assuming neutrality at the species level. From the simulations, the best estimates were for an eventual equilibrium of approximately 50 species, with a turnover rate of 0.20 species per year, to be reached around 2200 AD. Most feeding guilds showed an initially rapid increase in species richness, followed by a levelling off, though frugivores showed no such plateau (i.e. minimal extinction) and may be involved in positive feedback with plant succession. We conclude that it is difficult to reject ETIB for Krakatau's birds, with current evidence, though statistical inference is challenging.

### **V-51-2: Growth Form Diversity of the Krakatau Flora, a Long-running Natural Experiment**

Partomihardjo Tukirin; *Botanical Division, Res. Center for Biol.-LIPI*

An analysis of the growth form composition of the flora of the Krakatau Islands is given based on checklists published by Borssum Wallkers (1960), Tagawa et al (1982), Whittaker et al (1989), Partomihardjo (1995) and the most recent authors' field surveys. Special attention is given to the colonization stages of vegetation communities in relation to the succession assembly. Changes in vegetation communities on the Islands, during the last 125 years period provided a classical model of colonization pattern of a tropical rain forest. In various surveys between 1981 and 2008, 122 species of trees, 42 of shrubs, 71 of lianas and climbers and 173 species of herbs are recorded out of a total of 408 species or about 77 % of the total Krakatau's flora. The growth-form composition of the Krakatau Islands is discussed in the context of the prevailing present-day environmental condition. Characteristic features are the low percentages of primary species and even of the annual primary component, the high percentage of pioneer, the strong development of arborescence, the richness in broad leaf and the paucity of species. Growth form diversity of the islands is also compared with recent available data from surrounding islands Sebesi and Peucang that also known disturbed by 1883 eruption. Keywords : Succession, diversity, Krakatau Islands, pioneers, primary species, vegetation and island flora.

### **V-51-3: Does Fruit Morphology Affect the Ability of Vertebrate-dispersed Plants to Cross Wallace's Line? A Preliminary Biogeographic Analysis**

Ian R. McFadden

The Malay Archipelago contains both Asian and Australian zoogeographic regions, separated by Wallace's Line. However, it contains only one phytogeographic region as many families and genera occur across the whole of the Archipelago. While this is true for a significant portion of the flora, many of these genera are unevenly distributed across the two zoogeographic regions. This may be due

to the inability of certain guilds of vertebrate dispersers to cross the water barriers that make up Wallace's Line bearing plants specialized upon them. I will present patterns of distribution and data on fruit morphology for a set of focal plant genera thought to specialize on a range of vertebrate guilds in order to test this hypothesis. It is hoped that this work will partially illuminate the influence of plant-animal interactions on the biogeography and assembly of tropical forests in the Malay Archipelago.

#### **V-51-4: The Influence of Island Type in the Plant Diversity and Endemism of the Southern Pacific**

A. Jasmyn J. Lynch; *Regional Futures Research Theme, Centre for Environmental Management, School of Science and Engineering, University of Ballarat*

Macro-scale patterns of diversity and endemism across the southern Pacific confirm the general relationship evident in biodiversity hotspots, and that environmental and climatic stability and heterogeneity contribute to species diversity. However, they also indicate that island type is as important as island size and degree of isolation in determining patterns of plant richness and endemism. Highest plant species richness occurred in southern Pacific archipelagos on or near large continental and volcanic landmasses whereas plant endemism was highest on large continental islands or volcanic archipelagos that were isolated from source areas. The influence of substrate is evident in that island archipelagos that include continental and volcanic geologies tend to contain higher diversity than archipelagos of equivalent and even larger size and antiquity that include only atolls, low islands and raised coral islands. Along with low numbers of species, archipelagos of atolls, coral islands and low islands tend to have very low endemism. The autocorrelation between isolation, island type and island area in the southern Pacific has masked these relationships and led to a strong presumption that distance from source area was the key influence on diversity patterns in the region. In addition, the assumption that increased island size creates increased environmental heterogeneity – which enhances in situ speciation – also may be more relevant to continental and volcanic islands since atoll, coral and low island archipelagos tend to be of low elevation and productivity, and therefore are less resilient to catastrophic disturbance. In consequence, atoll and low island archipelagos tend to be dominated by a relatively small suite of resilient taxa that are more easily dispersible and have widespread distributions.

#### **V-51-5: Effects of Avifaunal Richness and Island Size on the Use of Agroforestry Systems and Tree Plantations by Forest Birds in the Malay Archipelago**

Christian H. Schulze; *Depart. Animal Biodiversity, Univ. Vienna*

Many bird species predominantly restricted to rainforest habitats are threatened by the ongoing decline of native forest cover in most tropical regions. The Malay Archipelago, a biodiversity hotspot with a high proportion of endemic species, faces a particularly high land use pressure due to its still rapidly growing human population. As a result, the region has one of the highest rates of forest loss. Recent studies provided evidence that disturbed forests and land-use systems such as agroforestry systems and tree plantations potentially are able to maintain at least a certain fraction of forest birds. However, the importance of such modified habitats for forest species may depend on the extent of habitat specialization, which may differ between forest bird assemblages of mainland areas and islands of different size. On smaller islands forest birds may occupy wider ecological niches due to a decrease of species richness and a related competitive release. In consequence, a higher proportion of forest birds may be able to use anthropogenically modified forest-like habitats on smaller islands. This hypothesis was tested using data on the habitat affiliation of forest birds on 18 islands of the Malay Archipelago. Indeed, the proportion of forest birds which is able to use agroforestry systems and/or tree plantations significantly increase with decreasing island size in both studied regions, the Greater Sundas and Wallacea. Thereby, these results provide clear evidence for a decreasing importance of human-modified habitats for forest birds with increasing island size. Further studies have to analyze how reproductive success of forest birds differs between primary/old secondary

forests and agroforestry systems and tree plantations. Although many forest birds occur in the latter two land-use systems these habitats may act as ecological sink or are only used for foraging but not as breeding habitat.

#### **V-51-6: Phylogeographic Patterns of Volant Animals Across the Archipelagoes of Southeast Asia**

David J. Lohman; *The City College of New York, CUNY*

Wallace's Line demarcates what is perhaps the planet's best-known biogeographic transition between areas typified by species from predominantly "Oriental" taxa on the west and species from "Australian" taxa on the east. However, a number of species are found throughout Southeast Asia on both sides of Wallace's Line, presumably through relatively recent dispersal. Molecular phylogeographic analysis permits the reconstruction of these recent dispersal events within species. I examined phylogeographic patterns across Southeast Asia in two particularly well-studied taxa, birds and butterflies, to ascertain whether patterns of genetic differentiation were congruent within and among taxa and to assess the extent to which morphological uniformity masks substantial genetic differentiation. Strongly supported monophyly and large genetic distances between Philippine and non-Philippine populations were the only consistent patterns in the intraspecific mitochondrial phylogenies of seven passerine bird species sampled throughout Southeast Asia (mainland Asia, Sumatra, Java, Borneo, Sulawesi, Philippines), suggesting the presence of cryptic Philippine endemic species in six of the seven avian taxa examined. There were few common patterns among the six butterfly species that I studied, but several species had genetically distinctive populations in parts of their range. Some butterfly species showed a distinct genetic discontinuity between Sumatra and Java, which are thought to have been connected by a land bridge within the past 11,000 years. In these species, Sumatran populations are more closely related to Philippine populations than to Javan populations. In addition, some butterfly populations were infected with the bacterial endosymbiont *Wolbachia*, which may have influenced differentiation.

#### **V-51-7: Sphingid Moths Across the Malay Archipelago and Pacific Islands**

Jan Beck<sup>1</sup>, Ian J. Kitching<sup>2</sup>; *1. Basel University, 2. Natural History Museum London*

Sphingid moths are an extremely dispersive group of insects. Nevertheless, clear spatial patterns across the Melanesian islands can be found, reflecting phylogeny and life history variation among moths, and continental vs. oceanic geological history among islands. We used comprehensive distributional data of the ca 400 species found between Southeast Asia and the South Pacific to delineate biogeographic units by means of quantitative, phenetic methods (e.g., ordination, cluster analyses). We contrast this methodology to cladistic approaches of historical biogeography, and we point out recent ideas that could fuse these methodologies. Furthermore, we explored the link between biogeographic patterns (across the Melanesian region, as well as more localized on environmental gradients) and life history traits of species. We found, for example, that variation in range sizes and dispersiveness of taxa are related to morphological traits (putatively affecting flight ability), niche breadth, adult and larval resource use, and phylogeny. Lastly, we present our current attempts of extending the investigation of sphingid moth biogeographic by supplying species range data at higher spatial resolution (using Ecological Niche Modelling) and at larger extent (Old World to Pacific, involving >900 species). These shall, in the near future, provide one of the first data sets of insect geographical distributions at near-global extent.

#### **V-51-8: Ant communities on small tropical islands: effects of island size and isolation are obscured by habitat disturbance and 'tramp' ant species**

Akhmad Rizali, David J. Lohman, Damayanti Buchori, Lilik Budi Prasetyo, Hermanu Triwidodo, Merijn M. Bos, Seiki Yamane and Christian H. Schulze

Comparisons among islands offer an opportunity to study the effects of biotic and abiotic factors on small, replicated biological communities. Smaller population sizes on islands accelerate some ecological processes, which may decrease the time needed for perturbations to affect community composition. We surveyed ants on 18 small tropical islands in Thousand Islands Archipelago (Indonesian name: Kepulauan Seribu) off Jakarta, Indonesia, to determine the effects of island size, isolation from the mainland, and habitat disturbance on ant community composition. Ants were sampled from the soil surface, leaf litter and vegetation in all habitat types on each island. Island size, isolation from the mainland, and landuse patterns were quantified using GIS software. The presence of settlements and of boat docks were used as indicators of anthropogenic disturbance. The richness of ant communities and non-tramp ant species on each island were analysed in relation to the islands' physical characteristics and indicators of human disturbance. Forty-eight ant species from 5 subfamilies and 28 genera were recorded from the archipelago, and approximately 20% of the ant species were well-known human-commensal 'tramp' species. Islands with boat docks or human settlements had significantly more tramp species than did islands lacking these indicators of anthropogenic disturbance, and the diversity of non-tramp species decreased with habitat disturbance. Human disturbance on islands in the Thousand Islands Archipelago promotes the introduction and/or establishment of tramp species. Tramp species affect the composition of insular ant communities, and expected biogeographical patterns of ant richness are masked. The island with the greatest estimated species richness and the greatest number of unique ant species, Rambut Island, is a forested bird sanctuary, highlighting the importance of protected areas in preserving the diversity of species-rich invertebrate faunas.

#### **V-51-9: Impact of invasive ant species in shaping ant community structure on small islands in Indonesia**

Akhmad Rizali, Abdul Rahim, Bandung Sahari, Lilik Budi Prasetyo, Damayanti Buchori

Study about the effect of invasive ant species on small islands is very important due to conservation issue. Limited resources and high competition of invasive species on small islands will highly impact for accelerating the extinction of local and endemic ant species. This research were conducted to study the implication of invasive ant to local biodiversity especially ant community. Ecological research was conducted on three islands (Bokor, Rambut and Untung Jawa) with different land use types located in Thousand Islands Archipelago off Jakarta, Indonesia. Ants were sampled using pitfall traps in 5 m x 5 m plots that were spread randomly on each island. Spearman rank correlation and general linear models (GLMs) were used to assess the impacts of invasive ants to local ant diversity. We found three invasive ant species i.e. *Solenopsis geminata* and *Paratrechina longicornis* that co-occur on every island; and *Anoplolepis gracilipes* that only occur in Rambut Island. *A. gracilipes* and *S. geminata* are the most abundance invasive species and have correlation with occurrence of other ant species. Based on GLM analysis, habitat condition (island) is the main factor affecting ant species composition ( $F_{2, 52} = 19.469$ ,  $p < 0.001$ ). However, habitat or island condition on each island obscured the effect of invasive species.

#### **V-51-10: The Evolutionary Biogeography of Tropical Elevational Gradients: a Stochastic Model for Quaternary Range Dynamics**

Robert K. Colwell, Thiago F. Rangel; *University of Connecticut, USA*

Glacial cycles over the past three million years are believed to have repeatedly forced thermal bands up and down the slopes of tropical mountains. The biogeographical and evolutionary responses of tropical species to climatic cycles on these gradients are poorly known, but are likely to have left their

signature on contemporary patterns of geography and phylogeny. We explored a range-based, stochastic model that incorporates speciation, anagenetic evolution, niche conservatism, range shifts, and extinctions under Quaternary temperature regimes along elevational gradients. We analyzed patterns of speciation, extinction, range-size dynamics, species richness, and phylogeny that arise from the model under a wide scope of parameter settings. To the degree possible, we assessed correspondence to empirical patterns reported in the literature, highlighting the role of pattern-producing mechanisms in the model. A principle finding is a role for species selection, based on higher extinction at the lowest and highest elevations, that favors mid-elevation lineages.

## **Biodiversity and conservation in Wallacea (#52)**

**(July 23 pm; Wantilan middle)**

Organized by: **Philip Wheeler**

*The Wallacea region is one of the least studied major tropical eco-regions. It has typically been characterised by relatively low diversity compared to adjacent regions, but high rates of endemism in several groups. However there is emerging evidence that the terrestrial biodiversity of Wallacea may have been significantly underestimated, in some cases by an order of magnitude. The complex biogeographical history of the region has produced a unique combination of flora and fauna that combines influences from the Asian and Australasian continents and yet is distinct from both these. The dramatic faunal transitions that occur in some groups over relatively short distances have led biogeographers, beginning with the father of the discipline, Alfred Russel Wallace to define faunal transition zones at the eastern and western extents of what is now called Wallacea. Wallacea is a region composed of islands, with its largest, Sulawesi, a collection of four peninsulas, each with distinct flora and fauna. In line with most island groups, Wallacea is under significant threat from human activity; most lowland forests on Sulawesi have been removed and montane forests are increasingly threatened by encroachment and a changing climate. This symposium will examine the biodiversity of Wallacea and threats to its persistence. The first papers will explore aspects of the emerging evidence for previously unrecognised diversity in several groups of organisms. The second group of papers will discuss anthropogenic threats to that diversity, monitoring and the state of conservation in the region.*

### **V-52-1: The Distribution of Bitti (Vitex cofassus) in Wallacea Region**

Atus Syahbudin<sup>1</sup>, Osozawa<sup>2</sup>, Ehime University<sup>1</sup>, Ikuo<sup>1</sup>; 1. Ehime University, 2. Katsuya

Populations of tree species used in the boat building, mainly bitti (*Vitex cofassus*) continually decreasing rapidly because of high demand and reason related to deforestation. In fact, some trees species with lower quality wood is used to replace it. The idea of establishment of forest boat as an effort of Wallacea's species conservation and fulfillment of the basic materials needs to be supported. Some explorations were done in August and September 2008 by research ship, namely Cinta Laut in order to know the distribution of bitti in Indonesia which become one step toward the forest boat. Some islands in Province of South Sulawesi, West Sulawesi, Central Sulawesi and Gorontalo were visited. Data also collected in June 2009 and January 2010 by study of specimen of bitti in National Herbarium "Bogoriense" and Herbarium of Faculty of Forestry, Universitas Gadjah Mada (UGM). In addition, some related publications used to indicate other locations where bitti has been found and utilized. Bitti distributes in most of Eastern part of Indonesia. Those are Sulawesi Island, Moluccas Islands, Aru Islands and Misool Island in Papua as well as Lesser Sunda Islands. Two varieties were found are *V. cofassus* var. *α typica* and *V. cofassus* var. *timorensis*.

### **V-52-2: Effects of Climate Change on the Endemic Avifauna of Central Sulawesi, Indonesia**

J. Berton C. Harris, Damien A. Fordham, Dadang Dwi Putra, Navjot S. Sodhi, Barry W. Brook, Dewi M. Prawiradilaga; *University of Adelaide*

Sulawesi, Indonesia is a globally important center of avian endemism with approximately one third of species found nowhere else. Despite this diversity, Sulawesi is ornithologically one of the least understood regions of the world, and geographical and altitudinal distributions of birds in Sulawesi are poorly documented. Disconcertingly, accelerating habitat loss, both outside and inside protected areas, is threatening to extinguish the region's avian diversity even before all the species are described. We used intensive point counts and transect surveys to document bird distributions from 175–2525 m.a.s.l. on four mountains in Lore Lindu National Park, Central Sulawesi. We used these data to model the distributions of endemic species for conservation status evaluations under climate and land-use change scenarios. We report substantial range extensions and large modeled ranges for two endemic species, Cinnabar Hawk-Owl (*Ninox ios*) and Sulawesi Eared-Nightjar (*Eurostopodus diabolicus*). These species are currently considered Vulnerable by the IUCN, but our data suggest they should be downlisted to Near Threatened. Our results indicate that published altitudinal distributions of the Sulawesi avifauna are incomplete approximations of true distributions, and are biased towards lower elevations. It is unclear if the upward range expansions we documented resulted from habitat loss, incomplete historical sampling, or climate change. Our models indicate that a large proportion of Sulawesi's endemic avifauna may be threatened by climate change induced range shifts.

#### **V-52-3: Herpetofaunal Community Composition in Relation to Habitat Disturbance in Sulawesi: Implications for Biodiversity Conservation in Disturbed Forests**

Graeme Gillespie<sup>1</sup>, Michael Scroggie<sup>2</sup>, Samuel Howard<sup>1</sup>, James Stroud<sup>1</sup>, Adininggar UI-Hasanah, Bjorn Lardner; *1. Zoos Victoria, 2. Arthur Rylah Institute for Environmental Research*

Biodiversity conservation and sustainable development in Southeast Asia hinges on identifying important areas to focus limited conservation resources, identifying key threatening processes, and how best to manage them. Many remaining forests of Southeast Asia are subject to subtle or substantial human disturbances, and biodiversity conservation is increasingly dependant upon these altered habitats. Herpetofauna communities may comprise the bulk of vertebrate biodiversity in tropical rainforests. However in Southeast Asia few studies have examined these communities in detail; species ecological requirements and responses to environmental change are poorly known. Herpetofauna communities have been identified as potentially important indicators of environmental change; however comprehensive studies of these relationships for entire communities have not been undertaken. We examined rainforest herpetofauna community composition across a disturbance gradient in Sulawesi, Indonesia; including near-pristine forest through to significantly disturbed, selectively logged forest. Over an eight year period herpetofauna assemblages were comprehensively documented at 73 sampling sites and the influence of habitat structure on community composition assessed. Significant shifts in community composition occurred between mostly-intact forest and highly disturbed secondary forest. However, forest structural changes associated with selective logging and rattan harvesting exerted minimal influence on community composition. Community composition was more strongly influenced by habitat characteristics not directly associated with human disturbances. Thus rainforest subjected to significant levels of human disturbance retains high levels of herpetofauna diversity and is therefore valuable for biodiversity conservation.

#### **V-52-4: Sulawesi Island Biogeography and the Taxonomy and Population Structure of the Largest Endemic Mammal, a Dwarf Buffalo**

James Burton, Peter Galbusera, A. Macdonald, H. Musrati, G. Larson, S. Gillemot, K. Leus

Sulawesi Island is the home to certain groups of species that show high diversification. For example, there are seven species of macaques (*Macaca* sp.), a complex population structure of the Celebes toad, and many other groups have multiple species. The distribution of these species and populations is in some cases linked to biogeographic regions of Sulawesi and in other groups is differentiated by

altitude. The majority of species groups studied to date show parapatric geographic distribution. Another example group is represented by the Anoa; two species are currently thought to occur on Sulawesi. However, their taxonomic status and distribution is uncertain. These dwarf buffaloes are the largest endemic mammals on Sulawesi and the offshore Buton Island. Hence, they are important species as emblems of the Wallacea Region's biodiversity. The current classification of two Anoa species (*Bubalus depressicornis* and *Bubalus quarlesi*) was formerly explained by vertical stratification (Groves 1969). Employing genetic techniques we were able to show a very different population structure of this charismatic species. In this study we analyse mtDNA D-loop, Cytochrome b and 13 bovine microsatellite markers in 92 wild Anoa individuals. Results revealed that the new genetic diversity of the anoa population was not correlated with the descriptive characteristics of the two putative Anoa species. In addition, microsatellite diversity was not correlated to the reported altitudinal distribution of the species. The sea barrier between Buton and Sulawesi Islands acted as a stronger dispersal barrier than predicted by geographic distance alone. On Sulawesi, our results showed a less well defined population structure using partial Mantel tests. This has implications for the conservation of this species, and protected area development across these islands. It also adds to the understanding of the potential arrival route of the Anoa to these long isolated islands.

#### **V-52-5: Anthropogenic Influences on the Sosoecology of Long-tailed Macaques (*Macaca fascicularis*) in Lombok Island, Indonesia**

Islamul Hadi, Bambang Suryobroto, Kunio Watanabe; *Bogor Agricultural University*

The intermittent survey on distribution of long-tailed macaques in Lombok Island was carried out during 2001-2009 revealed 37 groups, a sub-adult males and 3 solitary individuals from 27 localities. They were found from the coastal area to mountainous area. Of the 27 localities where the groups of macaques found, 63% were the area that influenced by human. Human influences or anthropogenic factors such as provisioning and leftover food were suggested to be main factors those affected the number of individuals in group (group size). The group size tent to be greater in semi-provisioned groups than those in wild ones( wild = 7.08, semi-provisioned =19.04,  $X^2 = 5.4763$ ,  $df = 1$ ,  $P = 0.01928$ , respectively). Those anthropogenic factors also promoted the dependence of long-tailed macaques to human food and transformed the behavior to be aggressive to human being. The logging of forest where mainly the groups of the macaques found and shifting the habitat into human settlement and agricultural field drive the macaques to raid the crops and attack human settlement.

#### **V-52-6: Phylogenetics and Biogeography of SE Asian Flying Lizards (*Draco*)**

Jimmy A. McGuire<sup>1</sup>, Rafe M. Brown<sup>2</sup>, Djoko T. Iskandar<sup>1</sup>, Ben J. Evans<sup>1</sup>, Jatna Supriatna, Noviar Andayani, Awal Riyanto; *1. University of California, Berkeley, 2. University of Kansas*

Flying lizards of the genus *Draco* occur throughout the Southeast Asian region with multiple species occurring in continental SE Asia, on the Greater Sunda Shelf, in the Philippines, and throughout Wallacea. The genus includes ~45 species, with as many as seven species occurring in sympatry on the Sunda Shelf. Consequently, flying lizards represent an excellent model system for biogeographical analysis. We present a series of nested multilocus phylogenetic analyses of *Draco*, which provide insight into the biogeography of the region. We present coalescent-based phylogenetic analyses, and time-calibrated Bayesian analyses in order to elucidate overarching biogeographical patterns, including multiple dispersal events across Wallace's and Huxley's Lines, as well as diversification on the Sunda Shelf, in the Philippines, and in Wallacea.

#### **V-52-7: National Strategy and Action Plan for Conservation of Anoa (*Bovidae: Bubalus spp.*) in Sulawesi**

Abdul H. Mustari<sup>1</sup>, James Burton<sup>2</sup>; *1. Bogor Agricultural University, 2. Earthwatch Institute-UK*

The anoa is the largest mammal native to Sulawesi Island and one of only two wild bovine species in Indonesia, the other being the Banteng. Sulawesi is an important priority for conserving biodiversity in Indonesia because it is the largest island in the Wallacea 'biodiversity hotspot'. Traditionally, the animals are classified into two species, lowland anoa (*Bubalus depressicornis*) and mountain anoa (*B. quarlesi*). Despite full legal protection since 1931 in Indonesia and listed as endangered species by IUCN Red Data Book and on Appendix I CITES, these smallest living buffaloes are on the brink of extinction due to hunting and extensive habitat loss. The strategy and action plan for conservation of anoa aims to 1) Maintain viable population of anoa in their natural habitats through improvement of population and habitat management, reducing anoa hunting, management of ex-situ anoa, strengthening research and information; 2) Strengthen government regulations and policy support; 3) Strengthen collaboration and partnership; 4) Increase community participation and people awareness; and 5) Increase funding support from stake-holders. Keywords: anoa, action plan, conservation

#### **V-52-8: Documenting the Decline of the Anoa on Buton: Implications for Conservation**

Wheeler Philip, Asri Adyati Dwiyahreni; *University of Hull*

The anoa, an endangered forest buffalo, is Wallacea's largest land animal and a flagship for forest conservation. It is threatened by hunting and habitat loss, but because of its elusive nature is very poorly studied. We present data from the first detailed population monitoring study of the species and an assessment of threats to its persistence in one population on the island of Buton. Annual broad scale monitoring combined with village surveys of hunters and population modelling indicate strongly that this population is undergoing a rapid decline. Human access rather than habitat quality is the primary determinant of anoa distribution, so that even in well forested areas, declines persist. Our results indicate likely extinction of this population within 50 years should current hunting rates continue. The effects of hunting are only apparent with detailed monitoring at broad spatial scales and it is likely that other populations of the species are undergoing similar, but undocumented declines. We discuss the implications of this for the study and conservation of anoa in Sulawesi and elusive forest ungulates elsewhere.

#### **V-52-9: Lambusango: the Conservation Value of Forest on a Smaller Island of Sulawesi**

Bruce Carlisle; *Northumbria University*

Sulawesi's tropical lowland rain forest is of high conservation value particularly due to the levels of faunal endemism. With continued habitat loss due to deforestation on the mainland, the conservation role of forests on Sulawesi's smaller islands becomes potentially more important. This presentation outlines research into the conservation value of Lambusango forest on the island of Buton, southeast Sulawesi. The inaccessibility of the forest and the designation of Lambusango Wildlife Reserve (Suaka Margasatwa) in 1974 suggest important conservation value. On the other hand, several factors could limit the conservation value of this forest, including the size of the island and Lambusango forest, historic shifting settlement and agriculture, and contemporary rattan extraction. A series of forest surveys have been undertaken since 2004 to assess Lambusango's tree diversity, forest structure and biomass. The effect of natural factors (soil characteristics and topography) and anthropogenic impacts (previous land use, designation of forest zones, rattan extraction) are investigated. None of these factors are found to have a strong influence on the spatial variation in forest characteristics. There is much forest of conservation value outside the Wildlife Reserve. Rattan extraction has not been found to negatively impact forest characteristics. Incomplete botanical identification of tree species makes comparison with mainland Sulawesi difficult. However, current knowledge suggests Lambusango can be considered an important component in Sulawesi's remaining lowland forest.

#### **V-52-10: Anthropogenic Disturbance and Responses of Avian Community in Sulawesi**

Winarni, Nurul L., Martin Jones; *Manchester Metropolitan University*



Human activities in the forest of Sulawesi region have long been a part of forest dynamic history in the region. Experiencing the most alarming rate of deforestation compare to other islands in Indonesia, only a few studies were carried out in addressing the effect of disturbance to avian community. Evaluation on the effect of disturbance was mostly discussed in a land-use context and was less in an anthropogenic disturbance context where illegal logging and poaching were included. Lambusango forest in the Central of Buton Island, Southeast Sulawesi was the subject of three year monitoring program to detect the response of the forest structure to anthropogenic disturbance in which we monitored it through avian community. Surveys were carried out at six study sites within Lambusango forest, comprising vegetation survey and bird monitoring using Point Count Distance Sampling. Point count distance sampling was used to survey the birds. At each site, four transects were laid at 1-km apart where points were located along the transects at 150-m apart. Vegetation data were also collected at each of the point. Two disturbance levels characterized the Lambusango forest – lightly disturbed forest and more heavily disturbed forest and this affected the birds at community, population, and species level. Short-term monitoring did not detect significant changes in diversity and abundance which may be related to the low levels of disturbance. Although bird diversity was relatively similar, the community composition was affected. The lightly disturbed forest supported higher frugivore populations suggested the higher habitat quality and thus indicated that disturbance increased vulnerability of frugivore population.

## **New Guinea biodiversity and ecosystems (#53)**

**(July 21 am; Wantilan wing)**

Organized by: **Charlie D. Heatubun and Campbell O. Webb**

### **V-53-1: Plant - Insect Food Webs in Tropical Forests: a Papua New Guinean (ad)venture**

Vojtech Novotny; *Ecology and Conservation Biology, Institute of Entomology, Czech Academy of Sciences*

The study of tropical rainforests is slowly moving from the inventory of species, which was on the cutting edge of research in the 19th century, through the inventory of trophic relationships modern in the 20th century to modern analysis and experiment. Recent advances in the analysis of complex food webs, together with the introduction of phylogenetic perspectives into the study of tropical communities, the proliferation of large-scale field censuses of rainforest composition, and first community-scale manipulative experiments set the scene for an interesting and promising future of ecological research in tropical rainforests. All this will be illustrated using our long-term research of rainforest ecology in Papua New Guinea.

### **V-53-2: Diversity and Distributional Patterns of New Guinea Termites**

Yves Roisin, Thomas Bourguignon, Jacques M. Pasteels, Maurice Leponce; *Université Libre de Bruxelles*

Insects are often better than vertebrates at crossing water gaps and ignoring Wallace's line, but the dispersal of termites is hindered by constraints on colony foundation. Small-colony drywood termites (Kalotermitidae) easily colonize islands from drift wood, but overseas dispersal of large-colony ground-dwelling Termitidae is more difficult. Termite distribution is also limited by mountain ranges. In addition, New Guinea presents contrasting lowland ecosystems, between equatorial rainforests surrounding the central and northern ranges and Australian savannas in the southern plains. Extensive termite collecting in New Guinea between 1978 and 1995 allowed us to carry out detailed taxonomic work and assemble a large array of distributional data. We identified 80 species representing 24 genera in 3 families: Kalotermitidae (5 genera, 20 species), Rhinotermitidae (6 genera, 15 species),

and Termitidae (Termitinae: 7 genera, 23 species; Nasutitermitinae: 6 genera, 22 species). Rare, remarkable findings include *Termitogeton planus*, formerly unknown east of Borneo, and *Calcaritermes krishnai*, only known from the Nicobar Islands. One species, the neotropical *Nasutitermes corniger*, appears as a widespread, well-established invader. Most New Guinean species are wood feeders, while some feed on grass or lichens. Only the 10 species of the *Termes-Pericapritermes* group show some degree of specialisation towards soil feeding. As predicted, most termite species occurring in the southern savannas also occur in northern Australia. By contrast, many New Guinean forest termites are endemic or shared with nearby islands to the east. The forest fauna shows limited differentiation between northern and southern sides of the central ranges and some east-west discontinuities. This is consistent with a colonization from Sundaland followed by local speciation.

### **V-53-3: Recovery or Degradation? Dynamics of Natural Tropical Forest After Selective Timber Harvesting in Papua New Guinea**

Cossey K. Yosi, Julian C. Fox, Rodney J. Keenan; *The University of Melbourne*

The dynamics of forest after timber harvesting is a major issue for tropical forest managers and communities. Timber harvesting has also been identified as a potential contributor to deforestation and degradation of tropical forests. In Papua New Guinea (PNG), selectively-harvested forests amount to 10% of forested areas. The objectives of this study were to analyse trends in basal area (BA) from impacts of selective timber harvesting; precipitation; forest fires caused by the 1997-1998 El Niño drought; and assess harvesting impacts on species diversity using data from permanent sample plots (PSPs) in the natural tropical forests of PNG. We tested two hypothesis: that a critical threshold BA may exist that determines if a harvested forest degrades or recovers; and that the mean basal area increment (MBAI) for plots measured <10 years and >10 years since harvesting is equal. Analysis suggested that a single critical threshold BA does not exist, rather, the response to harvesting is variable, with the majority of PSPs (76%) showing an increase in BA and remainder a decrease. There was no significant difference in MBAI between plots measured <10 years and >10 years since harvesting ( $P=0.94 > 0.05$ ). Average annual increment in BA across all plots was  $0.18 \text{ m}^2 \text{ ha}^{-1} \text{ y}^{-1}$  while BA is affected by high mortality rates on plots severely burnt during the fire. Change in BA for plots on high rainfall sites was a positive trend while those on low rainfall sites indicated a constant trend. Thus, these forests show capacity to recover after selective timber harvesting, even when the residual basal area is low. The future fate of these forests will depend on the degree of future harvesting, potential conversion to agriculture and the impact of fire and other disturbances. Key words: Basal area, El Niño, mortality, permanent sample plot, precipitation, species diversity, Shannon-Wiener Index.

### **V-53-4: Ecology of Freshwater Snail Thiaridae Family (Mollusca: Gastropoda) in Papua**

Suriani Surbakti<sup>1</sup>, Adi Basukriadi<sup>2</sup>, Mufti P. Patria<sup>2</sup>; *1. Department of Biology, University of Cenderawasih, 2. Department of Biology, University of Indonesia*

Research of freshwater Thiaridae Family (Mollusca: Gastropoda) in Papua was conducted from October 2007 to August 2008 in Papua regions and West Papua (Main land and the surrounding islands). The Thiaridae specimens were collected from Sentani lake and 29 rivers. A quadrat transect method was used throughout the areas from  $1 \times 1 \text{ m}^2$  metal frames which was systematically located every 20 m in 200 m line transects. Approximately, 10 species were categorized as new record (need further study). The Shannon-Wiener Biodiversity Index ranged from the lowest 0,3 to the highest 1,16. The index showed trend increased in the northern part of island and decreased in the Southern part. Likewise, the density level also showed similar pattern, which increased in the north and decreased in the south, ranged from  $12,24 \text{ ind./m}^2$  to  $56,22 \text{ ind./m}^2$ . Furthermore, the distribution level of Thiaridae was influenced by the distance. The similar species increased in the nearest location and on the contrary, the similar species decreased in the distance location ( $R^2 = 0.3862$ ). Therefore,

the future conservation efforts need to be emphasized in the northern part of Papua. Key words: Biodiversity, Gastropoda, Mollusca, Papua, Thiaridae,

### **V-53-5: A Fifty-hectare Forest Dynamics Plot for Papua New Guinea**

Gibson Sosanika; *New Guinea Binatang Research Center*

The island of New Guinea is the third largest tropical forest wilderness on earth after the Amazon and Congo basins. New Guinea is also the only major tropical forest region without the capacity to monitor large-scale long-term forest dynamics. Scientific research in New Guinea is essential to understand the response of Pacific forests to global change and the ecological processes that sustain healthy ecosystems. Papua New Guinea is also unique among nations in that most of the forest is owned by rural subsistence farmers. Tribal landowners in Madang Province, PNG have joined an international team of scientists to establish a permanent fifty-hectare forest plot in lowland rain forest. The challenges of establishing a permanent plot on private land are discussed using the Papua New Guinea plot as the case in point.

### **V-53-6: Engaging Local People for Conservation and Research in Papua New Guinea**

Elvis Tamtai; *New Guinea Binatang Research Center*

In Papua New Guinea (PNG) 80% of population live in villages, often within tropical rainforests which are used for subsistence agriculture, hunting and as a source of building materials or medicines. Further, PNG villagers are in exceptional position as they own their traditional lands and decide about their future use, including conservation, research or logging. I am a member of a team of paraecologists working with village communities; some of them invited biologists and conservationists to work on their lands, others opted for logging. My talk will examine attitudes of villagers, as well as benefits and problems of their choices between conservation and logging, using our long-term experience from Middle Ramu 100,000 ha logging concession, where different villages and clans opted either for conservation or logging. These choices has resulted in present logging by Rimbunan Hijau company on some tribal lands, and a conservation project supporting also a biological research station in another part of the customarily owned lands. The social dynamics of this development and lessons for rainforest conservation are discussed.

### **V-53-7: The Threat to Crop Pollination in Papua New Guinea and Comparisons with Australia**

Saul A. Cunningham, David Cook, Paul DeBarro; *CSIRO Entomology*

Australia stands as the only continent where honeybees (*Apis mellifera*) have not been infected with highly pathogenic *Varroa* mites. The risk to Australia has been heightened recently by the emergence of a new and dangerous *Varroa* species in Papua New Guinea (PNG) that is already damaging honeybee populations there and could cross the Torres Strait into Australia. One of the major effects of *Varroa* invasion elsewhere in the world has been dramatic decline in the feral honeybee populations, and this is expected to be repeated both in PNG and Australia. The impact of such declines, however, is likely to be very different in the two countries. Pollination dependent crops (especially coffee) are a very important source of export income in PNG so potential economic impact is great, but we suggest that local conditions mitigate against large pollination declines. In contrast, pollination dependent crops are not central to the Australian national economy, but for many crops the degree of dependence on feral honeybees is great, exposing particular crops to considerable risk. The key to predicting impacts is in understanding how wild bee communities will respond to what is a major perturbation; the loss of what has been an extremely successful invader. Unfortunately there has been little research on this question, and generalizing from experiences in other countries has limited potential. We will illustrate this problem by highlighting the differences between near neighbors, Australia and PNG.

### **V-53-8: Litter Production and Net Primary Productivity of a Tropical Montane Forest in Papua New Guinea**

Gamui Banak; *Papua New Guinea Institute of Biological Research*

Forest Litter Production and Net Primary Productivity studies look at quantifying above ground biomass of forest plants. This is a correlate of the amount of carbon taken up by plants from the atmosphere for photosynthesis and incorporation into their living biomass. With the help of research assistants, I conducted over 12 months sampling of forest litterfall and looked for seasonality and production rates in the various litterfall components (leaves, flowers, fruits, twigs, moss, and others). To calculate above ground biomass and aboveground biomass increment, we measured trees  $\geq 10$  cm diameter at breast height on 20 permanent 50m x 50m vegetation plots covering a total of 5 hectares in 1998 and again in 2003. I then calculated the Net Primary Productivity for this forest, which is the sum of litterfall production and aboveground biomass increment. Litter Production in the Mekil lower montane forest is 5.59 Mg ha<sup>-1</sup> y<sup>-1</sup>. Assuming dry mass is 50% carbon (Clark et al 2001), the forest produces 2.52 Mg C ha<sup>-1</sup> yr<sup>-1</sup> with a 95% confidence interval of 2.26 to 2.78. The forest is aseasonal, based on temperature and rainfall recorded. There was no seasonality in litterfall either, and leaves accounted for 61 % of litterfall, other debris for 15%, twigs  $\leq 1$  cm diameter for 13%, moss for 5%, fruits for 4%, and flowers for 2%. Based on the 5 hectare sample, in 1998 total above ground biomass was 196.8 Mg ha<sup>-1</sup>. In 2003 total estimated above ground biomass was 198.6 Mg ha<sup>-1</sup>. Using census and re-census data from these 5 ha over a 5.5-year census period, I measured aboveground biomass increment at 3.73 Mg ha<sup>-1</sup> yr<sup>-1</sup>, or 1.87 Mg C ha<sup>-1</sup> yr<sup>-1</sup>. At a time when Papua New Guinea and the world over, grapple for carbon sequestration credits and carbon trade opportunities, this study may give some insight into how much carbon a PNG forest may absorb with implications for carbon credits.

### **V-53-9: The Flora of New Guinea: The Centre of Plant Diversity in the Western Pacific**

Robert Johns; *Botanical Research Institute of Texas*

New Guinea is the largest tropical island supporting probably the most number of named specimens represented by single collections is often up to 60 percent of the species. Additional results are presented based on the data bases. diverse flora of the Western Pacific. Estimates of this diversity range from 1-12,000 species up to 25,000-30,000 species. Data is presented supporting the higher estimate. An important characteristic is the absence of endemic families, the low number of endemic genera, but the very high levels of species endemism which are over 90 percent in some genera. Another feature of the flora is the low intensity of plant collections, with most of the country being virtually unknown. Many species are only known from 1 (or 2-3) collections which means a large number of critically endangered species cannot be given the required formal 'scientific' rating of critically endangered, endangered etc. This has 'serious implications on conservation in New Guinea. The data presented is largely based of the New Guinea database being put together by the author (204,000 herbarium collections), the map being developed from this database and a database of Papua New Guinea plants at the Forest Research Institute, in Lae. In both species lists assembled for selected areas in New Guinea and taxonomic revisions of published genera the number of named specimens represented by single collections is often up to 60 percent of the species. Additional results are presented based on the data bases.

## **African ecology (#54)**

**(July 22 am; Jauk)**

Organized by: **Robert Nasi and Rob Pringle**

**V-54-1: A Tale of Two Species – African Shrubs between Competition and Isolation**Nils Hasenbein, Manfred Kraemer; *University of Bielefeld*

Logging for timber and firewood is the foremost reason for the decline of African rainforests and, subsequently, biodiversity. The disruption of ecosystem processes due to fragmentation often accelerates the loss of species in various ways. In changing environments, organisms may have to adapt to new interactions (e.g. predation, competition, pollination) as well as to altered climatic conditions. The two shrub species *Acanthus eminens* and *Acanthus polystachyus* occur sympatrically in Kakamega Forest (western Kenya), with *A. eminens* depending on forest gaps and the closely related and morphologically similar species *A. polystachyus* growing in the surrounding open landscape, i.e. mainly in hedgerows and at forest edges. Flowering phenology, pollinator visitation rates and pollinator species composition render pollen transfer between the two species very likely. Interspecific pollen transfer is even fortified by ongoing fragmentation of the forest that has further reduced the distance between the plants, thus causing an increase of possible ecological and evolutionary interactions. Fragmentation and disturbance are also likely to isolate populations of *A. eminens* within the forest, with anthropogenic disturbance as a likely cause for a reduction of pollinator abundance and, subsequently, visitation rates and pollination success. Here we present data on pollination and reproductive processes of both species, with emphasis on *A. eminens*, for habitats with different disturbance and microclimate conditions. The data sets provide insights into ecological challenges of and evolutionary pressures on plant species in a changing natural forest ecosystem.

**V-54-2: Role of an Ecosystem Engineer in the Organization of Tropical Savanna Biodiversity**Sarah E. Wittman<sup>1</sup>, Daniel F. Doak<sup>2</sup>, Kena Fox-Dobbs<sup>1</sup>, Todd M. Palmer<sup>1</sup>, Alison K. Brody; *1. La Trobe University, 2. University of Wyoming*

Savannas comprise one-fifth of the world's land cover, and provide rangeland for a large number of the world's livestock and native wildlife. As ecosystem engineers, termites may serve as primary organizing agents with savanna ecosystems. Through their foraging and mound building activities, termites (order Isoptera: *Odontotermes* spp.) create large, discrete areas of high productivity, which exert ecosystem-wide effects and provide critical resources to a diverse suite of species. Termite mounds create regular spatial patterning in nitrogen fixation rates in *Acacia drepanolobium*: N<sub>2</sub> fixation is significantly higher away from mounds than near mounds, likely because *Acacia* trees preferentially use more readily available soil-based N near mounds. Termite mounds are associated with increased productivity in both tree and grass communities, and host significantly higher abundance of the palatable grass *Pennisetum stramineum* and significantly lower abundance of the unpalatable grass *P. mezianum*. Native wildlife likely spend more time grazing on termite mounds, and may further concentrate soil nutrients on mounds via increased rates of waste deposition. Finally, termite mounds appear to mediate the mutualism between *A. drepanolobium* and its obligate ant symbionts by enhancing tree rewards and altering ant trophic ecology. These results demonstrate that termites' direct effects on soil quality and productivity cascade throughout the savanna ecosystem, indirectly affecting entire communities through altering the distribution and foraging patterns of a wide suite of species.

**V-54-3: What are the Prospects for Reducing Deforestation and Increasing Carbon Storage in African Dry Forests and Savannas?**Peter G.H. Frost, Robert Nasi; *CIFOR*

The prospect of global climate change is prompting calls for innovative ways both to slow the rate of release of anthropogenic greenhouse gases and to increase carbon uptake and storage: REDD is such an initiative. One critical element for REDD mechanism is knowing the carbon-storage potential of a site, and the factors likely to influence the rate and eventual amount of carbon stored. To date, most nascent REDD initiatives have focused on tropical moist forests because of their large carbon stocks per unit area and the substantial emissions of greenhouse gases that would result from converting

these forests to pastures, cropland, or commercial timber plantations. Much less attention has been paid to the potential for reducing emissions from, and increasing carbon storage in, tropical dry forests, woodlands, and savannas. Although these systems support a lower and more variable woody biomass per unit area they are more widespread than tropical moist forests. This is especially so in Africa where land supporting or capable of supporting dry forest, woodland or savanna covers more than 11 million km<sup>2</sup>, in contrast to 4 million km<sup>2</sup> moist tropical forests and forest-grassland mosaics. When other benefits of protection, such as support for local livelihoods and biodiversity conservation, are taken into account, a case can be made for extending REDD schemes to such areas. We review biomass stocks and dynamics of these systems and evaluate their potential for REDD-type schemes. There is little reliable data on biomass and carbon stocks, most coming from small non-randomly selected plots. Woody biomass is spatially highly heterogeneous, and much degraded by clearing for agriculture. Fire, often in conjunction with deforestation by people or wildlife, is the main factor restricting regrowth of trees to maturity. Nevertheless, dry forests and related systems have the potential to store substantial carbon, if suitably managed. We discuss the complexities of doing this.

#### **V-54-4: Forest Cover and Forest Cover Change in the Congo Basin, 1990-2000-2005**

Daniel A. Slayback<sup>1</sup>, Erik Lindquist<sup>2</sup>, Matthew C. Hansen<sup>1</sup>, Alice Altstatt<sup>1</sup>; *1. SSAI / NASA Goddard Space Flight Center, 2. FAO*

We have recently completed high-resolution wall-to-wall mapping of forest cover and clearing in the Congo Basin for the 1990, 2000, and 2005 time periods. Previous efforts using high-resolution imagery have been unable to generate spatially consistent products across the basin. However, as much landcover change in the basin is driven by small-scale agricultural expansion, a high-resolution product has been needed to evaluate basin-wide change. We implemented a semi-automated approach that uses decision trees and regional forest cover derived from 250-m MODIS satellite imagery to calibrate a higher resolution (30 m) Landsat-based analysis. The approach also uses multiple dates of Landsat imagery to overcome the persistent cloudiness found in much of the basin. The result provides the first consistent high resolution estimates of forest cover and clearing across the Congo basin. Overall we see deforestation rates on the order of 0.1% per year, but a much higher increase in forest edges, as the observed change is fragmenting the landscape. This presentation will review the methodology and present maps and basin-wide statistics for the 1990-2000 -2005 periods, along with localized maps and statistics for the 10 CBFP (Congo Basin Forest Partnership) Landscapes and major protected areas.

#### **V-54-5: Understanding the Impacts of Climate Change on Biodiversity: Lessons from Afrotropical Amphibian Declines along Microclimatic Gradients**

Caleb Ofori-Boateng, W. Oduro, M-O. Rodel; *Kwame Nkrumah University of Science and Technology*

We assessed the composition and diversity patterns of the forest frogs of Ghana along a microclimatic gradient to gain insight into how climate change may affect Afrotropical fauna. The study site was selected to include three forest types (wet, moist and dry) such that species in the different forest types experience different thermal and moisture gradients. Following a stratified random design, several two-hectare plots were selected in each forest type and surveyed for species data for a period of 18-months. Results showed that species diversity does not vary significantly between the different microclimatic zones. However, species composition strikingly differs with loss of several primary forest species in the drier and warmer forest type. Also, abundance of several shared species declined drastically along the wet-dry microclimatic gradient with lower abundance in the drier habitat types. The observed variation in species compositions along this microclimatic gradient is best interpreted in the light of differences in species breeding adaptations to moisture variability and differential physiological tolerances to changing thermal regimes. Rapid declines in species numbers in the drier habitat type may be attributed to both inter and intra species competition for limited ovipositing sites and prey items triggered by prolonged dry periods. This response of amphibians to such microclimatic

variation may serve as an early warning system indicating stresses on vertebrate species in the Afrotropical region prior to more profound changes such as rapid population declines and species extinction.

#### **V-54-6: Dynamics of Monodominant *Aucoumea klaineana* Succession Forests in Gabon and Congo**

Robert Nasi; *CIFOR*

Gabon and Congo abound in monospecific stands of *Aucoumea klaineana*. Changes with age in their floristic composition show succession stages during which pioneer species associated with okoumé are progressively replaced by mature forest species with changes in species richness and abundances. This is rather a shift in species composition with more richness at transitional stage than a real increase in species number after the establishment phase of the forest transgression. Basal area increases and density decreases with age, reaching stable values at ca. 40–45 years then becomes variable in more mature stages. Mortality generally affecting small diameter individuals in the dominated storey is very high in young stands but decreases with age. There is no clear relationship between species composition and abundance in mature forests and that in secondary forest stages for common primary forest species so defined. In all abundance classes, some species become common in secondary forests and others do not, creating possible diversity bottlenecks along the succession stages. The major contribution to the maintenance of tree species diversity in agricultural landscapes comes from people's incorporation or conservation into farming systems of trees with particular uses or values. These trees may be remnants of the original forest or individuals naturally regenerated in the habitat mosaic created by shifting agriculture, in which case they are likely to be pioneer species. The tree species likely to be conserved outside areas of native habitat in a forest-agriculture mosaic landscape are therefore a small subset of the original community. Many forest tree species might be finally lost from landscapes as remnant individuals die and are not replaced. This scenario seems to be the most likely in the great majority of "agroforestry" systems whose contribution to the conservation of vertebrates has generated great interest in the literature.

#### **V-54-7: Ecology of the Two Most Important Commercial Species of D.R. Congo: *Pericopsis elata* and *Milletia laurentii***

Faustin Boyemba, Pisco Menga, Nicolas Picard, Nicolas Bayol, Sylvie Gourlet-Fleury, Jean-Pierre Mate, Robert Nasi; *University of Kisangani*

Studying of timber species populations is necessary to guide forest harvesting practices for sustainable management of Central African forests. What are the suitable growing conditions? How fast the species grow, regenerate? How fast standing volume is recovered after logging? In the D.R. Congo, logging relies almost exclusively on two major commercial species: *Pericopsis elata* (Afromosia) and *Milletia laurentii* (Wengé). These two semi-deciduous forest species have a disjointed distribution with Afromosia frequent around Kisangani (Province Orientale) and Wengé frequent in the Maï-Ndombe region. To study the populations and dynamics of these two species we identified, located and measured the structural parameters of trees greater than 10 cm DBH in a 250 ha plot in the Réserve Forestière de Yoko (Kisangani) for Afromosia and on 54 ha in the SODEFOR logging concession (Maï-Ndombe) for Wengé. The two main species show diverging characteristics confirming their very different ecology: (1) 1 tree/ha, 10 m<sup>3</sup>/ha for Afromosia vs. 9 trees/ha, 30 m<sup>3</sup>/ha for Wengé on average; (2) diameter distribution curve bell-shaped with few individuals (9%) below 30cm for Afromosia vs. inversed J curve with about 50% of individuals below 30cm for Wengé; (3) pioneers represent 50% of the individuals in Afromosia stands; (4) greater spatial heterogeneity for Afromosia. This suggests the need to tailor specifically management rules for the two types of forests for ensuring sustainability.

**V-54-8: Assessment of Damages Inflicted on Plant Biodiversity and Forest Ecosystem by Logging Operations in a Tropical Rainforest in Southwestern, Nigeria**

Adewole O. Olagoke, Victor A. J. Adekunle; *Federal University of Technology, Akure, Nigeria*

Damages inflicted by logging on non-targeted plant species and the forest ecosystem during logging operations (trees felling, crosscutting, skidding, arrangement in the gantry and haulage) was assessed in the tropical forest ecosystem, Nigeria. Data were collected during harvesting of 41 timber species in Owo Forest Reserve, Southwest Nigeria. Well-structured questionnaires were administered on randomly selected 20 tree fellers and 20 timber contractors to extract information on the types and causes of damage to residual plants, and measures to reduce damages. Tree variables were obtained before felling and after felling. All damaged plants during felling, skidding and hauling were enumerated and identified, and the nature and level of damage were determined. Basal area (BA) and volume of trees were computed, and questionnaires data were analyzed to obtain frequency and percentage distribution. The results show that the trees were selectively felled because they are valuable hardwood species for sawn timber. The dbh of the trees varied between 46.2cm and 199.5cm. A total of 154 stems of 26 plant species, distributed among 21 families, and 1,571 stems of herbaceous plant species were damaged during the felling and hauling of the selectively felled trees. During felling operations, neighbouring plants are damaged, the soil is compacted and the ecosystem is disturbed. The observed and reported types of damage to residual plants by the respondents include bole-breakage, stem splitting, de-branching, bark peeling and uprooting and the percentage of damage is between 5 and 70%. Reduced Impact Logging (RIL) and training of loggers are therefore recommended to minimize the menace of logging damages to residual plants.

**V-54-9: Barking Up the Wrong Tree? Conservation, CITES and Controls on Commercial Trade in *Prunus Africana* Bark**

Anthony Cunningham<sup>1</sup>, Terry Sunderland<sup>2</sup>; *1. Cunningham Consulting WA (Pty) Ltd, 2. CIFOR*

Based on an examination of the history of international trade in *Prunus africana* bark since the early 1970's, this paper evaluates the conservation policies and practices that have been attempted to solve unsustainable bark harvests. These range from harvest rules implemented by commercial companies, national forest departments, the European Union and CITES, with varying levels of success. Although *Prunus africana* has been successfully cultivated in plantation trials in Kenya since 1919, efforts to sustain supplies in all African countries have focused primarily on wild harvest. This contrasts with large scale commercial production of most commercially harvested bark products, such as black wattle, cinnamon, cassia and quinine, all of which had to shift from wild harvest to commercial plantations in order to sustain commercial demand. In the case of *Prunus africana*, despite CITES Appendix II listing in 1995, the management of wild harvesting has largely been unsatisfactory and, arguably, unsustainable. In addition, internationally funded attempts to shift production to agroforestry systems and plantations have met with mixed success. In concluding this paper, we make recommendations that take these past experiences into account, suggesting practical steps that need to be followed to avoid repeating problems that have already been experienced in the past across montane Africa and Madagascar.

**V-54-10: Ecological and Social Feasibility of Commercializing a New Non-timber Forest Product from Namibia: *Colophospermum mopane* (Fabaceae) Seeds**

Laura Shiels, Tamara Ticktin; *University of Hawaii at Manoa*

Selling non-timber forest products may improve living standards in developing nations while preserving ecosystem function, biodiversity, and human cultural diversity. However, social and ecological feasibility of such endeavors need investigation prior to implementation, particularly in the under-studied arid tropics. *Colophospermum mopane* (Fabaceae), endemic to southern Africa, is the dominant woody species in arid northern Namibia and critical to ecological processes and human livelihoods there. Wood but not fruit of *C. mopane* is heavily utilized by local people. We



investigated social acceptability and *C. mopane* population structure, stand density, and fruit production at six sites in northern Namibia from August 2005 to August 2006 to assess feasibility of internationally marketing seeds of the plant. We observed very few *C. mopane* seedlings within the 150 study plots, and *C. mopane* population structures differed significantly among sites ( $P < 0.001$ ) and between the interior and exterior zones of villages ( $P < 0.001$ ). This indicates that *C. mopane* recruitment and survival is spatially variable and related to human habitation. Stand density and fruit production of *C. mopane* did not differ significantly among sites. Size of a *C. mopane* plant best predicted fruit production ( $P < 0.001$ ), rather than growth form, stand density, damage, or parasite infestation. Average *C. mopane* fruit production,  $27,434 \pm 4669$  fruits/ha  $\pm$  SE was similar to that of other aridland woody species successfully commercialized in Africa. The high frequency of vegetative reproduction at all sites, and apparently rare recruitment events from seed, suggest that appropriately managed *C. mopane* woodlands can sustain some fruit harvest without affecting the population structure. Furthermore, *C. mopane* seed commercialization was well supported by local people and may provide valuable income in several developing nations providing for food security and sustainable development options.

## **The Praxis of biodiversity conservation in conversion landscapes: A SLOSS debate for the 21st century (#55)**

**(July 21 pm; Wantilan wing)**

Organized by: **Gary D. Paoli**

*Conversion of natural areas to mono-culture plantations for food, fiber and biofuels is among the most significant long term threats to biodiversity in the tropics, second only to global climate change. Estate crops of oil palm, Acacia, soy and sugarcane are replacing forest areas in mega-diverse regions of the Amazon, Indonesia and Congo Basin, causing direct habitat destruction, population fragmentation and increased susceptibility to drought and fire.*

*Growing recognition of this threat by consumers, producers and policy makers, however, has created the unexpected opportunity to transform enlightened corporate members of these industries to mitigate such impacts, and even transform select industry leaders into responsible biodiversity stewards.*

*To this end, biodiversity conservation is being actively pursued in conversion landscapes by conservation practitioners on-the-ground, and vigorously debated by conservation scholars on-the-pages of peer reviewed scientific journals.*

*Two broad paradigms are being debated that differ in the emphasis placed on off-site versus on-site biodiversity gains. The so-called 'land sparing' approach advocates putting plantations on degraded lands for 'pure production' purposes, thereby maximizing output and alleviating pressure to convert more intact, high biodiversity areas elsewhere. An alternative, more holistic approach sees plantations as multi-purpose landscapes, valued not only for commodity production but also biodiversity protection, achieved by retaining a mosaic of 'designer landscapes' elements, including set asides, riparian buffers, and agro-forestry corridors within the plantation.*

*Key philosophical and practical points of difference relate to set-aside ('reserve') size, species representation, population viability, hunting pressure and resiliency to climate change, concerns not unlike the SLOSS (Single Large or Several Small) Debate of the 1970s and 80s, albeit with more pronounced social factors today.*

*This symposium aims to address a number of key questions and tough choices relating to the practice of biodiversity conservation in plantation landscapes.*

### **V-55-1: Conservation Set-asides in Anthropogenic Landscapes: Benefits to Bat Diversity and the Effects of Landscape Subsidies**

Matthew J. Struebig<sup>1</sup>, Tigga Kingston<sup>2</sup>, Adura Mohd Adnan<sup>1</sup>, Zubaid Akbar<sup>1</sup>, Stephen Rossiter; *1. FFI Indonesia / Universiti Brunei Darussalam, 2. Texas Tech University*

Retaining habitat fragments as conservation set-asides within agricultural land is perceived as a valuable ‘wildlife-friendly’ management practice, and has received renewed interest following accelerated conversion of rainforest to oil palm. However, the value of this approach over protecting large habitats outside the agricultural matrix has been questioned. Small fragments typically support fewer species and smaller populations than larger fragments, and remaining species are susceptible to declines in genetic diversity and incur associated fitness costs. We provide evidence of simultaneous area-dependent declines in both bat species and genetic diversity in habitat fragments in Malaysia, and show that the magnitude of allelic loss across fragments varies among species with different dispersal capabilities. We quantify the biodiversity value of retaining fragments of various sizes and show that for the most sensitive taxa, conserving genetic diversity at levels typical of pristine forest could require habitats that are 30-fold larger than those needed to safeguard equivalent levels of species richness. The long-term survival of wildlife in anthropogenic landscapes is further confounded by the extent to which declining fragment diversity can be ‘rescued’ by subsidies from sources of species associated with other landscape elements, such as karst outcrop for bats. Directing mitigation efforts towards small fragments within plantations rather than large habitats elsewhere should not be viewed as mutually exclusive conservation strategies. Ideally, mitigation investments should be part of a landscape-wide conservation strategy in which small habitat fragments and key (large) landscape elements are conserved and linked through corridors to promote connectivity among adjacent large areas.

### **V-55-2: Do increases in agricultural yield spare land for nature?**

Robert M. Ewers<sup>1</sup>, Jorn P. W. Scharlemann, Andrew Balmford and Rhys E. Green  
; *1. Imperial College London*

Feeding a rapidly expanding human population will require a large increase in the supply of agricultural products during the coming decades. This may lead to the transformation of many landscapes from natural vegetation cover to agricultural land use, unless increases in crop yields reduce the need for new farmland. Here, we assess the evidence that past increases in agricultural yield have spared land for wild nature. We investigated the relationship between the change in the combined energy yield of the 23 most energetically important food crops over the period 1979–1999 and the change in per capita cropland area for 124 countries over the same period. Per capita area of the 23 staple crops tended to decrease in developing countries where large yield increases occurred. However, this was counteracted by a tendency for the area used to grow crops other than staples to increase in the countries where staple crop yields increased. There remained a weak tendency in developing countries for the per capita area of all cropland to decline as staple crop yield increased, a pattern that was most evident in developing countries with the highest per capita food supplies. In developed countries, there was no evidence that higher staple crop yields were associated with decreases in per capita cropland area. This may be because high agricultural subsidies in developed countries override any land-sparing pattern that might otherwise occur. Declines in the area of natural forest were smaller in countries where the yield of staple crops increased most, when the negative effects of human population increases on forest area were controlled for. Our results show that land-sparing is a weak process that occurs under a limited set of circumstances, but that it can have positive outcomes for the conservation of wild nature.

**V-55-3: Designer Landscapes for Pil-palm: How Useful are Forest Fragments?**Keith C. Hamer; *University of Leeds, UK*

Expansion of agriculture is a principal driver of biodiversity losses in the tropics, prompting suggestions that plantations should be made more hospitable to wildlife. Such 'wildlife-friendly' practices contrast with the alternative 'land sparing' strategy, which promotes separation of agricultural and conservation areas. Focusing on the wildlife-friendly strategy of retaining fragments of forest within the agricultural matrix, here I report the results of collaborative research projects examining the density and diversity of birds and butterflies within oil palm plantations, contiguous forest and forest fragments of different sizes. Results are then discussed in terms of the contribution that fragments make to landscape-scale diversity, and the best strategies for advancing conservation at the landscape level.

**V-55-4: Prospects for the Long-term Survival of Tropical Forest Biodiversity in Conversion Landscapes**Richard T. Corlett; *National University of Singapore*

Surveys of recently converted landscapes may give a misleading impression of the ability of such areas to support elements of the tropical forest biota over the longer term. Tropical East Asia provides many examples of landscapes that were converted from forest at various times in the past, including the progressive deforestation of southern China over the last millennium and the ecological transformation of Singapore within the last 200 years. These examples suggest a grim outlook for the long-term survival of tropical forest biodiversity in unmanaged conversion landscapes, with the loss of all large vertebrates and a large fraction of the diversity in most other groups. Such retrospective studies of human impacts have many inherent limitations, including an inability to separate the cumulative impacts of deforestation, fragmentation, forest degradation, hunting, and invasive species on the surviving biota, thus making it difficult to use these data in designing potential mitigation measures. Some lessons appear robust, however, including the crucial role of hunting in limiting the survival of large vertebrates and the very slow recovery of biodiversity in extensive secondary forests on abandoned cultivation. Another worrying trend that needs further study is the increasing tendency for alien species to dominate in disturbed landscape mosaics, with unknown implications for the long-term potential for landscape recovery.

**V-55-5: Assessment on Kusan Hydropower and Transmission Line Impact to the Rare and Protected Species of Flora and Fauna in Kalimantan Selatan Province**

Jarot Arisona<sup>1</sup>, Suyud W. Utomo<sup>2</sup>, Ridwan Djaffar<sup>1</sup>, Dwi Susanto<sup>1</sup>, Tri Agustini<sup>1</sup>, Nugroho Sumanto<sup>1</sup>, Andi Maryanto<sup>1</sup>, Ni Made Rai Intari<sup>1</sup>, Dimas Pradana<sup>1</sup>, Sunarya Wargasmita<sup>1</sup>, Toni<sup>1</sup>, Yoyok Prayogi<sup>1</sup>, Subekti Widodo<sup>1</sup>, Elly Arwani<sup>1</sup>, Aditya Pratama<sup>1</sup>, Hadian Sasmita<sup>1</sup>, Suriyanto<sup>1</sup>; *1. Department of Biology, University of Indonesia, 2. CRHDE, University of Indonesia*

The Provincial Government of Kalimantan Selatan plans to build a 65 Megawatt hydro power. The project include DAM construction which is predictable will inundate 8km<sup>2</sup> of forest into reservoir and transmission line across protected forest. As a prerequisite, an environmental impact analysis must be prepared, particularly project impacts on endangered and protected species of flora and fauna. The survey has been conducted on July 2009 (dry season) and November 2009 (rainy season) in seven observation sites in Kusan River and surrounds. Survey result indicates that Kusan river and surrounding forests have high biodiversity. We recorded 35 species of protected plants (some have economic value and known as a keystone species), 24 species of protected mammals including five endemic primate species of Borneo, namely *Nasalis larvatus*, *Hylobates muelleri*, *Presbytis rubicunda*, *Presbytis frontata*, and *Nycticebus menagensis*, 137 species of birds (44 species are protected), 15 species of reptiles (2 species are listed in Appendix II of CITES), 32 amphibian species (8 species endemic), 30 species of fish (5 species endemic) and 17 species of butterflies (6 species listed in Appendix II of CITES). Mapping and data analysis indicates high impact of dam and transmission

line to the biodiversity. Impact of dam include habitat change as dam construction will change flowing river into stagnant lake, build a barrier between the upstream and downstream habitat of migratory fish and other river animals, floods the existing plants along the rivers, creating unnatural ecosystem to endemic species, reduced water level, homogenization of river flow and thus reduced ecosystem variability, and reduced support for wildlife. Impact of transmission line includes land clearance and fragmentation of protection forest. We recommend some mitigation to minimize impact including reforestation, establishing green belt, green corridor and long term monitoring program.

#### **V-55-6: Utilization and Enhancement of Agrobiodiversity in Oil Palm Landscape: Linking Conservation and Sustainable Production**

Henny Hendarjanti, Bandung Sahari, Satyoso Harjotedjo, Bambang Palgoenadi; *PT Astra Agro Lestari*

Oil palm landscape is a complex ecosystem containing a high extent of agrobiodiversity that provides various ecosystem services. Natural control of pest by existing natural enemies, such as predators, parasitoids, entomopathogenic microbes and fungi is an important service that can be used to enhance crop productivity. Some alternative methods have been well established to maintain these natural enemies. Integrated Pest Management is a powerful approach not only for maintaining lower pest population, however it can also be applied to restore functioning ecosystem component. Early warning system (EWS) has been developed to monitor pest attack, estimate pest population, and identify ecosystem quality. Habitat management through enhancement of non crop vegetation is developed. Several flowering herbs, such as *Turnera subulata*, *Turnera umnifolia*, *Cassia tora*, dan *Antigonon leptopus* are identified as beneficial non crop vegetation that can be used to maintain parasitoids community in the field and providing alternative preys and alternative habitat for insect predators. Development of ecological infrastructure model is a critical homework to ensure the sustainability of natural control services. Implication of overall works toward the conservation of agroecosystem are discussed.

#### **V-55-7: The Importance of Rainforest Fragments and Their Associated Ant and Parasitoid Wasp (Hymenoptera) Fauna to Oil-palm Plantations**

Timothy D. Cockerill, William A. Foster, Gavin R. Broad, Chey Vun Khen; *University of Cambridge*

The pressure on natural habitats of conversion to agriculture has never been greater. In Malaysia, home to some of the world's most highly biodiverse rainforests, this pressure is exemplified by the threat of conversion to plantations of the highly versatile and valuable crop, oil palm (*Elaeis guineensis*). Across such landscapes, there often exists a matrix consisting of fragments of natural habitat within or adjacent to agriculture. Although important in maintaining biodiversity across otherwise agricultural landscapes, little is known of whether these fragments provide benefits to the plantations within which they are found. These fragments of natural habitats such as rainforests can have wider value to agriculture by providing ecosystem services. The provision of natural enemies to agricultural pests could be enhanced by areas of high biodiversity adjacent to plantation land, as has been shown to be the case with the provision of pollinators in some tropical crops. Insect parasitoids and predators are a particularly important subset of the natural enemies of insect pests in such a situation. Here we present data from Sabah, Malaysia, describing the diversity and abundance of ants and parasitic Hymenoptera at increasing distances from rainforests into adjacent oil-palm plantations. Also presented are data describing similar transects measuring levels of herbivory of oil palms close to and further away from the forest boundary. These, combined with data on host-parasitoid association obtained from rearing parasitoids from pest larvae, will allow estimations of the value of forest fragments that are left standing rather than converted to plantation. As the conservation of biodiversity relies increasingly upon sparing fragments of highly valued habitats within an agricultural context, the value of such fragments to agriculture becomes of key interest. These data suggest that fragments of natural habitat could have an important and valuable role within agriculture.

### **V-55-8: The Goldilocks Hypothesis -- Does 'Sparing Land for Nature' Lack a Credible Political Economy?**

Michael J. Chappell; *Cornell University*

Proposals for biodiversity conservation have broadly coalesced around two paradigms: "Land sparing" and "Wildlife-friendly farming." Despite numerous existing critiques and support for both positions, one question that seems to have been insufficiently addressed is "can land sparing work"? Despite some recent evidence for a correlation between yield and land-sparing, its basic conceptualization seems to founder on several counts in basic terms of socioeconomic reality: 1) Food (and fuel and fibre) production in the current world system is not predicated on making "enough", but rather ever-increasing throughputs; this is reflected in part by the widespread malnutrition seen today in the face of sufficient global, and often national and regional food production. Food is not "demanded", in economic terms, by the poor and hungry but rather by those with the money to make their demand count in the market, and expanding "solutions" for the "problem of the limited stomach" seem to abound, thus there is little reason to think that making more product on less land will slow land expansion (or resource use generally). Indeed, 2) intensification has been shown in a number of cases to further increase land expansion, following elementary economic principles predicting that a system demonstrating increasing return on investment will attract others to buy into and expand on this system, and empirical investigations have shown this pattern to be extant in numerous (but not all) cases. 3) Because food production per se is at best weakly tied to hunger reduction in most cases, land sparing fails to realistically address the other problem it is nominally targeted at. Given these factors and evidence, I posit that it behooves conservationists and any concerned with social justice to work to tie production to equitable distribution, among other factors, rather than intensify a system known to have severe consequences for biodiversity alongside notable failures to reduce hunger.

### **V-55-9: Examining Larger Spatial and Temporal Scales of Biodiversity Conservation in Conversion Landscapes**

Mark Leighton<sup>1</sup>, Philip Wells<sup>2</sup>, Gary Paoli<sup>1</sup>; *1. Harvard University Extension, Cambridge, MA, USA, 2. Daemeter Consulting, Bogor, Indonesia*

Scientific understanding of the ecological processes that determine the distribution and persistence of species, their assemblages and habitat mosaics should be the basis on which policies are made for incorporating biodiversity conservation within forest conversion landscapes. This proposition, however, is more easily said than done. The legacy of historical biogeographical processes creates broad-scale patterns of biodiversity sub-structure that, if well understood, can aid in the setting of conservation targets across a region (e.g. Amazon) or island (e.g. Borneo). Yet, even within a biogeographical region, heterogeneity of climate, elevation, geology and soils can lead to complex fine scale patterns of biodiversity, whose origins and persistence are only poorly understood. Two questions of critical importance to biodiversity conservation in conversion landscapes concern (i) the extent to which ecological communities are dependent on processes operating at spatial scales larger than a typical plantation landscape, and (ii) the long term prospects for biodiversity persistence when such processes are severed. Wide-ranging keystone predators, seed dispersers and pollinators illustrate dependency on ecosystem integrity and large scale interactions for long term persistence, and may be especially challenging to manage in conversion landscapes. The frequency of local extinction and recolonization events are similarly important processes, whose dynamics can be highly dependent on spatial structure and extent. How can this broader lens on biodiversity conservation be incorporated into bioregional spatial planning, where conversion and its consequences are evaluated on a limited site basis? We explore these questions with special reference to Borneo, drawing on recent advances in ecological theory, empirical studies on fragmentation, and spatio-temporal patterns of deforestation over the past 20 years to draw attention to areas where long term prospects for conservation within multi-functional forest landscapes likely remain high.

## V-55-10: The Praxis of Biodiversity Conservation in Conversion Landscapes

Gary Paoli; *Daemeter Consulting*

Conversion of natural areas to monoculture plantations for food, fiber and biofuel is a leading threat to biodiversity in the tropics. Estate crops of soy, sugarcane, oil palm and Acacia are replacing forest at a rapid pace, causing direct habitat loss, population fragmentation and increased susceptibility of forest to drought and fire.

Reflecting growing awareness of this threat by consumers, producers and commercial lenders, corporate commitments to third-party voluntary certification schemes have surged in popularity, creating an opportunity for conservationists to work with corporations to mitigate plantation impacts. Prominent examples include the Roundtables on Sustainable Palm Oil (RSPO), Responsible Soy (RTRS) and Biofuels (RSB).

Corporate commitments to nature conservation are generally viewed in a positive light by most conservationists, especially in regions where governmental regulation of forest resources is weak. Critics of big business are understandably skeptical, however, and experience to date shows that significant biological, economic, social and political constraints must be overcome for private sector engagement to deliver lasting, positive biodiversity outcomes.

This presentation describes these limitations, drawing upon research and case studies to highlight areas where biological knowledge remains incomplete; where government policy often works to undermine conservation efforts in conversion settings; and where difficult choices must be made in the face of incomplete data and trade-offs among cost, long term prospects for success and local socio-political realities. Ultimately, the merits of this approach should be judged on its achievements, and this will require greater transparency on the part of both private sector actors and their conservation partners.

## Living with Nature; lessons from Bali ('Tri Hika Karana') and Japan ('Satoyama') (#56)

(July 20 pm; Jauk)

Organized by: **A. A. G. Raka Dalem**

*In many ways human activities have polluted and have been disastrous to nature. Illegal logging, land clearing, discharging of untreated sewage into waterbodies, inefficient use of natural resources, etc has been a global concern. This causes problems, such as land slides, water pollution, decrease of biodiversity, and extinction of species. Burning of fossil fuel have increased the release of carbon dioxides and other ozone depleting substances into the atmosphere which then causes global warming.*

*The concern about environmental problems has increased recently. Now people are asked not only seeking for money but also looking after the environment, and in their daily lives should also be friendly with local culture. This triggers the emergence of the movements of ecotourism, green productivity, and push the people to live in harmony with nature.*

*Some efforts have been conducted internationally as an alternative solution on environmental problems occurring recently. Implementation of programs for achieving MDGs, declaration of 2010 as The International Year of Biodiversity (IYB) are examples of the efforts. "Environmental sustainability" becomes one of 8 Millennium Development Goals (MDGs).*

*Implementation of Green Globe or ISO 14001 certifications are also other alternatives for creating sustainable development. These certifications have been widely participated by industries and other parties. The Government and Non Government Organization (NGO) have also had an important role in this issue. Implementation of programs to achieve MDGs 2015 has also been one of solutions in looking after the nature.*

*Managing nature by living in harmony with nature based on indigenous knowledge has also been encouraged. This include the implementation of the concept of Satoyama in Japan, Tri Hita Karana (THK) philosophy in Bali-Indonesia, etc. In Bali, for example, the movement for implementation of the philosophy of THK (THK means three sources of happiness/wealthiness, as a result of harmonious and balance relationship between human being and the God, human being and other humans, and between human being and the environment) has been considered to be very important in creating a harmonious life with nature and sustainable life in the future.*

### **V-56-1: Yucatec, Mopan and Kekchi Domestic Gardens are Biodiversity Hotspots**

David G. Campbell<sup>1</sup>, John Guittar<sup>2</sup>, Sarah Batterman<sup>1</sup>, Chantale Clarke<sup>1</sup>, Dan Lesh, Devan McGranahan, Karen S. Lowell; *1. Grinnell College, 2. University of Michigan*

Maya domestic gardens, being of complex architecture and phenology, are repositories of native plant species and the ethnobotanical traditions that pertain to them. We examine the alpha and beta diversities of 10 Yucatec, 10 Kekchi and 10 Mopan Maya domestic gardens in western and southern Belize in order to evaluate their ecosystemic service as refuges for flowering plants. In total, our data set embraces 37,700 individual plants, consisting of 645 species, 515 of which are native to Belize. We demonstrate that Maya domestic gardens are botanical hotspots that are richer in species (including native species) of flowering plants than the subtropical forests that surround them. They derive from a biophilia – sustained since precolombian times – that we regard to be as great a legacy as late classic Maya mathematics, architecture and astronomy. For purposes of their economic utility to the Maya, these gardens function as anthropogenic extractive reserves. Moreover, these gardens – intergenerational devotions that have endured for thousands of years - may be the antecedents of the contemporary Maya Forest, making that forest, in effect, a feral domestic garden. In Cayo District, western Belize, we use nonmetric multidimensional scaling ordination to affirm the feasibility of this hypothesis, comparing the species compositions of woody plants in the 10 Yucatec gardens vs. those of three edaphically dissimilar samples of Maya Forest.

### **V-56-2: The Ecological Deterioration of Satoyama**

Dr. Ir. Ardhana I Putu Gede, M.Agr.Sc; *University of Udayana*

The objective of this article is to examine the ecological deterioration of “Satoyama” that is presented in the form of descriptive case study approach and literature approach to collect reading materials which related in this object through the website of internet. The meaning of Satoyama is the mountains near the village. The mountains are put in the ecosystem that is influenced by the life of the communities. Actually, since 5000 years ago inhabitant of Japan already knew and maintained their forests in harmony. They lived around the fields near the rivers. Approximately 2000 years ago they began to plant rice in their field. Harmonious relationship between humans, forests, land and water ran from year to year in tradisional ways, they utilized the environment as wise as they could. Such conditions made Satoyama as traditional wisdom of use. Due to population growing forest conditions gradually began to change. The forest encroachment and logging for building materials of the giant castles and fuelwood destroyed forest in Japan widely. With the development of science and technology the economic value of forest in Satoyama have been influenced negatively. In short since the early 1960s years Satoyama has no economic value anymore and the traditional wisdom Satoyama society began to fall down, so the economical thinking take precedence because the rapid growth of population and development science and technology. At this time many Satoyama areas have been changed shape and it has been converted to land for housing development on a large scale into the “New Town” by the big city like: “Sendri New Town” area of North Osaka “Tama New Town” area

of West Tokyo “Sumboku New Town” area of South Osaka Keyword: Satoyama, Traditional Wisdom, The Decline of Ecology.

### **V-56-3: Conservation of Local Flora Kayu Pala (*Dipterocarpus hasseltii*) through Religious or Traditional Utilization in Bali**

I Gusti M. Tantra; *Ministry of forestry, Republic of Indonesia*

Bali Island is well known as world tourist destination, it has a rich culture. In its culture which dominantly related to Hindu (Bali) religion, the Balinese communities generally believe in a life concept called trihitakarana. A concept in which (1) the people should pay tribute (devote their life to serve Ida Hyang Widi Wase? (God Almighty), this could be witnessed in Hindu Balinese everyday life with religious offerings in many places and temples and practice many religious ceremonies within their entire life; (2) to be friendly with people and general society and (3) living in harmony with their environment or nature. Some natural floristic components such as kayu pala (*Dipterocarpus hasseltii*, Dipt.), its fruit has been utilized in their some religious life which have sustained the plants existent in Bali. In this example, the utilizations itself could serve as conservation in-situ and ex-situ. To name some of other plants which their parts are also very commonly utilized, are coconut (*Coconut nucifera*, Palmae), jake (*Arenga pinnata*, Palmae), many kind of flowers and fruits from other plants; the other are some quite rare (not common) plants in Bali like the kayu pala (*Dipterocarpus hasseltii*, Dipt.) and majegau (*Dysoxylum densiflorum*, Meliac.). The kayu pala in particular, in Bali later- on have been conserved in the ex- Sangeh Nature Reserve (now is called Sangeh Natural Tourism Park) and in other small temple forest called Pura Dalem Sawah, Kuwum village, Badung District and in that particular society their farmer group is even called 'Pala Sarwa Nadi' which is related to the local name of the *Dipterocarpus hasseltii*. The kayu pala itself is one of big trees in the National Park of Bali Barat and one of the main forest trees and timber producer in the lowland rainforest of Kalimantan and Sumatra. The species is also to be found in the some mixed lowland forest of Java, Lombok and Sumbawa.

### **V-56-4: Demographic Changes and Behavioural Ecology of a Commensal Long-tailed Macaque Population at Padangtegal, Bali (Indonesia)**

Fany Brotcorne, Marie-Claude Huynen, Wandia I. Nengah, Agustin Fuentes, Roseline Beudels; *University of Liege, Behavioural Biology Unit*

The current anthropic pressures lead to a growth of the commensalism phenomenon with primates and humans interacting and competing for space and food. As these situations generate inter-specific conflicts, an extensive analysis seems essential for primate conservation issues. Bali (Indonesia) is characterized by a high density of long-tailed macaques (*Macaca fascicularis*) living in association with humans. The macaque population of the Padangtegal Monkey Forest (Ubud) has been the focus of successive studies since 1986 (Wheatley, 1986; Fuentes et al., 2007). Here, we present updated data (September-December 2009) on demography, activity budget and diet of this population while analyzing variations over time. The macaques at Padangtegal showed a substantial population growth over the last thirty years (34% average growth every 6 years). In 2009, we listed 498 individuals split in 5 groups with an average adult sex ratio of 1:4,5. The home range size also increased over time (7ha in 1986 vs. 30ha in 2009) but was finally limited by surrounded human infrastructures. Consequently, the population density doubled in the course of the last 8 years and counted 16.6 macaques per hectare in 2009. On the other hand, the activity budget pattern appeared quite stable over time with a large proportion of time spent inactive and socializing and a relatively small proportion of time spent in feeding activities. This activity pattern is characteristic of provisioned primate populations. Finally, the diet composition slightly varied over time except for the radical decrease of provisioned carbohydrate-rich food proportions, following some management decisions. Macaques at Padangtegal thus show some stability in their behavioural ecology despite considerable changes in demography. Nevertheless, these positive population trends do not protect macaques from



some long term risks tied to commensalism, such as inbreeding depression and increased probability of disease transmission.

#### **V-56-5: The Philosophy of Tri Hita Karana and Its Implementation for Sustainable Development in Bali: A Case Study on Tourism Sectors**

Anak Agung Gede Raka Dalem; *Biology Department, FMIPA, Udayana University*

Tri Hita Karana (THK) is a balance and harmonious Balinese life philosophy. The words of THK means three sources of happiness or wealthiness, namely: an harmonious and balanced relationship between humans and the God, between humans and other humans and between humans and the environment. This philosophy is in line with the global vision of sustainable development. In Bali, THK has been frequently spoken and discussed in seminars or workshop but rarely spelled out in indicators and measure, so its implementation hard to measure. Based on a result of an international seminar and workshop on the THK in year 2000, the philosophy of THK was spelled out in issues related to sustainable development. Thirty urgent issues determined. Indicators and measures for sustainable development was then spelled out based on these issues. In addition, a benchmark was set up. Based on measures and benchmarks, implementation of THK on tourism sectors was measured and benchmarked. Results showed a variable degree of implementation of THK on tourism sectors. Key words: Tri Hita Karana, environment, sustainable development, tourism, local values, Bali

#### **V-56-6: Brief Overview on Research of Medicinal Trees from Tropical Rain Forests of Indonesia**

Titiek Setyawati; *Kementerian Kehutanan, Puslitbang Hutan dan Konservasi Alam*

ABSTRACT Medicinal plants have been so popular recently since one of the benefits from the Indonesian tropical rain forest is producing non timber forest products. In addition, knowledge on medicinal plants is mainly generated from non-tree species such as herbs, undergrowth, liana, non-woody and other species that is easy to collect from the wild. Thus focus of medicinal plant in our institution was on trees. Research on medicinal trees species has been carried out in several forest areas since 1997 either in or outside Java island but it was limited only for inventory and species description including its utilization based on the information from the local community using the medicinal trees. A number of problems was identified through studies carried out by researcher from Center for Forest Research Development and Nature Conservation in Bogor. From these problems the author has tried to look at challenges and opportunities that derived from them. This paper discussed on the progress of research concerning to tree for medicinal purposes including past and present activities as well as the research needs for the future of this traditional medicine. Keywords: Medicinal plants, non timber forest products, Java, local community.

#### **V-56-7: The Dangerous Underappreciation of Rain Forest Biodiversity for Future Human Wellbeing**

P. S. Ashton

Tropical rain forest diversity has arisen and is maintained by the interactions of tree species and their insect pests and microbial pathogens. The war continues through the evolution by plants of complex defensive chemicals, and their degradation by chemicals evolved by insects and microbes. These have, on occasion, provided important starting points for research into development of new pharmaceuticals, usually by large well capitalized international companies. Often ignored, though, is that such chemicals provide vital information, and their organisms vital gene sequences, for protecting tropical crops, particularly woody crops. If we fail to conserve rain forest biodiversity, we threaten the future of tropical woody crop diversity. The steadily increasing extinction of temperate tree species at the hands of introduced pests and diseases from other regions should serve as a warning.

**V-56-8: Wakatobi People Live in Harmony with Marine Environment: A Lesson Learned**

Hugua

A traditional knowledge and practices relate to environmentally sound have been practiced with a broad meanings, but because of they could not state in term of scientific terminology, so they did not publish and well documented unlike a statement of scientist or politicians. However, event through a lot people understand but they don't have commitment for a better environment. The Wakatobi people is one of the rest of last people in the world who practicing a harmony living with the nature especially to coral reef ecosystem through their culture, called "maritime culture" which eventually experiencing the people to love marine environment. They maintained coral reef and its' associate ecosystems. As we all know Wakatobi situated at the center of "Coral Triangle Center" (CTC) which well-known as the global epicenter of marine life abundance and diversity, with more than 750 known coral species, 942 coral fish species, spawning and juvenile growth areas for the world's largest tuna fishery. Moreover, the biological and geographical conditions within the CTC may also enable the region to maintain its exceptional productivity in the face of future impacts of climate change, making it potentially the world's most important "refuge" for marine life. Ensuring the resilience against climate change impacts and sustainability of the CT region – all parts of it – is crucial for the fish production and food security for the entire Western Pacific and East Indian Oceans. Therefore, the Wakatobi people could conserve the world's importance resources within the CTC and if be valued economically, they could support food security, income non-tax and coastal protection for about 120 millions people, provide income from marine ecotourism of \$ 2.3 billion/year and spawning of tuna \$ 3 billion per year, and other importance's. In conjunction with this situation Wakatobi people have had played an important role to conserve the valuable resources for the sustainability of Coral Triangle Center. As you know, the Year 2010 has been declared the International Year of Biodiversity (IYB) by the United Nations. The celebrations of the International Year of Biodiversity with activities and events that have been launched and will take place in many countries around the world a year-long in 2010 are a unique opportunity to raise public awareness about the vital role of biodiversity sustaining life on Earth and supporting ecosystem services, and of its importance to human wellbeing and poverty reduction. In conjunction with the international biodiversity year, the United Nations should provide "A reward" for the people of Wakatobi who success could heritage the high diversity for the world happiness'. In order to explain more detail about how Wakatobi people live in harmony with` the nature, I will described and demonstrate various attraction culture which show environmentally sound actions to conserve and utilize the marine resources in the Wakatobi. In conclusion, practicing the environmentally sound actions performed by Wakatobi people, so the potential resources within the center of CTC be conserved and utilize in sustainable manner, and therefore, the resources maintained and existed to be explored and enjoyed by new generation. Homely, with advanced innovation technology developed now, it could conserve and maintain the existences of these important resources for the future of Wakatobi and happiness' of the world.

**Orangutan ecology, behavior and conservation (#58)****(July 21 am + 21 pm; Mercure)**

Organized by: Rondang S. E. Siregar, Damayanti Buchori, Noviar Andayani, Cheryl Knott

**V-58-1: Primate Diversity and Abundance in Two Protected Forests of East Kalimantan**Roberto A. Delgado; *Anthropology / Biological Sciences, University of Southern California*

A widely recognized and accepted approach for establishing conservation priorities is to identify biodiversity hotspots, generally regarded as areas with high levels of species richness, endemism, and imminent threat. Previous studies have examined patterns of primate diversity with implications for choosing favored conservation areas and there has been some discussion as to the value of using

primate taxon richness as an index of diversity on a larger, regional scale. Because accurate and reliable data are needed to evaluate the conservation status of species, the overall goal was to assess primate diversity and relative population abundance at two protected forests in East Kalimantan, Indonesia. Specific aims included collecting data on forest structure, habitat use, and measures of potential resource availability at Lesan and Wehea. Additionally, given the dire conservation status of the orangutan, the project sought to determine their relative population density at these two sites. Line transects and nest surveys were conducted to collect data on primate distributions and abundance, whereas vegetative sampling was performed to characterize habitat and, where possible, gauge levels of disturbance. Although fewer primate species were encountered at Wehea than Lesan (4 vs. 6), the overall relative abundance of primates was twice as high at Wehea (0.47 parties/km) than at Lesan (0.23 parties/km). Historical hunting pressures at Lesan, but not Wehea, are a leading explanation for the observed patterns, though seasonal changes in habitat use and ranging behavior cannot be excluded. Hence, further longitudinal studies are necessary. Findings from this study have implications for developing and implementing strategies for identifying forests with high conservation value, making recommendations for wildlife conservation and management, and establishing protocols for long-term biological monitoring.

### **V-58-2: Learning from Local Knowledge: Statistical Modelling of a Village-based Questionnaire on Orangutan Distributions, Threats and Interactions in Kalimantan, Indonesian Borneo**

Jessie Wells<sup>1</sup>, Erik Meijaard, Anton Nurcahyo, Kerrie Mengersen, Damayanti Buchori; *1. The Ecology Centre, University of Queensland*

The 2009 survey of orangutans in Kalimantan is one of the most comprehensive endeavours to elicit information about an endangered species from local villagers. The survey of villagers' knowledge and experiences was conducted by The Nature Conservancy with APAPI and 18 local organizations, and encompassed all regions in Kalimantan with suspected orangutan presence, excluding specific areas (e.g. national parks) for which data already exist. The survey was based on a questionnaire delivered to ten residents in each of 687 villages, selected from approx. 1500 villages (~40% sampling), stratified by high/medium/low threat of landuse change. All high threat villages were included; others were selected randomly. The survey questionnaire comprised 32 questions and 34 optional sub-questions that were critically reviewed by orangutan experts, then confirmed in an international workshop in Jakarta. Questions were translated from English into Indonesian and entered into palmtops, and finally reviewed during field trials and training workshops. The questionnaire was divided into sections focusing on basic information; assessment of interviewee reliability; presence and abundance of orangutan; perceived changes in the past decade; local threats due to forest loss or hunting; and views on forest use and management. The survey data was analyzed using a range of multilevel mixed models, with levels corresponding to respondents, villages and provinces. A Bayesian framework was used to develop estimators of presence, relative abundance, conflict and threats based on individual responses and village-level environmental and social data; to accommodate sources of bias and uncertainty; and to describe spatial and temporal features of the data. Results of this modelling and analysis include estimates of the presence and reported relative abundance of orangutans throughout their Kalimantan range, and associated conflict and threats as perceived by the villagers who coexist with them.

### **V-58-3: Function of Longcalls on Sumatran Orangutan (*Pongo abelii*)**

Tatang M.S. Mitra Setia<sup>1</sup>, Jatna Supriatna<sup>2</sup>, Carel P. van Schaik<sup>1</sup>; *1. F.Biologi UNAS/Pascasarjana Biologi UI, 2. Pascasarjana Biologi UI*

Orangutans are Asia's only great apes. Survive only on Borneo and Northern of Sumatra islands. Within their habitat, each independent orangutan lives within its own home range, an area it uses regularly. Neighbors' home ranges overlap. Their social organization form loose community, the adult female regularly form association with immature and they preferences for associating with particular males. Flanged adult male emitted long call as media communication, especially among adults. Long

call known as attracted adult females. The aim of this research is to know the function of long call on adult orangutan day range in their habitat. The research has been done in Ketambe Research Station, Gunung Leuser National Park, Aceh Tenggara. Orangutan followed simultaneously from dawn to dusk (nest to nest). The results showed, after long calls from the flanged male, female orangutan tend to sleep closer (nest position) toward the long caller.

#### **V-58-4: Village Based Data Approach for Orang utan Habitat Suitability Mapping in Borneo**

Lilik Budi Prasetyo, K.Mengersson, D.Buchori, E.Meijaard, Y.Hadiprakarsa, L.Christi, B. Okarda, A. Rizali; *Bogor Agricultural University*

Habitat Orang utan in Borneo have been decreasing due to forest conversion for plantation, forest exploitation, mining, and settlement (transmigration). Moreover, there were also orang utan killing reported occurred many parts of Borneo. Conservation effort should be taken, and for that purposes is an urgent need to map suitable habitat of orang utan. Logistic regression approach was applied to estimate distribution of orang utan, that could be interpreted also as suitable habitat. The model employed binary data for dependent variable which was derived from Relative abundance (RA) data. RA data were constructed from village survey data using questioners. As for independent variable some biophysical data (Slope, Land cover, road & river density), and village based socio-economically (Potensi Desa/PODES) namely : population, source of income resources of Household, number of Labor, & welfare) data were considered.

#### **V-58-5: Predicting Orangutan Occurrences in Kalimantan Multifunctional Landscapes**

YokYok Hadiprakarsa<sup>1</sup>, S. Suci Utami Atmoko<sup>2</sup>, Lenny Christy<sup>1</sup>; *1. Orangutan Conservation Services Program, 2. Fakultas Biologi, Universitas Nasional*

Orangutan known as their uniqueness and only can be found in Indonesia and Sabah, Malaysia. Rapid forest loss becomes eminent threats for orangutan and Kalimantan has the highest rate of its loss. As a result, many orangutan prime habitats were disappeared and remain population pushed their adaptation limits to live in hostile human made landscape. Previously, our knowledge only recognized primary forest as their only habitats, until recently we found orangutan it is likely occurred in the human made landscape, which dominated by highly disturbance habitats. However, orangutan survival fate in these environment still uncertainty, whether only for transitory or last refuges before they expatriated in landscape. Thus, evaluations of orangutan occurrences in Kalimantan need to widen their habitat spectrum to understand their persistence and distribution. Moreover, this information is essential to setup conservation action in the Kalimantan multifunctional landscape. Knowing the facts to evaluate species occurrences in the vast landscape such in Kalimantan need a great resources, spatially explicit habitat modeling has been widely use to assist conservationist to evaluate species occurrences. In this paper, using village based survey data and orangutan nest data we present a spatial modeling exercise to predict orangutan occurrences in Kalimantan using Maximum Entropy framework.

#### **V-58-6: Using GIS and Remote Sensing to Analyze Sumatran Orangutan Distribution and Habitat Associations in Batangtoru, North Sumatera: a Preliminary Study**

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Batang Toru forest area is an important Sumatra orangutan habitat in the south of Lake Toba, Indonesia. This area is currently under serious threat due to intensively conversion of the landuse to other usage. Despite the fact that only a small orangutan population lives, a conservation plan is badly needed in order to protect the already scarce orangutan habitat in this area. Therefore, information on orangutan distribution and habitat association in this landscape is essential. Unfortunately, such information incomplete until a 10 month survey is conducted during the period of November 2005

until September 2006. To represent the whole area, we located 20 different sites of transect line with a total length of 40.6 km and recorded 287 of nests position along transects. We starts with a premise that orangutan distribution is greatly influenced by human disturbance, topography and quality aspects of habitat. Seven habitat variables are selected include elevation, slope, Normal Distribution Vegetation Index (NDVI), proximity to river, proximity to settlements and proximity to roads. We used topographic map and Landsat 5 imagery as data sources. GIS and remote sensing are employed to generate data layers of habitat variables selected include nest position along transects. Furthermore, GIS is used to overlay those variables and resulted values ranges of each variable to be analyzed. We found that orangutan distribution is in the elevation ranging from 113 to 1482 m and most of them are distributed near the river (<0.5 km), near the settlements (< 2 km) and near the road (<3 km). As far as the vegetation condition is concerned, orangutan distribution tends to select the habitat with good vegetation condition, as indicated by high NDVI values (0.72–0.89). Finally, the range of value in each variable described the preference of orangutan distribution, the value of which can be used as an indicator to assess the level of potential conflict between orangutan and human in that area.

**V-58-7: Orangutan (*Pongo pygmaeus wurmbii*) Population Density in the Logged Peat Swamp Forests of Rimba Raya Restoration Concession, Central Kalimantan**

Leslie A. Bolick<sup>1</sup>, Birute M. Galdikas<sup>2</sup>; *1. University of California, Davis, 2. Simon Fraser University*

We conducted an orangutan nest survey in Rimba Raya restoration concession adjacent to Tanjung Puting National Park, Central Kalimantan, July-September 2009. We used a line-transect nest count methodology to survey a total of 25 km on 50 transects at 5 sites. Habitat was dominated by selectively hand-logged peat swamp forest in a mosaic of kerangas forest and flooded, deforested peatlands. Detailed field surveys of habitat (55 hectares total) provided data for analyzing variation in orangutan density and ground-referencing remote sensing analysis of vegetation. Average orangutan density was 1.5 individuals/km<sup>2</sup>, with high variation in density best explained by logging damage, forest biomass and landscape context of habitat patches. Remote sensing analysis shows that 41 percent of the 101,000 hectare concession remains forested. We estimate there to be ≈600 orangutans in Rimba Raya restoration concession, concentrated in the major forest blocks shared with Tanjung Puting National Park. The Rimba Raya concession augments protected orangutan habitat by as much as 12 percent in Greater Tanjung Puting National Park. This is an especially important conservation gain given that unprotected forests in the vicinity are experiencing a 9% average annual rate of forest loss. Furthermore Rimba Raya has been proposed for palm oil development, which would accelerate total deforestation and complete loss of its orangutan population. This study confirms that logged peat swamp forest has high conservation value for the orangutan and that there is significant variation in orangutan densities within this habitat type. Accounting for variation in components of habitat quality within peat swamp forest can be used to design orangutan surveys that minimize within-site variation in nest density and produce more robust and spatially detailed population estimates for targeting site restoration and informing conservation management.

**V-58-8: Reintroduction of Orang-utan in Meratus Protected Forest: a Study Case of Orang-utan Behavioural Adaptation after Release to the Natural Habitat**

Rondang S.E. Siregar, David J. Chivers, ; *Wildlife Research Group, Univ. of Cambridge*

Over the last few decades, the population of orang-utan in Indonesia has been declined drastically. Habitat destruction and fragmentation are the greatest threats to wild orang-utans and responsible for the drastic reduction in their numbers. 4 million hectare (of a total 13 million hectare of tropical forest, which also orang-utan habitat, have converted for agriculture and palm-oil plantations (UNEP 2007). The PHVA workshop result in 2004 revealed that only about 7,300 for Sumatran and 35-45,000 for Bornean species left. Several attempts have been conducted to rehabilitate the confiscated orang-utan into their natural habitat with the assumption that after release, the ex-captive population will be able to established the 'self-sustaining ex-captive' population. This expected could add the number of remained population in the wild as a part of conservation efforts to save the animals. This

study assessed the behavioural adaptation of 40 reintroduced orang-utan after release to their natural habitat. Several behaviour are assessed in order to measure the adaptation of the juveniles in the natural forest such as foraging for food, nest building, orientation, arboreality and predator avoidance. These variables are expected to develop well as the essential skills animal must experience prior to release. Moreover, the result would be taken as lesson learned to develop the better approach in supporting the success of overall programme. Success is not simply by counting the number of animal released, but the degree of adaptation which will result in survivability and subsequent reproduction, are the key point of the success of the whole program. Keywords: orang-utans, reintroduction, behaviour adaptation, conservation

#### **V-58-9: Habitat Restoration in a Logged Area for Orangutan Conservation**

Bungaran Saragih<sup>1</sup>, Rondang SE. Siregar<sup>2</sup>, David J. Chivers<sup>1</sup>; *1. BOS Foundation, 2. Wildlife Research Group*

The orangutan is the only great ape living in Asia, on the islands of Sumatra and Borneo. There are two species of orangutan, the Bornean orangutan (*Pongo pygmaeus*, divided into three subspecies: *Pongo pygmaeus morio*, *Pongo pygmaeus wurmbii* and *Pongo pygmaeus pygmaeus*), classified as “endangered” and the Sumatran orangutan (*Pongo abelii*), classified as “critically endangered”, in the IUCN Red List. To date, orangutan populations have declined drastically, as almost 90% of orangutan habitat has now disappeared from both islands. Habitat destruction and fragmentation are believed to be the main causes for the population decline. If there is no dramatic effort to protect orangutans by reducing forest fragmentation, deforestation and poaching, then the species will be extinct in the wild by the year 2020. The efforts of Borneo Orangutan Survival Foundation (BOSF) and PT RHOI (Indonesian Orangutan Habitat Restoration) to restore logged area of ‘Forest Forever for Orangutan’ that covers 86,450 Ha in East Kalimantan will be discussed. This is to provide a ‘home’ for the reintroduced orangutans from Wanariset Orangutan Reintroduction Project (WORP) of BOSF. To date, WORP has about 220 orangutans that are waiting to be released in suitable and secure habitat. Moreover, it will also achieve the commitment of the Indonesian government, in the Strategic and Action Plan of Indonesia Orangutan Conservation 2007-2017, to implement successfully the rehabilitation and reintroduction of orangutans. The aim is to end orangutan rehabilitation, as all animals will live free in the forest with greater independence. The activities and roles of participants for restoring the forest for the reintroduction of orangutans will be highlighted in this paper. Keywords: habitat restoration, orangutan reintroduction, conservation action

#### **V-58-10: Sexual Selection for Large Male Body Size in Orangutans, the Largest Canopy Animal**

Tri Wahyu Susanto<sup>1</sup>, Cheryl D. Knott<sup>2</sup>, Meredith Bastian<sup>1</sup>, Josephine Beck<sup>1</sup>, Melissa Emery Thompson; *1. Gunung Palung Orangutan Project, 2. Boston University*

Orangutans are one of the most sexually dimorphic primates, with flanged males weighing over 80 kg, more than twice as much as females. This makes them the largest arboreal mammal. Here we argue that selection for extreme body size has been intense, overcoming constraints imposed by the orangutan's arboreal adaptations. We examine how sexual selection has led to orangutan sexual dimorphism, investigating the roles of female choice, male-male competition, and sexual coercion. Data come from a population of wild orangutans living in Gunung Palung National Park, West Kalimantan, Indonesia, between 1994-2010. The role of female choice is tested through analysis of female behavior in relation to reproductive status. Urine samples were collected and urinary metabolites of estrogen and progesterone were measured. These data were used to establish the female ovulatory period in this species with hidden ovulation and show that females have higher encounter rates with prime flanged males when they are ovulating. Flanged male orangutans typically use a 'sit-and-wait' mating strategy emitting long calls to attract ovulating females. Thus we argue that increased encounter rates between ovulating females and flanged males is likely female driven, reflecting clear evidence of female choice. Because orangutans only give birth once every 7-9 years, ovulating females are extremely rare, and male-male competition is intense. We present data on

ranging patterns, male-male aggression and dominance interactions showing that male-male aggressive encounters were correlated with periods of high food availability as well as a higher proportion of ovulating females in the population. The cost of this aggression is measured through behavioral changes and health indicators showing that males frequently were wounded in these encounters, sometimes mortally. Third, we discuss the relative contribution of a third form of sexual selection, sexual coercion, to orangutan sexual dimorphism.

#### **V-58-11: Dietary Preference and Nutrition in Orangutans at the Tuanan Field Station**

Astri Z. Zulfa, Tatang M. Setia, Sri S.U. Atmoko, Erin R. Vogel; *Universitas Nasional*

The forests of Southeast Asia show extreme supraannual variation in fruit availability. Previous studies have shown that while orangutans prefer ripe fruit, they diversify their diet when ripe fruit is not available. Females with dependent offspring face additional challenges, as they have to acquire enough energy to sustain themselves and their infant. We examined the activity budgets, dietary composition, preference and the total caloric energy of foods consumed by female orangutans with and without offspring at the Tuanan Research Station, a secondary peat swamp forest located in Central Kalimantan. We hypothesized that fruits would have higher dietary preference compared to all other food items including leaves, inner-bark (cambium), and other vegetation. Finally, we hypothesized that females with dependent offspring would include more high-energy items in their overall diet. We used focal animal and ad libitum sampling method to observe feeding and ranging behavior. Nutritional analyses were conducted at the LIPI Nutritional Laboratory. Our results showed that orangutans spent the largest percentage of their daily activity budget feeding, followed by resting, moving, nesting, and social behavior. Statistical analyses showed that feeding, moving and nesting activities were influenced by the age of the child, while resting and social behavior were not. Female orangutans at Tuanan included 48 species of plants in their diets. They spent the greatest percentage of time feeding on fruit, followed by leaves, flowers, insects, and other vegetation. Statistical analyses showed that age of child was not related to the dietary composition of food consumed by adult, female orangutans. Fruit was also preferred over all food items, and had the highest energy gain per patch. This was result was the same for females with and without dependent offspring. However fruit did not have more total energy than leaves, inner cambium, or vegetation when energy/item was examined.

#### **Situational analysis of Kalimantan communities and its implication towards orangutan conservation: key results of Kalimantan-wide survey**

Damayanti Buchori<sup>1</sup>, Anton Nurcahyo<sup>2</sup>, Lenny Christy<sup>1</sup>, Yokyok Hadiprakarsa<sup>3</sup>, Kerrie Mengersen<sup>4</sup>, Erik Meijaard<sup>5</sup>; 1. *The Nature Conservancy, Indonesia*, 2. *The Orangutan Conservation Services Program, Indonesia*, 3. *The Borneo Orangutan Society*, 4. *Queensland University of Technology, Australia*, 5. *People and Nature Consulting International*

The Nature Conservancy Survey of Orangutans in Indonesia, conducted in 2009, is one of the most comprehensive endeavours to elicit information about an endangered species from villagers themselves. The survey area encapsulated all regions with suspected orangutan, excluding specified areas (national parks etc) for which good information already existed. The survey design was based on a questionnaire delivered to ten residents in each of a total of 724 villages, selected from approximately 1500 villages in total (approximate 40% sampling), stratified by high/medium/low threat. All high threat villages were included in the study.

The survey questionnaire comprised 32 questions and 34 optional sub-questions that were initially drafted in English, critically reviewed by orangutan experts and then confirmed in an international workshop held in Jakarta. The questions were subsequently translated into Indonesian and entered

into palmtops, then subjected to a final review during provincial training workshops. The questionnaire was divided into a number of sections that focused on basic information, assessment of interviewee reliability, presence and abundance of orangutan, and forest use and management.

Analysis of the data arising from this survey was based on a variety of multilevel mixed models, with levels corresponding to respondents, villages and provinces, under both frequentist and Bayesian frameworks. Statistical considerations included deriving adequate estimators of presence, abundance, conflict and threats based on the questionnaire responses, describing spatial and temporal features of the data, accommodating sources of variation and uncertainty, and developing accurate inferences based on the analyses.

This presentation will describe the design and conduct of this project, and present a summary of the characteristics of the respondents with respect to demographics, orangutan sightings and perceived trends, threats to orangutans and attitudes to the forest.

### **Population and Distribution of Orangutan in Southern Part of P.T Suka Jaya Makmur Logging Concession, West Kalimantan**

Chairul Saleh, Azwar, Ambriansyah, Amri yahya, Joko Sarjito, Henri Ziasmono

Survey of orangutan population and distribution of *Pongo pygmaeus wurmbii* have been conducted in southern part of Suka Jaya Makmur, a logging concession in West Kalimantan which covered areas of around 44,000 Ha. The survey areas selected based on different annual cutting plan of the logging concession, including logged over areas and protection forest as a buffer zone. The survey orangutan survey was part of the orangutan management plan development that will develop based on the annual cutting plan and will be used as an additional value for the company on forest certification process, especially on ecological aspect. The orangutan management plan then will be used as a model of the integration of orangutan conservation with sustainable forest management. The orangutan survey conducted in the total 27,400 meters of transect length which included in 28 of transects where every transect has 1 kilometre length. Based on analysis, the estimation of orangutan population in Southern part of Suka Jaya Makmur logging concession is 315 individuals. The highest density of orangutan found in protected areas or buffer zone areas is 3,48 ind./km<sup>2</sup> compared to other surveyed areas. Furthermore, based on vegetation study conducted on 5,6 Ha of surveyed areas, the survey identified of 353 of tree species which included of 64 tree families and 147 of tree species (43 %) identified as orangutan fruit trees. The southern part of Suka Jaya Makmur logging concession has good orangutan population as well as habitat suitability to support orangutan conservation, so need to manage in sustainable way. In the future, logging concessionaries play a crucial role in continued existence of orangutan since the orangutan dwell in larger number in logging concessions than in protected areas.

### **New finding from Sumatera with special references to orangutans in Dairi and Pakpak Bharat**

S.Suci Utami-Atmoko<sup>1,2</sup>, Azwar, Gondanisam, Ambriansyah, Nuzuar<sup>3</sup>, Jamartin Sihite<sup>2</sup>; *1. Faculty of Biology Universitas Nasional, 2. OCSP-USAID, 3. YEL-Paneco: Jl. Wahid Hasyim, Medan, Sumatera Utara*

Orangutan Sumatra (*Pongo abelii*) had been categorized as critically endangered, according to IUCN red list species. Orangutan in North Sumatra had been known lives in limited areas: east wing of Gn. Leuser NP (Langkat, Deli Serdang and Karo), Batangtoru, East Sarulla and Sidiangkat/ Batu Ardan (PHVA 2004). However, research and publication are very limited in this area. OCSP need information on orangutan status from Pakpak Bharat areas that will be used as an OCSP baseline data and to support data in updating PHVA data. Population surveyed on distribution and population density of sumatran orangutan (*Pongo abelii*) with line transect method (van Schaik et al 1995; Buij et al 2003) has been conducted in Batu Ardan Protection Forest and Siranggas Wildlife Reserve+ in January-February 2009. More pre-survey orangutan distribution conducted as well in January-February 2010 in the forest areas below Siranggas WR (Pakpak Bharat) to the south (Sikulaping PF



and Simpon PF in Pakpak Bharat) towards Barus (Tapanuli Tengah) that the survey never been before to find out the conservation status of the orangutan in the areas. The finding of orangutan population in Siranggas WR, Sikulaping PF and Simpon PF in Pakpak Bharat district is good news for Sumatran orangutan conservation, especially since this area did not yet include in Sumatran orangutan distribution map (see Soehartono et al, 2007; Wich et al, 2008). This information is also important in order to support development corridor to connect the forest fragmentation as a landscape of orangutan habitat in North Sumatra.

## **Biodiversity-friendly agriculture in the tropics: sustainable food production system (#59)**

**(July 20 am; Garuda)**

Organized by: **Iskandar Z Siregar and Damayanti Buchori**

*One serious threat facing many developing countries in the tropics is the inability to fulfil food requirements, especially rice and other strategic commodities due to low food production and productivity. Data show that domestic food requirements in Indonesia for example tend to increase year by year due to high population growth and increased welfare as well as shift in food consumption pattern, including non domestic production food that have high volume and export values (flour, milk, soy bean, sugar). The livelihood of the local population in most of tropical rural areas critically depends on agriculture. In this context, agriculture recognizes the biodiversity benefits on agriculture, which allows the creation of new varieties and breeds for the achievement of economic, health, technical and ecological objectives. Agriculture benefits for biodiversity are also recognized, by maintaining both wild and domesticated plant and animal species, varieties or breeds, as well as ecosystems, at times under threat of extinction, in the case of non-intensive agriculture. During the past decades, however, non-sustainable practices of agriculture have resulted in ecosystem degradation in many parts of tropical countries. Looking at the general causes of biodiversity deterioration in agro-ecosystems, the part played by the inappropriate agricultural farming in the general context of production intensification and under-utilization of land is also acknowledged. As a consequence, the gap between impoverished rural areas and quickly developing areas has increased. Therefore, revitalization of the agriculture sector in broad sense aimed at alleviating poverty as well as improving eco-systems, became an important issue. Although there has been a significant development of agricultural technologies in the tropics during the last decade, farming practices within the context of biodiversity friendly agriculture (BFA) are still not yet widely adopted due to some constraints in suitable land, man-power, initial investment as well as poor understanding on the local culture, ecosystems, species as well as the status of natural resources. The proposed symposium aims to explore the lessons learned and best practices in biodiversity friendly agriculture (BFA) encompassing diverse ecosystem in Indonesia. In this event, BFA will not be discussed as an abstract concept, but as a concrete concept for the development of sustainable food production system.*

### **V-59-1: Politics of Marine Conservation and Sustainable Fisheries**

Arif Satria; *Human Ecology Faculty, Bogor Agricultural University (IPB)*

This paper aims to analyse the current situation resulting from the Marine Conservation Area (MCA) in Indonesia in terms of the legal framework, institutional conflicts and the response of the local people. Some cases of the centralised and decentralised MCA in Indonesia is presented, and the process of establishing the MCA and its institutional performance are reviewed. The performance of centralised system is still questioned because this system often marginalises the local people that leads to the rise of conflict and eventually weakens the institution of MCA. Therefore, strengthening decentralised system is necessary to increase the sense of stewardship of the local people over the

resources, and to shape a new paradigm of the relationship of poor people-environment and conservation-fisheries, so marginalisation of the local people can be avoided and finally a robust institution can be created.. The case study also shows that there is a conflict between conservation and fisheries. This occurs due to two extreme approaches in their activities: conservation is identical with protected area, whereas fisheries are identical with exploitation. Fisheries, however, have their own paradigm over conservation. Fisheries use Maximum Sustainable Yield as a measure for 'conservation' that leads to the management of gear and the rise of restocking action. Meanwhile, conservation is usually synergetic with eco-tourism or/and activity, which seeks to preserve nature from development. To reconcile conservation with fisheries need a new synthesis of ecological paradigm and institutional reform. One paradigm offered is sustainable fisheries system  
 Keywords: Marine Conservation Area (MCA); political ecology; decentralisation; property right, sustainable fisheries

### **V-59-2: Forest Remnants and 'Close to Nature Forestry' in the Tropics: Genetic Considerations**

Reiner Finkeldey; *Goettingen University*

The maintenance of a forest cover dominated by the natural vegetation promotes intraspecific biodiversity in many tropical landscapes. Conservation of biodiversity in fragments and managed forests is rapidly gaining importance in view of dwindling untouched forest ecosystems. Natural regeneration as practiced in different 'close to nature' silvicultural systems is a precondition for the conservation of biodiversity at different levels, but does not rule out cryptic losses of diversity. The dynamics of intraspecific diversity is an important aspect in this context, but is particularly difficult to monitor in forests. Life history traits of most forest trees and empirical studies suggest that high levels of intraspecific diversity can be maintained even in comparatively small fragments of both unmanaged and silviculturally treated forests. The dynamics of genetic diversity in forests severely affected by degradation, fragmentation and non-sustainable utilization is reviewed with focus on declining African tree species. Methods for the enhancement of intraspecific diversity and adaptive potentials of tropical tree species which have not yet been subjected to intensive breeding or which are in an early stage of domestication are described. The potential value of even small relics of natural vegetation for the conservation of forest genetic resources is stressed, and both risks and benefits of an active management of genetic resources in managed forests for example by enrichment planting are mentioned. The incorporation of genetic expertise in efforts to conserve biodiversity in managed tropical landscapes is highlighted.

### **V-59-3: Sustainable Utilization of Local Varieties for Food Production in Marginal Areas**

Trikoesoemaningtyas, Desta Wirnas; *Dept. Agronomy and Horticulture, Bogor Agric. Univ*

One of the characteristics of traditional agricultural is the diversity of crops and cropping system used, characterized by the use of local varieties of crops known as landraces. A landrace, is genetically heterogenous variety which represents a mix of adapted genotypes, evolved under low input cultural practices. Studies conducted in Bogor Agricultural University (BAU) since 1995, have characterized landraces of food crops and identified various adaptive characters to low soil fertility, nutrient toxicity, low light intensity and other abiotic stresses occurs under less favourable environment. These local varieties have been used in breeding programs to develop improved varieties of food crops for marginal areas. To maintain these valuable genetic resources, landrace should be conserved in situ by farmer through continued utilization. This paper, discusses innitial works by BAU in improvement and released of landraces as local varieties for utilization by local farmers.

### **V-59-4: Bee Pollination, Management Practices and Coffee Production**

Virginie Boreux<sup>1</sup>, Kushalappa G. Cheppudira<sup>2</sup>, Philippe Vaast<sup>1</sup>, Jaboury Ghazoul<sup>1</sup>; *1. ETH Zurich, IFP India, 2. UAS Bangalore*

Agricultural productivity, particularly in the tropics, is at least partially dependent upon natural ecosystem services such as pollination, pest control, and water and soil conservation. While empirical studies have shown that the productivity of coffee is enhanced by insect pollination, rarely have management practices been included in such analyses. This omission means that the value of pollination services cannot be set within the range of management interventions available to farmers. Without this broader context it is difficult to evaluate how farmers might respond to calls for managing land to secure pollination services. In Kodagu, a major coffee-growing region in southern India, we investigated the contribution that insect pollination makes to coffee production in the context of fertilisation, irrigation and shade management interventions, as well as environmental variables. Our results show that even taking into account management decisions, bee abundance contributes more to coffee production in terms of number of berries harvested than other management practices, such as liming. Bee abundance, however, is highly contingent upon management actions, particularly irrigation, rather than the nature of the surrounding habitat matrix. Raising awareness among coffee growers of the role of asynchronously irrigating can potentially contribute to improved quantity and quality of coffee yields.

#### **V-59-5: Genetic Biodiversity of Horticulture for Sustainable Food Production**

Sriani Sujiprihati, Muhamad Syukur, Anas D. Susila; *Bogor Agricultural University*

Indonesia has genetic biodiversity of horticultural crops (especially vegetables and fruits species), that are play important role in food security in the country. Horticultural crops, especially indigenous vegetables and fruits are excellent sources of vitamin A and C as well as iron, protein, mineral and fibre. They are also provide food, herbal medicine and income especially to rural farmers. This has positively contribute for sustainable food production in the country. However, the important role of Indonesian vegetables and fruits in food security is threatened through extinction of the genetic resources of theses species. Several landraces of horticultural crops are in the process of being replaced by modern or imported varieties. In addition, for a moment, research program on horticultural crops in Indonesia, focus mainly on the routinely cultivated species. Therefore, IPB has been promoting the increased production of indigenous vegetables and fruits, through crop improvement program and dissemination of the new promising varieties to the farmers. (Keywords : horticultural crops, indigenous, landraces, promising varieties)

#### **V-59-6: Biodiversity friendly cacao in Central Sulawesi**

Yann Clough, Jührbandt, Barkmann, Buchori, Tschardt T.; *Univ. Göttingen*

Agricultural intensification is a necessity to satisfy increasing demand for food and energy crops, but is also a driver of global biodiversity loss. Proposed solutions to combine biodiversity conservation and crop production include wildlife-friendly farming or combining high-intensity farming with land-sparing for nature. Here we integrate biodiversity and socio-economic data for smallholder cacao in Indonesia and show that for tropical agroforests there is little relationship between yield and biodiversity. This may open substantial opportunities for win-win management. Our results from plant, invertebrate and vertebrate surveys exhibit almost no decrease in species richness with yield. Yield is mainly affected by high shade and low investment in labour and agrochemical input. Results of shade tree monitoring suggest shade tree removal is widespread, and that many farmers rely on this practice to improve or maintain yields. Combining a high diversity of shade trees dispensing moderate shading levels, along with the maintenance of remnant forest patches as an important source of organisms, and improved plot maintenance practices by adequately trained farmers is a necessity for modern, multifunctional agroforestry systems.

#### **V-59-7: Potential of Ethnobotanical Knowledge for Biodiversity-Friendly Functional Food Production System in Indonesia**

Ervizal A.M. Zuhud, Arzyana Sunkar; *Bogor Agricultural University*

Responding to the threat of reduced food production and productivity, the Indonesian government had taken the initiative of importing rice and expanding rice cultivation areas across Indonesia including in areas where rice was not the main dietary staple of the locals. Expansion of rice fields was destructive to the natural forest ecosystem. These have often caused the emergence of new food-related diseases associated with foreign substances that were not genetically fit with the local ethnicities. This paper reviews the concept of food sovereignty as an alternative to failing conventional food policies, through re-diversification of food, back to indigenous food. One such means was through the use of an ethnobotanical approach. The adoption of a specific farm system defined the way a rural community coped with the environment to produce food. It may be argued that food security was often achieved at the expense of environmental degradation, but on the other hand evidences suggested that indigenous food production systems were biodiversity friendly. Ethnobotany for functional food showed the potential of food diversity based on various ethnicities as well as ecosystems. The unique and specificity nature of the food production system supported the ecophysiological lives of local communities that are healthy and biodiversity friendly. Therefore, the development of Indonesian society as a whole and biodiversity management should be deep rooted into indigenous knowledge and be used in modern knowledge, where they were innate from the ethnobotanical knowledge that had been developed based on ethnicity to promote food sovereignty.

#### **V-59-8: Importance of Pollinator Services of a Sacred Landscape Mosaic to Coffee Production**

Smitha Krishnan, Jaboury Ghazoul, Uma Shaanker; *ETH Zurich*

Many studies have shown that proximity to natural habitats, particularly contiguous forests enhances crop productivity and quality through the provision of pollinator services. This study was conducted in a unique landscape with a high density of forest fragments (1214 forest fragments in 4100km<sup>2</sup>) interspersed in a matrix of coffee plantations, paddy fields and human settlements. The coffee plantations are shaded with a high density of native trees (256±128/ha). This study is unique especially because of the uniqueness of the landscape. This paper addresses the following questions: 1. does distance from the forest have an effect on pollinator abundance at a local scale, 2. do pollinators contribute to coffee production and seed quality, 3. does the adjoining forest (vegetation) type and size have an effect on pollinator abundance in coffee plantations. The study was conducted in coffee plantations at 5 distance classes (<10, 50, 100, 250, 500m) each from the forest edge. The study was carried out at 40 forest fragments of varying dimensions (previous studies are based on observations with respect to 2-3 forest fragments). Distance from the forest did not have a significant affect on pollinator diversity or abundance on coffee flowers. Mass flowering in coffee initiated by rain attracted fewer pollinators than in sites with isolated flowering initiated by irrigation. Pollinator abundance increased fruit production and fruit quality. Size of the adjoining forest has a significant positive influence on pollinator abundance. Abundance of bees in plantations closer to semi-evergreen forests was significantly greater than in plantations adjoining moist-deciduous and evergreen forests. Our study confirms the importance of pollinator services for coffee, but finds no local distance effect of declining service with increasing distance from forest margins. Instead, pollinator services at plantation scales are better explained by the size and type of nearby forest patches.°

### **Open session: The ecology and conservation of large tropical mammals (#61)**

**(July 23 pm; Jauk)**

Organized by: **Joe Smith and Donny Gunaryadi**

*Human enterprise is having a massive effect on global biodiversity. Natural habitats are being lost at unprecedented rates and more still are being converted or degraded, especially in the tropics where*

most biodiversity is found. For large mammals, these habitat pressures are often combined with additional threats; notably the direct persecution of the animals themselves. These anthropogenic threats, acting in combination, have led to well publicized declines and bleak prospects long-term for many large mammal populations. Given these challenges, one might question whether science and conservation can offer a life line to these imperiled species. This symposium aims to demonstrate that in fact conservation scientists are accumulating practical and effective tools for the conservation of many large tropical mammals. Speakers will describe these techniques and also some current efforts to better understand the ecology of several poorly known species. The development of new techniques able to monitor the status of even the rarest and most elusive species offers the opportunity to track future recoveries and the conservation measures that made the difference. We hope that this symposium will provide an opportunity for all those involved to share their experiences and insights gained throughout the tropics, and to look for the success stories that can catalyze effective conservation in new areas.

#### **V-61-1: The White-lipped Peccary: Conservation Implications of Habitat and Space Use by a Keystone Amazon Species**

George V.N. Powell, Alfonso Zuniga, Lucas Huaymana P., Marlon Guerra V.; *World Wildlife Fund-US*

Tayassu pecari can be the most common large mammal of intact Amazon forests, existing in groups of up to 400 individuals, yet the species' use of habitat remains unclear, complicating efforts to design conservation areas that protect them. They are reported to be migratory, even nomadic, yet radio-telemetry studies have found them to be sedentary. Here we present findings from the southwestern Amazon (Madre de Dios, Peru) suggesting that T. pecari is a palm specialist (72% of food items taken were palms, 57% of the genus Iriarte), and their use of space is highly variable as a function of palm densities. In the large Tambopata River floodplain, with high densities of Iriarte (39.4 ind/ha), compared to adjacent terrace (5.9 ind/ha), T. pecari was present in high densities (0.2 ind/ha) and groups maintained stable overlapping home ranges, primarily using floodplain habitat. In the more limited floodplain of the Los Amigos River, groups maintained overlapping home ranges with large proportions of terrace, but tended to leave them and disperse to other river floodplains up to 65 km away. These large-distance movements suggest that protecting robust populations of the species will require conserving large-scale connectivity in the Amazon basin.

#### **V-61-2: The Shared Preference Niche of Sympatric Asiatic Black Bears and Sun Bears in a Tropical Forest Mosaic**

Steinmetz Robert<sup>1</sup>, David Garshelis, Chuitpong Wanlop, Naret Seuaturient; *1. WWF Thailand*

Patterns of habitat partitioning by ecologically similar species can occur through either divergent or shared niche preferences. We investigated overlap in habitat use and spatial co-occurrence by sympatric Asiatic black bears (*Ursus thibetanus*) and sun bears (*Helarctos malayanus*) in three forest types in Thailand, and thereby assessed evidence for their coexistence via one of these two niche models. We used density of different types of foraging signs, distinguished to species, to assess habitat use. Foraging signs of both bear species occurred in all three forest types, and on >60% of sampling transects. Both species fed mostly on fruit; insect feeding signs were rare, and were mostly from sun bears. Significant differences in habitat use occurred only in montane evergreen forest, the habitat in which fruit was most abundant; black bear activity there was six times higher than that of sun bears. Habitat use was more equable between the two species in semi-evergreen and mixed deciduous forest. Of 10 local and landscape-scale habitat attributes examined, fruiting tree density was the best predictor of occurrence for both species. Models that included interspecific competition (fresh foraging activity of the other species) were less supported than the top models without competition. Bear species co-occurrence at both coarse and fine spatial scales and use of the same resources (fruit trees) indicated common niche preferences. However, their habitat use differed in ways expected from their physical differences: larger black bears dominated in the most fruit-rich habitat, and smaller sun

bears used less-preferred insects. Thus, the results indicate broadly overlapping fundamental niches combined with asymmetric competition—features consistent with the concept of shared preference niches. This model of the niche has received little attention in ecology, but appears to be relatively common in nature.

### **V-61-3: Rapid Assessment of the Effect of Hunting on Seed Dispersal and Predation in Two Neotropical Nutmeg Tree Species**

Pierre-Michel Forget, Olivier Boissier, Axelles Bouiges, François Feer; *Museum National Histoire Naturelle*

Hunting pressure is arising in the worldwide neotropical forests and concerns mainly large mammals. In these forests, most plants species are animal-dispersed. This hunting could affect the seed dispersal (in particular the large-seeded species) and, in consequence, the plant communities in favour of the small-seeded species against the large-seeded trees. In this study, we have developed a fast method of crop removal estimation. It should be an indirect indicator of the forest health and of the present fruit-eating communities. It has been tested in forests under different hunting pressures. The method consists in crop samplings under the *Virola* spp. crown with 1m<sup>2</sup> quadrats. Our results show both hunting negative effect on seed dispersal (Nouragues>Kaw>Matoury) and an indication of the reminding frugivores (whole community in the Nouragues with monkeys and large birds, mainly large birds at Kaw and very rare consumers at Matoury). This method could be used in an assessment study in order to better manage the biodiversity.

### **V-61-4: Assessing Density and Threats for a Sunda Clouded Leopard (*Neofelis diardi*) Population in Sabangau Peat-swamp Forest, Indonesian Borneo**

Susan M. Cheyne<sup>1</sup>, David W. Macdonald<sup>2</sup>; *1. Orang-utan Tropical Peatland Proj, 2. University of Oxford*

The Sunda clouded leopard is the top carnivore on the island of Borneo, existing in the absence of tigers or large canid carnivores. Few data are available on the distribution and density of this elusive predator. The first long-term intensive study to determine the density of Sunda clouded leopards in Indonesian Borneo was initiated in May 2008 in the Sabangau forest, Central Kalimantan, Indonesia, and involved continuous sampling until October 2009. A total of 44 cameras in 27 locations were used over 5,777 functional trap nights (of 6,542 survey nights) resulting in 29 photos of four clouded leopards: three males and one female. A buffer of maximum mean distance moved for males was used as the baseline for density estimates (based on the need to cover  $\geq 130\text{km}^2$  to accurately estimate clouded leopard density). Population density for one habitat type (Mixed Swamp Forest) was calculated in the 145 km<sup>2</sup> research area was calculated based on a capture-recapture analysis of four confirmed animals differentiated by their pelage. Extrapolation of these results led to density estimates of 2.75 per 100 km<sup>2</sup> in the MSF) habitat. We extrapolated our local-scale results to the ecosystem landscape level to estimate clouded leopard population size and density in all of Sabangau and estimate a population of ca. 154 individuals throughout Sabangau. Direct and indirect threats to clouded leopards were assessed through interviews and questionnaires with local people inhabiting villages around the study area. Indirect hunting for non-felid bush meat, including clouded-leopard prey species, accounted for 71% of all animals taken from the forest (the remaining 29% was for the pet trade). Based on these data, the population dynamics of the clouded leopards were assessed using Vortex population modelling which highlighted habitat loss through fire as being the major threat, above hunting and prey depletion.

### **V-61-5: A Preliminary Study of the Flat-headed Cat, *Prionailurus planiceps*, in Semi-natural Conditions**

Carl Tracholt; *Copenhagen Zoo*

The flat-headed cat, *Prionailurus planiceps*, is one of the World's smallest wild cat species and the one with the highest degree of webbed feet. It is listed as "endangered" on the IUCN red-list and is very rare in even in captivity with only a few zoos in Thailand and Malaysia housing less than a dozen individuals. Songklah Zoo in Thailand has successfully bred the flat-headed cat whereas the Department of Wildlife and National Parks, Malaysia, recently started up a captive breeding programme for the species in Malaysia. Very little is known about this species, both in captivity and in the wild. This study is the first of its kind that looks into the behavioural ecology of flat-headed cats, particularly in relation to food preference, diurnal rhythm and social interaction between male and female individuals.

#### **V-61-6: Using Camera Traps to Estimate Densities of Key Mammal Species in an Indonesian Lowland Forest**

David C. Lee, Victoria J. Powell, Jeremy Lindsell; *Harapan Rainforest*

Camera traps have been applied extensively to abundance surveys of cryptic and rare species. In particular, they have been used to estimate densities of species that are individually identifiable based on capture-recapture modeling. Recently it has been shown that density estimation of species without individual identification is possible providing estimates of animal movement rates and camera detection area accompany the camera trap photo rates. Using this approach, we conducted camera trap surveys in a previously logged dry lowland forest site in southern Sumatra from September 2009 to June 2010 to assess abundance and broad habitat associations of a range of key forest species. Reconyx digital cameras were positioned 1.8km apart following a systematic sampling design across the 986km<sup>2</sup> site. Cameras were set to record 24 hours/day and deployed for approximately 35 days/location. Camera detection distance and arc were estimated by modeling the decay rate in detection distances of target species from cameras. Published day ranges were used as independent estimates of animal movement rates. Density data are presented here for two globally threatened mammal species, Malayan Tapir *Tapirus indicus* and Malayan Sun Bear *Helarctos malayanus*. The viability of using camera traps to estimate densities for these species is assessed using indirect sign data collected from line transects in the same areas as camera traps. Since broad habitat type may influence spatial variation in density, camera trap data are stratified by habitat class to improve the precision of abundance estimates. Attempts are made to associate differences in underlying density with broad scale habitat features. The impacts of positive forest management, in the form of site protection and active restoration, are considered for the conservation of these species.

#### **V-61-7: Estimating the Abundance of Rare Carnivores in Shrinking Asian Forests**

Antony J. Lynam<sup>1</sup>, Alan Rabinowitz<sup>2</sup>, Saw Htoo Tha Po<sup>1</sup>, Myint Maung<sup>1</sup>, Than Myint, Wildlife Conservation Society, Myanmar Program; 1. *Wildlife Conservation Society Intl Programs*, 2. *Panthera Corporation*

Southeast Asia suffers the highest rate of deforestation in the world. Available habitats for wild carnivores are shrinking and their populations are fragmented and reduced. As an example, 65% of the world's wild Tigers survive within less than 8% of their current range and less than 0.7% of their historical range. Increasingly, managers of protected areas that support tigers desire to monitor trends in their populations. However, rarity makes the task of estimating abundance more challenging than for more common species. In this study, we develop an approach for estimating abundance where normal capture – recapture analysis is inconclusive due to insufficient recaptures or numbers of individuals in the sample. This is derived from the daily detection probability  $\hat{p}$  an empirically derived maximum likelihood estimate, and the number of occasions in the sampling period  $T$ , by estimating  $\hat{p}^{-1}$ ; the probability of detecting an individual at least once during the sampling period. For example, if two individuals are observed in the survey, and  $\hat{p}^{-1}$  is 0.8, the number of individuals in the population is then estimated as  $\hat{N} = Mt + 1 / \hat{p}^{-1} = 2.5$ . We apply the approach to estimating the tiger population at a site in northern Myanmar, and suggest other rare carnivores to which the method might be applied.

**V-61-8: An Alternative Approach to Assess the Status and Conservation of Sumatran Rhinoceros within the Bukit Barisan Selatan National Park, South Sumatra**

Wulan Pusparini, Hariyo T. Wibisono, Noviar Andayani, Widodo S. Ramono; *Wildlife Conservation Society*

Sumatran rhinoceros in Sumatra occur in three isolated habitats of Bukit Barisan Selatan (BBS), Way Kambas and Leuser. This study was carried out in BBS holding the second biggest rhinoceros population to Leuser. Despite its importance, no systematic and robust monitoring approach has been implemented yet until recently. A rapid survey has been conducted utilising the newly developed patch-occupancy approaches. In doing so also test and refine the methodology as a tool in conducting low-cost, rapid, accurate rhinoceros surveys within large forest areas. This provides a robust alternative to the track-based assessment methods currently more prevalent among rhinoceros conservationists. A total of 55 grids of 8.25 by 8.25 km were surveyed between November 2007 and July 2008 and collected rhinoceros signs along a total of 843 km searching routes. Detection/non-detection matrices of rhinoceros were compiled from presence signs such as track, tree twist, wallow and other signs. Repeated samples from each grid were defined at a 200m, 400m, 800m, 1.6km and 2km of the searching routes. Finally, a single session constant model simulation was compared with Royle/Nichols Heterogeneity model to estimate the proportion of area occupied (Psi). The Psi at different segment length for single session constant model and Royle/Nichols heterogeneity model were increasing 0.28 – 0.35 (0.07-0.10) and stable 0.32-0.34 (0.08-0.1) respectively. The heterogeneity model performed better over the constant model since we introduce the heterogeneity on the detection probability into the model. Therefore, we conclude that Sumatran rhinoceros at BBS were occupying 28-32% of the park area. Proportion of area occupied can serve as a robust surrogate for an index of abundance. Further analysis using the multi-seasons models of the technique on time-series data can provide the management authorities with accurate information to targeting and prioritise rhinoceros conservation interventions in the region.

**V-61-9: Success and Challenges of Community Engagement for Conservation: The Case of Wildlife Management Areas (Wmas) in Tanzania**

Julius Keyyu; *Research, Tanzania Wildlife Research Institute*

The Wildlife Policy of Tanzania recognized the role that can be played by local communities in conservation of biological and cultural resources many years ago. In the year 2002, the regulations for establishment of WMAs were put in place in 2002 establishment of WMAs was officiated in the year 2003. From 2003 to 2006, the Government embarked on a pilot phase of establishing 16 WMAs to see their success and potential. In the year 2006, an extension of 8 months was granted before a final evaluation of the pilot 16 WMAs. The final evaluation was conducted after the extension period and it recommended positively WMAs as a gateway to involvement of communities in wildlife conservation and as an alternative way for benefit sharing with communities. In 2008, it was advertised that WMAs are a good way of community involvement in conservation and offer a prospect for sustainable conservation of wildlife resources adjacent to protected areas in Tanzania. To date, 12 out of the 16 pilot WMAs and one more which was not included in the pilot phase have been registered and received an 'Authorized Association' (AA) status. An Authorized Association is a group of community members from one or more villages that has been established with a purpose of wildlife conservation for the benefit of local community members living in a given area, and which has been given permission by the Director of Wildlife to do the said activities in the village land. In the WMA, the Authorized Authority is allowed to make sustainable use of wildlife resources in the area after it has been given 'USER RIGHT' or 'PERMISSION TO USE' by the Director of Wildlife. Common benefits of WMAs by community members include fees from local/community hunting, tourist hunting, ecotourism, campsites/ lodges, etc. Conservation awareness and revenues accrued from WMAs have been increasing steadily in all WMAs. This paper reviews the successes and challenges of WMAs after 7 years of implementation in Tanzania.



### **V-61-10: Strategic Mitigation Methods for Conserving Wild Elephant and Reducing Human – Elephant Conflict at Kaeng Krachan National Park**

Chution Kanwatanakid-Savini, Anak Pattanavibool, Manoon Pliewsungnern, Thongbai Chareundong, Simon Hedges, Chumpol Kaewket; *Wildlife Conservation Society - Thailand Program*

Kaeng Krachan National Park (KKNP) is Thailand's largest National Park, covering 2,900 km<sup>2</sup> at the southern end of the Tenasserim Range on the border with Myanmar, and is part of a larger protected forest complex covering 4,373 km<sup>2</sup>. The Wildlife Conservation Society (WCS), Department of National Parks, Wildlife and Plant Conservation (DNP) is addressing major problems by: (1) collecting baseline data on wildlife population and distribution in KKNP, (2) improving the capacity of the park's staff to manage elephant population (3) facilitating better protection for the park's elephant population. Human–elephant conflict (HEC), particularly crop raiding, had long been known to be a major problem around KKNP. We have assessed HEC rates, crop damage assessment and estimating the damaged cost in order to understand the conflict level and provided farmers the standard mitigation methods for reducing HEC. Our experimental HEC reduction plots showed that alarm and vigilance based crop guarding systems are the key to effective crop protection and additional measures such as chilli fences and locally-made electric fences did not add much value to overall mitigation efforts. Standard mitigation methods have been introduced to local communities since August 2008 as well as monitoring their effectiveness of fences and guard teams. Mitigation using alarm fences and guard teams has been introduced in about 30% of the cultivated area surrounding KKNP. The main budget needed to construct the infrastructure was provided by the farmers and the local government. Other additional scientific methods are needed to be able to understand elephant population in the park and reduce threats. Elephant population distribution were found and mapped from elephant survey in year 2005. The numbers of elephants in the Park have been identified by using fecal DNA based population assessment techniques. These baseline data will help conserve wild elephant in the area and for park management.

## **Open session: Freshwater ecosystems and their organisms (#62)**

**(July 21 am; Jauk)**

Organized by: **Michael Douglas**

### **V-62-1: Riparian Condition, Aquatic Biodiversity and Foodweb Structures in Tropical Coastal Streams**

Frederieke J. Kroon, Caroline Bruce; *CSIRO*

Riparian zones are the interfaces between terrestrial and aquatic systems, and are thought to regulate ecosystem patterns and processes in most streams and rivers. In this study, we examined potential relationships between the riparian zone and in-stream ecological patterns and processes in tropical coastal streams. Specifically, we asked (i) whether riparian condition affects aquatic biodiversity, and (ii) whether the riparian zone contributes to aquatic food webs. Our study was conducted in tropical coastal streams in North Queensland, Australia. First, out of our four indicators of aquatic biodiversity, only macroinvertebrate species diversity directly related to, but decreased significantly with, riparian condition. Second, stable isotope analysis showed that both autochthonous and allochthonous primary producers contributed carbon to food webs in intact and degraded tropical creeks. These results suggest that linkages between riparian zone and in-stream ecology in tropical coastal streams are not yet well understood. We discuss our results in light of potential reasons for the lack of relationships found in our study, including (i) the use of functional diversity to signify

ecosystem processes, and (ii) the role of driving factors expressed at different temporal and spatial scales.

### **V-62-2: Environmental Filters Determine Strong Spatial Concordance among Multiple Species in Tropical Australian Riverscapes**

Danielle M. Warfe<sup>1</sup>, Neil E. Pettit<sup>2</sup>, Peter M. Davies<sup>2</sup>, Brad J. Pusey<sup>3</sup>, Michael M. Douglas, Stuart E. Bunn; *1. Charles Darwin University, 2. University of Western Australia, 3. Griffith University*

Predicting the consequences of anthropogenically-induced changes to tropical ecosystems is contingent on understanding the nature and causes of spatial variation in their biotic communities. We investigated the spatial distribution of vegetation, fish and macroinvertebrate assemblages from 46 sites across riverine landscapes in Australia's wet-dry tropics to determine the relative importance of environmental, spatial and dispersal filters in structuring communities. There was highly concordant spatial structuring between the three assemblages, with each group showing relatively consistent variation between catchments and also within catchments, between tributaries, main channels and floodplain waterholes. Variation in each assemblage was primarily determined by environmental (58 – 67%) rather than spatial (~3%) or dispersal (3 – 5%) filters. This suggests that these freshwater communities were structured deterministically according to species-sorting processes along environmental gradients. Six to eight (of a possible 19) environmental factors explained a significant proportion of the variation and two of these, flow regime and channel width, were significant descriptors of variation in all three biotic assemblages. Channel width is typically an analogue of ecosystem size (or catchment area) and its importance is a manifestation of the species-area relationship, whereas different flow regimes result in different disassembly and reassembly processes structuring communities. Riverine landscapes in Australia's wet-dry tropics are currently relatively hydrologically intact, and our results demonstrate that these intact flow regimes are responsible for a significant proportion of their biodiversity and represent a benchmark against which river health and water resource development can be assessed into the future.

### **V-62-3: Dynamics of Aggregated River Wood and Importance as Fish Habitat in a Tropical Australian River**

Neil E. Pettit<sup>1</sup>, Danielle Warfe<sup>2</sup>, Bradley Pusey<sup>1</sup>, Mark Kennard<sup>1</sup>, Michael Douglas, Peter M. Davies, Stuart Bunn; *1. University of Western Australia, 2. Charles Darwin University*

The input of wood into the Daly River in tropical northern Australia provides habitat complexity that is likely to have a major influence on aquatic biodiversity and river geomorphology. Wood recruitment to the river from the riparian forests occurs sporadically during flood events in the wet season. Surveys in 2008 and 2009 of the aggregated river wood formations (ARW) found densities of 37 - 78 pieces km<sup>-1</sup> with five distinct types of ARW identified. After large wet season flows in 2008/2009 between 46 – 51% of ARW had moved. Distribution of wood age classes indicated continual recruitment and slow turnover of wood within the river. Fish species richness was higher in river reaches with a high proportion of wood, but there was no significant effect of wood on the total abundance of fish. The importance of wood as habitat appeared to vary for different species and ages of fish. Wood was also a significant habitat feature that influenced fish community composition. This study demonstrates the dynamic nature and complex characteristics of in-stream wood and its importance as fish habitat. This highlights the need to consider in-stream wood in the development of relevant flow-habitat-ecology relationships.

### **V-62-4: Context Dependency in Periphon and Invertebrates: Interactions between Velocity and Nutrients in the Australian Wet-Dry Tropics**

Erica A. Garcia, Simon Townsend, Michael Douglas; *Charles Darwin University*

The interactive effect of river velocity and nutrient addition on paver periphyton and benthic invertebrates was examined in a 2-factorial experiment conducted in a 7th order river in the Australian wet-dry tropics during base flow conditions. The velocity factor was represented by 5 categories (0, 0.27, 0.48, 0.78 and 0.97 m/s) and nutrient addition by control and treatment. Nutrients were added by slow release capsules contained in mesh bags. Overall periphyton biomass was lowest at the highest velocity site and responded positively to nutrient addition only at the 0 m/s and 0.78 m/s sites. AFDM varied significantly between the different velocity sites but did not vary relative to nutrient treatments. Invertebrate communities in the high velocity sites differ greatly from all other sites regardless of nutrient treatment but at 0 m/s sites the community was more diverse with nutrient addition. These results highlight the importance of considering context dependency when examining periphyton biomass and invertebrate community structure.

#### **V-62-5: Restoring Rivers in Global Biodiversity Hotspots undergoing Climate Change.**

Peter M. Davies; *Centre of Excellence in NRM, University of Western Australia*

Global biodiversity hotspots are geographically constrained limiting movement of species as a response to climate change. This is particularly the case for those hotspots located in the tropics. Even in their pristine state, many tropical freshwater species are close to thermal limits. Therefore, increased water temperature as a consequence of climate change may exceed thresholds of fauna leading to local extinction. Globally, temperate south-western Australia was one of the first regions to undergo significant climate change with increased temperature and reduced rainfall and streamflow. Consequently, river restoration techniques developed in this region may provide an example and be transferable to other hotspots yet to undergo significant climate change. With geographic constraints, river restoration has to be able produce a suitable biophysical envelope within the species' thermal tolerances. Riparian replanting reduces water temperature and vegetation mapping at a catchment scale and is therefore a useful tool to spatially prioritise restoration activities. Restoration techniques using water temperature to focus activities is applicable to other global biodiversity hotspots where geography constrains species' movement.

#### **V-62-6: Ecology and Conservation of Spiny Eel Mastacembelidea in Klawing River, Central Java**

W. Lestari, Sugiharto; *Ecology Laboratorium, Faculty of Biology, University of Jenderal Soedirman*

A Family Mastacembelidae consists of *Macrognathus* and *Mastacembelus*. These small freshwater spiny eels are found in tropical Africa, South and Southeast Asia. Their lengths are up to 550 mm, compressed tails and a row of small spines along the back. The colourful Mastacembelidea is known as an ornamental fish and is sold by Rp10.000 up to Rp 150.000 in Purwokerto. Unfortunately, the demand of this fish is fulfilled only by taking from rivers. Consequently, the populations would be pressured by over fishing and destructing natural habitats. Therefore this study was conducted to determine the ecology and conservation aspects of this fish. The survey method was applied in the fifteen sites of the Klawing River. The sites were selected based on the physical characteristics of water body and its surrounding areas. Fish samplings were performed during the day only (08.00 pm – 17.00 am) by utilised the combined seine net and an electric fishing. Each site was observed three times (rainy, mid and late of dry seasons). Some parameters of the river were determined. Currents were 2.1 – 0.9 m/second, pH were 6.0 – 8.0 and Dissolved Oxygen (DO) were 5.0 - 8.0 mg/L. Thirty seven male and one female of *Macrognathus aculeatus* and 66 male and 54 female of *Mastacembelus unicolor* were documented. Both fish presented in mid stream, meanwhile *Mastacembelus unicolor* wasn't found in down stream as well as *Macrognathus aculeatus* in upper stream. The former occurred with smaller population and the mid stream sites were the richest part. Therefore, *Macrognathus aculeatus* could get higher priority to be conserved and the mid stream part of river is recommended as reference site.

Key words: Mastacembelidae, ecology, conservation Status, Klawing River

**V-62-7: Key Drivers of River and Wetland Food Webs in Australia's wet-dry tropics**

Neil E. Pettit<sup>1</sup>, Tim D. Jardine<sup>2</sup>, Danielle M. Warfe<sup>1</sup>, Michael M. Douglas<sup>1</sup>, Steve K. Hamilton, Peter M. Davies, Stuart E. Bunn; *1. University of Western Australia, 2. Griffith University*

Five general principles have been proposed as being characteristic of aquatic food webs in northern Australia: (i) Seasonal hydrology is a strong driver of ecosystem processes and food web structure, (ii) Hydrological connectivity is largely intact and underpins important terrestrial-aquatic food-web subsidies, (iii) River and wetland food webs are strongly dependent on algal production, (iv) Omnivory is widespread and food chains are short, and (v) A few common macroconsumer species have a strong influence on benthic food webs (Douglas et al 2005). We undertook stable isotope surveys of food sources and consumers across the region to test support for these principles. Three were generally supported: (i) Food sources varied between wet and dry seasons, (ii) Consumer-resource coupling was weaker at sites with greater hydrological connection, and (iii) Food webs were generally dependent on algal production. However, food chain lengths were similar to those in temperate systems. Although isotope surveys showed that consumer diversity was high, other experimental evidence suggests that some common macroconsumers do indeed exert strong control on benthic food webs. Seasonal hydrology and hydrological connectivity appear key drivers of aquatic food webs in northern Australia.

**V-62-8: Recognition and Relationships of Areas of Endemism in Southeast Asia Based on the *Rasbora sumatrana* Species Group (Teleostei; Cyprinidae)**

Daniel N. Lumbantobing; *The George Washington University*

The *Rasbora sumatrana* species group is one of the most diverse and widespread yet problematic taxa in the freshwater genus *Rasbora* (Teleostei; Cyprinidae). Its species are superficially similar and therefore have been ignored taxonomically. In a phylogenetic analysis of the genus using morphological characters, the *R. sumatrana* species group is paraphyletic: some species are sister to the monophyletic *R. caudimaculata* species group; the two groups are now classified together. The *R. sumatrana* species group is a clade supported by three synapomorphies: (1) triangular basicaudal blotch; (2) 25–26 pored lateral line scales; and (3) medial ramus of pelvic girdle without anterior process. Twenty-five species, including 9 undescribed, are recognized in the species group, herein further classified in 4 species complexes: (1) *R. caudimaculata* complex; (2) *R. elegans* complex; (3) *R. sumatrana* complex; and (4) *R. volzii* complex. New species and species complexes are identified using differences in body color patterns (black midlateral stripe, supra-anal pigmentation, basicaudal blotch, and distal caudal pigmentation) and osteological characters (basihyal and urohyal shape). A cladogram of each complex is reconstructed using morphological characters. Within the *R. sumatrana* complex, all species are allopatric, and some are sympatric with species of the other complexes. Based on distribution of the four species complexes and of other *Rasbora* species, 20 endemic areas are recognized in South East Asia. The relationships of the areas are inferred by generating areagrams of each complex and examining them for general patterns. These patterns are interpreted with respect to the geological and biological history of South East Asia. The recognition of Areas of Endemism in South East Asia based on this analysis will contribute to the conservation prioritization and the designation of management unit for the conservation of freshwater habitats.

**V-62-9: Tropical Rivers in Australia and Customary Resource Use: Putting People into Flow-ecology Relationships**

Marcus A. Finn, Sue Jackson; *CSIRO*

Water resources in northern Australia's tropical areas are relatively undeveloped in comparison to other parts of Australia. However, as water scarcity becomes a prevalent issue there is increasing demand for water in Australia's north for agriculture, mining and urban water supply. There is

potential for the relatively intact aquatic ecosystems of northern Australia to be altered by anthropogenic impacts ranging from climate change to flow alteration through water extraction. Aboriginal people make up a large proportion of the population of northern Australia, especially in more remote areas away from major urban centres. Harvest and consumption of wild resources such as fish and plants (customary use) from aquatic habitats can make up a substantial part of Aboriginal livelihoods, forming the basis of indigenous dependence on "healthy" and functioning tropical rivers and other waterbodies. Environmental flow assessment methods in Australia largely focus on ecological requirements of river systems and do not directly incorporate social requirements, and human needs are sometimes viewed as directly competing with the protection of biodiversity and other conservation values. This paper argues that strategies aimed at achieving sustainable water resource development such as environmental flow assessments need to incorporate the requirements of Aboriginal people to be considered successful. A year of data will be presented on household consumption of aquatic resources from Aboriginal communities on two river systems in northern Australia; the Daly River (NT) and the Fitzroy River (WA) to quantify the value of customary use from these rivers, and suggest a number of challenges to contemporary environmental flow assessment that, if met, should improve the ability of environmental flow assessments in Australian tropical rivers to protect Aboriginal values.

#### **V-62-10: Dissolved Organic Carbon (DOC) Transport from the Kapuas River to South China Sea**

Anshari, Gusti, Gusrizal, Rima Setyawati, Wijaya Novrita; *Agrotechnology, Universitas Tanjungpura*

This study aims to document concentrations of Carbon content in the Kapuas River, and preliminarily assesses the lateral Carbon fluxes from the Kapuas River into South China Sea. The Kapuas (1,086 Km) is the longest river in Indonesia and on an island in the world, passing through from 108 - 114° E and covering 100,000 Km<sup>2</sup>. The region enjoys very wet climate, with an annual rainfall ranging from 3,000 mm in the lower Kapuas River Basin to 7,000 mm in the Upper Kapuas Basin, and without clear distinction between rainy and dry seasons. The Kapuas runs through flat topography and mostly associates with tropical peats, which are an important storage of terrestrial Carbon in the world. A total of 21 water samples from the upper into lower Kapuas were collected in April 2007, and 12 water samples from the lower stream of the Kapuas River were collected in late January and February 2008. Samples were preserved in saturated HgCl<sub>2</sub>, and analyzed with Shimadzu TOC Analyzer, using high temperature combustion and Non-Dispersive Infra Red (NDIR) method for CO<sub>2</sub> detection. The Kapuas belongs to an oligotrophic black water river. The average values of DO, pH, conductivity, and TSS are 47%, 5.57, 31  $\mu\text{Scm}^{-2}$ , and 79 mgL<sup>-1</sup>. This study shows that DOC, POC and DIC concentrations in April 2007 from the upper to lower stream of the Kapuas River, ranged from 302 to 2,858  $\mu\text{M}$ , 224 to 911  $\mu\text{M}$ , and 114 to 228  $\mu\text{M}$ , respectively. Estimated DOC flux from the Kapuas River into South China Sea is 1,300 Gg a<sup>-1</sup>, and DIC flux is estimated to be 430 Gg a<sup>-1</sup>. DOC and DIC yields are approximately 13 and 4 t.km<sup>-2</sup> a<sup>-1</sup>. This preliminary finding suggests a large implication on global Carbon cycle, and indicates this region as a Carbon source.

### **Open session: Entomology (#63)**

**(July 20 pm; Garuda)**

Organized by: Nigel Stork

#### **V-63-1: Spatial and stand-level factors influencing the colonisation of reforested tropical habitat by forest insects**

Peter S. Grimbacher<sup>1</sup>, Carla P. Catterall<sup>2</sup>; *1. Melbourne University, 2. Griffith University*

It is unknown whether reforestation can mitigate the negative effects of tropical forest loss and provide habitat for forest biota. This is part stems from the many different forms that tropical reforestation can take but also because there have been few studies testing if forest biota recolonise reforested areas. This last point is particularly acute for species rich groups such as insects. Working in rainforest landscapes in north-eastern Australia, we quantified how spatial factors (isolation) and stand-level factors (site age, structure and reforestation style) influence beetle colonisation patterns. In the first of two experiments, beetles were sampled from 104 sites representing five different reforestation styles and reference sites of rainforest and pasture. The reforestation styles ranged from abandoned pasture and timber monocultures through to replanted rainforest. Beetle assemblages in all styles of reforestation were intermediate in species composition between pasture and rainforest. The similarity of beetle assemblages to intact rainforest increased with the age and structural complexity of reforested sites. In the second experiment we simultaneously tested the influence of stand age and spatial isolation on beetle colonisation patterns among 24 sites of the one reforestation style. Older sites and those adjacent to rainforest had a more rainforest-like beetle species composition than younger sites or those distant from rainforest and age effects were generally stronger than distance effects. Collectively these results show that tropical reforestation can support some but not all rainforest species although exactly what species colonise reforested plots depends on structural complexity, stand age and spatial position relative to existing forest.

### **V-63-2: Host Specificity and Species Richness of Sap-sucking Insects (Auchenorrhyncha, Hemiptera) on Rainforest Trees in Papua New Guinea**

Francesca Dem; *New Guinea Binatang Research Center*

This is the first host specificity study from a tropical rainforest based on rearing leafhopper and planthopper larvae on their host plants. We sampled Auchenorrhyncha larvae from lowland rainforest vegetation in Papua New Guinea and reared them to adults on caged live saplings grown in the forest understorey. The study focused on 15 tree species selected so that they represented both closely related (congeneric) species as well as representatives of major plant lineages. The study documented low host specificity of phloem and particularly xylem sucking guilds, as only <10% of species were specialized on a single plant family. There were only 0 - 19 species of phloem and xylem feeding Auchenorrhyncha found on individual tree species; the total of 57 species was found feeding on the set of 15 focal tree species. These results stand in contrast to more specialized Auchenorrhyncha feeding on mesophyll cells, rather than vascular elements. Further, low species diversity of feeding larvae is in contrast with high diversity of adult Auchenorrhyncha in the studied forest (>400 species), suggesting that their larvae are not feeding on aboveground plant biomass.

### **V-63-3: Response of Butterfly Communities to Rainforest Succession along an Altitudinal Gradient in Papua New Guinea**

Legi Sam; *Biology, University of Papua New Guinea*

The composition of butterfly communities was monitored along 300 m long transects in primary forest, secondary forest and deforested areas along a complete rainforest altitudinal gradient. The study sites were located at intervals of 500 altitudinal m from the lowland forest at 200 m asl to timber line at 3700 m asl. on the slopes of Mt. Wilhelm, the highest peak of Papua New Guinea. All butterflies were recorded during replicated surveys of permanent transects. We report trends in species composition, species diversity and abundance of butterflies along altitudinal and succession gradients, as well as specific preferences of individual species. Further, we test relationships between altitudinal range, habitat specificity and geographic range for common species of butterflies.

### **V-63-4: Rapid Detection of the Africanized Honey Bee: a Tool for Indonesian Animal Quarantine**

Rika Raffiudin<sup>1</sup>, Chandra Widjaja<sup>2</sup>, Achmad Farajallah<sup>1</sup>, Bambang Purwantara<sup>1</sup>; *1. Bogor Agricultural University, 2. Perhutani-West Java and Banten Province*

Molecular detection methods were used to determine if Africanized Honey Bees (AHBs) are present in populations of imported *Apis mellifera* in Indonesia. The cytochrome b (cyt b gene) was amplified from mitochondrial DNA and digested with the BglIII restriction enzyme (cytb/BglIII). Two types of animal DNA extraction kits were used and found suitable for rapid preparation of DNA from *A. mellifera* by the Animal Quarantine facility. Results showed that all 94 colony samples from beekeepers in Java produced a 485 bp PCR product from the amplification of this gene. Two DNA fragments of 194 and 291 bp from all samples were produced after digestion with BglIII. This cyt b/BglIII result together with the DNA sequence of cyt b showed that all collected samples of *A. mellifera* were the non-AHB type. Hence, this study did not detect AHB in Indonesia.

### **V-63-5: Thermal Tolerance Explains Unusually Rapid Decadal Range Shifts and Extinctions of Andean Dung Beetles**

Trond H. Larsen; *Princeton University & WWF*

Tropical ectotherms are predicted to be among the most sensitive organisms on earth to climate change because of their narrow physiological tolerance, but almost no studies have examined this response. I sampled dung beetles using standardized pitfall traps in 1999 and in 2009 along a steep altitudinal gradient from 1050-3450 masl in the Andes in southeastern Peru. To help understand mechanisms underlying species response to climate change, I also measured the critical thermal limits (CT<sub>max</sub>) of 30 dung beetle species. After ten years, total species richness declined by 20% and abundance declined by 45%. Eleven species were lost while one species, which previously occurred only in the lowlands, was gained. Species' mean altitudinal range increased by 72 m. This rate is faster than average range shifts observed for other taxa worldwide, but is consistent with warming trends in the region, suggesting that many dung beetles are quickly tracking temperatures as they change. Because 16 species shifted upslope and only 3 species moved down, there was a net loss of species richness at the lowest sites and a small net gain of species at the highest sites. Out of species that persisted, 15% expanded their upper range limit and 20% contracted their lower range limit, while none showed upper limit contractions or lower limit expansions. Species with low warming tolerance (difference between CT<sub>max</sub> and mean ambient temperature) showed greater upslope range shifts. These results suggest that climate change is rapidly affecting sensitive taxa such as tropical ectotherms due to physiological constraints, causing extinctions, population declines, and range shifts. Biotic attrition due to lack of species replacement appears to be strong at low elevations. In addition to biodiversity loss, range shifts are resulting in novel communities with unknown ecological consequences.

### **V-63-6: Effects of Habitat Fragmentation on Ant Richness and Functional Composition in Atlantic Forest of Northeastern Brazil**

Inara R. Leal<sup>1</sup>, Alan N. Andersen<sup>2</sup>; *1. Federal University of Pernambuco, 2. CSIRO Sustainable Ecosystems*

Ants are a dominant group in tropical ecosystems and mediate many key ecological processes. They are sensitive to a range of threatening processes, but the effect of forest fragmentation on the functional composition of ant assemblages is still poorly known. Here we examine the effects of habitat fragmentation on the functional composition of ant communities in Atlantic forest in northeast Brazil addressing the following questions: (1) What are the relative effects of fragmentation (fragment size and isolation) and habitat structure (tree density and richness) on ant richness and functional composition? (2) To what extent do ant responses reflect those of two other functionally important invertebrate groups, dung beetles and termites? Our study was carried out in a large, old and highly fragmented landscape where we surveyed ants, trees, dung-beetles and termites in 19 fragments ranging in size from ten to 3,500 ha. We recorded 146 ant species (all native) from 41 genera.

Fragment area was the variable that explained most of variation in ant richness ( $R^2 = 0.21$ ) though tree density also contributed ( $R^2 = 0.17$ ) to the overall regression models. Fragment area, tree density and tree richness variously explained the richness of a range of Atlantic forest (Cryptic predators:  $R^2 = 0.51$ , Epigaeic predators:  $R^2 = 0.34$ , Epigaeic omnivores:  $R^2 = 0.50$ ) and global functional groups (Cryptic species:  $R^2 = 0.48$ , Generalised Myrmicinae). Ant species and functional composition were not influenced by any of the explanatory variables, and were not correlated with ordination of other taxa surveyed in the same sites. Our results indicated that ant functional groups may reduce the complexity of response to forest fragmentation as compared to species composition and allow comparative analyses of habitat fragmentation in different systems.

### **V-63-7: The Forgotten Fauna: Flowers Sustain Highly Unique and Abundant Beetle species Diversity in Tropical Rainforest Canopies**

Carl W. Wardhaugh; *James Cook University*

Many studies have attempted to quantify the distribution and ecologies of tropical rainforest canopy beetle communities. Few have examined biodiversity or population density on microhabitats other than foliage, however. Beetles associated with five canopy microhabitats (mature leaves, new leaves, flowers, fruit and suspended dead wood) were collected to investigate the within-tree distribution of canopy beetles in an Australian tropical rainforest. Beetle density was two orders-of-magnitude higher on flowers (1643.27/kg) than on flush foliage (12.19/kg), and almost three orders greater than on mature foliage (1.96/kg). Despite flowers (or floral resources) representing < 0.001% of the biomass in the canopy, they were estimated to support >45% of all individuals and >40% of all canopy beetle species. Comparison between these results and a four-year study of beetles sampled with Malaise-flight intercept traps (M-FIT) at the same study site revealed the inadequacy of M-FIT to detect flower visiting species. Of the 63 most common beetle species (>15 individuals collected) in this study, 19 were not recorded in the M-FIT study. Of these, thirteen were flower specialists (>90% of individuals collected from flowers), while a further two species were collected predominately from flowers (75% - 90%). In contrast, only four common foliage inhabiting or non-specialised species in this study were not recorded by the M-FIT technique. The results of this study clearly indicate the importance of flowers to the high biodiversity and abundance of beetles in tropical rainforest canopies, and emphasises the necessity of incorporating multiple microhabitats and sampling methods in biodiversity research.

### **V-63-8: Studies of the Butterfly Diversity at Manupeu Tanadaru National Park, East Nusa Tenggara**

Siva Azahra, Maiser Syahputra, Lin N. Ginoga; *Institut Pertanian Bogor (IPB)*

Butterflies are a group of insects of the order Lepidoptera. Butterflies are known to be good pollinators, and good environmental indicators. Additionally, butterflies have potential as tourism object because of their beautiful wing patterns that attract tourist's attention. Butterfly survey was conducted in Manupeu Tanadaru National Park, Sumba to reveal the diversity of butterflies. Located in the Wallacean region, it is expected that this area have rich and unique biodiversity. Timed-search method was done in Watumbelar and Padiratanah villages in the national park area that included four habitat types: primary forest, secondary forest, riparian, and savanna. A total of species of butterflies were recorded 41 species that consist of 4 family: family Papilionidae 7 species (29 individu), family Nymphalidae 23 species (123 individu), family Pieridae 6 species (17 individu), and family Lycaenidae 5 species (13 individu) in 182 individu. *Troides vandepolly vandepolly* is endemic and already protected by Indonesian law. It is also revealed that local people have already used butterflies for economical needed and inspiration for traditional clothes patterns. Conservation measures to protect butterflies while considering people's welfare is important. Keywords : Butterflies, diversity, Manupeu Tanadaru National Park.



## Open session: Ornithology (#64)

(July 23 am; Garuda)

Organized by: Yeni Mulyani

### V-64-1: Six Years of Habitat Modification in a Tropical Rainforest Margin of Indonesia Do Not Affect Bird Diversity but Endemic Forest Species

Bea Maas<sup>1</sup>, Matthias Waltert<sup>2</sup>, Teja Tschardt<sup>1</sup>, Christian H. Schulze<sup>1</sup>, Dadang Dwi Putra, Yann Clough<sup>1</sup>; *1. Agroecology, University of Göttingen, 2. Centre for Nature Conservation, Göttingen*

Studies on temporal changes of tropical bird communities in response to habitat modification are rare. We quantified changes in bird assemblages at the rainforest margin of Lore Lindu National Park, Central Sulawesi, over an interval of six years. Standardized bird counts were conducted in the years 2001/2002 and 2008 at 15 census points representing natural forest, secondary forest, agroforests and openland sites. Although overall species richness remained nearly identical, different species groups were affected unequally by habitat modification within the forest margin landscape. The mostly endemic forest species declined in abundance (72.0% of forest species) and were detected at fewer census points in 2008 (56.0%). In contrast, 81.8% of the solely widespread openland birds became more abundant and 63.6% of the species were recorded at a larger number of census points. Hence, recent human activities in the forest margin ecotone negatively affected species of high conservation value. Species richness turned out to be a poor indicator of habitat change, and our results underline the importance of considering species identities. Biotic homogenization as result of habitat conversion is a global phenomenon. In our study, the winners were widespread openland species, while the losers were endemic forest birds. The replacement of traditional land-use systems formerly acting as buffer zone habitats at the margin of established reserves and the enormous pressure on the forest margin itself may devalue forest margin habitats thereby negatively affecting the status of entire conservation areas. In conclusion, our study shows that 6 years of land-use change had negative impacts on bird community structure and endangered species, but not on overall bird species richness.

### V-64-2: Effects of Historical and Current Landscape Structure on Bird Extinction Debts in the Brazilian Atlantic Forest

Paula K. Lira<sup>1</sup>, Robert M. Ewers<sup>2</sup>, Jean Paul<sup>1</sup>; *1. University of São Paulo, 2. Imperial College London*

Species local extinction sometimes occurs with a substantial delay following landscape change, resulting in the so called "extinction debt". Extinction debts are especially great in communities in which many species are close to their extinction threshold following landscape change, because the time-lag to extinction is especially long in such species. To evaluate the magnitude of the extinction debt in three 10,000-ha Atlantic Forest fragmented landscapes with different amount of forest cover (11, 31 and 49%), we investigated the effects of historical and current landscape structure on understory bird communities. Results showing that current species richness and abundance is better described by historical than by current landscape structure would give support to the hypothesis of an existence of extinction debt. Birds were sampled in a total of 53 forest fragments distributed across the three landscapes. We estimated species richness and abundance for the entire assemblage, but also subdivided species in two categories according to their published responses to human disturbances: sensitive species, which should reach their extinction threshold in higher levels of forest cover; and generalist species, which should only go extinct in more heavily deforested landscapes. Historical and current landscape structures were evaluated using forest cover maps of three different dates: 1960's, 1980's and 2000's. For each date, landscape metrics representing forest cover and aggregation were estimated, and their influence on the richness and abundance of the three birds' categories were assessed using structural equation models and variance partitioning. Preliminary results indicate that the temporal scale of bird response to landscape change depends on the current amount of forest in the

landscape and on the guild considered. We discuss the implications of these results for bird species conservation in fragmented landscapes.

### **V-64-3: Food Resource Use and Seed Dispersal by an Obligate Frugivore, the Taiwan Barbet (*Megalaima nuchalis*)**

Sing-Yi Chang, Ya-Fu Lee, Wen-Chen Chu, Jia-Huai Chen; *National Cheng Kung University*

Many species of barbets are primarily frugivorous and potential or actual seed dispersers. Yet, studies of food resource use by barbets are still scant. The Taiwan Barbet (*Megalaima nuchalis* Gould, 1863) is endemic to Taiwan and occurs in forests from lowlands to mid-elevation mountains. This study investigated the diet of Taiwan Barbets, the phenology, and morphometry of fruits to evaluate the pattern of food resource use by Taiwan Barbets in Kenting, the southern Taiwan. We adopted direct observations to record foraging behaviors of barbets. Taiwan Barbets appeared to be generalists and obligate frugivores, and were opportunistic in feeding fruits. Plant species with a greater number of fruiting individuals and larger fruit biomass were visited more frequently by barbets, and the former factor was particularly important. Barbets revealed variable degrees of preference for different fruits, with *Myrica adenophora* the most selected for. On average, barbets spent  $6.3 \pm 0.8$  min staying on a tree, and ate  $6.4 \pm 0.5$  fruits per visit, then left within 1 min after feeding. The gape width ( $18.9 \pm 0.1$  mm) of barbets limited the maximum fruit size (ca. 16 mm) that barbets would swallow. We also conducted feeding experiments to count seed retention time, and combined former results with residual time of barbets. Consequently, we found barbets taking most ingested seeds away from parent trees, as far as 150 m. The germination experiments indicated that the digestion by barbets significantly improved seed germination. Our results suggest that Taiwan Barbets can be legitimately considered as effective seed dispersers.

### **V-64-4: Multiple-scale Forest Restoration Options for Atlantic Forest of Brazil**

Cristina Banks-Leite<sup>1</sup>, Robert M. Ewers<sup>2</sup>, Alexandre C. Martensen<sup>1</sup>, Jean Paul Metzger<sup>1</sup>; *1. University of Sao Paulo, 2. Imperial College London*

The Atlantic Forest has been reduced to 15% of its original area, whilst much of the extant forest is second growth and distributed in patches of less than 50 hectares. Remarkably, few bird species have been driven extinct from this biome, yet many are highly threatened and may be committed to extinction over the coming decades unless precise restoration measures are undertaken. One of the great challenges in the restoration of natural habitats is that each landscape presents its own peculiarities and requires a specific strategy. In this talk, we will present a framework in which the optimum scale of restoration strategy can be predicted from the amount of forest cover in the landscape. To build this framework we used data from more than 7000 birds captured in 65 sites located in six landscapes in the Atlantic Forest of Brazil (three fragmented landscapes, 10 %, 30 % and 50 % of forest cover and three continuous landscapes). Results showed that bird community composition changed consistently with forest disturbance, patch size and landscape forest cover. Across the gradient from continuous old-growth to small patches in highly deforested landscapes, disturbance-sensitive species were continuously replaced by habitat-generalists, showing how habitat alteration precipitates a turnover from a specialized avifauna to a community of cosmopolitan species. These patterns of species responses to habitat alteration allowed us to build a multi-scale restoration framework where: as forest cover in the landscape reduces from 100 to 10%, the scale of restoration is amplified from the local to the regional scale. Eventually to ensure the survival of this unique suite of species, fragmented landscapes have to be largely restored and large tracts of old-growth have to be seen as irreplaceable. But having the ability to select the best scale of restoration actions greatly enhances our chances to avoid paying the impending extinction debt of the endemic Atlantic Forest avifauna.

### **V-64-5: Factors Affecting the Annual Survival of a Group-living Tropical Passerine**

George A. Gale, Wangworn Sankamethawee, Andrew J. Pierce, Britta Denise Hardesty; *King Mongkut's University of Technology Thonburi*

Tropical passerines generally have higher survival rates than those in northern temperate regions, while birds that live in groups are likely to have even higher rates relative to those that live singly or in pairs. However, relatively little is known about the factors which affect survival of tropical passerines, particularly those that breed cooperatively. We examined variation in apparent adult survival of the cooperatively breeding Puff-throated Bulbul (*Alophoixus pallidus*) in an evergreen forest in northeastern Thailand. We determined whether there was evidence for major temporal differences in annual survival, seasonal survival (breeding vs. non-breeding) as well as variation related to sex. Using an information theoretic approach based on both mark-recapture and resighting data collected over six years, annual survival was  $0.85 \pm 0.02$  and essentially constant. However, survivorship was lower during the breeding season than during the non-breeding season, presumably related to energetic demands and/or predation risks during reproduction. Survival of males and females appeared to be similar. The mean life expectancy of males and females was  $6.70 \pm 7.73$  years and  $5.87 \pm 4.88$  years, respectively and the average for the population was  $6.2 \pm 4.4$  years. This annual survival rate is high compared to estimates from other tropical and temperate passerines possibly due to the relatively stable climatic conditions of our study area and Puff-throated Bulbul being a generalist able to exploit a wide range of fruits and invertebrates in space and time.

#### **V-64-6: Interactions between Natural and Human Disturbance; Cyclone Larry, Birds, and Fragmented Lowland Rainforests**

James Moloney

We have much to learn about interactions between natural and anthropogenic disturbance on biological communities. In March 2006, Cyclone Larry crossed the North-eastern Australian coast, causing widespread damage to already fragmented lowland rainforests. A prior study examining the avifauna of patches provided an opportunity to a) examine the impacts of a severe cyclone on a tropical bird community, and b) compare the impacts and recovery between continuous and fragmented habitats. Three unfragmented sites, 3 large fragments (>25 ha) and 3 small fragments (<25 ha) were surveyed prior to the cyclone, and 6-8 weeks, 5 months, 12 months post-cyclone, and 2 years post-cyclone. Birds were sampled by strip transect, and hemispherical photographs were used with visual estimates to quantify vegetation structure. Vegetation was largely defoliated and canopy cover was reduced to below 10%. Overall bird diversity and abundance decreased, with frugivores virtually disappearing from all sites after the cyclone. Insectivores were less impacted, but the diversity of rainforest specialist insectivores dropped significantly, and remaining insectivores tended towards mixed flocking, possibly due either to predator avoidance or to limited food resources. Although all sites lost bird species after the cyclone, fragments did not lose proportionately more species than unfragmented sites. In other words, there is little evidence at this stage of an interaction between the human and natural disturbances.

#### **V-64-7: Incorporating Altered Fire Frequency Scenarios in Species Distribution Models Improves Climate Change Predictions for Tropical Savanna Birds**

April E. Reside<sup>1</sup>, Jeremy VanDerWal<sup>2</sup>, Ian Watson<sup>1</sup>, Alex Kutt<sup>1</sup>; *1. CSIRO, JCU, 2. CCTB, JCU*

Biodiversity conservation in the face of changing climate requires reliable predictions of species distributions. Distribution models need to include variables that strongly influence species persistence. Species will be affected by climate change directly by altering the amount and location of suitable climatic space, and indirectly by climate driven modification of habitat. While climate is a good predictor of species distributions, biotic and abiotic landscape factors also influence distribution. Very few studies of climate change effects on biodiversity have included key landscape factors in distribution modelling, despite recognition that landscape alteration through processes such as fire and land clearing changes fauna patterning. For birds in Australian tropical savannas, change in fire

regimes is a critical conservation issue, linked to species decline. While species may show gradual shifts in distribution due to changes in temperature and rainfall, species are likely to show a more immediate response to changes in fire as a result of climatic changes. This study examines species' responses to changes in fire by projecting species distribution modelling algorithms built using Maxent onto scenarios with increased fire frequency. We accounted for important static landscape elements by including remnant vegetation and soil spatial layers. This study identified that increased fire frequency alters the predictions for birds by changing the amount of suitable habitat. Climate change combined with increased fire frequency will reduce available habitat; more than simply using climate predictions alone. Our results demonstrate the importance of including landscape factors into distribution modelling when generating species predictions. Understanding the impacts of landscape factors on bird distributions, in particular fire, is a critical step in conservation planning and adaptation of land management for combating biodiversity loss due to climate change.

**V-64-8: Ecological Strategy of the Javan Green Peafowl (*Pavo muticus muticus*) Linnaeus 1758 Against to Pressure of Their Population and Habitat**

Jarwadi B. Hernowo; *IPB*

The javan green peafowl (*Pavo muticus muticus*) have high pressure to the population and the habitat. Baluran, Alas Purwo, Meru Betiri national park, teak plantation and intercropping area of KPH Sumedang (Buah Dua), and pine forest and sub mountain forest of Cikuray mountain are samples cases of the javan green peafowl distribution. Those places were chosen as case study on the population and habitat type selection. The populations were analyzed by demographic analysis and the habitats were analyzed with habitat used. The paper was aimed to gain the knowledge of strategic population and habitat selection of javan green peafowl on defend from the high pressure to the bird living. The result shown that, the individual number of population is in small size population 29 – 44 individual. The age structure of the javan green peafowl population indicated that tend to opposite pyramidal, where adult birds more abundance than sub adult or juvenile. The sex ratio indicated that the peafowl live in polygamous system 1 male : 4 female -7 female. The javan green peafowl live in social groups. The bird prefers habitat forest patchily with open area which is growth by grasses and shrubs. The javan green peafowl are edge forest species. The green peafowl's are searching food more at open area as feeding site. The green peafowl as herbivorous bird and ground animal feed much on leaf, seed of grasses and leaf and fruit of shrubs. They are choice luxuriant tree or shady place for sheltering during the hot days. The birds select certain trees are tall tree or emergent tree for roosting and not for the tree there any open area. Nesting site of the bird is open area where shrubs are growing. The javan green peafowl prefer habitat such as savanna, grazing area surrounded by forest and intercropping teak forest plantation.

**V-64-10: Bird Species Diversity in Pondok Ambung Research Station, Tanjung Puting National Park, Central Kalimantan**

Harri Purnomo, Yeni A. Mulyani, Ani Mardiasuti; *Fakultas Kehutanan IPB*

Tanjung Puting National Park (TNTP) which is located in Central Kalimantan Province is registered as an Important Bird Area. One of the research stations which is being developed in Tanjung Puting National Park is Pondok Ambung. The aims of this study were to identify bird species and to compare bird diversity in four types of habitats: swamp forest, lowland secondary forest, heath forest, and after- fire forest. This study was conducted from July 29th to September 5th 2009. Bird data was collected by using MacKinnon species list and point count method. A total of 107 bird species comprising 38 families were recorded. Twenty- two species are categorized as protected by Indonesian government regulation No.7 of 1999, while 4 species are having the status of IUCN (Endangered and Vulnerable), and 15 species are included in CITES (Appendices I and II). The highest diversity was found in swamp forests ( $H' = 2.87$ ). However, the results of t test indicated that there was no significant difference in bird species diversities between habitat types. It is suggested

that lack of significance in bird diversity among habitat types might be due to the small sample size, or proximity among those habitat types.

## **Open session: Plant ecology and systematics (#66)**

**(July 23 pm; Wantilan front)**

Organized by: **Gillian Dean and Kuswata Kartawinata**

*This symposium was developed from the myriad of abstracts concerning plant biology in the tropics, and includes research from Asia, Africa and South America. The symposium begins with four talks looking at plant diversity and adaptation to specific habitats, as well as evolution. The next three talks will address the effects of climate change on plants and their ecosystems. Finally, loss of diversity due to changing land use, forest regeneration and influence of microclimate on conservation efforts will be examined. Therefore, this symposium will cover a broad range of topics that are pertinent to the current status of forests worldwide and their benefits to mankind.*

### **V-66-1: Tree Recruitment Patterns Across an 85,000 sq.km Western Amazonian River Basin**

Varun Swamy, John Terborgh; *Nicholas School of the Environment, Duke University*

We analyzed recruitment patterns and spatial organization of >100 common lowland western Amazonian tree species using data collected from a network of tree plots distributed over 8 sites spread across the ~85,000 sq.km Madre de Dios River basin in southeastern Peru, including 6 sites from mature floodplain forest and 2 sites from mature tierra firme forest. The dataset comprised 16,800 large stems (>10cm dbh) sampled across 28 hectares, and ~58,500 saplings (stems >1m tall, <10cm diameter) sampled across 6.5 hectares. Amongst large stems, *Iriartea deltoidea* (Arecaceae) was the most abundant species overall, followed by *Otoba parvifolia* (Myristicaceae), *Pseudolmedia laevis* (Moreaceae), *Quararibea wittii* (Malvaceae), *Astrocaryum murumuru* (Arecaceae) and *Theobroma cacao* (Malvaceae). Amongst saplings, *Pseudolmedia laevis* was the most abundant species overall, followed by *Piper laevigatum* (Piperaceae), *Quararibea wittii*, *Guarea kunthiana* (Meliaceae) and *Guarea macrophylla* (Meliaceae). Median sapling recruitment distance (i.e. distance to the nearest large conspecific tree) ranged from <6m to >100m, and averaged 34m for all species examined, which represented an average of 4x crown radii. Bird dispersed species had longest recruitment distances, followed by wind-dispersed, primate-dispersed and bat-dispersed species. Rodent-dispersed and autochorous species had the shortest median recruitment distances. Spatial distribution patterns and spatial associations across different life stages were analyzed using Ripley's univariate and bivariate functions. Within-cohort clumping was observed for a majority of species at the adult and sapling stages, whereas adult-sapling spatial association was random or negative for the majority of common species examined. We explore these results in a phylogenetic context and also examine the consequences of hunting-induced defaunation on recruitment processes and patterns.

### **V-66-2: Functional Diversity in Amazonian Floodplain Forest Trees**

Pia Parolin; *Dept. of Plant Systematics, University of Hamburg*

One of the biggest flood pulsed environments worldwide occurs in the Amazon basin, with an immense biodiversity in terms of species richness. More than 1000 flooding tolerant trees grow there, many of them are endemic. However, not only species diversity but functional diversity in terms of life cycle strategies and ecophysiological responses to the periodical flooding is remarkable in this ecosystem. Tree species show a large variety of responses to the extreme changes of hydric conditions in the annual cycle. Difficult conditions for tree growth are caused by 3-7 months of uninterrupted periods of waterlogging or even submergence with high amplitudes, rapid changes of water levels, anoxic conditions in the rhizosphere, and high sedimentation. High functional diversity may result

from the fact that this extreme site has only a reduced number of abiotic factors representing real stress for the trees, and the regular disturbances may even represent a driving force for resistance and adaptive evolution. The high complexity of the system and the short but regular and thus predictable occurrence of factors enhancing tree growth in the low-water period allowed the formation of highly diverse adaptations and functions. Most tree species have wide ranges of ecological tolerance. However, these ranges are still narrow enough to allow a spatial succession along the flood gradient supporting the theory of continuous adaptation to different habitats as driving force for diversification. In fact, functional diversity has direct consequences for plant distribution along gradients of flooding intensity, which are reflected in a clear vegetation zonation in Amazonian floodplain forests.

### **V-66-3: Diversity and Evolution of Podostemaceae (River Weeds) in Southeast Asia**

Masahiro Kato; *National Museum of Nature and Science, Japan*

Podostemaceae is an aquatic angiosperm family distributed in the tropics and subtropics of the world. The family is unusual ecologically. Plants grow submerged on rock surfaces during the rainy season, and they flower and set fruits, while protruding and drying above the water, during the following dry season when the water level becomes low. Their morphology is also unusual and diverse. The plants adhere to the rocks by ribbon-like or crustose roots developed from the hypocotyl in most species with rudimentary or no primary shoots and roots, or by crustose or multi-branched adventitious shoots in rootless species. Recent exploration found that 10 genera and 42 species or more of Podostemaceae occur in Thailand, indicating the highest diversity of the family in Asia. Probably more than 20 species occur in Laos, and three and four species in Cambodia and Vietnam, respectively. Four species occur in Malesia. Podostemaceae prefer seasonal climate to year-round wet climate. It is interpreted that subfamily Tristichoideae appeared in tropical Asia, while Podostemoideae immigrated in Asia via a single colonization event.

### **V-66-4: The Floristic Composition, Diversity and Threats to Malagarasi-Moyowosi Wetland, a Tanzanian Ramsar Site**

Henry J. Ndangalasi, C. Nahonyo; *University of Dar es Salaam*

The Malagarasi-Muyowosi Ramsar Site is Tanzania's first Ramsar Site and at about 35,000 km<sup>2</sup> the third largest Ramsar Site worldwide. It is the largest of the three Ramsar sites in Tanzania, others being Kilombero valley and Lake Natron wetlands. In addition to supporting a number of plants and animals, the wetland is also recognized as one among the 80 Important Bird Areas (IBAs) in Tanzania, supporting a wide range of water birds of conservation concern such as Shoebill stork and Wattled Crane. Yet little is known about its floristic composition and diversity, and its relevance to habitat conservation. A study to bridge this knowledge gap was carried out in 2007. A total of 15 transects each about 1000 meters long were established in elected sites spanning the entire range of the wetland. Along each transect, 20 quadrats each one meter square were placed at 50 metres intervals. Results show that a total of 64 species representing 50 genera and 18 families were recorded in the entire wetland. Cyperaceae and Graminae were the most dominant families, with 18 and 13 species respectively. The most frequent species were (Relative Frequency value in brackets) *Vossia cuspidata* (100%), *Leersia hexandra* (86.7%) *Cyperus* sp. (66.7%), *Eleocharis dulcis* (60.0%) *Ipomoea aquatica* (60%) *Oryza longistaminata* (60%) and *Polygonum senegalense* (53.3%). Species richness ranged per transect ranged from 3 to 23 (mean 13.8±6.0). Species diversity (Shannon-Weiner Diversity Index) ranged from 1.57-2.69 (mean 2.03±0.56) whereas species evenness ranged from 0.11-0.61 (mean 0.46±0.13). Overall, the northern part of the wetland was more species rich than the southern part. Major threats to this wetland including wild fires and cattle grazing are discussed. Conservation of this important Ramsar site must take into account some of the unique vegetation, which in turn supports a unique fauna.

### **V-66-5: Southeast Amazonia - 25,000 Years of Environmental Dynamics in Relation to Global Climate Change**

Barbara Hermanowski, Hermann Behling; *University of Goettingen*

Present transition areas between savanna and Amazonian forest biomes are known to be sensitive to climate change as well as fire events. In the light of future climate change and the threat to the Amazonian rainforest through droughts and fires, it is important to gain a deeper understanding how past tropical forest communities responded to different climatic conditions. However, only few paleoecological studies provide insight into the vegetation history of Amazonian ecosystems in forest-savanna transition areas. With our new palynological and micro-charcoal dataset from the southeastern Brazilian Amazon region spanning the Last Glacial Maximum (LGM), Late Glacial and the full Holocene, we are now able to give a detailed overview on vegetation changes in a region, where palynological studies are rare. Compared with already existing data from adjacent regions the recorded changes in vegetation are most likely climate-driven. Thus, our data from two sediment records from the Serra Sul dos Carajás indicate changes between drier and wetter climatic conditions in this region since the LGM, reflected e.g. by natural fire events and nowadays unknown Amazonian forest communities. The presence of several cold-adapted taxa indicates a cold and dry period from c. 25,000 to 11,400 cal yr BP, followed by a short wet phase lasting until c. 10,200 cal yr BP. Afterwards pollen spectra and high micro-charcoal concentrations correspond to the establishment of an increasingly warm, seasonal climate. The onset of seasonality around 10,200 cal yr BP falls within the Early Holocene warming period, with possibly longer dry seasons and/or decreased precipitation during wet season, with an explicitly drier phase from c. 9500-3700 cal yr BP. Apparently, rainforest communities as known today have only established around 3700 cal yr B.P. possibly triggered by an incipient modern seasonal climate in southeast Amazonia, with shorter dry seasons and/or increased precipitation during wet season.

### **V-66-6: A Model of Leaf Acclimation to Light Based on Optimal Photosynthetic Light Use: Implications for the Spatial and Temporal Scaling of Photosynthesis**

Juan M. Posada, Ramón Fayad; *University of el Rosario*

Leaves can change their form and function depending on the availability of light (photosynthetic photon flux density, PPFD) in their immediate micro-environment. Recent studies suggest that the goal of these adjustments is to maximize photosynthetic PPFD use efficiency. This optimization principle has important implications because it can greatly facilitate the scaling of photosynthesis from leaf to ecosystem. Here, we evaluated to which extent leaves with different acclimation potentials could maintain maximum instantaneous photosynthetic PPFD use efficiency ( $\epsilon_{max}$ ) in contrasting light environments. We developed a mathematical model of leaf acclimation with a series of rules and which ultimate goal was to attain  $\epsilon_{max}$ . The model allowed leaves to change the scale and shape of their photosynthetic light response curves, their angle of inclination, and the rate of acclimation, all within realistic biological limits. We exposed leaves to PPFD environments corresponding to sunny, cloudy or variable days. The sun position and the distribution of PPFD in the sky hemisphere also changed during the day. Our simulations indicate that leaves only attained  $\epsilon_{max}$  during parts of the day because PPFD changed more rapidly than leaf acclimation. As a result, daily photosynthetic efficiency ( $\epsilon_{daily}$ ) was systematically below  $\epsilon_{max}$ . Yet, leaves with rapid leaf angle adjustments (heliotropic leaves) could maintain higher photosynthetic efficiency during certain parts of the day than leaves with slow leaf movements. An increase in leaf erectness played a crucial role in the efficient use of PPFD during sunny days because it reduced midday beam radiation. We conclude that acclimation allows leaves to efficiently use PPFD in different environments by concentrating photosynthetic activity on the ascending part of the light response curves. Our results indicate that a simple scaling of photosynthesis from leaves to ecosystems is possible under diverse environmental conditions.

### **V-66-7: Diversity and Production of Ethiopian Dry Woodlands Explained by Climate - and Soil - stress Gradients**

Abeje E. Wassie<sup>1</sup>, Frans Bongers<sup>2</sup>, Frank Sterck<sup>1</sup>; *1. Ethiopian Institute of Agricultural Research, 2. Wageningen University*

Dry woodlands cover about 14 percent of the total African surface and represent about 25 percent of the natural vegetation. They are characterized by a seasonal climate, with rainfall between 700 to 1200 mm per year and a wet season of 3-6 months. These ecosystems are threatened by the increasing pressure by local communities and, with them, increasing disturbances by grazing, fire and exploitation. We studied species richness and carrying capacity patterns along length of wet season and soil gradients in woodlands in Ethiopia. For such stressed ecosystems, classic productivity and diversity hypotheses predict that species richness and carrying capacity decrease with decreasing wet season length, and with soil conditions that increase water stress. We inventoried and measured trees in 18 2-ha plots distributed at two contrasting climate zones (long versus short wet season). We found that the carrying capacity (estimated from the stand volume per hectare) decreased with a shorter wet season, and with stronger soil water stress (estimated from texture and depth). This was in line with the prediction. The species richness was lower in shorter-wet-season woodlands, but was unaffected by variation in soil conditions. This suggests that climate driven constraints (wet season length) set the limits to species richness, and probably not soil conditions. We also discuss the potentially large consequences of increasing disturbance levels created by a rapidly growing population in Africa, as this will negatively affect the species richness and productivity of these climate-stressed woodlands. As far as we know, this study is one of the first studies that started to test classical productivity and diversity hypotheses for dry African woodlands.

### **V-66-8: Loss of Flora Diversity in Java**

Elizabeth A. Widjaja, Tika Dewi Atikah, Abdulrokhman Kartonegoro, Alex Sumadijaya, Johanis P. Moge & Arief Hidayat; *Botany Division, Research Centre for Biology-LIPI*,

According to Backer & Bakhuizen v.d. Brink, Jr. (1963-1968) there were 6258 species of flowering plant in Java, whereas Posthumus (1936) mentioned that there are 515 species of fern in Java. The Herbarium Bogoriense which kept about 2 million specimen herbarium, only about 400,000 specimens (20% of total specimens) a If all data of the Java specimens have been entered, this basic data can be used to monitor the loss of flora diversity in Java. On the other hand, Java has the highest population as well as rapid development either for industries or agricultural, because of that the decreasing of the forest can make the loss of the flora diversity. A citra landsat has been used by overlaying with the land cover map. Then the endemic species data was upload in the map. Based on the search finding from several references, IUCN data, specimen database, it is known that there are 288 species of endemic species in Java. Among this, only 15% from the total species has been monitored and still exist in the wild. The endemic species mostly found in the West (33,7%), East (32,9%) and Central Java (13,9%), whereas sometimes the endemic species is also found in both or even all provinces. However, the most disturbance area occurred in West and Central Java; East Java the least disturbance forest as shown on the map. Therefore the endemic species in the West and Central is probably extinct, as well as the species in East Java which grow in the lowland, but the species grow in the forest may still exist as far as the forest has not been disturbed. Keywords. Biodiversity loss, Java, endemic species.

### **V-66-9: Measurement the Effect of Microhabitat on Growth Distribution Pattern of *Gonystylus bancanus* (Miq) Kurz to Develop Species Conservation**

Pribadi D.O., Kusuma Y.W.C.; *Center for Plant Conservation-Bogor Botanic Garden, Indonesian Institute of Science*

Plant growth distribution pattern is influenced by distribution of habitat characteristic, capacity of adaptation, and association with other plant or animal. Some plants are more influenced by habitat



characteristic distribution. The others, have strong capacity of adaptation, thus they could spread in wide area along different habitat. The rest, are depend on the existence of plant or animal species association. According to global climate change issues, the first group of plant face the most seriously threat because of their habitat alteration. This paper has aims: (1) measuring plant growth dependence on their microhabitat; (2) defining kinds of microhabitat variable that influence growth significantly; (3) formulating conservation effort at species level. *Gonystylus bancanus* is one of major timber species that at once time before facing high exploitation in Indonesia. This species usually be found on specific “peat swamps” habitat. In this research, collecting data were done through primary survey in Riau Province. Analyzing data was started by clustering the adult base on variable of height and basal area, and described distribution pattern of each cluster. Then, we use Discriminant Function Analysis to overlay the cluster with the distribution of microhabitat characteristic consist of altitude, canopy cover, slope and soil characteristics. The result shows, distribution of microhabitat match with 67.4% of height distribution and 78.3% of basal area distribution. Altitude and canopy cover percentage have significantly correlation with height distribution ( $\alpha=0.05$ ). Meanwhile, altitude, canopy cover, and slope have significantly correlation with basal area distribution ( $\alpha=0.1$ ). However, peat depth variable shows interesting pattern since the bigger of basal area are followed by shallower peat depth. High correlation between plant growth and its microhabitat suggests that in-situ conservation is better than ex-situ conservation for *Gonystylus bancanus*.

#### **V-66-10: The Genus *Cecropia*: A Biological Clock to Estimate the Age of Disturbed Areas in the Neotropics**

Paul-Camilo Zalamea<sup>1</sup>, Patrick Heuret<sup>2</sup>, Pablo R. Stevenson<sup>1</sup>, Stéphane Guitet<sup>1</sup>, Carolina Sarmiento; Manuel Rodríguez; César Delnatte; Eric Nicolini; Anne Berthouly; Daniel Barthélémy; *1. Universidad de Los Andes, 2. INRA, UMR AMAP*

In the tropics, the surfaces covered with secondary forests are rapidly increasing due to high deforestation rates. A critical question that has recently been a focal point for heated debate in tropical ecology is to know whether secondary forests are able to recover following degradation. Tropical secondary forest succession is a slow process, and continuous data on vegetation change are scarce. Consequently, the chronosequences approach is frequently used. However, the use of this approach requires knowledge of ages of secondary forests, and this type of data is currently difficult and/or expensive to gather. In this study, we propose a rapid straightforward method to estimate the age of secondary forest based on age estimation of *Cecropia* trees. *Cecropia* is one of the most emblematic pioneer tree genera of the Neotropics. We tested *C. sciadophylla* and *C. obtusa* as chronometers for dating different types of anthropogenic disturbance, where the real age of disturbance is well known. We found that *Cecropia* inferred ages were highly correlated with real ages of disturbances in all cases. In addition, we propose 21 *Cecropia* species distributed over the geographical range of the genus and showing an annual flowering pattern as potential chronometer species. For the first time is shown that the genus *Cecropia* is a promising and very precise tool for dating disturbances and studying secondary forest dynamics in the Neotropics.

## Posters presentations

### Poster session: Forest ecology (#01; July 22)

#### P-01-1: Chemical Diversity of Humid Tropical Forest Canopies: New Global Data from the Spectranomics Project

Asner Gregory, Roberta E. Martin; *Carnegie Institution*

Canopy chemistry is central to defining the functional role of trees in tropical forests, and thus it is directly connected to primary production, decomposition and nutrient cycling, and ecosystem interactions with climate change. However, patterns in the chemical properties of tropical canopies remain poorly understood. On the one hand, regional and site conditions may drive variation in canopy chemistry, as has been repeatedly highlight in low-diversity forests or under carefully controlled conditions. On the other hand, there is potential for phylogenetic control of tropical canopy chemistry resulting from an evolutionary history shaped by competition and coexistence under high diversity conditions. We report on a study of 17 foliar chemical composition among more than 4000 canopies found throughout 100 humid tropical forest sites. On average, phylogeny accounts for 65% of variation in leaf nutrients and molecular composition in humid tropical canopies. All other factors including climate, geologic substrate, hydrology, soil fertility, tree selection, taxonomic identification, and analytical error contribute to the remaining 35%. Phylogeny accounts for 60-72% of variation in foliar phenols, tannins, cellulose, hemi-cellulose and lignin, suggesting strong evolutionary control over compounds that combat herbivory and increase leaf toughness and longevity. The taxonomic organization of chemical traits is, on average, partitioned 25%, 19%, and 21% at family, genus and species levels, respectively. Strong family-level control indicates that chemical traits, especially N and defense compounds, have a long evolutionary history. Site-level patterns in chemical phylogeny mirror that of global canopies in general. Our results have major implications for ecological, biogeochemical and remote sensing studies of humid tropical forests.

#### P-01-2: Effects of Population Spatial Structure on Pollination Success of Dipterocarps

Kirsty S. Nutt<sup>1</sup>, David Burslem<sup>1</sup>, Colin Maycock<sup>1</sup>, Eyen Khoo<sup>1</sup>, Chris Kettle, Jaboury Ghazoul<sup>2</sup>; *1. University of Aberdeen, 2. ETH Zurich*

Dipterocarps are cross-pollinated by insects but little is known about how the spatial distribution of flowering trees influences pollination success. We analysed flower samples from 18 *Dipterocarpus grandiflorus*, 16 *Hopea beccariana*, and 25 *Parashorea tomentella* trees and mapped all flowering individuals of these species during minor flowering events in 2006 and 2007 at Sepilok Forest Reserve, Sabah. There was no influence of the number of conspecific flowering trees in expanding concentric rings out to 750 m on the percentage of flowers pollinated for the large-flowered *Dipterocarpus grandiflorus*. However, for *Parashorea tomentella* pollination success increased with the number of conspecific flowering neighbours in the range 275-875 m, while for *Hopea beccariana* pollination success was related positively to the number of flowering conspecifics within 125-175 m of the target tree. The contrast in the influence of the density of conspecific flowering trees could be associated with variation in pollinator types for species with different sized flowers. There is also a significant negative effect of magnitude of flowering of an individual tree on its pollination success suggesting some level of pollinator limitation.

#### P-01-3: The Role of Environmental and Spatial Factors in Structuring Phytotelm Communities

Paloma M. Lopes, Vinicius F. Farjalla, Diane S. Srivastava, Fernanda D. Azevedo, Nicholas A.C. Marino, Viviane Dib, Alexandre S. Rosado, Reinaldo L. Bozelli, Francisco A. Esteves; *Federal University of Rio de Janeiro*

Understanding the patterns in species occurrence is one of the major goals in ecology. Two very different paradigms have emerged to explain such patterns. The first is based on niche mechanisms and assumes a major role of environmental factors in shaping community composition (the species sorting perspective). The second is related to neutral processes and, in this case, one could expect a preponderance of spatial predictors in shaping community structure. The aim of this work was to test how different organisms (bacteria, zooplankton and insects) in the same habitat are affected by niche versus neutral processes. We sampled fauna from 60 bromeliads located in the Restinga de Jurubatiba National Park, in Rio de Janeiro State, Brazil. Redundancy analysis (with a variation partitioning technique) were used to determine how much of the variation of the communities composition were explained by environmental versus spatial factors. Bacteria had no habitat associations, as would be expected from neutral processes, but bacterial species still had strong interspecific associations, as would be expected from niche-based processes. Insects had strong habitat and species associations, indicating niche processes, except amongst closely-related species, which were randomly associated as expected from neutral dynamics. Zooplankton showed intermediate patterns in terms of species and habitat associations. Together, these results demonstrate that those communities have fundamentally different mechanisms structuring their composition, and that elements of niche and neutral patterns can be found in most natural communities.

#### **P-01-4: Soil CO<sub>2</sub> Efflux in a Bornean Tropical Forest**

Lip Khoon Kho, Yadvinder Malhi, Sylvester T. Kheng San; *University of Oxford*

Soil respiration is a crucial process in the carbon cycle of terrestrial ecosystems. However, soil CO<sub>2</sub> efflux is still poorly quantified and their relationships to environmental factors are not well understood. We investigated temporal and spatial variation of soil respiration and the relationship to environmental factors within two major soil types in a mixed dipterocarp forests of Lambir Hills National Park in Sarawak, Malaysia. The objectives of this study are: 1) to analyze seasonal variation in soil respiration in a mixed dipterocarp forests and on different major soil types; and 2) to examine the relationship between soil respiration with environmental factors and belowground production. Soil CO<sub>2</sub> flux were measured and correlated with belowground production (fine roots, litterfalls, microbes) and environmental factors (soil temperature, soil moisture, temperature). Soil respiration increases over time from October 2008 to September 2009. Mean soil CO<sub>2</sub> fluxes were  $2.821 \pm 0.817$  and  $3.607 \pm 1.207$  (mean  $\pm$  S.E.)  $\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$  in clay and sandy loam sites respectively. Soil CO<sub>2</sub> fluxes were higher in sandy loam site, but showed relatively similar rates in the Neotropics. The spatial variation of soil respiration rates could be explained by fine root production, litterfalls and microbial activity between the two contrasting sites. In addition, we established the long-term DIRT (Detritus Input Removal and Transfer) experiment to control and manipulate soil organic matter. Our goal is to assess CO<sub>2</sub> flux from soil partitions under different treatments of chronically altered above- and belowground inputs. Monthly and continuous soil CO<sub>2</sub> efflux was measured to capture seasonal variations.

#### **P-01-5: The Effects of Forest Disturbance on the Reproductive Success in *Dillenia suffruticosa* in Sarawak, Malaysia**

Tokumoto, Michinari Matsushita, Takao Itioka, Michiko Nakagawa; *Nagoya University*

Tropical rain forests in Southeast Asia have been disturbed, and it is known as one of critical environment problems. The deforestation and degradation might lead not only the loss of biodiversity or changes in the composition of fauna and flora but also alternation of the interaction between plants and animals such as plant-pollinator interaction. Furthermore, plant reproductive success and vegetative succession might be also affected, because most of trees were pollinated by insects in the

tropical area. However, few researches evaluate the effect of forest disturbance on plant reproductive success together with pollinator community structure. The objective of this presentation is to determine the pollinator community structure and plant reproductive success in three vegetation types using a pioneer shrub species *Dillenia suffruticosa* (Grif.) Merlli (Dilleniaceae), which distributes along forest edge and road or in a secondary forest. The study was conducted at Lambir Hills National Park (LHNP), around fallows near LHNP, and mixed vegetation area 10km north of LHNP. We collected pollinators for *D. suffruticosa* during every 30 minutes from 6 to 11 o'clock, and counted the reproductive organs periodically. After counting dried mature and immature seeds in the fruits, mature seeds and pulp were weighted. To examine the effect of vegetation types on reproductive success, we used model selection approach with Generalized Linear Mixed Models. Most pollinators of *D. suffruticosa* were stingless bees (*Trigona* spp.) and carpenter bees (*Xylocopa* spp.) and pollinators in LHNP were the richest and most abundant. However, the reproductive successes were not different among vegetation types. Our results indicate that although forest disturbance alter the community structure of pollinators, reproductive successes in *D. suffruticosa* might not be influenced.

#### **P-01-6: Seed Dispersal and Spatial Patterns of Trees in a Tropical Dry Forest**

Soumya Prasad, H.S. Dattaraja, H.S. Suresh, R. Sukumar; *Centre for Ecological Sciences, IISc*

Spatial point patterns are the footprints of underlying biological processes. For plants, seed arrival patterns vary depending upon their dispersal mode and form the primary matrix upon which further forces shape spatial patterns. We examined linkages between dispersal mode and spatial aggregation of trees at community scales in a tropical dry forest at the Mudumalai Forest Dynamics Plot (50 ha). We used the pair correlation function ( $\Omega$  statistic) and statistics derived from cluster models (Matern process) to examine spatial patterns. Considering only trees that had  $\geq 10$  individuals (48 species), we found that all species were more aggregated at 0-10m annuli than larger annuli. At smaller spatial scales ( $< 50$  m), there were differences between mechanically-dispersed and animal-dispersed species (less aggregated), which did not persist at larger spatial scales. Animal-dispersed species had larger cluster radius, with bird-dispersed species having the largest radii. Dispersal syndromes with greater potential for long-distance dispersal exhibited significantly larger clusters. These results are contradictory to Hubbell (1971, 30 species, tropical dry forest) but are in concordance with Siedler & Plotkin (2006, 637 species, tropical wet forest) and Li et al. (2009, 124 species, sub-tropical forest) who find that mechanically-dispersed species are more aggregated than animal-dispersed species. However, our results confirm Hubbell (1971)'s observation that bird-dispersed species exhibit most diffuse spatial patterns.

#### **P-01-7: The Carnegie Spectranomics Project: Building a Chemical, Spectral, and Taxonomic Library for Biodiversity Mapping**

Roberta E. Martin, Gregory P. Asner; *Carnegie Institution*

The chemical diversity of humid tropical forests is largely derived from their vast taxonomic diversity, and is thought to exceed that of all other terrestrial ecosystems combined. The variation in leaf chemistry is directly expressed in the spectroscopic patterns of tropical canopies which can now be measured from new airborne and future space-based imaging spectrometers, supporting large-scale mapping of tropical forest biodiversity for the first time. To address this new frontier in spectroscopy, we developed the Carnegie Spectranomics Project (CSP), which seeks to quantify and understand linkages between chemical, spectral and taxonomic patterns among tropical forest species. This project requires a large number of collaborators with many special talents from around the world. Here we present a celebration of the project and our collaborators, as well as some of our methods of collection and analysis. We hope it will encourage others to join our team.

#### **P-01-8: Phosphorus Use Efficiency of Bornean Tropical Rain Forests**

Amane Hidaka<sup>1</sup>, Reuben Nilus<sup>2</sup>, Tatsuyuki Seino<sup>1</sup>, Shin-ichiro Aiba<sup>1</sup>, Kanehiro Kitayama; *1. Center for Ecological Research, Kyoto University, 2. Forest Research Center, Sabah Forestry Department*

In tropical rain forests, it is believed that plant growth and productivity are limited by soil nutrients, especially phosphorus (P). Therefore, efficient use of P is important for tropical trees growing on P poor soils. P use efficiency (PUE) has been studied in various tropical regions of the world, and varies from 1000 to 8000 kg DM / kg P (Vitousek 1984). However, it is still unclear what kind of biological process (e.g. leaf life span, P resorption rate and P productivity) is important for increased PUE in tropical rain forests. We investigated a pattern of PUE in relation to soil P availability and investigated the relationship between PUE and biological process across various types of vegetation in Borneo (e.g. lowland mixed dipterocarp forests, hill forests, montane forests, swamp forests and heath forests). Among 40 Bornean tropical rain forests, PUE varied from 1360 to 7330 kg DM / kg P. P resorption rate, leaf life span and canopy P residence time increased with increasing PUE. P concentrations in both crown leaves and leaf litter decreased with increasing PUE. P productivity (i.e. the ratio of ANPP to canopy P mass) did not negatively correlate with PUE. P resorption rate was more important for increased PUE than leaf life span and P productivity were. The maximum value of P resorption rate does not exceed 70 %, suggesting either that the cost of P resorption exceeds benefits above 70 % or that the remaining 30 % is physically recalcitrant in leaves. It seems that various strategies are involved in increasing PUE in tropical rain forest tree species.

**P-01-9: The Dynamics of Species Composition, Stand Structure and Aboveground Biomass of Undisturbed Forest in East Kalimantan**

Haruni Krisnawati, Djoko Wahjono, Rinaldi; *FORDA*

The dynamics of species composition, stand structure and above-ground biomass were studied over a 4.3-year period (December 2004 - April 2009) in an undisturbed forest in East Kalimantan, Indonesia. This study was conducted in six permanent plots (100x100 m<sup>2</sup> each) distributed over an area of 26.5 ha of Samboja research forest. All woody plants  $\geq 10$  cm dbh (diameter at 1.3 m above ground) were identified. In December 2004, 2143 stems were measured in the six plots, consisting of 39 families, 82 genera and 111 species. The distribution in April 2009 (after 4.3 years) was: 2466 stems, 40 families, 86 genera and 123 species. Most species were found in both occasions, except for *Trigonostemon laevigatus* that did not occur in 2004. Thirteen new species were registered, which contributed to 9.8% of a net addition of the total number of species found in the six plots. Over the 4.3-year period, there was also an increase of 15.07% in density, 12.89% in basal area, and 12.41% in above-ground biomass, respectively. The density increased from 357 trees per ha to 411 trees per ha; the basal area increased from 20.09 m<sup>2</sup> ha<sup>-1</sup> to 22.67 m<sup>2</sup> ha<sup>-1</sup>; and the above-ground biomass increased from 131.23 ton ha<sup>-1</sup> to 147.5 ton ha<sup>-1</sup>. The family Dipterocarpaceae was the richest in species (more than 20 species found in both occasions), followed by Euphorbiaceae, Burseraceae, Fabaceae, and Anacardiaceae (more than five species). Most genera (80%) contained just one species, but *Shorea* with 13 species was the richest. Five families (Dipterocarpaceae, Myrtaceae, Fabaceae, Lauraceae and Sapotaceae) contained more than 75% of the density and more than 80% of the both basal area and above-ground biomass in both occasions. The increases in number of species, density, basal area, and above-ground biomass suggested that the vegetation of the study area maintains its original composition and structural features over the period.

**P-01-10: Forest Regeneration and Succession on the Mo Singto Forest Dynamics Plot, Thailand: Tree Diversity Depends on Constant Chan**

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The 30-ha Mo Singto Forest Dynamics Plot, Khao Yai National Park, central Thailand, was set up in forest that appeared to be relatively mature, but recent analysis reveals that most or all the forest on the plot must be late successional or old growth forest (OF). A total of 262 species of trees and shrubs

$\geq 1$  cm in dbh have been identified, measured and tagged. Many species on this plot have unimodal dbh distributions. Of 142 species for which 12 individuals were present, the number of juveniles was less than twice the number of adults in 42 species (30%), indicating a probable shortage of recruits. This includes half of the emergent-class species ( $>1$  m dbh). The plot slightly overlaps a 30-y old secondary forest regenerating post-fire from a former swidden; a 1-ha plot in this successional forest (SF) has been inventoried and contains 75 species. Most species with poor recruitment in the OF are present at higher density in the SF, suggesting that they are late successional species surviving into OF. However, the OF has no known history of clearing or destruction by humans. Species diversity in the SF plot was compared to three 1-ha OF control quadrats adjacent to and within 40 m of the border of the SF quadrat. Out of a total of 194 species occurring in the four 1-ha plots, 119 occurred only in one or more of the OF quadrats, and 58 occurred in all three of the OF quadrats, but not in the SF. The proximity of the OF quadrats and the existence of a diverse array of potential animal dispersers at Mo Singto virtually rule out dispersal limitation as a likely explanation of the lack of colonization of the SF by the majority of OF species. The picture that is emerging is that major disturbances including fire, perhaps mimicking anthropogenic destruction, may be necessary to maintain the full spectrum of tree diversity in the landscape. In situ experiments will be necessary to determine what environmental factors in the SF are inhibiting recruitment of many species.

#### **P-01-11: Biodiversity and Conservation of Tropical Peat Swamp Forests**

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Tropical peat swamp forests are a unique ecosystem formed when undecomposed vegetative debris accumulate in waterlogged conditions. They occur in the greatest extent in Southeast Asia, where they are under enormous threat from logging, fire and land conversion. Recent research has shown the significance of peat swamps as a global carbon store, but their ecology and value for biodiversity remain poorly understood. We review the current status and biological knowledge of tropical peat swamp forests, as well as the impacts of human disturbance. They are an important habitat for the conservation of a wide range of threatened taxa, particularly specialized freshwater fishes. They are also extremely vulnerable to synergistic effects of multiple threats compared to other forest ecosystems. The protection of remaining tropical peat swamp forest is a priority that requires urgent conservation and policy action.

#### **P-01-12: The Influence of Habitat Disturbance on Epiphyte and Liana Communities in East African Rain Forests**

Katja Rembold, Eberhard Fischer; *University of Koblenz*

The biodiversity of epiphytes in African rain forests is low compared to Neotropical or Asian rain forests, though our knowledge about African epiphyte communities is very limited. Our study aims to record the species composition of vascular epiphytes along a disturbance gradient and give evidence about the conservation status of the respective species. In order to cover the full range of primary forest to young secondary forest, under different anthropogenous and ecological pressures, the study was carried out in two East African rain forests - Budongo Forest in Uganda and Kakamega Forest in Kenya. With increasing disturbance level, we observed not only a decrease in vascular epiphyte diversity, but also an increase in the number of liana species. As both trends are likely to be linked, the latter were included in this study. A large number of species occurs only in forest types with a certain degree of disturbance or at least in a conspicuously increased number. Those species provide information about the recovery capacities of epiphyte and liana communities after deforestation, which allow us to estimate the extent of species loss resulting from the continuous decline of primary forests.

#### **P-01-13: Plant Succession and Alternative States Model for Mt. Merapi**

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Succession has been a central concept in ecology and the phenomenon of changes in species composition over time has captured the interest of ecologists and naturalists for centuries. Various models of succession have been described in various ecosystems types. Recent emphasis has shifted towards the idea of non-equilibrium dynamics where disturbance can occur at any of the succession stages and that when thresholds in the succession are crossed alternative states arise, are recognized. In this talk I will share the results of my studies on Mt. Merapi, one of the major active volcanos in Indonesia where I will describe the plant succession following the unique Merapi-type nuées ardentes and discuss the possibilities of alternative states that may occur. Recognizing the potential of alternative states is an important element in linking ecological succession with restoration efforts.

**P-01-14: The Effect of Area on Local and Regional Elevational Patterns of Species Richness of Ferns on Tropical Mountains**

Dirk N. Karger, Jürgen Kluge, Thorsten Krömer, Andreas Hemp, Marcus Lehnert, Michael Kessler; *Systematic Botany, University of Zurich*

Studies of species richness along elevational transects can be divided into two groups, the first focusing on field studies (local studies), and the second deriving data from literature and scientific collections (regional studies). Local and regional studies often show a mismatch in elevational diversity patterns. In particular, the maximum of regional species richness in regional studies often lies at lower elevations than the local species richness maximum. This may either be because regional richness is more strongly influenced by area effects than local richness or because local and regional richness patterns are determined by fundamentally different mechanisms. To test if area accounts for the difference between local and regional species richness along elevational transects, we studied six elevational transects in Bolivia, Costa Rica, Ecuador, La Réunion, Mexico, and Tanzania. We sampled ferns in standardized field plots and collated regional species lists based on herbarium and literature data. We then used the Arrhenius function  $S = cAz$  to correct regional species richness for the effect of area, and compared the concordance of local and regional patterns prior and after this correction. We found a better match between local and regional elevational species richness after including the effect of area. Correction values for area differ between gradients, showing that there is no generally applicable elevational species-area relationship for ferns. The differences between local and regional elevational richness patterns can at least partly be accounted for by area effects, suggesting that the underlying causes of elevational richness patterns may be the same at both spatial scales.

**P-01-15: The Ecology of Conifers in Tropical Montane Forests on Mount Kinabalu, Borneo**

Shin-ichiro Aiba<sup>1</sup>, Tatsuyuki Seino<sup>2</sup>, Kanehiro Kitayama<sup>1</sup>; 1. *Kagoshima University*, 2. *University of Tsukuba*

We studied the ecology of conifers along the elevational gradients (700-3100 m) on Mount Kinabalu, Borneo, the highest mountain in Southeast Asia (4095 m). The permanent plots were established in ten sites with contrasting substrate and soil types (zonal soil on sedimentary and granitic rocks, azonal soil on ultramafic rock, and rocky substrate of alluvial origin). Nine species belonging to six genera and two families occur in the plots: *Agathis borneensis*, *A. kinabaluensis* (Araucariaceae), *Dacrycarpus imbricatus*, *D. kinabaluensis*, *Dacrydium gibbsiae*, *D. gracilis*, *Falcatifolium falciforme*, *Phyllocladus hypophyllum* and *Podocarpus gibbsii* (Podocarpaceae). No species is restricted to ultramafic soil though most species showed biased distributions to particular soil or substrate type. Conifers are generally abundant in montane forests, but their abundance varies with substrate or soil-nutrient status and they can occur in lowland forest on ultramafic soil. These patterns suggest control by substrate type and soil nutrients rather than by temperature. Conifers generally show flat or monomodal diameter distributions, which indicate that they are shade-intolerant and require canopy

gaps for regeneration, whereas some species seem to regenerate continuously in montane forests on ultramafic soil because of the sparse canopy structure. Analyses of growth rate and crown light conditions in a montane forest also indicated that conifers are generally fast-growing, light-demanding, pioneer-like species. Conifers generally have greater maximum tree sizes than angiosperms. Once they reach the upper canopy layer they persist for a long time due to their long life span, allowing them to regenerate in rare events of canopy disturbance. We suggest that the architectural and life-history advantages and physiological adaptations to nutrient limitation are essential for the persistence of conifers, despite their lesser shade tolerance as compared to angiosperms.

**P-01-16: Do Spatial Surfaces of Microclimate Improve the Accuracy of Species Distribution Models? a Case Study With Soil Moisture and Rainforest Skinks**

Collin J. Storlie, Jeremy VanDerWal, Stephen Williams; *James Cook University*

**Introduction:** Spatially explicit surfaces of macroenvironmental variables, such as BIOCLIM, are widely available resources that assist with mapping species distribution and abundance in space. Species interactions with macroclimate are mediated by multiple factors that ensure these macroenvironmental surfaces rarely reflect conditions experienced by species in-situ. The implementation of spatial surfaces of microclimate (e.g. soil moisture, under canopy temperature, etc...) into species distribution model (SDM) algorithms has the potential to increase their accuracy. **Methods:** Data have been gathered from an array of conductive capacitance based soil moisture sensors distributed across an altitudinal and latitudinal gradient within Australia's Wet Tropics World Heritage Area (WTWHA). These data were input into a multiple linear regression model to create a spatially explicit surface of soil moisture for the whole WTWHA. Species distribution models were constructed using the MAXENT modelling technique incorporating the microenvironmental surface as a predictor variable. Standard goodness-of-fit measures (AUC, AIC, kappa) were used to assess model accuracy and compare SDM's constructed with and without the microenvironmental surface. **Discussion/Conclusion:** Not all sites showed a strong relationship between soil moisture sensor output and gravimetric soil moisture. This indicates that factors apart from soil moisture strongly affected sensor output. High levels of heterogeneity among soil features at a fine scale (i.e. organic content, bulk density, fine root mass) resulted in highly variability among values of gravimetric soil moisture; this in turn reduced the accuracy of the spatially interpolated surface of soil moisture. The soil moisture surface did not significantly increase the accuracy of the SDM when compared to a model constructed using solely macroenvironmental surfaces as predictor variables.

**P-01-17: The Effect of Removing Litter of Tropical Rainforest Floor in North Sumatra on Soil Infiltration Capacity and Flooding**

Rauf Abdul, Sabrina, Tengku, Erwin Nyak Akoeb; *University of Sumatera Utara*

The study about the effect of removing litter of tropical rainforest on soil infiltration capacity and flooding have been done on May to July 2005 at Langkat and Karo District, North Sumatra, Indonesia. The research was begun with surveying the location of removing litter forest floor. Then choosing the research locations: the forest without litter (litter was taken by men or farmers), and forest with litter (virgin forest). Infiltration rate was measured by using double ring infiltrometer with 5 replications for each forest condition. The flooding evidence was estimated by comparing the soil infiltration capacity of forest without litter with the infiltration capacity of virgin forest. The result of these research show that infiltration rate (and capacity) at forest in Gunung Leuser National Park (Langkat District) was higher 1.5 – 7.90 times than infiltration rate at Conservation Forest of Gunung Sinabung (Karo District). The soil infiltration capacity at forest without litter decreased up to 5.6 – 7.3 times compared to the soil infiltration capacity of virgin forest in Gunung Leuser National Park, and 1.5 – 2.2 compare to the soil infiltration capacity of Conservation Forest of Gunung Sinabung. Water drained from forest without litter was 500 m<sup>3</sup>ha<sup>-1</sup>h<sup>-1</sup> - 5000 m<sup>3</sup>ha<sup>-1</sup>h<sup>-1</sup>, and was potential to cause flooding in the downstream.



**P-01-18: The Relationship between Soil Type and Leaf Characters in Tropical Montane Forest of Mt. Kinabalu, Malaysia**

Satomi Shiodera<sup>1</sup>, Kanehiro Kitayama<sup>2</sup>; *1. Hokkaido University, 2. Kyoto University*

Mt. Kinabalu is characterized by patches of various edaphic conditions that reflect the diverse geological substrates. Due to the poor nutrient condition of the soil, on the ultrabasic substrate, the forest developing low productivity and short state compared to the unconsolidated tertiary sediment substrate. In this study, we compared leaf characters (such as; leaf size, leaf mass per area; LMA, leaf nitrogen contents, leaf thickness and water contents), photosynthetic nitrogen use efficiency (PNUE), the ratio of CO<sub>2</sub> assimilation rate to leaf organic nitrogen content and water use efficiency (WUE) of the tree species in the ultrabasic and non-ultrabasic substrate (tertiary sedimentary substrate) forest. Tree species in the ultrabasic soil had smaller and thicker leaves, compared to that of in the non-ultrabasic soil. PNUE was higher in non-ultrabasic site than in ultrabasic site. High LMA species in the nutrient deficient ultrabasic soil showed lower PNUE than the species with low LMA in the nutrient sufficient non-ultrabasic soil. On the other hand, WUE was not different between two sites. Depending on the soil type, the relationship between PNUE and WUE displayed different patterns. In the non-ultrabasic soil, there is a negative correlation between PNUE and WUE. The species with lower PNUE show higher WUE, and the species with higher PNUE show lower WUE. However, the relationship could not be detected in the ultrabasic soil. From these results we conclude, only the species with high LMA and low PNUE can dominate in the nutrient deficient environment, such as ultrabasic soil due to the low nutrient availability. On the other hand, in the environment that contains relatively sufficient nutrients, such as non-ultrabasic soil, species that have variable strategies of nutrient use for photosynthesis can coexist.

**P-01-19: Ecosystem Reconstruction Concepts and Impacts of the Decreasing Quality Gunung Pancar Forest and Surrounding Area, West Java-Indonesia**

Roemantyo, M. Noedjito, S. Riswan, W. Widodo; *Research Centre for Biology – LIPI*

Gunung Pancar forest (447 hectares, 840 m asl.) and surrounding area is located about 50 km of the south eastern Jakarta. This area originally covered by lowland forest but due to the pressure of increasing population this area was converted to resettlement, agriculture and industrial area. About 20 hectares still remain on the top of the Gunung Pancar at the elevation between 600 – 800 m asl. as a old secondary forest. As a part of the Ciliwung – Cisadane watershed especially in the eastern part of upper rivers, Gunung Pancar forest and surrounding area is important in the controlling ecosystem of the lower parts of this watershed system, comprises north eastern of Bogor and eastern of Jakarta includes Bekasi. Decreasing ecosystem quality of this area will be directly influence to the area where are millions people lives along the riverbanks of Ciherang, Cikeruh and Citeureup rivers or on the slopes of Sentul, Hambalang Wangun hill with high risks of flood and landslides. Ecology study on the year of 2009 in this area has been conducted to develop a ecosystem reconstruction model. The results showed that about 112 plant species belong to 44 families and 91 genera occur in this area, such as kiara (*Ficus* spp.), huru (*Beilschmiedia madang*) pasang (*Lithocarpus sundaicus*), kihaji (*Dysoxylum densiflorum* and *D. macrocarpum*), ki rambutan (*Xerospermum noronhianum*) was dominated in the old secondary forest. Rare birds species as one ecosystem indicators was noted occurs in the Gunung Pancar hill such as *Spizaetus bartelsi*, *Pitta guajana*, *Stachyris melanothorax*, *Brachypteryx leucoprys* etc. Relation between plant species and birds species is important to supporting ecosystem. Spatial analyses to develop digital models of elevation, aspects, slopes and land cover of this area showed that some villages on the foot of this area have a high risk on flood and landslides when heavy rain occur and directly affect to the ecosystem in general especially at the lower watershed.

**P-01-20: Study of Pteridophyte Diversity and Vegetation Analysis in Jatikerep, Legonlele, and Nyamplungan, Karimunjawa Island, Central Java**

Fahreza Saputra, Labibah Qotrunnada, Abdul Rohim, Zulfa Hanif, Diny Hartiningtyas, Tiara Dewi, Sentot Tri Prabowo, Anisa Balqis; *University of Indonesia*

Pteridophyte diversity and vegetation analysis were studied at Jatikerep, Legonlele, and Nyamplungan, Karimunjawa Island. The aim of the study was to record pteridophyte diversity which can survive in a certain environment condition like low amount of rainfall, dry soil, and lowland rain forest like Karimunjawa Island. Using line transect method, thirty plots with 10 x 10 m for each plot were made randomly and separated in three areas consists of Jatikerep (1839,285 m<sup>2</sup>), Legonlele (553,118 m<sup>2</sup>), and Nyamplungan (708,695 m<sup>2</sup>). Thirteen species of pteridophytes were recorded with *Lygodium flexuosum* as a dominant species (Indices of Important Value : 1.331) followed by *Pteris vittata*, *Lygodium mycrophylum*, *Lindsaea ensifolia*, *Pteris ensiformis*, *Nephrolepis brownii*, *Cheliantes tenuifolia*, *Nephrolepis hirsutula*, *Cyclosorus extensus*, *Blechnum finlaysonianum*, *Taenitis blechnoides*, *Abacopteris triphylla*, and *Pteris semipinnata* respectively. Pteridophyte diversity in Karimunjawa is low with indices of Shannon-Wiener ( $H'$ ) = 1.5462. The affection between Shannon-Wiener indices for each quadrat and abiotic factors for instances pH and soil moisture were analyzed. The result showed that soil moisture and pH were not affecting the pteridophyte diversity significantly, but have a tendency to incline the diversity of pteridophyte since soil moisture is high and pH is low. Keywords : Diversity; Karimunjawa; Lowland Rain Forest ;Pteridophyte

**P-01-21: Mortality of a Neotropical Savanna Tree is Related to Quantity of Dry Season Precipitation**

John Du Vall Hay, Raimundo P.B. Henriques, Livia H.C. Silveira; *Univ. de Brasilia*

Trees are fundamental components of savanna ecosystems. Considering that water is one of the four factors (fire, nutrients, herbivory) indicated as determinants of savanna ecosystems, we expect that limited water availability in the dry season would have a strong effect on tree mortality. We tested this idea using field data collected from 1984 to 2009 in the core region of the Brazilian Cerrado (Neotropical savanna). In 1984, four 0.25 ha plots were established in the Fazenda Água Limpa in the Federal District of Brazil and all individuals of the tree species *Sclerolobium paniculatum* were mapped and tagged. Over this 25 yr period, we made 11 surveys during which each all individuals were measured for circumference at 20 cm, DBH and height. Recruitment was included in the data base and death of any individual was also recorded. To test our hypothesis, we calculated the annual mortality rate during each collection interval and related this to the mean monthly dry season precipitation (May to August) during the collection interval. The results supported our hypothesis, indicating a significant break point, below which ( $\approx 12$  mm/mo) mortality rate of this tree species dramatically increased. If the present trend of global warming continues, with marked decrease in precipitation patterns in the Brazilian Cerrados, these results support the idea of large scale alteration in the dynamics of the Cerrado tree community.

**P-01-22: Spatial Distribution Patterns of Reproduction in Dipterocarp Trees in a Tropical Rainforest, Sarawak, Malaysia**

Satoshi Nanami<sup>1</sup>, Sylvester Tan<sup>2</sup>, Akira Itoh<sup>1</sup>, Tsuyoshi Harata<sup>1</sup>, Takuo Yamakura, Bibian Diway and Lucy Chong; *1. Graduate School of Science, Osaka City University, 2. Sarawak Forestry Corporation*

'General flowering' is a reproductive phenomenon unique to the tropical rainforests of Southeast Asia and is characterized by the synchronous flowering and fruiting of the majority of plant species at intervals of several years. We investigated population-scale spatial distributions of reproductive trees belonging to 15 dipterocarp species in a 52 ha plot in Lambir National Park, Sarawak, Malaysia. The reproductive organs of trees larger than 30 cm in d.b.h. were observed at monthly intervals using binoculars. Random labeling of reproductive trees revealed that clump formation in *Dryobalanops*

aromatica and *Shorea acuta* was significant while the spatial distribution of reproductive trees belonging to the other species appeared random. A possible reason for the observed random distributions was the high ratio of reproductive trees observed during the reproductive event of 2009. The ratio of reproductive trees varied among species, ranging from 0.704 for *S. acuta* to 1.000 for *Dipterocarpus crinitus*. Flowering probability was found to be dependent on tree size and almost all non-reproductive trees were smaller than 60 cm d.b.h. In nine of the 15 species studied, flowering occurred in all trees larger than 60 cm d.b.h. Flowering phenology varied among species, occurring in *D. aromatica*, *D. lanceolata* and *Dipterocarpus globosus* in September, and in *Shorea laxa* and *Shorea ovata* about a month later. Intraspecific differences in flowering phenology were also observed within a species, with 90% of reproductive *S. laxa* trees flowering twice during the observation period, while the remaining 10% flowered only once. Future research will examine the relationship between the location and flowering intensity of the trees.

### **P-01-23: Functional Beta-Diversity of Amazonian Forest Trees**

Claire Fortune<sup>1</sup>, Paul V.A. Fine<sup>2</sup>, Christopher Baraloto<sup>1</sup>; 1. *INRA*, 2. *UC Berkeley*

The assembly of diverse communities such as tropical trees remains a subject of debate, and a principal question addresses the extent to which environmental filtering, niche differentiation and stochastic factors shape community structure at different scales. The measure of key plant phenotypes, or functional traits, provides a novel means to distinguish among the signatures of these processes and to quantify their contributions across environmental gradients. We have examined the distribution of key functional traits describing leaf, stem and root morphology, anatomy and physiology in three widespread habitats of lowland Amazonian forests – white sands, seasonally-inundated forest, and clay terra firme forest. We measured traits for one individual of each woody plant species > 2 cm DBH (n=1118) occurring in each of twelve 0.5-ha permanent plots at opposite ends of the Amazon basin in Peru and French Guiana. Here we present two sets of analyses. First, we examine functional composition in each local community relative to the regional species pool to determine if patterns are consistent with environmental filtering for particular plant traits. Changes in community-level composition may be influenced both by local processes and by regional turnover in the species pool. We therefore provided phylogenetic control by examining the extent to which community functional composition changes across environmental gradients were consistent with patterns observed within five lineages for which we have phylogenetic hypotheses derived from molecular data lineages (*Bombacoideae*, *Protieae*, *Inga*, *Micropholis*, and *Swartzia*). We discuss the extent to which functional tradeoffs related to habitat specialization have contributed to the origin and maintenance of species richness in Amazonian forests.

### **P-01-24: Monitoring the Angular Distribution of Photosynthetically Active Radiation for Studies of Atmosphere-Radiation-Photosynthesis Relations in Forests**

Dennis G. Dye; *U.S. Geological Survey*

Past research has demonstrated that the photosynthetic light-use efficiency (LUE) of forest ecosystems at the canopy or landscape scale is strongly dependent upon the directional quality of the incident photosynthetically active radiation (PAR, 400-700 nm). The canopy-scale LUE generally increases with increasing atmospheric scattering of PAR by clouds and/or aerosols until the associated reduction in the total incident PAR becomes limiting. Past studies have characterized atmospheric scattering of PAR by the diffuse PAR fraction (ratio of diffuse to global fluxes of PAR). Diffuse PAR is typically assumed to be uniformly distributed across the sky hemisphere for all sky conditions, although this assumption is generally reasonable for only uniform cloud cover with a large optical thickness. A deeper understanding of the relations between atmospheric conditions, diffuse PAR and forest photosynthesis, and their effects on forest growth dynamics on both short and long time scales, has been constrained by the absence of detailed, time-series measurements on actual sky radiance distributions of PAR. This paper describes the design and application of a ground-based, radiometric sky imaging system to provide improved data and information on the angular distribution of PAR

across the sky hemisphere. Initial results from a moist tropical forest site and applications to modeling of forest canopy photosynthesis and growth dynamics are discussed.

**P-01-25: Association of Bamboos with Tree Community in a Primary Hill Rain Forest**

Junichi Fujinuma, Takashi Kohyama, Matthew D. Potts, Abd Rahman Kassim, Ahmad Fitri b. Zohari; *University of Hokkaido*

Bamboo is known to alter the course of succession in tropical forests after human disturbance. Understanding the ecology of bamboo in primary forest ecosystem may leads to management methods that may minimize the negative effects of bamboo after timber harvesting. In our study, the association of bamboo and local tree communities were investigated in a primary hill rainforest in Peninsular Malaysia. Twenty-four research plots of 20 m by 20 m were established over an area of 50 ha spanning an altitude range of 600 m to 800 m a.s.l.. Within each plot: bamboo foliage cover ratio, tree abundance (d.b.h. > 5 cm), tree species, tree d.b.h., and topographical attributes were measured. 910 trees and 265 species were censused in total. The relationships between bamboo foliage density and tree species richness was examined using generalized linear regression models. The factors determining tree species composition at local community scale were analyzed by comparing species composition dissimilarities between all pairs of plots and the differences in plot environmental factors. Stepwise selection of independent variables based on AIC was performed to select the best model. The decrease of species richness was not solely related to decreasing tree abundance and increasing bamboo foliage density, the deviation of residual of species richness against tree abundance was also negatively correlated with bamboo existence. The dissimilarity of plot species composition was explained by the differences of three plot attributes: average d.b.h., bamboo foliage cover ratio, and altitude. The result showed the importance of bamboos on tree species composition of a primary rainforest. Even though the causal relationship was not clear, bamboos are still likely influence local tree community structure.

**P-01-26: Bark Thickness of Dry and Moist Forest Trees; Relations With Adult Stature and Shade Tolerance**

Lourens Poorter; *Wageningen University*

Fire is a widespread disturbance agent in dry and wet tropical forests, affecting forest structure, composition, and dynamics. Fire frequency and intensity have increased dramatically over the past decades, due to the synergistic effects of increased drought, slash and burn agriculture, and logging. Bark thickness is an important component of plant adaptation to fire, and it might be expected that trees from dry environments are better adapted to fire. In this research I compare ontogenetic changes in bark thickness of 50 dry forest and 50 moist forest tree species in Bolivia. Surprisingly, dry and moist forest species did not differ in their bark thickness. However, they did so when their relative abundance was taken into account; the most abundant and successful dry forest species had the thickest bark. I also test the hypotheses that 1) light-demanding species have a smaller bark thickness than shade-tolerant species because they invest less in plant defense, and 2) tall species have a larger bark thickness than small species because they need to be well-protected in order to live long and attain their large reproductive size.

**P-01-27: Functional Richness and Evenness along a Post-Disturbance Successional Gradient in a Mexican Tropical Dry Forest**

Radika Bhaskar<sup>1</sup>, Todd Dawson<sup>2</sup>, Patricia Balvanera<sup>1</sup>; *1. Universidad Nacional Autónoma de México, 2. University of California, Berkeley*

Plant functional diversity (FD) may strongly influence ecosystem functioning; thus, an understanding of how FD changes post human land-transformation can provide insight into the functioning of secondary forests. The question of whether FD recovers is particularly relevant in the seasonally dry

tropical forests in Mexico. These forests are threatened by extensive conversion to pasture; after years of use these sites are often left abandoned to the process of succession. A chronosequence of secondary forest plots have been established in the state of Jalisco, on the Pacific coast of Mexico, as part of a long-term study on successional dynamics. Replicate plots were set up within three age categories, from recently abandoned to 15+ years of regeneration, as well as within neighboring old growth sites. We measured several key ecological traits including plant height, wood density, leaf size, leaf nitrogen content and specific leaf area. The collective range and spacing of these traits was used to assess measures of FD. We focused on two distinct components: functional richness and functional evenness, which may reflect the role of environmental filters and biotic interactions respectively. We found the youngest secondary sites have low functional richness that increases progressively, such that the oldest secondary stage is indistinguishable from the undisturbed forest. This trend suggests functional richness can recover rapidly in this system. The evenness of how species were distributed within that range differed in the regenerating stages compared to old growth forests. Thus different aspects of FD may show varied trajectories through time. As more of the landscape becomes dominated by secondary forests, functional diversity indices may prove an important tool to assess the legacy of human land-use on the diversity and functioning of these transformed sites.

#### **P-01-28: Decomposition and Nutrient Cycling in Australia's Tropical Rainforest**

Scott Parsons; *James Cook University*

The dynamics of nutrients and organic matter in forested ecosystems has a great bearing on ecosystem processes, from the smallest scale to the entire biosphere. The Australian wet tropics bioregion (AWT) is a relatively small area of seasonally wet tropical rainforest in northern Queensland. The region provides a valuable test case to understand nutrient cycling and decomposition in tropical rainforest, due to a spatially varied climate (temperature and moisture seasonality), regional differences in soil fertility and edaphic makeup, and rainforest communities as a whole. Here I present work from a region wide study of plant nutrient cycling and decomposition aimed at understanding these plant-soil processes, especially in the context of predicted climate change impacts in the region. Data comes from a multi year study of leaf and whole litter layer decomposition and nutrient dynamics, i.e. leaf litterbags and studies of litterfall and standing crop, from sites in rainforest spread throughout the Australian wet tropics from near sea level to ~1300 m a.s.l. Both local and regional variations in these ecosystem processes are explored. I test the hypothesis that leaf traits (e.g. litter quality) provide the strongest controls on decomposition rates in these forests, as opposed to climate, as many authors have noted (e.g. at the global scale). I also explain how near infrared spectroscopy has provided a valuable method for quantifying litter quality and nutrients, exploring chemical changes in the substrate during decomposition, and predicting in situ decomposition rates.

#### **P-01-29: Structure, Composition and Estimating Biomass of Agathis and Pine Forests at Bodogol, Gunung Gede Pangrango National Park, West Java**

Alhamd Laode, Joeni Setijo Rahajoe; *Indonesian Institute of Sciences*

A permanent 2-ha plot of agathis and pine forests at Bodogol, Gunung Gede Pangrango National Park, which is also a Biosphere Reserve, West Java, was established and investigated in 2009. Measurement and identification of all trees with DBH  $\geq$  4.8 cm were conducted, and we also calculated the standing biomass with volumetric method for estimating the carbon stock in both forests. Within these plots, 42 species, 29 genera and 25 families, and 29 species, 26 genera and 19 families were respectively recorded in agathis and in pine forests. The total basal area (BA) in agathis forest reached 34.7 m<sup>2</sup>/ha (72.9 % of total BA for *Agathis philippinensis*), and in pine forest the total BA was to be 33.8 m<sup>2</sup>/ha (88.8 % of total BA for *Pinus merkusii*). Araliaceae, Euphorbiaceae, Lauraceae, Moraceae and Rubiaceae were the highest families in agathis, while Euphorbiaceae and Moraceae were the richest family with 5 species of each in pine forest. The most important species in agathis forest were *A. philippinensis* with 110.6 of IV (Importance Value), followed by *Schima*

wallichii (71.7) and *Dendrocnide stimulans* (25.1 of IV). In pine forest the trees were dominated by *P. merkusii*, *Calliandra calothyrsus* and *Piper aduncum* with IV, respectively 140.9; 94.4 and 28.9. The tree density in agathis forest was lower than in pine forest, reaching 473 and 841 trees per ha, respectively. For the tree structure, the distribution of diameter class in both forests indicated that the juvenile trees (tree diameter lower or equal than 10 cm) dominated the tree number, also the pattern of individual tree tended to decreased with increasing the tree diameter. The biomass estimation were 144.9 and 115.7 t/ha for agathis and pine forest, respectively, with 113.4 of *A. philippinensis* and 110.4 t/ha of *P. merkusii*.

**P-01-30: The Phenology of *Ficus grossularioides* in Singapore**

Nanthinee J. Jeevanandam, Richard T. Corlett; *National University of Singapore*

In a relationship between long-lived woody plants and short-lived fig wasps, precise timing is crucial, since even a brief gap could result in the local extinction of obligate pollinators. In dioecious figs, the phenologies of different fig species are much more varied suggesting that there may be multiple alternative solutions to the timing problem, with the evolutionary choice depending on other factors, including climatic seasonality, growth form and ecological role. The phenology of a dioecious fig *Ficus grossularioides* is currently being studied in Singapore, an aseasonal country. Observations on 44 trees, 26 females and 18 males, began in December 2008 and are ongoing. The average crop cycle for males and females is approximately 6-8 weeks. Female trees exhibit asynchronous crop production while male trees are largely synchronous. Fig production is all year round with inter-tree fluctuations in crop intensity. Female trees produce crops continuously while male trees may have a brief gap before initiation of a new crop. A temporal pattern of leaf fall has been observed where flushing of leaves peaked between February and March 2009 and to a lesser extent between August and September 2009. The obligate pollinator has been identified as *Blastophaga (Valisia) malayana* Wiebes, 1993.

**P-01-31: Plant Genera Diversity at Siduk Watershed, Gunung Palung National Park**

Ibrahim Sumardi; *Gunung Palung National Park*

The area of Gunung Palung National Park (GPNP) which belong to Siduk Watershed was predicted have high variety of trees genera. This study is conducted to investigate plant genera diversity at Siduk Watershed, Gunung Palung National Park. Five plots of 0.4 ha (hectare) each (i.e 20 m x 200 m) were established in five different elevation within Siduk Watershed. The elevation were 0-300 mdpl, 300-600 mdpl, 600-900 mdpl, 900-1000 mdpl and 1000-1116 mdpl. Each of the 0.4 ha was divided into 400 quadrats of 20m x 20m each. Each plot to determine tree genera composition of trees with diameter at breast height (DBH) of 20 cm and above, trees with DBH 10 cm -19.9 cm, pole and seedling. A total of 392 trees with diameter 20-cm above from 43 genera, 120 trees with diameter 10 – 19.9 cm from 28 genera, 897 pole from 53 genera and 628 seedlings from 40 genera were recorded from this inventory. The most important genera at elevation 100 – 300, 300 – 600, 900 - 1000 m a.s.l. based on Importance Value Index was *Shorea* sp with range value of 78.0% - 101.23%, and at 1000 – 1116m a.s.l. was *Syzygium* sp with a value of 60.82%. The Shannon-Weiner diversity index for each elevation indicated value from 1.00 – 1.25. This value mean genera diversity and richness in this area was high. This study has provided new information in detail about plant diversity in Siduk Watershed. This information used by Gunung Palung Zonation Project (September-Desember 2009) as one of criteria to scoring Siduk Watershed zonation. Now Siduk Zonation appointed as Core Zone of National Park which was mean this area have high diversity of flora and fauna and must be protected.

**P-01-32: Relationships between Tree Architecture and Demographic Traits among 200 Co-occurring Rainforest Tree Species in Peninsular Malaysia**

Yoshiko Yazawa, Takashi Kohyama, Takuya Kubo, Abd Rahman Kassim, Lourens Poorter, Frank Sterck, Matthew D. Potts; *Hokkaido University*

Tropical rainforests are characterized by tall and complex forest structure created by the varying tree architectures of the multiple co-occurring species. Tree architecture partly reflects species-specific life-history traits. Here we present a community-wide analysis of tree architecture of 200 tree species, and 4000 trees, covering a wide range of ontogenic stages. We relate tree architecture to demographic parameters (growth, mortality) obtained from the 50-ha plot in Pasoh, peninsular Malaysia. All analyses were conducted using a hierarchical Bayesian modeling approach. Tree species show generally a trade-off between growth and survival, such that tree species that grow fast in high light usually have low survival rate in shade, while species that survive in shade cannot grow fast. Fast growth could be realized based on cheap construction costs of stem tissue (i.e., low wood density) and tree architecture, whereas survival trait could be realized based on the investment in expensive, tough, and persistent structures. We tested the hypotheses that, compared to slow-growing species, fast-growing species have, 1) a thicker stem for the same height, because of mechanically light wood than species with low potential growth rate in relation to dense wood, and 2) narrower crown width due to high investment cost for height growth at the same diameter for light capture.

**P-01-33: Growth and Recruitment of *Agathis Philippinensis* Saplings as a Function of Distance from Deforested Areas**

Lillian J.V. Rodriguez; *University of the Philippines*

With the continuing loss of lowland dipterocarp forests in the tropics, the lower montane areas are becoming the frontiers of biodiversity. Changes in forest dynamics are expected resulting from landscape modifications and competition between retreating and existing species. Unfortunately, in the Philippines, little research has been done on lower montane forest dynamics. In this study, I present the effect of deforestation on the early life stages of *Agathis philippinensis*, the dominant canopy tree in Philippine lower montane forests. The study area is in the boundary of the Mt. Kanlaon Natural Park, Negros Occidental, Philippines. Transects (2 x 50 m) were established around the deforested area and were designated as edge transects (0 m from edge), middle transects (50 m from edge) or interior transects (100 m from edge). Heights of *A. philippinensis* saplings were measured quarterly from October 2008 up to the present. Litter depth and percent canopy cover was also recorded per transect. Results show that the middle transects had the significantly lowest recruitment rates. Thus, recruitment is not affected by distance to a deforested area. It might be more affected by the proximity of mature, cone-bearing trees. Growth rate of the saplings, however, was higher in areas near the forest edge and in areas with adequate leaf litter. Moreover, mortality rate was not affected by location of transects and litter depth. Lastly, percent canopy cover was not seen to exert a significant effect on any of these parameters. These results imply that recruitment, growth and mortality of *A. philippinensis* saplings are minimally affected by deforestation, as long as forests adjacent to already deforested areas remain intact.

**P-01-34: Seed Accumulation beneath Parent Palms Affects Seed Predation by Bruchid and Scolytid Beetles in Small Fragments of the Brazilian Atlantic Forest**

Alexandra S. Pires, Tammy K. Yamashita, Ana Carolina Crisostomo, Mauro Galetti; *Universidade Federal Rural do Rio de Janeiro*

Seed accumulation beneath parent trees is an important feature of the empty forest's syndrome. Herein we studied how increased seed density beneath *Astrocaryum aculeatissimum* palms in Atlantic Forest fragments affects the behavior of its invertebrate predators. The degree of infestation per seed and the proportion of seeds damaged by the bruchid *Caryoborus serripes* and the scolytid *Coccotrypes* sp. were compared among small (19 and 57ha) and large (2400 and 3500ha) fragments in southeastern Brazil. Endocarps were collected within a 2m radius around palms (20 at small fragments, 38 at larger ones), spaced at least 50m from each other and 5m away from conspecifics adults. Seed density was

nearly six times higher in small fragments (mean±sd: small= 152.6±142.2, large= 24.6±30.9;  $t= 5.35$ ,  $p<0.0001$ ). Less bruchids were found inside infested seeds at small fragments (small= 3.9±2.8, large= 5.6±2.9;  $t=5.80$ ,  $p<0.0001$ ) but the number of scolytid entrance holes per seed was higher at these places (small= 12.5±14.9, large= 7.3±7.4;  $t= 5.51$ ,  $p<0.0001$ ). The proportion of seeds preyed by bruchids was higher in small fragments (small= 0.47±0.21, large= 0.26±0.26;  $t= 3.0$ ,  $p<0.01$ ), but for scolytids there was no difference (small= 0.80±0.29, large= 0.64±0.26;  $t= 1.80$ ,  $p=0.08$ ). These results indicate that seed density influenced predation behavior in different ways for each beetle species. For bruchids, the high density of seeds at small fragments favors the oviposition of fewer eggs per seed while at the larger ones either a single female lays several eggs per seed or there is multiple oviposition by several females. This results in a higher proportion of seeds damaged by bruchids at small fragments. For scolytids, which are smaller, have shorter generation times and are less selective about oviposition sites, the abundance of seeds in small fragments favors an increase in the number of beetles per seed but it does not affect predation rates. Support: CNPq, FAPERJ, FAPESP, IdeaWild.

### **P-01-35: Disturbance and Change in Vegetation and Bird Communities of White Sand Campinaranas in the Central Brazilian Amazon**

J. Marion Adeney<sup>1</sup>, Mario Cohn-Haft<sup>2</sup>; *1. Stanford University, 2. Brazilian Institute for Amazonian Research (INPA)*

Amazonian white sand campinaranas are “island” habitats of savanna-like vegetation and short stature forests, shaped by dynamic successional processes such as fire and flooding, and occurring in small patches in the surrounding terra firme forest. Their specialized plant and animal communities are high in endemism and contribute to regional Amazonian diversity. Because they are remote and relatively inaccessible, the frequency and effects of disturbance in these systems are not well understood. We used satellite imagery and ground data to assess processes of disturbance (mainly fire and blowdowns) and changing vegetation structure between 1987 and 2007 in campinaranas in the interfluvial area of the Madeira and Purus rivers, in the central Brazilian Amazon. An increase in classified open vegetation in 2001 correlated with an increase in visible signs of disturbance in the imagery. We also assessed bird community composition and found a trend of more generalist/savanna species in more frequently disturbed campinas. Long interval natural disturbances likely maintain the open character of these ecosystems. More frequent fire during the strong El Niño event of 1997-1998 may have led to a general increase in open vegetation, even in areas not normally subject to direct human impact. These results provide a foretaste of the likely trajectory of campinarana ecosystems if global climate change results in a hotter and drier Amazon. More immediately, conservation planning is needed before increased development, including the paving (already in progress) of the Manaus-Porto Velho highway adversely affects this fragile ecosystem.

### **P-01-36: Mapping Biodiversity and Ecosystem Services at a Tropical Watershed in Mexico**

Patricia Balvanera, Sandra Quijas, Maria Jose Martínez-Harms; *Universidad Nacional Autónoma de México*

Sustained development relies on simultaneously ensuring maintenance of biodiversity while guaranteeing the flow of services to human populations. Information on spatial patterns of both biodiversity and ecosystem service provision are needed to support such decision making, yet tools to do so are still incipient. Here we developed methods for mapping plant diversity and associated ecosystem service provision for a 1,000 Km<sup>2</sup> watershed in western Mexico. Based on intensive field surveys (50 sites), we then use geographic and remote sensed data into multiple regression models to explain observed variance, and produce predicted distribution patterns for plant diversity (total species richness, tree richness) and four ecosystem services (forage, timber, woodfuel, carbon stocks). Our field data showed a large variance in the response variables within and among surveyed sites. Multiple regression models explained between 35 and 70% of the observed variance of the response variables. Spatial patterns showed differential trade-offs along the watershed: the lowest tropical dry forest area maintained the highest plant diversity, and the highest carbon stocks and woodfuel



provision; pastures were low in plant diversity but provided most forage; temperate forests provided most timber with intermediate diversity levels. The tools developed can be applied to multiple watersheds of the neotropics.

**P-01-37: The Distribution and Abundance of Epiphytic *Rhododendron javanicum* (Bl.) Benn along the Mountain Elevational Gradients on Mt. Gede Pangrango National Park of West Java - Indonesia**

Subekti Sulistyawati, Mieke Miarsyah, Agung Sedayu; *Biology Department, State University of Jakarta*

We investigated the gradual changes of floristic composition and physiognomy along elevational gradients affect the abundance and distribution of the epiphytic *Rhododendron javanicum* (Bl.) Benn., along the elevation of 1300 – 2400 m asl against its phorophyte's characteristics on Resort Cibodas Mt. Gede Pangrango of West Java - Indonesia. The epiphyte's individual number were highly associated with the phorophyte species that dominate the changes floristic composition and the stem diameter. The patterns of vertical distribution and canopy openness relative to its altitudinal habitats reflect the epiphyte's ecological niche as a way of its adaptation on the ecosystem. A full explanation about host traits that favoured colonization of the epiphyte were still inadequate. Much less attention still receiving the great potential research on epiphyte and mountain ecosystems co-existence. Further study, particularly on the epiphyte life-form group which have close affinity with phorophyte biodiversity on mountain region is needed, especially during the present global climate change occurrence. Keywords: abundance, distribution, epiphyte, mountain ecosystem, phorophyte's characteristics, *Rhododendron javanicum* (Bl.) Benn., global climate change

**P-01-38: What Can Genetic Diversity, Habitat Preference and Traits Tell Us about Changes in Temporal Distribution of Rainforest Trees?**

Maurizio Rossetto, Margaret Heslewood, Robert Kooyman; *National Herbarium of NSW*

Australian rainforests contain considerable levels of biodiversity despite representing only a small proportion of the continental land-mass. Broad-leaved vegetation has endured considerable stress during the aridification of the continent in the last 10Mya, with the remaining refugial areas being further strained during the climatic instability of the Quaternary. An important challenge of understanding differences in species survival is to gain an insight into the relationship between ecology and evolution. A reconstruction of temporal changes in population dynamics across diverse co-distributed taxa can yield generalities about evolutionary constraints and differential success. In a range of separate studies, we gathered molecular, environmental and trait data from over 15 rainforest tree species from the Australian Wet Tropics and Northern NSW, with the overall aim of understanding what makes some species more successful than others. We found some interesting trends explaining current distributions, in particular in relation to the tension between persistence and dispersal. Interestingly, some interacting factors (such as dispersal-related traits and habitat availability) can impact differently across different regional communities. For example, while some species have attained genetic equilibrium without realizing their full niche potential, others have tracked environmental change through a number of expansion / contraction cycles. Such insights can help us understand how rainforest trees respond to environmental and climatic heterogeneity, and how high levels of biodiversity (that include a considerable number of unique paleo-endemics) are maintained within small remnants of a once-dominant vegetation type. In the long-term such knowledge is likely to help us better predict vegetation responses to future change.

**P-01-39: Floral Phenology and Breeding System of *Desmos chinensis* and *Dasymploche trichophorum* (Annonaceae): Protogyny and Intra-Individual Floral Synchronicity to Promote Out-Crossing in Early-Divergent Angiosperms**

Chun Chiu Pang, Richard M.K. Saunders; *The University of Hong Kong*

Early-divergent angiosperms differ from more derived lineages in their strategies to promote out-crossing and reduce selfing, often lacking genetically controlled biochemical mechanisms of self-incompatibility. Flowers of *Desmos chinensis* and *Dasymaschalon trichophorum* (members of the early-divergent family Annonaceae) are hermaphroditic with a floral chamber. *Desmos chinensis* has six petals in which the floral chamber is formed by three inner petals. *Dasymaschalon trichophorum* only has three petals which are morphologically homologous to the outer petals which form the floral chamber. Both species show intrafloral dichogamy (protogyny) with a reproductively inactive phase (interim phase) between the pistillate and staminate phases which limits autogamy. The floral chambers in *Desmos chinensis* and *Dasymaschalon trichophorum* have small basal apertures between the petals during the sexually matured phase (closed in staminate phase in *D. trichophorum*), limiting entry of larger, non-pollinating flower visitors. Small beetles, the major pollinator group of the Annonaceae and other early-divergent angiosperms, were observed to stay inside the floral chambers in both species throughout the pistillate and interim phases and subsequently leave the chambers during the staminate phase. They are inferred to be the effective pollinators. Intra-individual floral synchrony was observed in both species, with synchronized receptivity of flowers within individuals, and maturation of a new cohort of flowers occurring after 48 hrs, hence limiting opportunities for geitonogamy. Occasional asynchrony was observed, however, and results from controlled pollination experiments and analysis of inter-simple sequence repeats (ISSR) markers indicates that *Desmos chinensis* has a mixed-mating system. It is possibly an evolutionary advantage to retain a level of geitonogamy, particularly in small populations and when there is a limited availability or patchiness of pollinators.

#### **P-01-40: Functional and Species Diversity in Tropical Wet Forest Succession**

Madelon Lohbeck<sup>1</sup>, Frans Bongers, Lourens Poorter, Horatio Paz, M van Breugel, M. Martínez-Ramos; *I. WUR*

The conversion of tropical forest into farmland is one of the major challenges of the global environmental crisis, resulting in loss of biodiversity and impacting important ecosystem functioning such as carbon sequestration and nutrient cycling. Functional diversity ‘those components of biodiversity that influence how an ecosystem operates or functions’ receives ample theoretical attention but published empirical data are scarce. We analysed functional diversity changes in tropical secondary forest succession in Chiapas, Mexico and test the ability to detect differences in functional diversity among sites of different ages compared to conventional species diversity indices. Non-weighted measures of diversity (based on presence/absence) increased logarithmically with stand basal area, used as a proxy for successional development. Indices including a measure for abundances lacked pattern with succession in our secondary forest sites. When using functional diversity for gaining information on recovery of ecosystem processes after abandonment of agricultural land, there is need to weight for species relative abundances; the mass-ratio-hypothesis predicts that ecosystem functioning is mainly influenced by dominating species. Our results demonstrate that the relation between weighted functional diversity and species diversity depends on whether all (9) traits were included or just few or a single trait, and also on the type and importance of the selected traits. We conclude that the potential to differentiate between sites by including information on functional traits compared to more easily obtainable species diversity measures depends on the traits of interest, and thus on the processes and services of interest. This study substantiates the need for careful consideration of the functional trait(s) to be included in studies when targeting at the relation between functional diversity and ecosystem processes.

#### **P-01-41: Soundness Assessment of Canopy Trees in Pasoh Forest Reserve**

Hamada Tadatusgu, Tsuyoshi Yoneda, Toshinori Okuda, Wan Rashidah Kadir; *Kagoshima University*

Mortality of canopy trees tends to increase at the 50-ha plot in the Pasoh Forest Reserve, Peninsular Malaysia. We observed tree forms of canopy trees and tried to assess their soundness through relationships between scores from tree forms and dbh growth rates during the last 5 years. The growth rates could be predictable with these parameters by the Generalized Linear Model, being  $R^2=0.098$  for total canopy trees and  $R^2=0.154$  for Dipterocarpaceae. Average mortality during the following 5 years could be also estimated from the last growth rates stochastically. Basing on these two regressions, we will show you some process to estimate future mortality from the present conditions of tree-form, and discuss factors of the present high mortality with the spatial patterns of weak canopy trees.

## Poster session: Forest management and restoration (#02; July 22)

### P-02-1: A New Approach to Liana Management

Julia C. Sfair, André L.C. Rochelle, Andréia A. Rezende, Juliano van Melis, Veridiana de Lara Weiser; Fernando Roberto Martins; *Unicamp*

Lianas exert harmful effect on trees, such as decrease of growth and fruit production and increase of mortality. Most of the studies focus liana impact on a particular tree species, although lianas impose overall effects on forest regeneration: lianas stall gaps and slow down forest recovery after a perturbation. We aimed to investigate the best way to manage lianas using information from mathematical simulations performed in liana-dominated forests. We built a bipartite network in which lianas interact with trees. A previously work had shown that this network is nested, i.e., there is a gradient of the number of liana-tree interactions. We simulated three pattern of liana cut down: least-linked to most-linked species; random; and most-linked to least-linked species. The best approach is the latter, which releases nearly half tree species when cutting down half liana species, i.e., to release half trees, we should focus the most abundant liana species. This method may change forest dynamic, probably promoting slow growth trees and accelerating forest recovery. However, dead lianas may fall down from canopy and kill seedlings and saplings, decreasing tree species recruiting. Therefore we suppose that there is a balance between negative and positive effects on forest regeneration after liana cutting. The cost of liana management we propose would be lower than cutting all lianas in a plot. Future researches should calculate the costs of the management we propose as well its effects upon forest succession after liana cutting.

### P-02-2: The Effects of Experienced Versus Non-Experienced Charcoal Producers on Forests in Mexico

Tuyeni H. Mwampamba, Adrian E. Ghiraldi; *National Autonomous University of Mexico, 2. National Autonomous University of Mexico*

Charcoal is an important biomass energy in developing countries and a major contributor of forest loss and degradation. The effects of charcoal on forests is related to many factors such as population size and stove efficiencies. On the production end of the charcoal lifecycle, however, the effect on forests is highly affected by kiln efficiencies, a variable that varies widely among charcoal producers and is heavily dependent on the skills and motivations of the producer. In response to increased demand, charcoal sellers in Michoacan, Mexico have begun to contract young men to produce charcoal in large volumes. The contractual agreements that are made contain no incentives for charcoal makers to practice more efficient kiln techniques. Moreover, the young men usually have no prior charcoal making experience. We measured the efficiencies of kilns operated by experienced and non-experienced charcoal makers to test the hypothesis that efficient charcoal makers have lower impact on forests. We also interviewed charcoal producers to determine their motivation for pursuing a charcoal making career and how well they understand the charcoal making process. Our results provide a better understanding of how charcoal market forces affect the human resource dynamics at

charcoal production sites, and how this translates to actual effects on forest health and extent. Projections of forest availability for future charcoal demand often assume that kiln efficiencies are maintained over time. Our study suggests that kiln efficiencies may need to be adjusted to reflect the skills of charcoal makers and the characteristics of the contractual agreements they enter with charcoal sellers. As increase for biomass energy increases worldwide and more seller enter into similar agreements with charcoal makers, we can expect overall global efficiency of kilns to drop, and the negative impacts of charcoal on forests to increase.

### **P-02-3: Deforestation in Bukit Barisan Selatan National Park, Sumatra, Indonesia**

Suyadi FNU; *Bogor Agricultural University*

Deforestation is the greatest threat to conservation Bukit Barisan Selatan National Park (BBSNP), the third-largest protected area (356,800ha) on the Indonesian island of Sumatra. However, accurate estimates of the scale and rate of loss are lacking and the causes of deforestation are unclear. Here, I link time series satellite imageries and socio-economic data to provide an accurate estimates of deforestation in BBSNP and to unravel the causes of deforestation. The result shows BBSNP's forests have been cleared since 1960s, earlier than previous estimation. Before 1972 BBSNP forest has been lost of 46,100 ha, representing a 13% loss. From 1972 until 2006, deforestation in BBSNP averaged 0.64% per year. The forest of BBSNP 67,225 ha of the original forest of 310,670 ha that remained in 1972, representing a 21% loss from 1972 to 2006. The majority (80%) of forest conversion resulted from agricultural development started from buffer area goes inside the park. The deforestation rate in the park area near Tanggamus district (Zone II) which has high development higher than the park area near Lampung Barat district (Zone I) which the development lower than Tanggamus district. In zone II deforestation increase dramatically in the first decades, then decreased gradually in the next decades caused by topographic factors. On the contrary, the higher rate of deforestation in zone I occurred in the recent decades. There are three levels of the causes of deforestation: 1) agents, 2) immediate causes, and 3) underlying causes. Although, the agents who have physically cleared more BBSNP forest cover are farmers. The most important of the causes of deforestation in BBSNP are illegal logging and logging in the past as immediate causes and low law enforcement and socio-economic as an underlying causes. The immediate and underlying causes driving farmer to cleared more forest.

### **P-02-4: Measuring the Conservation Status of the Heart of Borneo**

Stephan Wulffraat<sup>1</sup>, John Morrison<sup>2</sup>; *1. WWF Indonesia, 2. WWF US*

The interior of Borneo, known as the Heart of Borneo (HoB), comprises the upstream sections of all the major river drainage areas of the island, and the preservation of this region is being given the highest conservation priority. A conservation measures framework was developed to characterize and monitor the conservation status of HoB and the impacts of conservation activities using a set of quantitative indicators. The first step was the identification of a small set of biological "targets" that comprise all major ecosystems and keystone species. From the key ecological attributes of these systems and species, quantifiable biological indicators were identified. For ecosystems, recent remote sensing images of forest cover were compared with the historic extent of each system. The analysis confirmed that primary lowland rainforest is becoming a rare ecosystem. The major ecosystem of HoB is upland rainforest and most of these are still standing, as are most of the montane forests. Measuring the status of keystone species turned out to be more complicated due to the limited inventory data, but practical estimates could be made for several species. Where data permits, each biological indicator is given a standardized rating of viability. Major direct threats to HoB biodiversity were identified and given an absolute rating by experts using objective criteria. Quantitative threat indicators have now been identified for follow up. The top threats to HoB were found to be industrial conversion of natural forests (for oil palm, acacia plantations), forest fires, illegal logging and mining. Protected area representation of ecosystems and protected area management effectiveness were identified as useful "conservation management" indicators. Ongoing work includes peer review and refinement of the indicators and determining appropriate frequency of

measurement. The results are being used for prioritizing conservation efforts and tracking conservation success or failure.

#### **P-02-5: Forest Recovery Process after 1998 Fire in Bukit Bangkirai, East Kalimantan**

Eizi Suzuki<sup>1</sup>, Herwint Simbolon<sup>2</sup>, Ngakan Putu Oka<sup>1</sup>, Natsuki M. Watanabe<sup>1</sup>, Shin-ichiro Aiba; *1. Kagoshima University, 2. RCB-LIPI*

The tropical rainforests in East Kalimantan were damaged by the forest fires. We conducted the study of forest recovery in Bukit Bangkirai, East Kalimantan fired in February to March, 1998. We established six 1-ha plots: heavily burned (HD1, HD2), lightly burned (LD1, LD2), and unburned (K1, K2) plots from 2001 to 2007. HD plots lost most trees during the fire, and the tree number (DBH>4.8cm) recovered by 80% of K plots. K plot had little increase in Biomass. The biomass in HD1 plot was 53 ton/ha in 2001 and 92 ton/ha in 2007. The species number per ha in K1 was 253 in 2001 and 287 in 2007, and that in HD1 was 91 in 2001 and 131 in 2007. The unburned forests were dominated by ca. 20 species of Dipterocarpaceae such as *Shorea laevis*, had species nearly 300 spp/ha. which is similar value of highly diversified forest in Borneo. Burned forests were dominated by *Macaranga* spp, and *Vernonia arborea* and had around 130 spp/ha. Few Dipterocarpaceae species regenerated in burned forest except *Cotylelobium melanoxylon* which has sprouting ability. One of multivariate analyses (DCA) using basal area (BA) of each genus in plots from 2001 to 2007 showed the relationship between plots. The first and second axis seemed to indicate the successional and environmental trends, respectively. If we expect the recovery process from the changing speed of score value of the first axis, the heavily burned forest may need 200 years to become nearly same with the unburned forest.

#### **P-02-6: Forest Vulnerability Assessment of Australia's Forests**

Robyn F. Wilson; *James Cook Univ. & NCCRF, Griffith Univ.*

This project sought to identify adaptive strategies, adaptive capacity and the vulnerability of Australia's forests to climate change. Thirty-four interviews with senior representatives in management or policy, involved in either conservation or production from northern and southern Australia were conducted. This was followed by a social learning workshop with the interviewees, researchers and National Climate Change Research Facility consultative committee for this project. The framework used for assessing vulnerability considered exposure, sensitivity and adaptive capacity of the forests in Australia. Adaptive capacity considered opportunities and constraints of the forests and forest industry to adapt to climate change. During the two day workshop big ideas and major concerns for forests with climate change were explored, as was the impact of climate change on Australian forests in 2030 and 2070 with no adaptation, worse case scenario, and adaptation. The adaptive capacity, barriers to adaptation and adaptive strategies for tropical northern Australia with and without adaptation for 2030 and 2070 climate change scenarios are presented. This project is the first in Australia to address adaptation strategies for forestry to climate change, an area identified by the commonwealth as significant. Key findings suggest adaptation will involve a shift in forest practice from timber to non-timber forest products.

#### **P-02-7: Dynamics of a 50-Year Old Secondary Forest in Singapore**

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With the clearance of large swathes of tropical forests, it becomes increasingly important to study resulting secondary forests (SF) that grow on them because they will form the majority of remaining forests. Over 90% of Singapore's forests were cleared during the colonial period, but the central part of Singapore was preserved and left to regenerate to serve as a water catchment area. The largest remaining primary forest (PF) remnant is in Bukit Timah Nature Reserve (BTNR), and together with

smaller patches in the neighbouring catchment forests, they make up only about 5% of the total forested area; the remainder is SF. Within BTNR, the SF landscape is heterogeneous with distinct tree communities. This is partly due to the agricultural and fire history of the area prior to the 1950s, after which the forests received nature reserve status. We set up a 2-ha SF plot in 2004 in BTNR with all trees >1cm tagged and measured, and censused the plot again in 2008. Certain parts of the plot that are adjacent to PF have big trees (>30cm dbh) and have a canopy height similar to that of PF, but the understorey remains sparse. These areas are dominated by one species, *Camposperma auriculata*, which is common in mature SF. In more degraded areas further away from PF, the forest is dominated by a fast-growing shrub *Dillenia suffruticosa*. Surprisingly this species is still recruiting at a high rate where it dominates. Recruitment of primary forest species into the mature SF was surprisingly low, given the proximity of primary forest trees. Possible reasons for the relatively poor recruitment of primary forest species into SF are legion, but edaphic factors and the peculiar leaf litter mat under the *C. auriculata* canopy may be among the principal impediments to recruitment. Thus while past land-use history may provide a guide to forest regeneration, species-specific characteristics may also play a large role in succession on degraded tropical lands.

**P-02-8: Strategy of Some Primary, Secondary, and Pioneer Tree Species in Recovering Burned Over Tropical Rain Forest at East Kalimantan, Indonesia**

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Revegetation process of heavily burned forest should be initiated by pioneer species, however at Bukit Bengkirai some primary species were found to compete with pioneer ones colonizing the heavily burned forest area. In order to clarify the regeneration strategy of these species, vegetation surveys, sprouting experiment, wood specific gravity measurement, and seed bank observation were conducted in 2-ha burned forest and 1-ha unburned forest plots at Bukit Bengkirai from 2005 to 2007. Unburned forest plot was dominated by primary species (*Shorea laevis*), whilst burned forest plot was dominated by pioneer species (*Macaranga gigantea*), but some primary species (i.e *Cotylelobium melanoxyton*) and secondary species (i.e *Schima wallichii*) were frequently found. Data of sprouting ability, multi stem ratio, wood specific gravity, and seed banks support the conclusion that revegetation process of the severely burned forest area was initiated by the seedling of pioneer species germinating from buried seed. *Cotylelobium melanoxyton* is a primary species capable to produce vegetative sprouts from its survived long-taproot coexisting pioneer species to initiate the revegetation process. The secondary species, *Schima wallichii*, invade the area latter through the seedling germinate form seeds produced by survived thick-barked mother trees. The colonization of *Dipterocarpus confertus* and *Shorea laevis* required seed supply from outside. Key words: primary, secondary, pioneer, burned and unburned

**P-02-9: Impact of Forest Fragmentation and Harvest of Non-Timber Forest Products on the Population Size and Structure of Three Palm Species**

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One of the main threats to natural populations in terrestrial ecosystems is habitat fragmentation and the exploitation of forest products. Here, we compared the density of the populations and the stage structure of three tropical palm species, *Astrocaryum aculeatissimum*, *Euterpe edulis*, and *Geonoma schottiana*, in Atlantic forest fragments of different size. Palms were censused in nine 30 x 30 m plots in five forest fragments, ranging from 19 to 3.500 ha in size. We tracked the survival of palms from year 2005 through the year 2007, and recorded all new individuals encountered. Each individual was assigned to one of the five pre-established class stages. The comparison of the demographic structure of each palm was analyzed with the sums of the differences between the proportions of the numbers of individuals in each class stage in each year between two fragments. The densities of the three palm

species were not influenced by the size of the fragment. *A. aculeatissimum* population structure was altered in the smaller fragments, specially the seedlings and the reproductives. *E. edulis* population structure varied a lot through the fragments. *G. schottiana* did not have a strong effect in its population structure by the size of the fragment and by the harvesting of its leaves. The main point to be drawn from the results found in this study is that the response of density and population structure seems to be highly dependent on the natural history of the species and on the type of harvest.

**P-02-10: Planning for Conservation of Threatened Rainforest Species in a Fragmented Landscape under Projected Climate Change Scenarios Using Habitat Modelling**

Michael A. Powell<sup>1</sup>, Accad Arnon<sup>2</sup>, Shapcott Alison<sup>1</sup>; *1. University of the Sunshine Coast, 2. Department of Environment and Resource Management*

This study develops niche models predicting habitat distribution under current climate and change under projected future climates for *Macadamia integrifolia*, and *M. ternifolia*. These species are vulnerable subtropical rainforest mid stratum trees endemic to southeast Queensland, Australia in an area of substantial historical land clearing. *M. integrifolia* is commercially important as its edible nuts form the basis of the macadamia nut industry. Its insitu conservation preserves genetic diversity and permits ongoing natural selection. The two species range overlap, with hybridisation recorded at sites of co occurrence. Areas of common habitat are potentially important for genetic diversity of the two species through hybridisation and back crossing conferring increased resilience to disturbance regimes. Thus identification of extent of current habitat coupled with predictions of the impact of future climate is important for conservation of these two species. Generalised Additive Models (GAM) and Maximum Entropy models (MAXENT) were employed to generate niche based models under 1990 baseline climate, and then incorporated future projected climates at decadal intervals derived from General Circulation Models (GCMs) using the A1F1 emissions scenario in spatial predictions of habitat. Preliminary results suggest an adverse impact of projected climate change on habitat distribution for both species, with less than 10% of areas of current habitat, including areas of common habitat, predicted as suitable by 2100. For *M. ternifolia* areas of suitable habitat are predicted to progressively contract, whereas for *M. integrifolia*, areas of suitable habitat are predicted to contract and shift to higher elevations and/or latitudes. It appears unlikely that *M. integrifolia* will be able to keep pace with predicted change in environment across a heavily modified landscape. The implications for insitu conservation are presented.

**P-02-11: Bioenergy and Society in Latin America: The Forest Replacement Associations Model**

Elaine Ceccon<sup>1</sup>, Rogerio C. de Miranda<sup>2</sup>; *1. CRIM-UNAM, 2. World Bank*

Woodfuels are the most important energy source and the most important forest product for many developing countries (50 to 90% of all energy consumed and 60 to 80% of all wood consumed). Although woodfuel is perceived as cheap energy and commonly as a primitive source of energy suitable for the poor, commercial woodfuel chains can grow to significant proportions, involving considerable amounts of money and labor. At the same time, unsustainable woodfuel markets can be a cause of forest degradation and eventually deforestation when demanded by concentrated markets and if it is not properly regulated. Most of sustainable forest management approaches for woodfuel production are theoretical, with only a few successful cases in Latin America. One of these cases are the Forest Replacement Associations (FRAs), which are a nonprofit civil association that promote woodfuel production in small and medium farms and has been extensively tested during the past 20 years in Latin America. The main objectives of this study were to review some experiences of FRAs in Brazil and Nicaragua, including field visits and semi-structured stakeholder interviews, to extract the lessons learned and the potential challenges in their future implementation as sustainable forestry strategies elsewhere. In Brazil, for each cubic meter of stacked wood consumed, the industry must pay the replanting of around five trees to a local FRA, who in turn would produce and provide free high quality seedlings and technical assistance to associate farmers. Sales revenues from harvesting the timber belong exclusively to the farmer. Wood harvested from FRA-related forest plantations supply

local fuelwood markets, avoiding destruction of native forests and the technical assistance supplied by the FRAs fills a gap left by the government. In general, the results have been mixed, although on average positive, with more successes than failures. Not all state governments in Brazil are completely supportive of

FRAs. While in Nicaragua, the lack of support by the central government (INAFOR) is hampering this effort which is believed, by local stakeholders, to be due to the lack of fully understanding the potential benefits of the FRA model.

**P-02-12: Habitat Reconstruction Development Model of Bali Straling *Leucopsar rothschildii* Stressman 1912 in Bali Barat National Park**

Mas Noerdjito, Roemantyo, Tony Sumampou; *Research Centre for Biology – LIPI*

Bali straling *Leucopsar rothschildii* Stressman 1912 is amongst the endemic birds in Indonesia. Naturally this species occur in the north western part of low land of Bali between Bubunan and Gilimanuk. This species prefers monsoon forests habitat on rainy season while on dry season on the evergreen forests habitat. Increasing people population caused the land use changes from forest habitat to resettlement and agriculture area. Pressure on the natural habitat and illegal hunting caused this species was stated as can not be recover in the nature since December 2005. To preserved in the natural function, some of bali starling fans doing the captive breeding. Since December 2007 about more than 10th individual was release to the nature. Monitoring and evaluation releasing on August 2009 showed that most of individual can not be compete with the competitors and predators such long-tail macaque, water monitor, common palm civet and decreasing the ability to find natural foods. To support the foods availability, it is necessary to rehabilitate the evergreen and monsoon forest that has been converted to resettlement and agriculture land. To prevent from the competitors and predators it was necessary also to protect temporary in the nature. Research should be done for developing model of land rehabilitation and looking for the decreasing pressure competitor and predators species method.

**P-02-13: Spatial Pattern and Preference of Illegal Fuelwood Collection in Nairobi, Kenya: Can Stumps Tell Us what People Want?**

Takuya Furukawa, Kazue Fujiwara, Samuel Kiboi, Patrick B.C. Mutiso; *Yokohama National University*

In developing countries, poor households depend heavily on biomass energy, which leads to local fuel shortages and degradation of surrounding vegetation. For the sustainable use and management of forests supporting local fuelwood production, knowledge on spatial pattern and preference of fuelwood collection is required. In rural areas, many studies have demonstrated that fuelwood collection is distance-dependent and that certain tree species with higher wood quality are generally more preferred. However, fuelwood collection by urban poor households, who have limited access to local biomass resources and larger demand for energy, are less represented. Additionally, since ordinary fuelwood surveys conduct interviews and require the cooperation of local communities, not many studies have investigated illegal biomass collection. Therefore, in this study we surveyed the stumps left in the forest, and investigated the spatial pattern and preference of illegal fuelwood collection by slum inhabitants in an urban forest of Nairobi, Kenya. The study forest was divided into 87 study plots (250m by 250m), and each plot was surveyed for at least 45 minutes (30 minutes for plantations). All encountered trees and stumps (diameter > 3cm) were recorded for their species and diameter. As a result, larger trees closer to the slum and far from the forest ranger camp had higher probabilities to be harvested. *Brachylaena huillensis*, a tall tree sold at high prices in black markets, had a high relative preference value and was actively cut, while that of *Lantana camara*, a prickly invasive shrub common near the slum, was low and avoided. Although we found many stumps of *Teclea simplicifolia*, *T. trichocarpa* and *Drypetes gerrardii*, their calculated relative preference values



were not as high as expected. This is due to the fact that more trees were left uncut, indicating that people have no specific preference for these species.

**P-02-14: Assessing Harvest and Fire Effects on Population Dynamics of ‘Golden Grass’, a Brazilian Non Timber Forest Product (NTFP) of High Economic Value**

Isabel B. Schmidt, Tamara Ticktin, Alessandra Fidelis, Heloisa S. Miranda; *University of Hawai'i at Manoa*

Local human communities rely heavily on non-timber forest products (NTFP) for subsistence and income but we have little understanding of the ecological impacts of NTFP harvesting. Most studies are short-term and include few replicates, preventing the development of accurate management recommendations. In the Brazilian savanna (Cerrado), a biodiversity hotspot, *Syngonanthus nitens* (Eriocaulaceae) flower stalks are harvested to produce handicrafts, a primary income source for hundreds of families. Traditional management involves burning the humid grasslands where *S. nitens* occurs, to promote flowering. To develop recommendations for sustainable harvest and management, we are carrying out a 5-year experimental study to test the effects of harvest and fire on *S. nitens* population dynamics under five treatments: (i) harvest, (ii) early fire (every second year), at the beginning of the dry season), (iii) late fire (every second year), (iv) harvest + fire (in alternate years), (v) control; each replicated across 6 sites. Matrix models indicate that the projected population growth rate ( $\lambda$ ) varies across years, irrespective to treatment: all 30 populations had a projected positive long-term growth rate ( $\lambda > 1$ ) in the first year of study but projected strong declines in the two subsequent years ( $\lambda < 1$ ). We also measured fire temperatures in 5 of the sites in the early and late dry season, Fire temperatures were low (max: 416°C, at 50cm height) compared to other Cerrado grasslands; temperatures rarely exceeded 60°C for more than 120 seconds on the soil surface and at 50cm height. Temperatures inside *S. nitens* rosettes rarely reached 50°C, due to high water content (180±138%, n=50); this explains *S. nitens*' resilience to frequent fires. Our results suggest that *S. nitens* dynamics are more influenced by interannual environmental variation than by flower stalk harvest. However, one more census will further clarify this and better help identify management recommendations.

**P-02-15: Lost Island Rediscovered – the Tropical Rainforest of Hainan Island, China**

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Xishuangbanna, at the south-western frontier of Yunnan Province, is probably the only site most ecologists recall when China's tropical rainforest is mentioned. Very few people, even within China, seem to remember the tropical island of Hainan, with the same latitude as Hawaii and some 250km south of Xishuangbanna, supports biota representative of Asia's tropical rainforest. And as a part of the Indo-Burma tropical region, the island is one of the biodiversity hotspots of the world. Hainan has high floral diversity with some 4,300 plant species recorded today, one-seventh of which are listed as endemic to the island. The vertical vegetation zonation comprises lowland rainforest below 700m, montane and ravine rainforest between 700-1,300m, and montane evergreen broadleaf forest between 1,000-1,300m. Small areas of dwarf mossy forest are distributed on ridges or mountain tops. Researchers have recorded 100 mammals and over 400 bird species; notable tropical mammal species include the endemic Hainan gibbon (*Nomascus hainanus*) and Hainan moonrat (*Neohylomys hainanensis*). The island is also an Endemic Bird Area supporting three endemic bird species and over 40 endemic subspecies. Every year, species new to science or new to the island are being discovered. However, natural forest of Hainan experienced substantial loss since the mid-1950s; from 35% down to 17% at present, and almost all lowland forest have been destroyed with only remnants of highly disturbed patches. There are nevertheless some 6,000km<sup>2</sup> of natural forest remains and one-fifth are "primary" rainforests, most of which are montane tropical rainforest in the inaccessible uplands. Although most of these old-growth forests are protected and there are active efforts to enhance management and preserve remaining forest sites of high conservation value, improved survey intensity, scientific research and management regime are badly needed to ensure the continued existence and recovery of this unique tropical forest.

**P-02-16: Effects of Forest Management on Woodpecker Communities in Sub-Himalayan Shorea Robusta-Dominated Forests, Northwestern India**

Raman Kumar<sup>1</sup>, Ghazala Shahabuddin<sup>2</sup>, Ajith Kumar<sup>1</sup>; *1. Centre for Wildlife Studies, 2. Ambedkar University Delhi*

With a strong affinity for wooded areas, woodpeckers are sensitive to forest modification. Hence, forest management has an impact on the woodpecker community. These impacts have not been adequately studied in Asia. The sub-Himalayan Sal (*Shorea robusta*) forests have high woodpecker diversity (17 species) and a history of intensive silviculture, planting exotics and selective deadwood removal. In this study we compared the woodpecker density, richness, and community structure at 8 sites representing 4 management regimes: natural sal, old managed sal, young managed sal, and teak plantations. Each site was surveyed for woodpeckers on a ~2-km transect 20 times over 2 years, and enumerated for habitat structure (tree density, DBH, basal area, number of snags and termitaria). Woodpecker density and mean richness were highest in natural sal (69 km<sup>-2</sup>; 5.9 species) and lowest in teak plantations (20 km<sup>-2</sup>; 1.8 species). Woodpecker community structure differed significantly across regimes (multi-response permutation procedure;  $A = 0.125$ ,  $P < 0.001$ ). From 53% in natural sal, relative abundance of 4 largest species declined to 15–17% in managed sal and only ~2% in teak plantations. Indicator analysis identified 7 species that had strong associations with natural sal, 1 with old managed sal and 1 with teak plantations. Woodpecker community was related to habitat structure (Mantel  $r = 0.585$ ,  $P = 0.002$ ). Our study shows that forest management significantly affects woodpecker communities, and modified forests (notably, teak plantations) have a limited capacity to conserve the natural woodpecker assemblage in the region.

**P-02-17: Restoring Tropical Dry Forests in Southwestern Puerto Rico: Effects of Planting Management on Native Trees**

J. Gilberto Martinez, Skip J. Van Bloem; *Department of Agro-Environmental Sciences, Univer*

Most of the original dry forest in Puerto Rico has been converted to agriculture or pastureland. The need to restore these forests is critical, but a lack of specific restoration techniques hinders its progress. Reforestation can be an important instrument for restoring these ecosystems by establishing native vegetation. However, reforestation projects are difficult without high maintenance, such as watering and grass trimming. A reforestation project started in September 2007 at the Cabo Rojo National Wildlife Refuge. The goal of this study was to compare the effects of soil preparation and planting arrangement on pasture grass control and the growth of tree saplings in abandoned tropical pasture in Puerto Rico. Saplings of six native trees were planted, totaling 600 saplings in the project, were planted in to arrangement (lines or groups) and subjected five treatments: control, irrigation only, mulch only, combination (mulch-irrigation) and combination plus grass removal by bulldozing. Growth and survival of all individuals were measured after one year. The overall survival rate was 94%. Treatments with mulch increased sapling growth by 50% over controls and decreased grass cover by 80%. Planting arrangement and irrigation had little effect and growth or survival or grass cover. All treatments with mulch had a positive effect on saplings growth. The results highlight the importance of reducing grass cover to improve the success of reforestation efforts. Reforestation in dry zones is particularly challenging, and identification of survival rates and successful species is important for land management.

**P-02-18: Landscape Structure Analysis of Mount Papandayan Region, West Java, Indonesia**

Endah Sulistyawati, Mahendra Primajati, Agung Budi Harto; *Bandung Institute of Technology*

Forest in Mount Papandayan of West Java, Indonesia is one of the protected forests that has been experiencing pressures from natural as well as human-induced disturbances arising from the surrounding environment. This study aimed to firstly describe the landscape structure of Mount

Papandayan; secondly, to identify the potential sources of disturbances to the protected forest from the surrounding land-uses; thirdly, to explore the placement of reforestation sites for achieving a better shape of the forest. This research was based on satellite data of SPOT 2008 comprising 36.963 hectares of study area. The data analysis and displays were conducted using ER Mapper 7.0, ERDAS Imagine 9.1 and Arc GIS 9.3 software. The results show that the study area consisted of patches of forest, tea plantation, dry-land field, shrub-grassland, settlement, crater, water body. The forest occupied 44.38 % of the study area and can be considered as one patch. Other land-cover types formed smaller patches spread over many parts of the study area. Identification of potential sources of human-induced disturbances was carried out by examining the land-cover types within 1 km distance from the forest edge. The results indicates that dry-land field was the dominant land-cover types (29%) surrounding the forest. Given the high human activity associated with managing agricultural fields and their proximity to the forest edge, dry-land fields could present potential source of disturbance for the forest. Judged by the shape index, i.e. 25.43, the forest patch in Mount Papandayan was highly convoluted, which is not an ideal shape for conservation purpose. From the simulation exercise, we found that reforestation located with 1 km from the forest edge can result in better shape of forest patch as it can lower the shape index from the presently 25.43 to 1.75. Keywords : Mount Papandayan, landscape structure, forest patch shape

**P-02-19: Agroforestry System Implementation as A Solution to Resolve The Failed of Mega Million Peatswamp Project in Central Kalimantan, Indonesia**

Thomas Akuarin Tanjung; *Lambung Mangkurat University*

Central Kalimantan is one of the province located in Indonesia, smoothly 15.38 million ha of peat swamp forest (swamp), every day the people lives in there closely related to the life of the swamp. Mega Million Hectare project Peatswamp in stages starting in 1996 in Central Kalimantan which the aims program to support community economic system around, peatland conversion in order to enhance the potential of national rice self-sufficiency, ironically with low mastery and facility level, it brings negative impacts such as changing patterns of water governance and quality, increasing the intensity of the fire area, opening access for people to do illegal logging in the wild forests in the region, it This shows the success of the project yet, other than that some species such as marsh Ramin (*Gonystylus* spp.) threatened with extinction. This project remains a variety of social and environmental issues. Seeing the above facts we know the negative impact arising from the failure of Project Ex-million hectares was very much hurt. Need to be a concrete step to reduce the harm of ex peat before it's too late, with a variety of efforts such as land rehabilitation (reforestation) based agroforestry. Agroforestry is very important to maintain the applied natural habitat lands that did not experience over the function and conserving the peatlands in order to stay physically durable and able to meet the food needs of forest communities in order to establish the ecological and economic interactions between the various components existed. Agroforestry itself is a farming system that combines woody plants with agricultural crops, with an emphasis that this combination over land use is not absolutely happen. Keywords: Mega Million Hectare Project, Peatswamp, Food, Agroforestry

**P-02-20: Seedlings Establishment of Reintroduced Manau Rattan in Bukit Duabelas National Park; in Respect of the Reintroduction Program of Bogor Botanic Garden**

Dodo, Yayan W.C. Kusuma, Hendrian; *Bogor Botanic Garden*

As one of the most commonly usable rattans, *Calamus manan* has been facing a severe depression of uncontrolled exploitation. Exploitation together with deforestation and agricultural activities has threatened the population of this manau rattan. Our surveys on its population have shown that this species was difficult to find even on its habitat and distribution range. This condition has put it into great concern that such a significant action of species recovery program like a reintroduction should be implemented. This paper discussed the result of the reintroduction program emphasizing on its seedling survival, fitness and growth. In 2004, a total of 670 seedlings have been planted in its former habitat in Bukit DuaBelas National Park. Three sites were chosen to cover three habitat types namely:

hills area (forest area), riverside (forest area) and rubber plantation. The result showed that the survival, fitness and growth after 18 mo of plantation were varied with habitat types. The highest survival percentage was found in rubber plantation site ( $44 \pm 17.82\%$ ), followed by hill ( $33 \pm 17.18$ ) and riverside ( $22 \pm 23.61$ ). Moreover, rubber plantation site seems to have the plainest trend on the survivorship than the other two. The best growth condition was also detected in rubber plantation indicated by the highest growth trend. Fitness of the seedlings was little difficult to conclude due to high variability on leaf length and width as the parameter. Nevertheless, it seems that riverside bearing the best fitness performances among all sites indicated by the highest leaf length and width.

**P-02-21: Facilitation and Competition: Interactions Between Tree Regeneration and Accompanying Vegetation in the Andes of South Ecuador**

Ximena Palomeque, Ruth Arias, Sven Günter, Bernd Stimm, Michael Weber; *Technische Universität München*

One of the worlds' hotspots of biodiversity is in the Andes of Ecuador. This region with a high number of endemic species is threatened due to conversion of forests into agricultural land, mainly pastures for cattle raising. However, the efforts for restoration of abandoned pastures in tropical mountain ecosystem are still very limited due to poor knowledge of the ecological processes. It is well established that accompanying vegetation can either suppress or facilitate growth and survival of tree seedlings. The aim of this study was to identify facilitation and competition effects of accompanying vegetation on the natural succession processes. Therefore, we monitored floristic composition in three different successional stages dominated by pasture grasses, bracken fern and shrubs. A total of 48 plots were monitored from 2003 to 2007. Half of the plots were weeded periodically during the first two years of observation. The results demonstrated: 1) Species richness in the shrub stage increased due to better development of vegetation structure along time. 2) Though bracken is frequently considered to suppress upcoming seedlings, we could observe a facilitative effect: beneath of dominant fern coverage the species richness and abundance was higher at the end of the monitoring. Obviously the dense bracken coverage provided shade and protection against high irradiation and drought stress. 3) At the pasture stage strongest competition was revealed due to higher Leaf Area Index compared to bracken fern and shrub stage. Additionally, the high belowground biomass allocation of the pasture grass could act as barrier for tree establishment in the pastures. Weed removal did not improve the natural succession process While bracken and shrub stages require less technical assistance for reestablishment of tree seedlings we consider that pastures stage needs other strategies in order to accelerate the restoration process, for example artificial reforestation with native species, such as *Alnus acuminata*.

**P-02-22: Strategy to Manage Invasive New Pest Attacking *Pinus merkusii* Plantation in Jawa, Indonesia**

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*Pinus merkusii* plantation was widely established in Jawa since the Dutch colonization, using seeds from the natural forests in Sumatra, in order to meet demand for turpentine and Pine timber. Since its establishment in 1931 only few pests and diseases were reported attacking the plantation, of which were easily managed. Starting in 1997, however, new invasive pest were found, which caused substantial tree mortality in Bandung, West Jawa plantation. The new pest, which is identified as wooly aldehyd, was then spread rapidly to other area in West, Central and East Jawa, attacking thousands of hectares Pine plantation. Few conventional controlling efforts, such as application of pesticides, have been done to manage the invasive pest, however, the results was very poor. Therefore, different strategy, employing resistant plant lines, needs to be developed to effectively protect Pine plantation. Development of resistant lines by selection and breeding program is promising, because some resistant individuals were found within severely attacked population. Preliminary investigation showed that the resistant individuals showed remarkable different response

to pest attack, due to different cell structures and composition of secondary metabolites. The fact indicated that the different characteristics are intrinsic in nature, and are not environmentally induced. Such characteristics will respond to selection and breeding program appropriately, and resistant lines will be obtained, which effectively control the new pest invasion.

**P-02-23: Forest Condition Analysis Based Forest Canopy Closure With Remote Sensing Approach**

Mahendra Primajati, Harto A.B, Sulistyawati E.; *School of Live Science and Technology*

Deforestation has been a threat for most of forest in Indonesia, especially in Java Island due to its high population. In Java, forest has been fragmented into patches among agricultural areas, such as rice fields and plantations, residential areas, and industrial areas. Expansion of such activities will certainly disturb the ecological functions of the remaining forest. This research aimed to detect the land cover around Mount Papandayan and to analyze forest condition based on canopy closure parameter. The satellite images used was SPOT 2 year 2008 with the standard correction of level 2A. The satellite data were firstly pre-processed (radiometric, geometric, and topographic correction) and subsequently classified using supervised classification method for detecting land cover, particularly to distinguish forest cover from other land-cover. Field works have been done in sample sites with varying canopy closure. The canopy closure on each site was recorded using hemispherical photograph taken from a digital camera. The resulting images were then analyzed using RGBFisheye software to measure the percentage of canopy closure. The forest canopy cover was then classified into open forest (10-40%), semi closed forest (40-70%), and closed forest (>70%). The result shows that the forested area in the study site was approximately 16,846 ha. The majority of forest (49.38% or 8,983 ha) were classified as semi closed forest forming 3,604 patches. Whereas, open forest comprised 15.07% (2,741 ha) of the total forested area forming 16,450 patches. The patches of open forest were found not only on the edge, but also in the interior of the forested area. The occurrence of open forest patches in the forest interior were attributed to natural disturbance as well as human activities such as illegal logging.

**P-02-24: A Habitat Enrichment Project to Encourage Breeding of *Kalophrynus pleurostigma* in Singapore**

Yea Tian Teo; *National University of Singapore*

The black-spotted sticky frog (*Kalophrynus pleurostigma*) population is on the decline in Singapore as its habitat is being degraded due to human activity and climate change. The aim of the project is to enhance the breeding habitat of this species in the Bukit Timah Nature Reserve (BTNR) and encourage a population increase. Artificial pools and refuge areas consisting of basins, cups and dishes of varying width, depth and material were added to a forested patch and monitored over a three month period. It was found that about 50% of the set-ups were utilized constantly by *K. pleurostigma* for about two months with a high survival-to-metamorphosis rate of the larvae, before other factors, such as the weather and the presence of predators, began to adversely affect the survival of the larvae. Audio surveys were carried out at night before and after modification of the habitat to estimate population density, but the time span was too short to accurately determine if there was any change. However, breeding activity was estimated to have increased by more than 30% in the treatment area, especially during dry periods. The successful utilization of such artificial habitat modifications suggest that it may be worth looking into similar projects to be undertaken on a larger scale for this species and other endangered amphibians in local as well as regional tropical forests.

**P-02-25: Effects of Harvesting on Population Structure of *Janaguba (Himatanthus drasticus (Mart.) Plumel - Apocynaceae)* in Brazilian Savanna**

Cristina Baldauf<sup>1</sup>, Raydine F. Oliveira<sup>2</sup>, Rosijânia S. Ferreira<sup>1</sup>, Alexsandra S. da Silva<sup>1</sup>, Marilyn F. Machado, Cícero I. D. Milfont, Flavio A. M. dos Santos; *1. State University of Campinas (UNICAMP), 2. Regional University of Cariri (URCA)*

Sustainable management of medicinal plants may allow the conservation of the target species and also be a source of income to local communities of Brazilian Savanna (Cerrado), which is considered a hotspot for biological conservation. *Himatanthus drasticus* (Apocynaceae), popularly known as Janaguba, is a medicinal tree of Brazilian Savanna (cerrado), whose latex is used by local populations of Cariri region, in south of Ceará State, Brazil. Populations of Janaguba have been explored since the 1970's, but ecological impacts of its harvesting have never been accessed before. The objective of this work is to compare the structure of populations under different intensities of harvesting. It was selected two different areas, one in cerrado (open vegetation) and the other on cerradão (dense vegetation). In each area six populations in different degrees of exploration were sampled in plots of 1 ha, totalizing 12 ha. It was recorded the stem basal diameter (DSH) of all individuals with DSH > 1 cm. Individuals with DSH < 1 cm were sampled in 100 sub-plots (4 m<sup>2</sup>) at one corner of the plots. The abundance of individuals between the areas was compared through a Mann-Whitney test and the population structures among the populations of each area were compared by a Chi-squared test, with Bonferroni correction for multiple comparisons. Abundance was different between the areas, being the cerrado area the one with higher number of individuals. Population structures within each area also presented many differences, probably due to variations in the proportion of individuals with DSH > 1 cm. When considered the other diameter classes, the differences are reduced. The differences found could not be related with management intensity. Environmental factors and disturbance history of the areas may be causing the mentioned differences. Studies of population dynamics that are being developed will confirm or not the absence of effects of harvesting on population processes of Janaguba.

**P-02-26: Management Alternatives for *Urochloa decumbens* Stapf. (Poaceae) Biological Invasion in Brazilian Savannas**

Elizabeth G. Barbosa, R. Vânia; *Pivello*

*Urochloa decumbens* is an African grass, highly competitive and aggressive that was introduced in Brazil for cattle feeding and became one of the most serious invasive species in Brazilian savannas – Cerrado -, threatening the native biodiversity. The objective of this study was to evaluate the efficiency of different management techniques to control the invasive grass *Urochloa decumbens*. The study was conducted in two Cerrado reserves in São Paulo State, Brazil, from July/2007 to July/2009. Six cerrado patches infested by *U. decumbens* were selected, and a randomized block design was applied with the treatments: clipping once a year (CRI) and twice a year (CRII), clipping and soil grubbing once a year (CRSI) and twice a year (CRSII), shading with nylon mesh (SOM), and smothering by covering with canvas (ABF). After the treatments all biomass in the blocks was cut and separated into categories (*U. decumbens*, native grasses, and dicotyledonous species), in July/2008 (first year) and July/2009 (second year). The analyses followed permutation tests. In the first year the treatments ABF, CRII and CRSII statistically differed from control, showing to be the most effective to manage *U. decumbens*, however in the second year the treatments CRI and CRSI also showed to be effective. Therefore, in two years of management *U. decumbens* can be controlled by smothering and grubbing once a year (with or without soil digging) in areas where the invasion is not very extensive, as edges or small isolated patches inside the native fragments.

**P-02-27: Potential Wildlife Corridor Design in Concession Area of PT. Balikpapan Forest Industries, East Kalimantan (preliminary study)**

Subeno, Sandy Nurvianto, Danang W. Purnomo, Yeni Widyana N.R.; *Faculty of Forestry, GMU*

In production forest as HPH mostly done activities such as area clearing and site management. Area management included making road, building camp and others. Those activities directly reduced

habitat and space of wildlife. The aim of corridor design of wildlife was related and expanded wildlife habitat which fragmented from above activities. For the long time, corridor can circulate stream of gene between isolated populations. The aim of research is to know the type of wildlife habitat in the region of PT. Balikpapan Forest Industries, to identify the basic needs of wildlife in the region of PT. BFI and to identify distribution model of wildlife in the region of PT. BFI. Quadrat sampling and protocol sampling methods were used to know wildlife habitat. To know the need of wildlife will be applied direct inventory and minimum convex polygon method. Line transect method was used to know dispersal or distribution model. Results showed that forest area in the PT. BFI is a diverse region with a very high type of vegetation. This region has recorded 206 species of vegetation with a diversity index value of Shannon-Wiener 4.2. The area also provides support capacity as a place to live for the area where wildlife is still able to provide basic needs such as animal feed resources, water resources, space and protection. Forest area in the area of PT. BFI has a diverse wildlife where there are 73 species of birds with a value of species diversity Shannon-Wiener reaches 3:26 (high enough). From 73 species of birds found in the nearly 12 species including endangered and 1 vulnerable species. It also found 25 species of mammals and 3 species of reptiles. Wildlives are spread almost evenly throughout the forest area of PT. BFI. Recently occurs very big pressure on the habitat and wildlife such as illegal activities, illegal logging and wildlife poaching. Those activities are very high and inte

#### **P-02-28: Resorting Tropical Forest – a Trial of Soil Seed Bank Transplantation**

Min Cao, Hui Chen, Luxiang Lin, Yong Tang; *Xishuangbanna Tropical Botanical Garden*

A manipulated experiment on the transplantation of soil seed bank has been conducted in an abandoned site following the plantation of pomelo (*Citrus maxima*), Xishuangbanna since the August 2009, with the purpose of monitoring the germination dynamics of seeds buried in the surface soil that was transplanted from the secondary forest dominated by pioneer tree species. Four treatments were taken. Treatment 1: We keep the vegetation undisturbed, allowing its natural succession (control). Treatment 2: We plowed 10 cm down to the soil on the spot and overturned the soil up to the surface with hoes (plowing). Treatment 3: soil seed bank transplantation without aboveground vegetation removal. Treatment 4: soil seed bank transplantation with aboveground vegetation removal. More seedlings and species of woody plants were observed in the treatments 3 and 4 (transplant plots) than in the treatments 1 and 2. *Trema orientalis*, a typical pioneer tree species in Xishuangbanna, dominated the seedling populations germinated from the soil. The mortality for the seedlings of woody species fluctuated quickly even within the first four months. Our study results suggest that there is a shortage in the seed sources of woody species in the soil under the pomelo plantations. Such seed limitation, however, can be improved by transplanting the soils containing more seeds of woody species, which in turn, accelerates the colonization and establishment of tree species at the early stage of forest restoration.

#### **P-02-29: Promoting Agarwood Cultivation Through Partnership Model in KHDTK Carita (Forest Area for Special Purpose), Banten Province, Indonesia**

Sri Suharti; *Forest and Nat Conserv Research and Dev't Centre*

Agarwood forms a fragrant resinous substance deep inside some kinds of trees belonging to the genera *Aquilaria*, *Gyrinops* and *Gonystylus* from Southeast Asia. The resin embedded wood is valued in many cultures for its distinctive fragrance, and thus is used for herbal medical and perfumes. However, habitat destruction and unsustainable harvesting has caused depletion of the wild resource. As a result, since 2004 all *Aquilaria* species were listed in Appendix II of CITES. In spite of its rapid extinction, agarwood price tends to increase hence induce cultivation of agarwood especially in South East Asia Region. In Indonesia, agarwood is very prospective business due to several supporting factors i.e its biological potency (wide variety of tree species producing agarwood), abundant potential land for agarwood cultivation and technology for injection is already available. However, since agarwood business is capital intensive, not many people could afford this. One alternative to stimulate agarwood cultivation more widely is through development of a partnership model between

capital owner and local community. Agarwood trees plantation in KHDTK Carita is one example of partnership model to encourage local people to implement agarwood cultivation by using Community Based Forest Management (CBFM) approach. CBFM is deemed to be the suitable approach as it is implemented by involving forest surrounding community in forest management. Forest management would be successful if all stakeholders involved are willing to cooperate and allocate space, time, benefit, right and obligation based on powering, promoting and benefiting each other principle. Through CBFM partnership model, it is expected that agarwood cultivation could be expanded widely, community income is significantly increased and people dependency toward forest could be decreased considerably.

**P-02-30: *Merremia peltata* Invading Bukit Barisan Selatan National Park (Inception Survey Report)**

R.S.B. Irianto, A. Susmianto, R. Garsetiasih, W.S. Ramono, K. Rauf, S. Tjitrosoedirdjo; *Forest and Nature Cons. Res. and Dev. Center*

Bukit Barisan Selatan National Park is located in the southern part of Sumatera Island, belonging to Lampung Province. The total area of this national park is 365,000 ha. In the 1980's, *Merremia peltata* L. (Merr.) was noticed to grow extensively and recently it has expanded occupying 7,000 ha area, especially in the southern part of the national park. The invasion of this plant rapidly destroyed native plants and grasses that are grazed by big mammals such as rusa deer, elephant and rhinoceros. This condition reduced "the home range" (including the source of feeding area) of those big mammals. The large invasion of this *M.peltata* in the southern part of Bukit Barisan Selatan National Park has forced rusa deer, elephant and rhinoceros to move to the northern part of the park where grasses are still available and the population of *M. peltata* is still rare. Sumatran tiger is reported tend to move to the northern part of the park also following the preys. Controlling this invasive plant needs immediate actions to eradicate the species both mechanical and using natural enemy followed by planting other useful local plants to reduce the growth of *M. peltata*. The problems are enormous affecting the world endangered animals, such as elephants, rhinoceros tigers as well as deer; in this opportunity we invite a national as well as international cooperation to rehabilitate the ecosystems and safe those endangered species. Key Words : *Merremia peltata*, Bukit Barisan Selatan National Park, invasive plant, deer, elephant, tiger, rhinoceros

**P-02-31: Multi-year Phenology Across Three Different Habitats in an African Tree of Economic Importance**

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Tropical forest trees of high economic value are being considered for domestication to help alleviate poverty in various developing nations. The biology of many of such species remain poorly understood, and yet vital toward domestication, especially in forested areas under different landuse pressures. We examine flower and fruit phenology of *Allanblackia stuhlmannii* (Clusiaceae) in farms, privately owned forest and protected forest (Amani Nature Reserve), in the East Usambara Mountains, Tanzania. Through the establishment of 15 vegetation plots that sampled a total of 18 ha across the three habitats, and through annual monitoring of 234 marked female trees over five years, we first (i) show how the sex ratio of this dioecious tree varies across this landscape, and then (ii) examine the variance of simultaneous fruiting and flowering among individuals. Finally, using the marked female trees in all three habitats, we show the high spatial and temporal patterns of fruit production. The implications of our findings are discussed in the context of seed harvesting rates, conservation and domestication of this tree species.



## Poster session: Carbon, climate change and REDD (#03; July 22)

### P-03-1: Understanding and Protecting Rainforest Biodiversity: Adapting to Global Climate Change

Stephen E. Williams, Luke Shoo, Jeremy VanDerWal, Yvette Williams; *James Cook University*

The Wet Tropics rainforest of North Queensland has the highest biodiversity of any region in Australia. While world heritage listing of the rainforest has provided protection from most human impacts, it will not protect against the impacts of global climate change. Our research suggests that the fauna of the region is highly vulnerable to global climate change. I will discuss the likely effects of climate change on species distributions and persistence in the Wet Tropics World Heritage Area, and the ecological and biological attributes that alter their susceptibility. We need to determine which species, habitats and ecosystems will be most vulnerable, exactly what factors determines their vulnerability and how we can target management that minimises impacts on the most sensitive species and ecosystems while avoiding wasting resources where there is sufficient natural adaptive capacity. Optimising the efficient allocation of resources for adaptation will be a balance of relative vulnerability, consequences of inaction, social/political/scientific will and available resources. I will discuss the advances we have made in developing a strategy that includes: 1) comprehensive and reliable approaches for assessing vulnerability with estimates of uncertainty; 2) quantitative predictions of impacts that include all facets of vulnerability including a) factors affecting exposure to regional climate change, b) factors affecting sensitivity that are broadly applicable across ecosystems and c) analysis of adaptive capacity (evolutionary, ecological and management) and 3) novel approaches to systematic conservation planning that account for a shifting climate. I will discuss novel analyses for the identification of refugia that will be particularly important for species persistence however we need to start considering refugia and restoration beyond current protected areas. Merely occurring in a protected area will not be enough to save some of these unique species.

### P-03-2: Integration of Habitat Models and Metapopulation Models to Investigate the Potential Impacts of Climate Change on *Triunia robusta*.

Shimizu Yoko<sup>1</sup>, Arnon Accad<sup>2</sup>, Richard Warwick<sup>1</sup>, Scott Burnett<sup>1</sup>, Mike Powell, Alison Shapcott; *1. University of the Sunshine Coast, 2. Department of Environment and Resource Management*

Climate change is already affecting plant distributions, and the species predicted to be the most vulnerable to climate change are the ones that have small and isolated populations and low genetic diversity. Many studies have modelled the potential impact of climate change on plant distributions, however, most of them are based on geographical and a-biotic factors and often ignore the potential effects on demography of a species. *Triunia robusta* is a small rainforest shrub endemic to the Sunshine Coast, Queensland, Australia. The species is nationally listed as endangered and its habitat is restricted to small subtropical rainforest fragments. Habitat models and metapopulation models are extremely useful tools for species conservation at the demographic, geographical and landscape scale, although few studies have demonstrated the integration of both. This research focuses on investigating the potential long-term viability and extinction risk of *T. robusta* under projected climate change scenarios through a combination of habitat and metapopulation modelling. Field surveys will be conducted to re-census populations of *T. robusta* extending the existing data surveyed in 1999 to obtain demographic population parameters and to obtain seed dispersal data. This, combined with genetic and demographic data, and habitat models of *T. robusta* from previous studies will be used to develop a comprehensive habitat/metapopulation model. An integrated climate change model will also be utilized to investigate possible climate change potential habitat for the species. This research will guide land managers in adaptive management of threatened species under climate change scenarios.

### P-03-3: Biological Diversity Contribution to Reducing CO<sub>2</sub> in the Atmosphere II

Hidayati Nuril, Titi Juhaeti; *Puslit Biologi-LIPI*

Biological diversity can make a significant contribution to reducing the build-up of greenhouse gases in the atmosphere. Forest represent 21% of the continental area, 76% of terrestrial biomass, and 37% of its bioproductivity. Thus, the trees in a forest stand form an essential part in the functioning of the terrestrial biosphere, especially in the carbon cycle. Yet tree photosynthesis is far less studied than crop photosynthesis for several reasons: the large number of species; difficulty in measuring photosynthesis of entire trees or of forest stands. This research aims to understand the variation of biological diversity in carbon sequestration by analyzing the physiological characteristics (photosynthesis, transpiration, stomatal conductance, leaf chlorophyll and carbohydrate content) and to study the effect of environment to CO<sub>2</sub> absorption of individual species native to humid highland and humid lowland forest ecosystems. The results showed that there was a wide range of variation of CO<sub>2</sub> assimilation rate between tree species. Photosynthesis values ranged between 2.0 – 31.39  $\mu\text{molm}^{-2}\text{s}^{-1}$  for typical highland specie and 2.0 – 40.64  $\mu\text{molm}^{-2}\text{s}^{-1}$  for typical lowland species. Light seems to have the most important role on tree photosynthesis. Variance in CO<sub>2</sub> assimilation rate is large among trees grown under different light conditions. degree of photosynthetic plasticity in response to changes of light regimes was high in the most-light demanding species. Key Words: Biological diversity, photosynthesis, carbon sequestration, greenhouse Gases

**P-03-4: Measuring Carbon for REDD in the YUS (Yopno- Uruwa- Sarawage) Conservation Area, Papua New Guinea**

Michelle Noel, Michael Bird; *James Cook University*

When gazetted in January 2009, The YUS (Yopno- Uruwa- Sarawage) conservation area of Papua New Guinean became the first protected area declared under the country's National Park Act 1978. The protected area is a continuous swath of 15 000 ha of rainforest and grasslands of the Saruwaged range starting at 4000 m elevation and descending to the northern coast of the Morobe Province. The land was set aside for conservation with the consent of over 35 villages comprising 10,000 villagers. The commitment made by these villagers is to conserve habitat for species such as the Matchie tree kangaroo, a significant species in their cultures. This new protected area also represents an important initiative towards efforts to Reduce Emission through Deforestation and forest Degradation (REDD) in Papua New Guinea. One of the key information needs of efforts to protect forests in YUS using REDD is knowledge of the amount of carbon stored in forest trees and soils, allowing changes in these stores to be tracked through time. Although progress has been made to improve methods to measure carbon stored in the woody biomass of tropical forest, available inventory data remains inadequate. This study is in the preliminary process of mapping land use cover, causes of forest cover loss, and determining the amount of carbon stored in different land cover classes in YUS, as well as exploring the costs and benefits of reforesting grasslands.

**P-03-5: Carbon Stock and Biomass Estimation of Four Different Ecosystems within Cibodas Biosphere Reserve, Indonesia**

Didik Widyatmoko, Sri Astutik, Endah Sulistyawati, Andes H. Rozak; *Cibodas Botanic Gardens-LIPI*

Due to the diverse ecosystems (both natural and man-made), Cibodas Biosphere Reserve (CBR) offers a challenging land use concept in coping with climate change and CDM issues. One of the main problems faced by Indonesia is the lack of quantitative data on CO<sub>2</sub> sequestration capacity. No single carbon stock assessment was conducted at CBR since it was declared. This research aims to estimate carbon stocks contained in different ecosystems, identify CO<sub>2</sub> sequestration capacity within different land uses, and establish carbon stock baseline data of four different ecosystems: natural forests, botanic gardens, monoplantation, and agriculture. The Brown formula was used to calculate above ground carbon, while the total dry weight of samples was used to estimate understorey and litter biomass. Necromass was calculated by multiplying volume and density ( $\rho$ ). Above ground carbon

was converted from the biomass (i.e. biomass\*0.46). Soil carbon was estimated by consecutively multiplying: soil organic carbon, weight of dry soil per soil volume, and area and depth of soil sample. The total carbon stock was the sum of above ground and soil carbon. The results showed that carbon sequestration capacity varied among ecosystems: natural forests contained 367.1 tonnes C/ha, botanic gardens 107.2 tonnes C/ha, tea plantation 13.6 tonnes C/ha, while agriculture only 8.1 tonnes C/ha. The contribution of above ground carbon to the total carbon stock was very high (99 per cent), in contrast with that of soil carbon which was only one per cent. The highest carbon stock in natural forests was found at Vaccinium site (2843 m). Carbon stocked in trees varied amongst locations, from 134.7 to 423.7 tonnes C/ha. Trees contributed 94.1 per cent of the carbon stock at the natural setting, while understorey only supported 2.9 per cent. These findings can be used as a benchmarking for guideline afforestation/reforestation programs within REDD/REDD plus mechanism.

**P-03-6: Ten Years of Research and Conservation along the Peruvian Andes-Amazon Interface (Amazon Conservation Association)**

Megan E. MacDowell<sup>1</sup>, Adrian Tejedor<sup>2</sup>; *1. Amazon Conservation Association, 2. Asociación para la Conservación de la Cuenca Amazó*

The southwestern Amazon supports among the highest levels of biological diversity and endemism in the world and encompasses extensive wilderness connecting the lowland Amazon with the Andes Mountains. The region represents an exceptional conservation opportunity, but faces several threats. The Amazon Conservation Association (ACA) and its Peruvian sister organization, la Asociación para la Conservación de la Cuenca Amazónica (ACCA), conserve biodiversity by supporting numerous research and conservation projects throughout a network of conservation concessions and research stations. Our research stations span from the highlands of Manu National Park to the lowland Amazon basin, providing a unique opportunity to study the impacts of climate change on species distributions. We present an overview of our research and conservation projects. At Los Amigos Biological Station (CICRA), more than 450 researchers have conducted over 160 research projects addressing botany, conservation biology, geology, hydrology, zoology, as well as biological inventories of 31 different taxa. Projects include long-term monitoring of animal populations following the creation of the conservation concession and ecology and distribution of the rare Amazonian short-eared dog. At Wayqecha Cloud Forest Research Center, Peru's only permanent research station focused on Andean cloud forest ecology and management, we hosted 156 researchers and 95 students in 2008. Current research includes a multidisciplinary study of carbon cycling in montane forests as well as monitoring and predicting the response of Andean forests to climate change. ACA is also working with local communities to evaluate the feasibility of using REDD to promote conservation in the Andes-Amazon interface.

**P-03-7: Biological Controls on Soil Organic Carbon Turnover in Contrasting Land Uses in Xishuangbanna, SW China**

Matthew W. Warren, Jin Chen, Xiaoming Zou, Xiaodong Yang, Douglas Schaefer, Lingling Shi; *Xishuangbanna Tropical Botanical Garden*

Climate, litter quality, and soil texture are generally viewed as the main determinants of soil organic carbon (SOC) turnover, and are the only factors included in dynamic ecosystem C models. However, climate and litter quality have indirect effects on decomposition through their influence on the activity of soil flora and fauna. Our research on proximate biological controls of SOC turnover considers three main topics: 1) Effects of land-use change on soil CO<sub>2</sub> efflux; 2) Effects of soil arthropod community structure on above- and belowground decomposition and 3) Role of soil microbial community structure and oxidative enzyme activity on lignin degradation in contrasting land uses. We are exploring these topics in a tropical secondary forest and rubber plantation in Xishuangbanna, SW China. Litter manipulations and chemical fertilizer treatments are being used in conjunction with a litterbag-decomposition experiment to study the effects of land use, soil fauna, and the soil microbial community on SOC turnover. Early results indicate soil CO<sub>2</sub> efflux, temperature, and moisture

relationships differ between natural forest and rubber stands. Also, soil microbial community profiles (assessed by DGGE) and oxidative enzyme activities differ between forest and rubber soils.

### **P-03-8: Tropical Monsoon Asia Forest Responses to Seasonal and Interannual Climate Variation**

Alfredo R. Huete; *University of Technology, Sydney*

Tropical forests are key components of the global carbon and water cycles, and understanding their large-scale ecology is critical to understanding ecosystem feedbacks to global climate. However, there remain many concerns about optimizing the detection of ecosystem phenology with remote-sensing data due to coarse resolutions and contamination influences of the atmosphere and clouds. In this study, we used space-based remote sensing combined with eddy flux tower measurements to elucidate tropical Monsoon Asia forest response to seasonal and interannual climate variation. We hypothesized that the use of tower flux measurements over different vegetation types can serve to "calibrate" spatially extensive satellite data and improve predictions of regional water and carbon fluxes. We used a 10-year MODIS satellite data record to track and diagnose phenology (timing and duration of greening and drying), and assess how land-use change dynamics interact with climate variability and affect ecosystem functioning and carbon and water cycling. We found very complex and heterogeneous patterns of landscape phenology patterns throughout tropical Monsoon Asia, and strong linkages of land-use, drought and ENSO events on tropical forest functioning were observed, in which intact tropical forests survive ENSO events, however, disturbed areas became drought susceptible, triggering widespread fires and a drastic reduction in the regenerative capacity of the forests. This region has some of the highest carbon densities in the world with high biodiversity, however more intense drought periods, combined with land degradation, may potentially stress these ecosystems beyond a threshold which will result in widespread forest drying with wildfires becoming a more dominant force. Knowledge of land use dynamics and environmental interactions at multiple scales are necessary to understand how these ecosystems function and how they may respond to climate variability.

### **P-03-9: Compensating for Defoliation under Altered Climate Regimes: a Case Study of Subtropical Eucalypts**

Adrienne B. Nicotra, Paul Killey; *The Australian National University*

The iconic Australian Eucalypts are the dominant component of natural forest stands throughout Australia and are important both ecologically and industrially. Globally Eucalypts are the second most widely planted genus in forestry and their use is increasing. In many ways Eucalypts typify trees of Mediterranean type ecosystems: they are adapted to fire, drought, frequent defoliation, and low nutrient soils. These features mean that their responses to increased CO<sub>2</sub> concentrations and other climate changes may differ from those of other trees. Previous research has demonstrated that Eucalypt species typical of forestry estates have a remarkable ability to tolerate high levels of defoliation. Here, we present an experiment examining physiological mechanisms underlying response to defoliation and explore how a broad range of sub-tropical species may differ in their response to defoliation treatments. We discuss the potential interaction between tolerance of defoliation and climate change focusing on sub-tropical Eucalypts as a case study. We suggest that increased drought frequency and intensity, and the likelihood of extreme temperature events may compromise the ability of Eucalypts to compensate for defoliation.

### **P-03-10: Impacts of Climate Change on the Amphibians and Reptiles of Southeast Asia**

David Bickford, Sam D. Howard, Daniel Jia Jun Ng, Jennifer A. Sheridan; *National University of Singapore*

Amphibians and reptiles will be adversely affected by projected rapid changes in climate in the next decades. Here, we review the known and potential impacts of climate change on the Southeast Asian amphibians and reptiles and make mitigation recommendations for both research and policy. Current amphibian and reptile distributions and ecologies mirror climate patterns, and we expect that adaptation to changes in these parameters will be too slow relative to their rate of change. Reflecting some of the best estimates of expected climate change scenarios, pervasive changes will also occur to species assemblages, communities, and ecosystem functioning and services. Reflecting specific known and hypothesized thresholds, we estimate that in <50 years, amphibians and reptiles in Southeast Asia will have reached or exceeded many tipping-point limits in their abilities to adapt to the effects of climate change and that temperature dependent sex determination, higher metabolic rates, and variation in water availability will have severe and irreversible effects on these organisms. We suggest that human decision-making and policy development have already lagged and that societal change is happening too slowly for effective mitigation. If we are to avert devastating loss of biodiversity and a complete meltdown of ecosystem services, we must quickly change our attitudes and thinking about how we interact with and use biological systems.

### **P-03-11: Shrinking Futures: Climate Change Effects on Body Size**

Jennifer A. Sheridan, David Bickford; *National University of Singapore*

Determining how climate change will affect global ecology and ecosystem services is one of the next important frontiers in environmental science. Here we review the overwhelming evidence that increasing temperatures and changes in rainfall patterns will have far-reaching effects on size of a wide array of taxa, from primary producers to top predators. Many organisms are already getting smaller and are likely to continue to shrink in response to continued climate changes, following fundamental ecological and metabolic rules. We present data from numerous taxa including SE Asian herpetofauna, discuss the major mechanisms causing these size declines, and the implications of widespread organism shrinkage. Ultimately, decreasing organism size could result in trophic cascades, and loss of biodiversity.

### **P-03-12: Climate Drivers of Rainforest Bird Assemblage Structure: Species-Energy and Climate History Mechanisms in a Meso-scale System**

Alex S. Anderson, Luke P. Shoo, Stephen. E Williams; *James Cook University*

The importance of climate as a driver of global patterns of species richness is well known. The species-energy hypothesis proposes that higher productivity climates should support more species, as they support higher population sizes and hence reduced rates of extinction. This process has found strong empirical support as a mechanism for the relationship between diversity and climate at global scales. However, within biome patterns appear to be more idiosyncratic. Differences in the seasonality of resource production (as apposed to annual totals) has been proposed as one factor potentially confounding straightforward links between climate, energy and species diversity. Another hypothesis points to selective extinction of species during historical climate fluctuations. Here we present tests of the species-energy hypothesis using meso-scale data on abundance and diversity of birds from rainforests across a broad latitudinal gradient in north-eastern Australia, and with contrasting biogeographic histories. We find a strong correlation between climate, energy-use of the bird community and local species diversity in some rainforest blocks, and for some trophic groups. In other instances, productive climates yield high energy-use of the bird community but this does not translate into more species. We argue that models incorporating both seasonal resource bottlenecks and selective extinction in the past provide a plausible explanation for these patterns. These models help to inform an understanding of the relationship between past and present climates and current patterns of biodiversity. This understanding will be crucial in predicting and managing the risks to biodiversity posed by anthropogenic climate change.

**P-03-13: Synthesis REDD in Supporting Conservation of Biodiversity in Biosphere Reserve in Indonesia**

Sri Astutik; *Indonesian Institute of Sciences*

Biodiversity in the tropics is an important resource for the sustainability of the present and future of our planet. Convention on Biological Diversity, Agenda 21, and Global Strategy for Plant Conservation, develop a strategic framework to guide an action to manage biodiversity so that human being able to face of global climate change. It is believe, that the concept of Biosphere Reserve (BR) may be used as a model tool for sustainable development. Indonesia has 7 BR with the total core area of around 2.001.212 ha representing a diverse tropical ecosystem with huge economic value for the country to adapt and mitigate global climate change and protect biodiversity lost from human threat. Biodiversity present at BR from the perspective of ecosystem services may include: (1) carbon stock, in the case of Cibodas BR, the Mount Gede Pangrango National Park/MGPNP, a core area could retain around 367.12 ton C/ha while in the buffer area (Cibodas Botanic Garden) store around 2203.50 ton C/20.56 ha, (2) catchment area, in the case of MGPNP estimated to have a value as high as 280 million USD/ha/year, (3) species diversity, in the case of Mount Leuser National Park is a hotspot area in Sumatra, (4) the uniqueness of cultures who live in nature harmony, for example Toro at Lore Lindu National Park, (5) the involvement of multy stakeholders in managing the BR which include Government Institutions, Non Governmental Organizations, Universities, and the society. We are proposing REDD/REDD (Reducing Emissions from Deforestation and Land Degradation) plus as the instrument to compromise between climate, bio-resources/biomass, and ecosystem services. BR in Indonesia could be a site to demonstrate the successfull implementation of REDD. BR has, in fact, the basic study of REDD for the following: (1) data and information, (2) biophysical and ecology, (3) threats to forest resources, (4) social, economic, and cultural, (5) economic feasibility, and (6) governance. The modeling of conservation of biodiversity at Cibodas BR with REDD/REDD plus instrument will be elaborated by using ecosystem approach and SWOT analysis. It is hope that this analysis could positively support the commitment of Indonesia to gradually reduce the greenhouse gas emission by 26% in year of 2020

Keywords: Biosphere Reserve, Carbon Stock, Climate Change, Ecosystem Services, REDD

**P-03-14: Novel Application of Methods Assessing Climate Change Impacts on Spatial Patterns of Distribution and Abundance: Australian Wet Tropics as a Case Study**

Jeremy VanDerWal, Luke P. Shoo, Stephen E. Williams, Collin Storlie, Yvette Williams; *James Cook University*

Ecology seeks to understand patterns of distribution and abundance of species. Increasingly, occurrence data is used to build correlative models of a species niche such that the environmental suitability (ES) derived from such models may be used to predict the potential distribution of species across time and space; applications of such models include assessing climate change impacts for conservation planning. Using the rainforests of the Australian Wet Tropics as a study region, we will show how such models can be used to create robust assessments of climate change impacts on the spatial patterns of distribution and abundance of rainforests and the associated vertebrate species. We will describe the novel application of methods from a variety of disciplines and demonstrate: - validation of the correlative links between climate and distribution using genetic lineage information and through space-for-time projections; - estimation of spatial patterns of abundance from occurrence-only data using known occurrence and abundance data for 71 rainforest vertebrates; - how dispersal capabilities can be incorporated into past and future projections; - the importance of identifying 'realized' exposure for any species; and - enhanced methods quantifying the changes through time. We conclude that ES modelled from presence-only data provides useful information on spatial patterns of distribution and abundance, and discuss implications of this for both our study area and addressing important problems in ecology.

### **P-03-15: Biomass Production and Carbon Sequestration in Various Ecosystem Types in Indonesia**

Joeni S. Rahajoe; *Indonesian Institute of Sciences*

Eight ecosystem types in some location of Java Kalimantan islands were monitored in order to estimate biomass production and carbon sequestration of the ecosystems. Those eight ecosystem types were included: lowland, low montane, heath, peat swamp, mixed Dipterocarp, agathis and pine forests. The lowland, low montane, pine and agathis forests were located in the Gunung Halimun-Salak and Gede-Pangrango National Parks. While heath and peat swamp forests were located in the Central Kalimantan and mixed dipterocarp forest was located in the Bukit Bangkirai, East Kalimantan. One hectare permanent plot was established for each ecosystem type and have been monitored at least two years of its stem diameter increment. In each ecosystem type, litter traps and litter bags were set up in the forest floor within the plot, in order to study the litter fall production and litter decomposition rate of the ecosystem type. Above ground biomass of each ecosystem type in this report is total of the biomass of standing tree plants, litter fall and the litter in the forest floor. The above ground biomass of each ecosystem types were (from the highest to lowest): 351.9; 267.7, 245.7; 149.5; 127.9, and 122.1 ton per hectare in each of: peat swamp, low montane, heath, lowland, agathis and pines forests, respectively. The estimated carbon stock in the above ground biomass of the ecosystems were (from the highest to lowest): 172.95; 133.85; 129.43; 122.88; 67.69; 66.7; and 55.73 ton per hectare, in each of: peat swamp, low montane, heath, pine, lowland, and agathis forests, respectively. Among the dominant species within each studied ecosystem type, the highest carbon content was found in pine species.

### **P-03-16: Comparison of Carbon Reserve of Mangrove Forests under Different Management Type in North Sumatra**

Ornizal<sup>1</sup>, Mashhor Mansor<sup>2</sup>; *1. Universitas Sumatera Utara, 2. Universiti Sains Malaysia*

Mangrove deforestation and degradation will be influence on the forest carbon stock and to be one of substantial factor of climate change. Indonesia has widest mangrove forest area in the world, however, these vital tropical ecosystems in the coastal zones to be under immense threat from variety human actions. The objective of this research was to estimate the carbon stock of mangrove forests under different management type in North Sumatra, such as conservation forests, village/community forests, and two types of production forests (with and without cutting for charcoal). We designed four sampling plots of 30m x 30m in each forest management system. All trees 5 cm at diameter at breast height (DBH) and above in sampling plot were identified and measured the DBH. The highest of carbon stock was found in village/community forests ( $78,387.54 \pm 43,307.93$  kg C/ha), and followed by conservation forests ( $22,393.84 \pm 9,542.12$  kg C/ha), production forests without cutting for charcoal ( $10,087.82 \pm 3,294.76$  kg C/ha), and the lowest of carbon stock was found in production forests with cutting for charcoal ( $2,474.30 \pm 2,216.41$  kg C/ha). The research result show that the mangrove forests under village/community forests is better than others forest management type within carbon reserve in North Sumatra. Therefore, the traditional wisdoms in mangrove forest management should be promoted to mitigate the climate changes.

### **P-03-17: Modelling Butterfly Distributions in Thailand in Relation to Current and Future Climate**

Sravut Klorvuttimontara; *University of York, Kasetsart University*

Studies of factors affecting species' distributions are currently lacking for most tropical regions, and more information is needed to aid conservation planning. Climate-envelope modelling of species' distributions is potentially a powerful tool for making use of incomplete distribution records in order to project potential distributions of species over much larger areas. I constructed a database of butterfly distribution records from existing documents. Across Thailand, distribution records were obtained for 827 species, of which 245 species were deemed to have sufficient quality and quantity of

records, and were used in subsequent distribution modelling. Species' potential distributions were modelled in relation to eight climatic variables, and for both current and future climate (A2 and B2 scenarios) using 'Maxent' niche modelling software. The distributions of 161 species were modelled successfully and used in further analysis. These models indicated that minimum monthly precipitation and a measure of seasonality (SD of mean monthly temperature) were most important in predicting butterfly distributions in Thailand. Currently, species richness is higher at mid to high elevation sites (> 500m), and models suggest that butterfly richness will decline across Thailand in future. The models also suggest that highest levels of species richness will shift to areas at higher elevation in future, and that mid-elevation areas will suffer the greatest loss of species. I conclude that the distribution of species is likely to change in future under global climate warming, and that overall species richness is predicted to decrease across Thailand, particularly at mid elevation. Thus, it is important to identify and protect those areas that are likely to maintain high diversity in future in order to ensure effective conservation management.

**P-03-18: Winter Carbon Assimilation of Evergreen Broadleaf Trees from a Montane Forest in the Tropical-Subtropical Transition Zone of SW China**

Zhang Yongjiang, Kunfang Cao, Guillermo Goldstein; *Xishuangbanna Tropical Botanical Garden, CAS*

Winter carbon assimilation of trees was well studied for boreal and Mediterranean forests, while little is known about the forests from tropical-subtropical transition zones and subtropical areas in East Asia. Forests in these areas are subject to seasonal low temperatures and probably seasonal water deficits. Evergreen broadleaf trees dominate the forests from elevation 1000 to 2600m in the tropical-subtropical transition zone and subtropical area of SW China, while forests in other parts of the world with similar latitude and elevation are characterized by deciduous trees (including SE China). In order to understand the eco-physiological mechanisms in explaining this unique pattern and the importance of winter carbon assimilation for evergreen broadleaf trees to establish dominance in montane forest in SW China, seasonal dynamics in photosynthesis of 10 evergreen broadleaf tree species from a montane forest in SW China (Mount Ailao) was studied. Environmental factors were monitored and plant water relations were also studied to reveal the underlying environmental and eco-physiological mechanisms. Although all the ten evergreen broadleaf trees studied down regulated photosynthetic capacity in winter, they could maintain considerably high carbon assimilation. The winter carbon assimilation made a significant contribution to the whole year carbon budget and the monthly carbon accumulation in winter was 60 to 70% of that in summer. During the winter, low temperature effects on photosynthesis were compensated by higher levels of incoming solar radiation. Low precipitation in winter was compensated by fog persistence and lowered evapotranspiration, and therefore trees did not experience water deficits in winter (predawn water potentials > -0.2MPa). The considerably high winter carbon assimilation of evergreen broadleaf trees in this area may convey advantages for them to establish dominance and allow these forests to sequester more carbon.

**P-03-19: Ecological Patterns along an Altitudinal Transect in NE Queensland Inform Projections of Climate Change Impacts on Rainforests**

David W. Hilbert, Dan Metcalfe, David Westcott; *CSIRO Sustainable Ecosystems*

We established twelve climate-change monitoring plots, from sea level to 1200m, in the rainforests of the Wet Tropics World Heritage areas in NE Queensland. Since their establishment in 2007 we have characterised their plant communities and forest structure, assessed how leaf-herbivory changes with altitude and measured the prevalence of avian haemoprotozoan diseases and their vectors. > Overall, the results show strong patterns in relation to altitude that are mostly driven by mean annual temperature. Forest basal area is negatively correlated with mean annual temperature, leaf-herbivory is positively correlated with temperature, mosquito diversity and abundance decline with altitude and haemoprotozoan infection in birds display a complex pattern but with infection rates lowest in the



higher altitudes. > These results suggest that global warming may affect rainforest by decreasing carbon stocks, increasing herbivory and increasing disease prevalence in native birds.

## Poster session: Plant physiology and anatomy (#04; July 22)

### P-04-1: Ions and Water Relations of Mangrove (*Avicennia marina*) along the Coast of the Arabian Gulf , Saudi Arabia

Suliman Al-Khateeb; *Environment and natural resources dept, King Faisal University*

Ions concentration and water relations of *Avicennia marina* were studied under natural condition along the coast of the Arabian Gulf , Saudi Arabia . eight trees were selected along 500 m transect of mangrove forest. Since leaves of *A. marina* have external salt glands hairs a comparison between the ion concentration of “leaf tissues” (leaf excluding salt glands) and leaves “leaf including salt glands” was done. The analysis of *A. marina* leaves in the present study shows that  $\text{Na}^+$  and  $\text{Cl}^-$  concentrations were much in excess of 200 mmol /m<sup>3</sup> in both expanding and expanded leaves. This result run the risks of an accumulation of these ions in the apoplast water in cell wall which could explain the lower turgor pressure reported in expanding leaves. A significantly increase in  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$  , and  $\text{K}^+$  is senescent leaf was noticed which run the risk of nutrient deficiency. However, the  $\text{K}^+$ ,  $\text{Ca}^{2+}$ , and  $\text{Mg}^{2+}$  concentrations of leaf tissues found in the present study, represent levels usually regarded as adequate for growth. The distribution of micronutrients (Fe, Zn, Mn) generally showed a gradual decrease in amounts from the roots to the leaves. In this study approximately 25% of the total salt content of the expanding leaves was sequestered into salt glands. Higher salt concentration in the rooting media of *A. marina* caused more negative values for leaf water and osmotic potential, increasingly so in expanding leaves and more negative during summer season.

### P-04-2: Of Water Slides, Waxy Walls and Toilet Bowls: Evolution of Trapping Strategies in Nepenthes Pitcher Plants

Ulrike Bauer, Walter Federle, Christofer Clemente, Charles Clarke, Jonathan Moran; *University of Cambridge*

The genus *Nepenthes* comprises more than 100 species of carnivorous pitcher plants that are the product of a recent and still ongoing diversification in tropical Southeast Asia. Trap morphology and prey spectrum vary substantially between species, indicating the presence of distinct trapping strategies. *Nepenthes* pitchers possess several adaptations for the trapping of insects, including a viscoelastic digestive fluid, slippery wax crystals and downward-pointing cells on the inner pitcher wall, as well as a superhydrophilic pitcher rim (peristome) which is only slippery when wet. While most species possess functional peristomes and downward-pointing cells, wax crystals are absent in a number of species, and viscoelastic pitchers fluids are rare. We investigated trapping strategies in two morphologically and physiologically distinct varieties of *N. rafflesiana* and found that one of them relies mainly on wax crystals while the other one uses mainly the peristome for prey capture. Using a comparative analysis of literature data and own measurements of pitcher geometry across the whole genus, we show that different trapping strategies are reflected in correlated functional adaptations of pitcher morphology. Species without a wax crystal layer on the inner pitcher wall had larger and more inwardly sloped peristomes. In contrast, peristome micromorphology showed little variation, indicating its structural significance for the trapping function of the peristome. Some species have even abandoned carnivory and evolved a mutualistic relationship with tree shrews that deposit their faeces in the pitchers. Prey specialisation and the use of alternative trapping strategies might provide a means for sympatric species to avoid competition for prey. Our results add to a growing body of evidence that selective pressures for nutrient resource partitioning have driven adaptive radiation in the genus *Nepenthes*, making it an ideal model system to study mechanisms of plant evolution.

**P-04-3: Water Use Characteristics of Homobaric and Heterobaric Leaf Species**

Yuta Inoue<sup>1</sup>, Kenzo Tanaka<sup>2</sup>, Tomoaki Ichie<sup>1</sup>; *1. United Graduate School of Agricultural Sciences, Ehime University, 2. Forestry and Forest Products Research Institute*

Tropical canopy species can be classified into two groups, heterobaric and homobaric leafed species (Kenzo et al. 2007). In this study, we investigated the relation between those leaf types and water use characteristics in canopy species of an aseasonal tropical rain forest in Lambir Hills National Park, Sarawak, Malaysia. Vessel diameter, leaf photosynthesis and leaf water use, including transpiration, stomatal conductance and leaf water potential, were measured in 20 canopy species (13 species with heterobaric leaves and 7 species with homobaric leaves). We had direct access to the canopy by tree towers and a crane system. Vessel diameter in heterobaric leaf species was significantly larger than in homobaric leaf species. Heterobaric leaf species also had significantly higher maximum rates of photosynthesis and transpiration, and larger diurnal variation of water potential (midday water potential variation against predawn water potential) than homobaric leaf species. In addition, there was a significantly positive correlation between vessel diameter and diurnal variation of water potential in all the studied species regardless of the leaf types. Therefore, our results suggest that morphological differences in heterobaric and homobaric leaf species are closely related with physiological characteristics of tropical trees even in the same habitat; heterobaric leaf species have large vessels and photosynthetic and transpiration abilities by efficient water supply with high water absorption abilities, whereas homobaric leaf species can maintain low water stress even during the midday due to low water use with small vessel diameter.

**P-04-4: Relationship between Leaf Flushing Phenology and Defensive Traits in Canopy Trees of Five Dipterocarp Species in a Tropical Rain Forest**

Aogu Y. Yoneyama<sup>1</sup>, Ichie T.<sup>2</sup>; *1. United Graduate School of Agricultural Sciences, 2. Faculty of Agriculture, Kochi University*

We investigated the relationship between leaf flushing phenology and defensive and photosynthetic traits, such as total phenolic and condensed tannin contents, leaf toughness, nitrogen content, photosynthetic rate at light saturation (P<sub>max</sub>) and LMA, in canopy trees of five dipterocarp species in a Malaysian tropical rain forest. Interspecific variations were observed in leaf flushing frequency, ranging from a continuous pattern to an occasional one. Total phenolic and condensed tannin contents as indicators of chemical defense significantly increased with leaf flushing frequency, whereas leaf toughness as an indicator of physical defense had no correlation with it. P<sub>max</sub> and nitrogen contents decreased significantly with increasing leaf flushing frequency, while LMA had no correlation with it. In addition, leaf herbivory rates significantly increased with leaf flushing frequency. There is a trade-off relation between the leaf defensive and photosynthetic traits related with leaf flushing patterns. Our results suggest that tropical canopy species have various defensive strategies against herbivore attack by regulating the intensity of chemical and phenological defenses.

**P-04-5: Spring Phenology of the Introduced Species in Response to the Extreme Chilliness in Xishuangbanna, China**

Junbin Zhao, Yiping Zhang, Fuqiang Song, Zaifu Xu, Laiyun Xiao; *Chinese Academy of Sciences*

Temperature is widely considered to be one of the most important factors impacting the spring phenophases, such as leaf flushing and flowering. However, different viewpoints still exist in the effect of the low temperature. Xishuangbanna (in China), which is located in the northern part of tropics, has a lower temperature than the equatorial tropical regions. Since 1959, the Xishuangbanna Tropical Botanical Garden (XTBG) here has introduced more than 40,000 tropical plant species for conservation from all over the world. And the low temperature here is proved to be a key factor that significantly impacts the growth of these plants. So the extreme chilliness took place in 1974 can be

quite a threat to them and also a test on their cold resistance. In this study, we compared the spring phenology (leaf flushing and flowering) of 43 introduced plants here in 1974 with it is in the regular years and evaluated their cold resistance by different origins (Asian tropics, American tropics and African tropics). Results show that 81% of the plants advanced their leaf flushing due to the rapid temperature rebound after the extreme chillness. At the same time, the chillness also caused non-flowering to 35% of the plants in 1974. Successful flushing after chillness represents a good vegetative cold resistance for all the species; however, the progenitive phenophase is more adversely impacted by the chillness. According to the performances of their spring phenology, species from Asian tropics are best cold resisted with the highest species percentage of flowering (83%) and the least shifts in the phenological durations after the chillness. Species from American tropics are followed. African species are the worst. Hence, species from Asian tropics should be firstly considered for ex-situ conservations in Xishuangbanna and African species must be carefully introduced.

**P-04-6: Canopy Stratum Affect and Breaking Seed Dormancy Methods on *Calliandra tetragona* Benth. and *Acacia tamarindifolia* (L.) Willd. as Bio-Energy Resources**

Ekasari I. Tjokrodimulyo; 1. Cibodas Botanical Garden – LIPI

Some factors were influenced the seedling growth such as a canopy strata for seed procurement and methods of breaking seed dormancy. Choosing *Kaliandra* (*Calliandra tetragona* Benth.) and *Akasia* (*Acacia tamarindifolia* (L.) Willd.) species was based on their function as pioneer species, fuel wood and forage production. The aims on this study were to determine tree canopy stratum position to collect the fruits and to examine methods of breaking seed dormancy on *Kaliandra* and *Akasia* seedlings growth as bio-energy resources. The study was located at Cibodas Botanic Garden for 4 months. The experiment applied two stratified tree canopy to collect the seed were upper and lower. The methods of breaking seed dormancy were control, physical and mechanical. In each treatment of seedling growth a combination of stratified tree canopy and methods of breaking seed dormancy was employed. The experiment was laid out using completely randomized designs. Each combination of treatment consisted of 100 seeds but only 20 seedlings were measured. One way ANOVA was used to measure the seedling parameters of shoots and root length. The upper strata canopy of seed procurement and mechanical breaking seed dormancy has the highest affect for *Kaliandra*'s seed viability. The highest percentage seed viability on *Akasia*'s seed showed for seed procurement from upper canopy and control breaking seed dormancy. The result for shoots growth interaction among stratified tree canopy treatment, methods of breaking seed dormancy and species had significance effect on level 5%. The result for root growth was significance on level 5% along interaction between stratified tree canopy treatment and species. And also interaction between methods of breaking seed dormancy and species was significance on level 1%. Keywords: Canopy Stratum, Breaking Seed Dormancy, Seedling Growth.

**P-04-7: Functional Explanations for Variation in the Bark Thickness of Tropical Trees**

C.E. Timothy Paine<sup>1</sup>, Clement Stahl<sup>2</sup>, Elodie Courtois<sup>1</sup>, Sandra Patiño<sup>1</sup>, Carolina Sarmiento, Chris Baraloto; 1. *Universität Zurich*, 2. *INRA, UMR Ecologie des Forêts de Guyane*

Tree bark is a salient but little-understood component of tropical forests. We surveyed bark thickness within and among species of trees in the tropical rain forests of French Guiana. Bark thickness increased dramatically with individual stature, and varied at all taxonomic levels. Mean bark thickness was 4.5 mm (range: 0.5 – 29 mm). Since tree survival through fire is strongly predicted by bark thickness, our survey should aid in refining mechanistic models of land-cover change in the face of global climate change. Tree bark is hypothesized to perform multiple functions, including defence against abiotic and biotic threats as well as structural support. Thick bark might, however, limit respiration by living tissues of the trunk. Nevertheless, no study, to the best of our knowledge, has tested multiple hypotheses to explain variation in bark thickness. We combined our survey data with multiple other datasets to test several functional hypotheses proposed to explain variation in bark

thickness. We found bark to provide an average of 10% of the flexural rigidity of tree stems, which was substantially less than that found in the only other study of bark stiffness. For species that range into fire-prone habitats, there was a significant, though weak, relationship between bark thickness and the degree of their association with fire-prone habitats. There was no evidence that bark thickness is affected by its function as a defence against herbivory. Nor was there evidence that thick bark limits trunk respiration. A re-analysis of previously collected anatomical data indicated that variation in rhytidome (non-conducting outer bark) thickness explains much of the variation in overall bark thickness. The positive correlations between bark thickness and the fire-association index, and between rhytidome thickness and overall bark thickness, suggest that defence is the function that most strongly shapes variation in bark thickness.

**P-04-8: Leaf Water Repellency: Relationship with Leaf Mass per Area, Vapor Pressure Deficit and Crown Exposure in a Lowland and a Montane Tropical Rain Forest**

Bruno H.P. Rosado, Rafael S. Oliveira, Marcos P.M. Aidar; *UNICAMP*

Environmental conditions can have major influences in shaping biophysical properties of leaf surfaces. In moist environments, high leaf water repellency (LWR) is expected because the presence of a water film on leaf surfaces can block stomatal pores, reduce the diffusion of CO<sub>2</sub>, promote pathogen incidence, colonization of epiphylls and leaching of leaf nutrients. However, LWR can also increase in dry environments as a consequence of higher epicuticular wax deposition induced by high temperatures, high radiation loads and vapor pressure deficits what could also lead to a high leaf mass per area (LMA). The aim of this study was to determine how LWR vary across tropical trees with contrasting crown exposures and submitted to distinct vapor pressure deficits in two different sites in the Atlantic Rain Forest. We hypothesized that (i) LWR will be higher in overstorey species because they are submitted to direct radiation and high vapor pressure deficit; (ii) At the Montane Forest, LWR will be higher for overstorey species in comparison to those in Lowland Forest because radiation and VPD increases with altitude; (iii) Overstorey species will also show higher LMA in response to exposition to drier conditions. We measured LWR by observing leaf angles in adaxial and abaxial surfaces in five species co-occurring in both forests. LWR were positively related to LMA, crown exposure and VPD in both sites. LWR was significantly higher at the Montane forest (mean angle = 66.25°) than at the Lowland forest (mean angle = 61.33°). We suggest that atmospherical conditions associated with contrasting crown exposures may exert important controls over leaf surface properties involved in the repellency or direct absorption of water.

**P-04-9: Comparative Analysis of the Transcriptomes of Mangroves and the Implications for Conservation**

Suhua Shi, Yelin Huang; *Sun Yat-sen University*

Mangroves occupy a common, extremely challenging and variable habitat. However, they are by no means behaviorally or physiologically homogeneous. With respect to salt handling, for example, the physiological strategies range from salt excreters (e.g. *Aegiceras*), to salt regulators (e.g. *Ceriops*), and to hyper-excluders (e.g. *Heritiera*). The genetic basis underlying these adaptations is also unknown. Based on advances in next-generation sequencing technology, we present here the comparative transcriptome analysis for plants which no prior genomic information was available. We selected six representative mangroves *Ceriops tagal* (Rhizophoraceae), *Sonneratia alba*, *S. caseolaria* (Lythraceae), *Lumnitzera racemosa* (Combretaceae), *Aegiceras corniculata* (Myrsinaceae) and *Hibiscus tiliaceus* (Malvaceae) as ecologically important extremophiles employing markedly different physiological and life-history strategies for survival and dominance in this extreme environment. The sequences obtained in this study represent a large dataset of expressed genes in mangrove species. After removing low-quality sequence reads, 6-8 million paired-end reads of each species were retained. A total of 23,000-34,000 unique sequences (contigs) of each species were used for annotations and further analysis. On average, 70-80 percent of the unique sequences of each species showed significant similarity to existing proteins in the NCBI database. Our goal is to mine the

transcriptome database for indications of a mangrove-specific transcript complement that might reflect their evolutionary convergence. Such convergence implies adaptive changes by which distantly related entities appear more related than they are. This study provides information to questions regarding mangroves. Our study has revealed that next-generation DNA sequencing technologies can be used for de novo sequencing of plant transcriptomes.

**P-04-10: Shifts in Moss Carbon Isotope Composition across an Elevation and Soil Age Matrix on Mauna Loa, Hawaii: do Mosses Behave Like Vascular Plants?**

Mashuri Waite<sup>1</sup>, Lawren Sack<sup>2</sup>; 1. *University of Hawaii*, 2. *University of California, Los Angeles*

The carbon isotope composition ( $\delta^{13}\text{C}$ ) of vascular plant leaf tissue is determined by carbon isotope discrimination, primarily mediated by stomatal and mesophyll diffusion resistances and by photosynthetic rate. These effects lead to predictable trends in leaf  $\delta^{13}\text{C}$  across natural gradients of elevation, irradiance and nutrient supply. Less is known about carbon isotope discrimination and composition in bryophytes which lack stomata and thus lack active control over  $\text{CO}_2$  diffusion. Twelve bryophyte species were sampled across a matrix of elevation and soil ages on Mauna Loa, Hawaii Island. We tested hypotheses based on previous findings for vascular plants: greater  $\delta^{13}\text{C}$  at higher elevation, irradiance, and for leaves with higher leaf mass per area (LMA). Across the matrix, bryophytes spanned the range of  $\delta^{13}\text{C}$  values typical of  $\text{C}_3$  vascular plants. Bryophytes were remarkably similar to vascular plants in exhibiting greater  $\delta^{13}\text{C}$  with increasing elevation, and irradiance; additionally  $\delta^{13}\text{C}$  was related to canopy projected mass per area (CMA), an analogous trait to LMA in vascular plants. The linkage of  $\delta^{13}\text{C}$  with CMA was apparently mediated by habitat irradiance, as both traits were strongly correlated with canopy openness. The similarity of responses of  $\delta^{13}\text{C}$  in bryophytes and vascular plants to environmental factors suggests conservation or convergence in physiological mechanisms despite differing morphologies and diffusion pathways, especially pointing to a strong role of photosynthetic rate in determining  $\delta^{13}\text{C}$ .

**P-04-11: Molecular Cytometry for Characterization of Plant Biodiversity**

David W. Galbraith; *University of Arizona*

2010 has been declared the UN International Year of Biodiversity. It is clear that the survival of the human race depends entirely on biological diversity and our understanding of how to manipulate this diversity. Preparing a complete inventory of existing eukaryotic species now takes on particular urgency, since we have taxonomic names for only 14% of an estimated 12 million species, since we know little about those identified, and since, yearly, thousands of species become extinct. Molecular cytometry has a key role to play in providing an inventory of existing and undiscovered species, and in providing a detailed molecular understanding of them. Two properties of organisms can be accessed using cytometric techniques: flow cytometry to determine genome sizes, and NextGeneration and Gen3 DNA sequencing to define the genome information content. Further development of these platforms envisages unprecedented accumulation of information at very reasonable costs. We are exploring application of these cytometric techniques to provide an inventory of the estimated 500,000 species of flowering plants. Flow cytometry provides a rapid means to characterize the genome sizes of plants over the entire range of C-values for which information exists. The methods are compatible with plants of disparate form, phenotype, growth habit, and storage location. NextGeneration short-read sequencing provides a cost-effective wealth of information that can be directly employed for taxonomic and phylogenetic purposes, and will identify valuable variation for agricultural improvement. Reductions in platform costs and increases in information output should allow us to provide a complete inventory of the flowering plants within a three year period. This will require unprecedented international cooperation, as well as local taxonomic expertise. Given the urgent need to achieve this inventory, allocation of resources toward this goal should be a top priority for funding agencies.

**P-04-12: Factors Involved in Species Success in a Tropical Subdeciduous Forest**

Paula C. Jackson<sup>1</sup>, Jose Luis Andrade<sup>2</sup>, Casandra Reyes Garcia<sup>1</sup>, Olivia Hernandez<sup>1</sup>, Thomas McElroy, and Juan Manuel Dupuy; *1. Kennesaw State University, 2. Centro de Investigación Científica de Yucatán*

We studied potential differences in the physiology and ecology of juvenile trees from three species that differ in abundance, and were growing in plots of different successional age (~15 and 60 years since disturbance) in a tropical subdeciduous forest of Mexico (Biocultural Reserve Kaxil Kiuic in Yucatan, Mexico). Physiological differences (photosynthetic rate, quantum yield, and water potential) as well as population dynamics (recruitment and mortality from seedling to juvenile) were determined for the species: *Piscidia piscipula* L.(Sarg.) (Fabaceae), *Bunchosia swartziana* Griseb. (Malpighiaceae), and *Psidium sartorianum* (Bergius) Nied. (Myrtaceae). Light curves (using a Licor 6400 photosynthesis system and separately a fluorometer: Mini PAM Heinz Walz GmbH) were determined for 5 individuals of each species in each plot, as well as predawn and mid day water potentials (using a psychrometric chamber C-30 and Wescor HR33 micro voltmeter) over the dry (May 2008) and rainy (July 2009) seasons. For most parameters we found differences among species, seasons, and plots. Among species, *Piscidia piscipula* tended to have the highest mean photosynthetic rates. In the dry season, all species exhibited higher mean maximum photosynthetic rates in the younger plot (15 years of secondary succession); however this was not the case in the rainy season. One of the species (*Bunchosia swartziana*) presented higher mean maximum rates in the older plot (60 years) in the rainy season. Our data suggest differences among species in physiological strategies to deal with drought, and that the capacity to regenerate may play a more important role in the success of a species in this tropical forest.

**P-04-13: Response of Shoot and Root Growth of *Jatropha* Accessions to Rocky and Heavy Soil as Determinant Factor for Rootstock Screening**

Hamim , Miftahudin , Andeng; *Biology, Bogor Agricultural University*

Grafting is one alternative method to improve productivity, disease resistance and adaptability to marginal land of plants including *Jatropha curcas* by combining two distinct accessions. To support this program, the selection of *Jatropha* rootstock with good characteristics in rooting system is required. The aim of the study was to observe the response of shoot and root growth of 11 *Jatropha* accessions to rocky and heavy soil. The experiment was carried out in 12 Kg polybag designed as a Completely Randomized Design with two factors. The first factor was the type of media, including organic-sandy soil as control (M0), rocky soil (M1), and heavy soil (M2). The second factor was the varieties of the *Jatropha* accessions collected from many area in Indonesia (coded by S1, S2, S3, J1, J2, J3, B1, B2, B3, T, and JB accession). To determine the best *Jatropha* rootstocks, Principle Component Analysis (PCA) was employed based on all growth parameters. The results showed that all parameters were significantly influenced by the media, where the plants grown on M0 showed growth characteristics better than that of M1 and M2. The rocky soil (M1) reduced all growth parameters more than heavy soil (M2), except in parameter of secondary root characters. Meanwhile there were variations among accessions in response to the obtained media. Only root dry weight parameter that was influenced by interaction of both factors. Based on PCA analysis the accessions of S2, J3, J2 and S1 were the best rootstock candidates for rocky as well as heavy soil.

**P-04-14: Photosystem II is More Sensitive to Chilling and Light Stress than Photosystem I in Tropical Tree Species**

Wei Huang, Shi-Bao Zhang, Kun-Fang Cao; *Xishuangbanna Tropical Botanical Garden*

Tropical plants are sensitive to chilling temperatures above zero but it is still unclear whether photosystem I (PSI) or photosystem II (PSII) of tropical plants is mainly affected by chilling temperatures. In this study, the effect of 4 °C associated with various light densities on PSII and PSI were studied in the potted seedlings of four tropical evergreen tree species grown in an open field,

Khaya ivorensis, Pometia tomentosa, Dalbergia odorifera and Erythrophleum guineense. After 8 h chilling exposure at the different photon flux densities of 20, 50, 100, 150  $\mu\text{mol m}^{-2} \text{s}^{-1}$ , the maximum quantum yield of PSII (Fv/Fm) in all of the four species decreased little, while the quantity of efficient PSI complex (Pm) remained stable in all species except E. guineense. However, after chilling exposure under 250  $\mu\text{mol m}^{-2} \text{s}^{-1}$  for 24 h, Fv/Fm was severely photo-inhibited in all species whereas Pm was relative stable in all plants except E. guineense. At the chilling temperature of 4 °C, electron transport from PSII to PSI was blocked because of excessive reduction of primary electron acceptor of PSII. Fv/Fm in these species except E. guineense recovered to ~ 90% after 8 h recovery in low light, suggesting the dependence of the recovery of PSII on moderate PSI and/or PS II activity. These results suggest that PSII is more sensitive to chilling temperature under the moderate light than PSI in tropical trees, and the photoinhibition of PSII and closure of PSII reaction centers can serve to protect PSI.

## Poster session: Marine biology (#05; July 20)

### P-05-1: Distribution and Concentration Several Types of Heavy Metal Correlated with Diversity and Abundance of Microalgae at Tallo River, Makassar, South Sulawesi

N. Rukminasari<sup>1</sup>, Sahabuddin<sup>2</sup>; *1. Marine Science and Fisheries Faculty, Hasanuddin University, Indonesia, 2. Fisheries and Backishwater Research Center, Maros, Indonesia*

The main problem of aquatic ecosystem is caused by pollution of heavy metal that comes from industrial disposal and domestic. This pollution is causing loss of biodiversity, also increasing of bioaccumulation and biomagnifications from the poisonous materials at the food web. There are some technique to lessen and eliminate content of heavy metal at waste industry and domestic, such as evaporation alkaline, ion transfer, disposal in chemistry and technology membrane and filtration. But all techniques have some limitations, for example: harmful metal ion stream from treatment, materials organic that often pursue process, low of process efficiency at low heavy metal concentration. Biotechnology bases action from microalgae growth in active can eliminate limitations from technology previously. Through this technology, microalgae as a bioremediation agent to absorb heavy metal in the water consequently can reduce heavy metal concentration in the water. The aims of this research are: 1. Determine concentration of existing heavy metal Tallo River ecosystem, 2. Identify microalgae dominant from Tallo River ecosystem where have polluted by several type of heavy metal. The results showed that there were three heavy metals at Tallo River which have a high concentration and above permissible maximum concentration of environment quality standard, such as Lead (Pb), Copper (Cu) and Chromium (Cr). Those heavy metals were distributed patchily between station sampling. The highest concentrations of those heavy metals were found close to the industrial location of the Tallo River. Statistical result showed that there was a significant different of heavy metal concentration between sampling stations. Statistically, concentration all of heavy metal measured was higher at sediment than in the water column. Only four genera found during sampling. Skeletonema sp and Synedra sp were abundance at all sites of the research location. However, there is a weak regression between abundance of microalgae, species dominant and concentration of heavy metal (Pb, Cu and Cd) in the sediment and water column. Keyword: Microalgae, heavy metal and Tallo River ecosystem

### P-05-2: Benthic Food Web Structure in the Segara Anakan Lagoon, Java, Indonesia

Carolin M. Herbon, Inga Nordhaus; *Center for Marine Tropical Ecology*

Segara Anakan, a mangrove fringed lagoon in south central Java, is strongly influenced by anthropogenic activities and related environmental factors, providing a highly variable system. In order to investigate the benthic food web, 14 abundant species of four systematic groups, leaves of four mangrove species and sediment were sampled in the intertidal area of four stations in the lagoon.

Samples were analysed for organic carbon and total nitrogen and stable carbon ( $\delta^{13}\text{C}_{\text{org}}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) isotope composition. Isotopic signatures in crab species did not vary between genders, but tissues (hepatopancreas, stomach content and muscle) showed significant differences. Animal tissues, leaves and sediment stable isotope values varied highly between stations. Leaves ranged between 1.9‰ and 7.1‰ for  $\delta^{15}\text{N}$  and -29.9‰ and -27.5‰ for  $\delta^{13}\text{C}_{\text{org}}$ .  $\delta^{15}\text{N}$  of invertebrate muscle tissue ranged between 7.6‰ and 17.1‰ in medium trophic levels and  $\delta^{13}\text{C}_{\text{org}}$  between -25.2‰ and -18.7‰. The crabs *Scylla serrata*, *Epixanthus dentatus* and *Episesarma versicolor* belong to the highest trophic level as inferred from the high  $\delta^{15}\text{N}$  of their muscle tissue (15.3‰). The gastropod *Telescopium telescopium*, assumed to be a grazer, is also at the top of the benthic food web and feeds on more nutritious diets, most likely dead organisms.  $\delta^{13}\text{C}_{\text{org}}$  of muscle tissue of crabs, assumed to be herbivorous, and stomach content analysis indicate that leaves are not their predominant carbon source. These crabs have a much more diverse diet, including polychaetes, fish, sediment, algae and leaves, depending on availability at each station. Our data suggest four trophic levels regarding the examined species. Single species show similar occurrence in trophic levels in all stations, but actual isotopic signatures depend highly on stations as well as food availability. Environmental factors, such as nutrient availability in lagoon water, also seem to influence food web structure.

### **P-05-3: Monitoring Structural Mangrove Forests Over Time (2001-2010)**

Marilia Cunha-Lignon<sup>1</sup>, Ricardo Palamar Menghini<sup>2</sup>, Renato de Almeida<sup>1</sup>, Clemente Jr. Coelho<sup>1</sup>, Yara Schaeffer-Novelli; Gilberto Cintron; Milton Mampel and Farid dahdouh-Guebas; *1. Université Libre de Bruxelles, 2. Instituto BiomaBrasil*

Mangroves occupy geomorphologically active estuarine settings but many studies have focused on short-term. Static views fail to capture the wholeness of these systems and could lead to failed conservation policies or management guidelines. These wetlands are of critical interest to resource managers because of their productivity, economic, and ecological roles. This paper describes the structural, temporal dynamics of forests at the Cananéia-Iguape Coastal System, located along the south coast of São Paulo State (Brazil), between latitudes 24°40'S and 25°20'S where three mangrove species occur in within different depositional facies: *Rhizophora mangle* (Rhizophoraceae); *Laguncularia racemosa* (Combretaceae); *Avicennia schaueriana* (Acanthaceae/Avicenniaceae). Monitoring was done in January/2001, November/2002, May/2003, November/2003, May/2004, November/2004, July/2008, January/2009, July/2009 and January/2010. In each of 15 plots in total, all plants were identified, and tree diameter and average height were recorded. Mean tree diameter, basal area dominance, and stem density were assessed. The forest's succession revealed three distinct stages of development with increasing diameter and mean height: 1. colonization; 2. young; and 3. mature. Where tidal energy dominates, the initial and young stages were dominated by *Laguncularia racemosa* (96-100%) and mature stages by *Avicennia schaueriana* (75-92%). Where fluvial energy dominates, *Rhizophora mangle* dominated in all stages. Sedimentary and hydrological conditions are essential in defining which typical mangrove forest species will colonize accretion areas and how zonation and succession will be manifested. Monitoring structural characteristics over time helps to understand processes involved the differentiation of the landscape. The analysis of historical satellite images allows the assessment of processes at higher hierarchical levels and the relations between morphogenetic and ecological views.

### **P-05-4: The Benthic Mollusk Dominancy, *Turbo* sp. on the Rocky Shores of Way Muli Coastal Village, South Lampung**

Made S.Y Lestari Harta, Made L. Harta ; *Department of Biology, University of Indonesia*

The study of *Turbo* sp. diversity (Turbinidae) was carried out on 16-29th Desember 2009 at the rocky shores of Way Muli coastal village and data was taken between 9 a.m. – 5 p.m. local time. Location examined are rocky shore on the southern part of the Sumatera Island directly toward The Indian Ocean and in consequence there were abundance mollusk nearby sea shore. There was significant



dominancy of *Turbo* sp. compared with other benthic mollusk relative abundance. Research data were determine by using visual quadrat technique with 30m length transect path and the quadrat of 40cm x 40cm. The data then calculated and analyzed by using The Simpson Dominance Index. About 8 mollusk species and contain with 7 families were found in the are. The Simpson Dominance Index shows the highest species dominancy ( $C=1,984$ ) is possessed by *Turbo* sp.. Due to the climate change effect and coastal inhabitant threat that used those abundance mollusk as their daily dietary consumption, might cause the degraded value of those benthic mollusk.

#### **P-05-5: Seagrass Diversity of Northern Papua, Indonesia**

Rosye Tanjung, Ani Y. Waromi, *Department of Biology, Cenderawasih University*

Study on diversity of Seagrass community of Northern Papua was carried out at three loations, which are Hamady Tanjung and Demta of Jayapura and Padaido of Biak Numfor . The aimed of this study was to examine the composition and structure of seagrass community of the area selected. Transect method was used in this study and data collected was analyzed quantitatively for each location. The species found in the field at all locations were belonging to family Patamogenaceae and Hydrocaritaceae. Ten species of seagrasses were found at Hamadi. Two dominant species at Hamadi were *Thalassia hemprichii* (IV: 46.31) and *Halophila spinolusa* (IV: 29, 28). Eight species was found at Padaido with two dominant species were *Thalassia hemprichii* (IV: 60.73) and *Cymodocea serrulata* (IV: 49.25) and seven species at Demta with two dominant species were *Enhalus acoroides* (IV: 66.99) and *Thalassia hemprichii* (IV: 57.88). *Thalassia hemprichii* was appeared as common species at all selected locations. Based on type on substrate, three different substrates were found at Hamadi and Padaido sites, whereas only two type of substrate were found at Demta site. From this study can be concluded that Northern Papua has diverse of seagrass species. It was observed in the field that seagrass damage mostly caused by human activity such as transportation and fishing activities. Considering the important role of seagrass ecosystem, it is very important to protect and conserve seagrass ecosystem from damage and pollution as result of human activities. Keywords: seagrass, diversity, Northern Papua

#### **P-05-6: The Comparative Fingerprint Analysis for Seven Mangrove Species Distributed in the Indo West Pacific (IWP)**

Yelin Huang<sup>1</sup>, Fengxiao Tan<sup>2</sup>, Guohua Su<sup>1</sup>, Shulin Deng<sup>1</sup>, Zhihong Zhang, Shuguang Jian, Suhua Shi; *1. Sun Yat-Sen University, 2. South China Agricultural University*

Unlike terrestrial systems, very little effort has been made to integrate an understanding of intraspecific variation within a variety of mangrove species in predictions of mangrove ecosystem functioning. In this study, we present the comparative fingerprint analysis for seven mangrove species which are widely distributed in the Indo West Pacific (IWP). We selected five true mangroves species including *Ceriops tagal*, *C. decandra* (Rhizophoraceae), *Lumnitzera racemosa*, *L. littorea* (Combretaceae), *Aegiceras corniculata* (Myrsinaceae); and two mangrove associates including *Excoecaria agallocha* (Euphorbiaceae) and *Heritiera littoralis* (Sterculiaceae). Genetic diversity of the seven species was screened in 15-30 populations using ISSR or AFLP. Our results showed a relatively high level of genetic variation at the species level ( $He = 0.240-0.294$ ) in most widely-distributed mangrove species, except *C. tagal* ( $He = 0.118$ ). The values of  $Gst$  range from 0.437 to 0.897, suggesting significant genetic differentiation among populations, while mangrove associates showed relatively lower  $Gst$  compared to true mangrove. At the population level, however, genetic diversity was low ( $He = 0.023-0.156$ ). Likely, mangrove associates showed relatively higher genetic variation at the population level compared to true mangrove. Cluster analysis identified three major geographical groups in correspond to the East Indian Ocean, South China Sea, and North Australia in both *Ceriops* and *Lumnitzera*, although no clear phylogeographic pattern were observed in other species. Analysis of molecular variance (AMOVA) indicated that more than half the total variation was partitioned among populations in all five true mangroves. In contrast, the partition of genetic variance for two mangrove associates was greater within populations than among populations. Our

study suggested that interpretation of the effects of globe climate change on mangrove species require a case by case study.

**P-05-7: Canopy Insect Herbivores in Mangroves: Terrestrial Diversity Plays a Key Role in a Marine Environment**

Damien Burrows; *James Cook University*

Mangroves are traditionally viewed as marine ecosystems and as such the diversity and ecological role of insects in these habitats has been underrated. However, even terrestrial canopy insects can be key elements of mangrove diversity and productivity. This study shows that the diversity of canopy herbivores in mangroves is similar to that of many other trees in adjoining terrestrial environments and that the mangrove insect fauna is quite distinct and specialised. Insect leaf herbivory rates are also comparable to terrestrial forests, countering paradigms that mangroves leaves are less damaged than leaves of other trees. Loss of leaf material to the forest floor through premature abscission of insect-damaged leaves (mostly young leaves which also have higher nutrient concentration) can be as great as that actually consumed by insects in the canopy. Thus herbivory promotes aseasonal leaf fall for benthic consumers and food chains as well as altering the quality of leaf fall and the pattern of nutrient return to the forest floor. Over half the leaf production of *Avicennia marina* may be impacted by insect herbivores. On *Rhizophora stylosa*, insect-induced loss of pre-emergent leaves was greater than rates of damage to emerged leaves. Damage to the apical tips also restricts leaf production and shoot extension but promotes lateral shoots, thus altering both leaf production and tree/canopy architecture. In some *R. stylosa* stands, wood-boring insects caused greater leaf loss than herbivores and leaf-feeding insects were the major cause of woody shoot death, demonstrating the varying mechanisms through which insects can impact upon mangrove trees. Herbivorous canopy insects can play major roles in mangrove tree growth, architecture and ecosystem functioning. These attributes can also be used in assisting restoration programs.

**P-05-8: The Effects of Light and pH on the Stabilization of Chlorophyll Pigment of Seagrass (*Thalasia hemprichii*) in the Several Depth of the Bandengan Sea, J**

Lisiard Dimara; *Biology Department Faculty of Math and Science UNC*

In vivo study was conducted to identity chlorophyll content of the seagrass *Thalasia hemprichii* that purchased from sea water environment in different of deeps. Furthermore the stability of chlorophyll was characterized by using 1300 lux of red light, 1600 lux of daylight and pH at. Minolta SPAD-502 Chlorophyllmeter data showed that chlorophyll content average of the seagrass *Thalasia hemprichii* at 1 up to 3 meter from water surface was 17,45 spad/cm<sup>2</sup>. The result of the stability test using UV-Vis spectrophotometer on a cuvet (1 cm) of chlorophyll in Qy region showed that the chlorophyll not stable under treatment of red light and daylight. Rate of chlorophyll degradation under red light in 8 hours and daylight in 7 hours were hourly 6,9 % and 20,4 %, respectively. Furthermore, the chlorophyll was not stable under sour pH at 1, 3 and 5, and not stable too under wet pH at 9, 11 and 13. Key words: Light, pH, Stability, Chlorophyll, Seagrass *Thalasia hemprichii*

**P-05-9: Ecological Status of Seagrass Communities at Leuweung Sancang Nature Reserve, West Java, Indonesia**

Susi Rahmawati, Devi N. Choesin; *Institut Teknologi Bandung*

The seagrass meadow is a coastal marine ecosystem with important biodiversity and ecological function. The occurrence of seagrass species is strongly related to the unique physical and chemical environment of the coastal area. Projected impacts of climate change, however, has become a potential threat to the sustainability of these ecosystems. In view of this, information on seagrass species diversity, community structure, and ecological function becomes an important prerequisite to effective management and conservation. A study was conducted on the diversity and biomass of

seagrass at Leuweung Sancang Nature Reserve, West Java. Data were collected along three cross-transects each measuring 50 meters, placed at near, middle, and offshore distances. Twelve plots measuring 25x25 cm<sup>2</sup> were placed randomly along the transects. Two main species of seagrass were found at Cikolomberan site, i.e., *Cymodocea rotundata* and *Thalassia hemprichii*, with the former being the dominant species. Distribution and biomass of the two species varied among transects: *C. rotundata* was found more widespread at mid-distances from the shore, whereas *T. hemprichii* exhibited the highest density near the shore. Biomass for *C. rotundata* and *T. hemprichii* respectively measured 19.4 g DW m<sup>-2</sup> and 18.5 g DW m<sup>-2</sup>. Seagrass community structure is discussed in relation to physicochemical conditions (e.g., water quality) and implications for conservation. Keyword:, *Cymodocea rotundata*, *Thalassia hemprichii*, Seagrass

**P-05-10: Ecological Assessment of Coral Reef Bleaching Impacts and Recovery Trends at Koh Tao, the Gulf of Thailand**

Thamasak Yeemin, Makamas Sutthacheep , Sittiporn Pensakun , Wanlaya Klinthong , Kanwara Saengmanee, Pitakphong Suantha; *1. Ramkhamhaeng University, Thailand*

Long-term ecological assessment of a coral community at Ao Tian, Koh Tao, Suratthani Province, in the Gulf of Thailand has been carried out since 1988. The first survey in 1988 showed that branching *Acropora* covered nearly 100%. A strong typhoon “Gay” hit southern Thailand in 1989 and caused significant damage to the coral communities. Live coral coverage at the study site declined to about 55% and there was a recovery trend. However the severe coral reef bleaching phenomenon in 1998 caused coral reef degradation in a large area of the Gulf of Thailand, especially at Koh Tao. Most branching *Acropora* died after the bleaching. The coral reef monitoring program in 2010 observed only 3% of live coral coverage, mostly small colonies (about 10 cm in diameter) of *Pocillopora damicornis*. The coral reef substrate was mainly coral rubble (88%). Macroalgae, especially *Turbinaria* spp. were abundant on the coral rubble. An average density of juvenile coral colonies was 0.6 colony/m<sup>2</sup> and most of them were also *Pocillopora damicornis*. The results clearly showed that coral recruitment rates on the coral rubble were very low however the coral community had sources of coral larval supply. As Koh Tao is a popular diving destination, we may need engineering designs for coral reef restoration in order to increase survival rate of juvenile coral colonies and to accelerate coral recovery.

**P-05-11: Coral Reef Health Assessment at an Intensive Diving Spot of Koh Rawi, Tarutao National Park, the Andaman Sea**

Makamas Sutthacheep, Thamasak Yeemin , Chaipichit Saenghaisuk , Watcharachai Donsomjit , Panatchakron Sangkum; *Ramkhamhaeng University, Thailand*

Tarutao National Park is located in Satun Province. There are 51 islands in the park archipelago which lie in the Andaman Sea, from 20-70 km. off the extreme southwest coast of peninsular Thailand. Tarutao and Adang-Rawi islands were declared as a national park in 1974, Thailand's second marine national park. The coral reef area in Tarutao National Park is approximately 14 km<sup>2</sup>. Assessment of coral reef health at an intensive diving site in Tarutao National Park, Haadsaikhaw of Koh Rawi, was carried out during 2009 – 2010. Partial mortality of coral colonies was recorded in 2x100 m. belt transects. Causes of partial mortality on coral colonies were also identified. The results showed that live coral coverage was 74% but healthy coral colonies were around 15%. The dominant coral species were *Acropora formosa*, *Lobophyllia hemprichii* and *Porites lutea*. Partial mortality on coral colonies caused by borers, grazers and parrotfish were frequently observed. The appearances of pink spots in *Porites lutea* and white bands in *Acropora formosa* were also documented. Long-term monitoring programs should be effectively implemented at the coral reef site in order to examine degradation trends or natural recovery processes. The coral reef management action plan should also focus on alleviating the impacts of tourism activities and land-based pollution in order to cope with impacts of climate change.

**P-05-12: Feeding and Reproduction of Fish in a Brazilian Estuary**

Ana L. Vendel, Adna F. Silva, Fernando R. Queiroga, Tayná O. Martins, Jéssica Golzio, Raphaela B. Santos ; *UEPB*

Qualitative and quantitative analysis of natural feeding and gonad condition in fish provide information about its physiological state, which is conditioned by the interaction of biotic and abiotic factors. However, these conditions could fluctuate and be influenced by both exogenous seasonal factors, such as food availability and distribution of rainfall, like by endogenous, linked to the stage of life cycle and reproduction of individuals studied. The feeding and breeding of fish in estuarine areas have been known to contribute to the species and local management, especially when dealing with species of commercial interest or artisanal fishing site. Such research means an important tool in understanding the complex trophic interactions, temporal and spatial variations, ontogenetic and sexual biology of estuarine species. Besides being an important tool for fisheries management and conservation of fish species and mangrove. This work aims to perform an auto-ecological study, from the standpoint of feeding and reproduction of abundant resident and migratory species in Paraíba do Norte estuary, Paraíba State, Brazil. Therefore, in the course of a year in monthly collections, the fish caught were identified and measured for further analysis of feeding and reproductive aspects such as length at first sexual maturity, spawning type and period of greatest reproductive intensity. In this sense, 10 species were studied: *Aspistor parkeri* and *Sciades herzbergii*, *Centropomus parallelus* and *C. undecimalis*, *Bathygobius soporator* and *Gobionellus oceanicus*, *Achirus lienatus*, *A. declivis* and *Trinectes paulistanus*, *Sphoeroides testudineus*. These fish assemblages were characterized in terms of: spatial and temporal distribution, abundance, feeding habits, sex ratio, reproductive period and stage of life in the study environment in order to contribute to proposals for managing these species and their environment.

**P-05-13: Geographic Structure of Masked Stingray in the Indo-Malay-Papua Archipelago**

Irma S. Arlyza<sup>1</sup>, Philippe Borsa<sup>2</sup>; *1. Research Centre for Oceanography-LIPI, 2. IRD-UR 227, Montpellier, France*

Masked stingrays, *Neotrygon kuhlii* (Myliobatiformes: Dasyatidae), is one of the most common elasmobranch species from Indonesian waters, where it occurs in reef-associated habitats. This species contributes substantially to the danis seine fishery catches in the Java Sea. The masked stingray, which has slow growth and low fecundity, should be used as a quantitative indicator of elasmobranch stocks in the Java Sea and elsewhere in Indonesian waters. It is therefore important to acquire fundamental knowledge of its stock structure. Here, we used *cox-1* sequences, the universal barcode, as a means to investigate the geographic structure of masked stingray across the Indo-Malay-Papua archipelago. Strong genetic differences were found between populations, but the patterns of differentiation did not obey to a geographic rationale. An explanation for this may be cryptic speciation.

**P-05-14: Establishment of Cell Cultures From Green Turtle (*Chelonia mydas*): The Conservation Way of Study for Endangered Species**

Anggraini Barlian, Tera d. Kispá; *Institute of Technology Bandung*

Green turtle, *Chelonia mydas*, is one of endangered animals found in Indonesia's ocean and belongs to animals with temperature-dependent sex determination (TSD). Studying the mechanism underlying TSD for conservation purpose needs abundant material from this endangered species, especially in protein level. The cell culture originated from adrenal-mesonephros-kidney complex of several gonadal sex differentiation stages have been established, and the cultures were maintained in masculinization (25°C) or feminization (31°C) temperature. Two mammalian homologues proteins, Sfl and WT1 that are well known involved in mammalian sex determination and differentiation

mechanism were present in the cell cultures and showed the differential expression during determination and differentiation period. The results of this research using Westernblot and followed by ECL (Enhanced Chemilluminescence) methods showed the possible role of Sfl and WT1 in green turtle sex determination and differentiation as also shown in vivo study. The cell cultures study on protein expression gave a new insight in studying the mechanism of TSD in cellular and molecular level with minimum source of endangered species yet reliable data. This research showed that the cell cultures can be used as a tool for studying the mechanism underlying temperature-dependent sex determination and differentiation in endangered species. Key words: TSD, green turtle, cell cultures

#### **P-05-15: Action Plan for Marine Turtles in Martinique : Research and Conservation**

Cyrille Barnérias<sup>1</sup>, Le-Scao<sup>2</sup>, Laffitte<sup>1</sup>; *1. Direction Régionale de l'Environnement Martinique, 2. Rozenn, 3. Direction Régionale de l'Environnement Martinique*

Out of the six species of Marine Turtles living in the Caribbean region, 3 are nesting in Martinique as the 3 others are seen on some occasion. We are implementing a complete program to protect marine turtles in Martinique. This presentation aims at giving a view on the main measures implemented and on some results already obtained. The first part of the program is based on knowledge improvement : - nesting and in-water studying program to better know local populations - Improve Marine Turtles habitat (preserving nesting beaches from degradation, diminishing light pollution, trying to create marine protected areas around turtles habitats) - developing awareness raising (communication in school) - developing regional cooperation actions (knowledge exchange, capacity building) Results : A local network has been built to input this program with local NGO's. Inwater and nesting studies have been conducted to detect main geographical patterns. This is a first and main step toward protection. Regional networking has allowed us to adapt existing tools (schools tools, awareness ...)

#### **P-05-16: Reproductive Phenology of Northeast Brazilian Mangrove: a Long-Term Study**

Tarcila L. Nadia, L. Patrícia C. Morellato, Isabel C. Machado; *Universidade Federal de Pernambuco*

Knowledge of mangrove long-term reproductive phenology at community and population level is sparse. We investigate the flowering and fruiting patterns of a mangrove community in North-eastern Brazil throughout four years. Ten mature individuals of *Avicennia schaueriana* (Acanthaceae), *Conocarpus erectus*, *Laguncularia racemosa* (Combretaceae) and *Rhizophora mangle* (Rhizophoraceae) were monitored monthly for changes in flowering and fruiting. We applied vector algebra analyses and circular statistics to detect seasonal phenological trends for each species. We applied null models to test for aggregated, staggered or random patterns, performed correlations between the phenophases and climatic factors, and calculated intra-specific synchrony. Each species presented a different flowering pattern, from brief annual to continuous and from regular to irregular, which resulted in seasonal bimodal pattern at community level. Fruiting was less diverse, presenting annual and continuous patterns and seasonal unimodal pattern at community level. Precipitation was the climatic factor showing strongest correlation with the reproduction of all species, except *L. racemosa*. The flowering was randomly distributed and each species presented high intra-specific synchrony. The western mangrove presented a diversity of flowering patterns despite the low number of woody species. Annual to sub-annual sequential flowering were prevalent, maintaining the pollinators of the generalized species in the community all year long, while wind-pollinated species present a continuous flowering. The rainfall and temperature shaped these patterns, which might be found on other mangrove communities.

#### **P-05-17: Heat Shock Protein Expression in Limpets on Hong Kong Rocky Shores**

Chien-Houng Lai; *Tropical Marine Science Institute*

Habitat partitioning in the intertidal has always intrigued ecologists. Traditionally, ecologists concentrated on organismal levels of survival and mortality, but recent advances in physiological

research have allowed sublethal stress indices to be studied. One of these candidates is heat shock protein (hsp), which is synthesized preferentially during events of cellular stress and protein damage. The kinetics of hsp synthesis were studied in two intertidal limpets, *Cellana grata* and *C. toreuma*, in response to environmental conditions such as heat and desiccation stress, to determine if this index correlates with zonation pattern of these species. This was combined with laboratory experiments to elicit the effects of time, heat shock, desiccation and low salinity shock on hsp expression. Temporal variation both on the shore and in the laboratory was examined, which seems to be regulated by tidal patterns and thermal history. On the shore, hsp induction was usually associated with the receding tide and subsequent exposure to heat/desiccation stress. Resting microhabitats also affected hsp synthesis, with unshaded animals generally showing elevated hsp levels compared to their shaded counterparts. In the laboratory, a second induction was observed when limpets were awash by a simulated incoming tide. *C. grata* generally showed a faster induction and downregulation of hsp in response to heat stress and stress removal respectively than *C. toreuma* which, in contrast, showed continuously elevated hsp synthesis. As hsp synthesis, function and downregulation are all energy demanding processes, the efficiency of hsp regulation in *C. grata* implies a better adaptation to a high shore environment than *C. toreuma*. This variation in response corresponds to the respective intertidal zonation patterns of the two species, and possibly provides an explanation for the success of *C. grata* higher on the shore, and the observed heavy summer mortality in *C. toreuma*.

## Poster session: Marine resources management (#06; July 20)

### P-06-1: Climate Change and Sea Level Rise in South East Queensland, Australia: Designing Small-Scale Migration Corridors for Coastal Wetlands

Karin Perhans, Catherine Lovelock, Hugh Possingham, Jonathan Rhodes, Lochran Traill, Kerrie Wilson; *University of Queensland*

Sea level rise poses a threat to coastal wetlands in many parts of the world. In South East Queensland, dense and growing urban development along the coastline constitutes a barrier for wetlands retreating landwards due to sea level rise, resulting in coastal squeeze. In this study, we identified cost-effective locations for small-scale reserve corridors to allow landward migration of mangrove, saltmarsh, Casuarina and Melaleuca wetlands. A digital elevation model formed the basis for inundation simulations for different levels of sea level rise and expected changes in wetland distribution. The conservation planning software Marxan was then used to identify optimal locations for corridors, taking economic land values and spatial connectivity aspects into account. Different scenarios were used for the capacity of wetlands to self-adjust by vertical accretion, for the optimal temporal prioritization of corridor establishment, and for the possibility to restore wetlands in currently developed areas. In a second stage of the study, we also evaluated how urban growth and human adaptation responses to sea level rise may conflict with wetland corridor establishment and investigated ways to tackle this trade-off. We conclude that a systematic and comprehensive approach to conservation planning for coastal ecosystems is required to find long-term solutions that are defensible in the face of competing pressures and interests.

### P-06-2: Estimating the Distribution and Impact of Abandoned Fishing Gear

Chris V. Wilcox, Britta D. Hardesty, Ruth Sharples, Riki Gunn; *CSIRO*

Lost, abandoned or discarded fishing gear from commercial fisheries is a serious environmental concern. This gear continues to fish unattended for up to 10 years, causing mortality to species that may be threatened or commercially valuable. In order to assess this threat or ameliorate its impact on marine species, we need to understand the at-sea distribution of the abandoned fishing gear. We used an oceanographic model that includes both wind and current forcing to track the paths of nets. Using this model we took a dataset of approximately 3500 fishing nets that had been recovered along the

northern coast of the Australian continent, and estimated the likely paths these nets followed to their stranding location. By aggregating these potential paths across many simulations over the whole dataset on stranded fishing gear, we were able to build a distribution of the fishing effort by this gear across the Timor, Arafura, Solomon, Bismark and Coral Seas. We found that estimated effort varied from almost nil at the southernmost point of the Gulf of Carpentaria to >600 nets per 1 km along the northernmost tip of the continent near the Torres Strait. Combining this distribution of fishing effort with species distributions, we were able to estimate the relative impact of the ghost nets on different threatened species in the northern Australian region to estimate potential biodiversity impact.

### **P-06-3: Achievements and Lessons from Trikora Seagrass Management Demonstration**

Malikusworo Hutomo<sup>1</sup>, Tri Edi Kuriandewa<sup>2</sup>; *1. Graduate Program of Study in Environmental Science-University of Indonesia, 2. Research Centre for Oceanography-LIPI*

The project is one of the demonstration site developed under the framework of UNEP/GEF and co-financed by Indonesian Government. The project component activities include (i) Improving the management of seagrass and associated habitats; (ii) Awareness raising and capacity building; and (iii) Promoting environmentally sustainable economic activities. The project started from end of 2007 and will terminate in the of October 2010. Currently, the major parts of proposed activities have been achieved. The most important outputs that should be completed in the rest of time are adoption of East Bintan Coastal Resources Management Plan and Plan and guideline for Sustainable Tourism and Spatial Plan by stakeholders which should be followed by the issuance of relevant regulation. In the level of local community, three community seagrass sanctuaries in three villages have been established under legal umbrella, village decrees. The results of awareness programs are quite significant, such as (i) most of the local community understand of function and benefit of seagrass; (ii) community information and training canters in the three villages have been established, and will be developed as village libraries by Bintan district government, (iii) the website has been visited by more than 20.000 visitors since its establishment and have been transferred to Research Centre of Oceanography website to become Indonesian Seagrass Website and as a guarantee for its sustainability. Implementation of monitoring and alternative income generation activities for local peoples are on-going and expected to be sustain beyond the project period. Lessons learned from implementing this project will be presented which include institutional arrangement, community participation, awareness campaign and alternative income as well as sustainability beyond project period.

### **P-06-4: Mangrove Status and Management Plan in Leuweung Sancang Nature Reserve, West Java, Indonesia**

Dimas T.A. Panjaitan, Devi N. Choesin; *Bandung Institute of Technology*

Leuweung Sancang Nature Reserve is an important conservation area located in Garut Regency, West Java, with a complete representation of unique coastal wetland ecosystems, e.g., coral reef, seagrass meadow, mangrove forest, estuary, Ipomoea-Barringtonia formation and lowland forest. However, the area is not considered a well-planned or managed conservation site. Among the many issues encountered in this area are land degradation, land conflicts, and illegal fishermen settlement. Within this setting, much of the mangrove area has remained sacred. According to local people, there is a legend related to Prabu Siliwangi, a former king in Western Javanese history. This legend has apparently produced an indirect effect on current mangrove conditions and conservation status. Mangrove vegetation in the reserve consists of *Avicennia marina*, *Sonneratia alba*, *Rhizophora mucronata*, *Rhizophora stylosa*, *Aegiceras corniculatum*, *Bruguiera gymnorrhiza*, *Nypa fruticans*, *Acanthus ilicifolius* and *Xylocarpus granatum*; generally showing clear zonation. According to the legend, *Aegiceras corniculatum* or Kaboa is believed to be an incarnation of Prabu Siliwangi's army. As a result, local people, mostly fishermen, have exploited relatively little of the mangrove area. They mainly use only dead-wood as fuel or catch fish for individual consumption or to sell. In relation to the above, a study has been conducted in order to identify the local community's current perception of

mangroves and their sustainable use, as well as comparing mangrove community structure in three sites within Leuweung Sancang Nature Reserve, i.e., Cikolomberan, Cipalawah and Cibako. Anthropogenic effects are compared among the three sites studied. Overall results of this study will be discussed in the context of the development of a strategic management plan for Leuweung Sancang Nature Reserve.

**P-06-5: Determination of Coastal Wetland Boundaries in Leuweung Sancang Nature Reserve, Indonesia: Implications for Management**

Devi N. Choesin, Dimas T.A. Panjaitan; *Bandung Institute of Technology*

Wetlands in general are characterized and distinguished from adjacent ecosystems by their unique hydrology, vegetation and substrate. However, the relative importance of these three components in determining ecosystem functional boundaries require further investigation. A study was conducted to assess the relative role and contribution of vegetation, substrate and hydrology in determining functional boundaries by detecting and comparing boundary locations determined by these three components separately and in combination. The study was conducted in Leuweung Sancang Nature Reserve in Garut Regency on the southern coast of West Java, Indonesia. Data were collected along the transition from seagrass meadow, mangrove forest, non-mangrove coastal forest, to lowland forest. Belt transects consisting of continuous 1x1 m<sup>2</sup> plots, measuring at least 600 meters each were drawn perpendicular to the coastline in three sites, i.e., Cikolomberan, Cipalawah and Cibako. Data on vegetation (species cover), substrate (e.g., pH, organic content, nutrient availability) and hydrology (e.g., inundation depth, salinity) were collected from each plot and analysed using the moving split window (MSW) technique. Boundaries separating the qualitatively observed communities (seagrass, mangrove, coastal forest and lowland forest) were determined based on maximum peaks in Squared Euclidean Distance (SED) values. Results indicate that boundaries in vegetation do not always coincide with boundaries in substrate and/or hydrology. The significance of overall findings are discussed in relation to issues of wetland management and conservation in general, and Leuweung Sancang Nature Reserve in particular.

**Poster session: Limnology (#07; July 20)**

**P-07-1: Roles of Riparian Vegetation on Stream Conservation**

Della Kemalasari, Devi N. Choesin; *Institut Teknologi Bandung*

Studies of riparian vegetation have revealed many of its ecological functions related to stream water conditions and aquatic ecosystem integrity, particularly in temperate areas. The study was conducted to reveal some of the riparian vegetation role on stream conservation, including the analysis of riparian vegetation with stream conditions in Cikapinis stream, in West Java. The study was conducted at three stations designated as upstream (station 1), midstream (station 2), and downstream (station 3) areas, where midstream riparian vegetation had been clear-cut and burned eight months prior to the study. Riparian vegetation at station 1 exhibited highest coverage for herbs, shrubs and trees (100%, 69%, and 28% respectively), followed by station 3 (100%, 27%, 0%), and station 2 (44%, 4%, 0%) with significant difference among the three stations (Kruskal-Wallis,  $p < 0.05$ ). Principal Component Analysis revealed a close relations among low vegetation coverage, high air temperature, light intensity, and bulk density. This suggests the ecological function of riparian vegetation to moderate stream conditions as well as maintain aquatic ecosystem integrity, particularly in mitigating pollutant runoff during the rainy season. Keywords: riparian vegetation, ecological function, stream condition, Indonesia.



**P-07-2: Diversity of Sessile Rotifers (*Gnesiotrocha*, *Monogononta*, *Rotifera*) in Thale Noi Lake, Thailand**

Phuripong Meksuwan, Pornsilp Pholpunthin, Hendrik Segers; *Prince of Songkla University (PSU), Thailand*

Whereas free-living, planktonic rotifers are relatively frequently studied, a clear knowledge gap exists regarding biodiversity of illoricate, sessile rotifers, belonging to the largest class (*Monogononta*) of phylum *Rotifera*. This gap results from the fact that observation and identification of these animals cannot be done through routine plankton study methods, but requires examination of living specimens. The present study addresses the gap by investigating the rotifers attached to several species of submerged aquatic plants from Thale-noi lake, southern Thailand, the first Ramsar Site of the country. We found a remarkable diversity of 40% of the known world fauna of sessile rotifers. One genus and 4 species belonging to 4 different genera are new to science, 7 species are newly recorded from the Oriental region, and 24 species were new to the Thai fauna. Besides these novelties, contributing knowledge on the biodiversity of the taxa at various scales, detailed morphological study of some rare taxa provided new insights into the taxonomy and zoogeography of sessile rotifers.

**P-07-3: The Phylogenetic of Gatul Fish (*Xiphophorus*. sp) in Sari Lake Purwodadi Pasuruan Regency**

Dwi Anggorowati Rahayu, D.Listyorini Al Jabari, Miftahul Jannah, Nuning Winaris; *State University of Malang*

Gatul fish belongs to family Poeciliidae. People around Sari Lake of Purwodadi Pasuruan Regency named Gatul fish for those of *Xiphophorus* sp. This fish is determined by a sword like ventral protruding on its caudal fin in only male fish as of possessed by common swordtail fishes. The size of this Gatul fish is bigger than those from other areas and even from commercially sword fish sold in fish market in Malang. Female is  $5.84 \pm 0.86$  cm, while male is  $4.57 \pm 0.92$  cm in length. According to its color, we found two types of fishes i.e. orange fish and transparent grey one. Both exhibit one or two brown longitudinal line along their body. As a member of Poeciliidae, male fish possesses gonopodium, a copulatory organ modified from anal fin. Females bear the embryos and deliver it as young fishes. Number of embryos ranged from 49 to 120 depends on the size of the female. Currently we are analyzing the phylogenetic (possible relation) of two specimens of Gatul fishes found in Sari Lake compared to commercial swordtail fish sold in fish market in Malang using partial sequence of 16S gene. We are using barcoding primers (Palumbi et al, 1997) to amplify that sequence. Key words: Gatul fish, Poeciliidae, Swordtail fish, 16S gene, phylogenetic

**P-07-4: Is the River Continuum Concept Applicable to Tropical Rivers? A Case Study: Chironomidae larvae (Diptera) Community at Ciliwung River, West Java, Indonesia**

Prima Mayaningtias<sup>1</sup>, Tati Suryati Syamsudin<sup>2</sup>, Gede Suantika<sup>1</sup>, Barti Setiani Muntalif ; *1. School of life Science and Technology, ITB, 2. West Java Environmental Management Agency*

River continuum concept in river system is based on structure and function of benthic community. This research attempted to evaluate the concept by using Chironomidae larvae from Ciliwung river – West Java Indonesia. Sampel collections were conducted by D-Frame Dip Net at 7 different locations during the period of July 2008 until June 2009. The results showed that 9 groups of functional feeding of Chironomidae larvae were found at the upstream of Ciliwung river, while 3 groups were found at the middle and downstream. In terms of relative abundance, gatherers-collector and shredder were the predominant groups at most sites. We conclude that there was a distinct headwaters functional feeding groups of Chironomidae larvae in Ciliwung river related with the changement of gradient river from headwater to downstream in species composition. Keywords: river continuum concept, functional feeding groups, Chironomidae larvae. Ciliwung river.

**P-07-5: Diatom Periphyton Vertical Stratification in Floating Net Cages Waduk Jatiluhur**Gede Suantika, Hutapea (Prawira P. Hasian) ; *SITH ITB*

Jatiluhur reservoir located in Purwakarta is utilized to support human activities. Organic and inorganic waste, especially from floating net cage culture, is inevitable, consequently eutrophication process continued rapidly. Periphytic Diatom can be applied as biological water quality alteration indicator, because of its high tolerance in organic and inorganic polluted water. Periphytic diatom growth in floating net cage fish culture area are analyzed using artificial substrate, submerged in depths of 0m, 2m, 4m, 6m, 8m, and 10m, in the middle of site, and sampled every 10, 20, 30, 40, and 50 days after submerging. Physical-chemical factors also measured. DA<sub>Ipo</sub> (Diatom Assemblages Index to Organic Water Pollution) was used to measure water quality in organically polluted waters based on relative density ratio between intolerant and tolerant diatoms in periphytic diatom communities. The objectives of this study are to assess the physical- chemical factors changes and the alternation of predominant species and compositions of periphytic diatoms through time and vertical stratification in Jatiluhur floating net cage culture area, to assess the water quality vertically based on periphytic diatom community in Jatiluhur floating net cage culture area. During this study, 38 genus was found, and 12 of them were predominant. Periphytic diatom abundance decreased with increased depth (411.3186- 20,83%) and the community structure changed (15- 27 genus). Shannon-Wiener diversity index ( $H'$ ) had a stable stable tendency with the range of 0,51-1,16. The community structure changed through time showed by the alternation of predominant genus, the fluctuation number of genus and diversity. Using stepwise regression, the physical- chemical factors that were relatively had the most affect on the abundance of periphytic diatoms was determined. The water quality status according to DA<sub>Ipo</sub>, ranging within 10,61-60,9; the floating net cage culture area were experiencing organic inputs.

**Poster session: Entomology (#08; July 20)****P-08-1: Forest Reserve Size Effects Ant Community Structure**Nur-Zati A. Mustafa<sup>1</sup>, Idris A.B<sup>2</sup>, Laurence G.Kirton<sup>1</sup>, Matthew D. Potts<sup>1</sup>; *I. Forest Research Institute Malaysia*

Reserves are the portion of the production forest landscape where commercial harvesting of wood products is prohibited in order to preserve elements of biodiversity that may be missing from the production areas. In Malaysia, it is a common practice to maintain certain areas within forest reserve as Virgin Jungle Reserves (VJR). They serve as natural arboreta and may enhance the re-colonization of species into the adjacent forest areas after logging. To understand the effect of reserve size on the persistence of ant species diversity in VJRs, we sampled ant communities in six VJRs of different sizes. Theory of Island Biogeography suggests that species richness in habitat fragment is expected to be a function of the island sizes and degree of isolation. Nine plots were established in each forest reserve and the surrounding over area. Four sampling methods were used in each plot; arboreal pitfalls, ground pitfall, baits, and leaf litter sifting. A total of 187 species representing 50 genera and 7 subfamilies of ants were sampled. A statistical analysis showed no significant difference in species diversity between sites in relation to forest sizes ( $P>0.05$ ). However, distinct changes in species composition were observed between the smallest forest reserve and the biggest forest reserve with arboreal ants being found to be the most diverse in the smallest forest reserve. In addition, the results show that isolated area tends to have higher diversity as compared to forest areas near the large contiguous forest area of Titiwangsa Mountains that is a main mountain range that act as natural divider of east and west of Peninsula Malaysia. Finally, the Chao-Jaccard dissimilarity index showed that similarity between species composition was not dependent on forest sizes but reveals that there

are close similarity among VJRs in the same main range. Overall, alpha diversity of ant communities was not explained by reserve size but aspects of composition was.

### **P-08-2: How Important is the Ant-Termite Interaction in Tropical Rain Forests?**

Tom M. Fayle, Olivia I. Scholtz, Paul Eggleton; *Natural History Museum, London*

Termites and ants make up the single largest animal biomass contribution in tropical rain forests and perform vital ecosystem functions. Given that many species of ant are at least partly predatory and termites are a highly abundant potential prey, it has always been assumed that ants eat large numbers of termites and that, therefore, the ant-termite trophic interaction is a key one in tropical rain forests. Although a small number of studies have confirmed the existence of this interaction between pairs of species, direct evidence for the general strength of these relationships is scarce. This is mainly because the majority of ant-termite predation events take place underground, making them difficult to observe. In order to quantify spatial covariance in ant and termite distributions we sampled ants and termites from grids of soil pits at sites in Gabon and Malaysia. We found that while non-predatory ants were distributed independently of termites, predatory ants were more often found at locations with termites than would be expected by chance. We then sequenced termite cytochrome oxidase subunit II sequences from the guts of ants collected from the soil pits and compared these sequences with those from a database of sequences for different termite genera. This enabled us to distinguish between three alternative dietary hypotheses for each ant species: 1. That the species does not feed on termites 2. That the species does feed on termites, but feeds on different species in relation to their availability i.e. it is a generalist 3. That the species is specialised on a particular species, clade or feeding group of termites Here we present some preliminary data for a selection of common ant species in Gabonese rain forest indicating overall reliance on termites as a food source and levels of dietary specificity.

### **P-08-3: Spatiotemporal Variation in Cicada Diversity and Distribution, and Tree Use by Nymphs, in Tropical Reef-karst Forests and Forestry Plantations**

Yu-Hsiu Lin, 1, Shu-Hui Wu<sup>2</sup>, Ya-Fu Lee<sup>1</sup>; 1. *Taiwan Endemic Species Research Institute*, 2. *Hengchun Research Center, Taiwan Forestry Research*

Spatiotemporal variation in the species composition, relative abundance, and plant use by cicada nymphs were studied among continuous and fragmented forests and man-modified forestry plantations upon an uplifted reef-karst substrate in tropical East Asia. Nymph emergence was concentrated in the rainy season but tended to begin earlier, end later, or both, on plantations. Species abundances fluctuated over time and among the types of forests, with greater variation in plantations and fragmented forests. Seven cicada species were present, but the overall similarity in species composition was low among the forest types. Higher mean numbers of species and mean abundances occurred on plantations than in fragmented and continuous forests, but the species heterogeneity was higher in continuous forests and lowest on plantations. Exuviae were found at various heights that were correlated positively with the abundance of exuviae and negatively with the diameter at breast height of trees, whereas coefficients of variation in the height distribution among trees were not correlated with the abundance of exuviae. The plant-use breadth was widest in the cicadas *Chremistica ochracea*, narrowest in *Cryptotympana takasagona*, *Platyleura takasagona*, and *Euterpnosia koshunensis*, with the other species intermediate, corresponding with their relative abundance. Among-species overlap was generally higher in the continuous forests but declined in forest fragments and plantations. Our results indicated that fragmenting tropical primary forests and creating plantations may generate higher richness and abundance of annual cicadas, but risk the loss of rare or endemic species that show a greater preference for tree species of the primary forests.

### **P-08-4: The Impact of Human Activities to Dynamic of Moth Communities: a Case Study in Gunung Salak, West Java**

Hari Sutrisno, Yayuk R. Suhadjono; *RC for Biology, LIPI*

A study on the impact of human activities to dynamic of moth communities with focused on macro-moths was conducted in Gunung Salak, West Java. The main aims of the study are to know the impact of human activities to their diversity and their structure within communities by comparing the index diversity, species richness and species composition across five different habitat types. The results showed that the habitat changes due to human activity had changed not only to the moth diversity but also to the structure of moth communities. The number of moth species decreased significantly as well as the number of lower taxa (family) in the disturbed forest (secondary forest, Agathis forest and transition area) within ranges: 20-50% and 10-20%. The composition of the two big families, Geometridae and Noctuidae also had change, family Geometridae decreased within ranges 10-50% in the disturbed area but Noctuidae increased significantly up to 50% in those areas. Indeed, the lost habitat due to human activity such as illegal logging, change of land use and land clearing is one of the main threats to decrease on macro-moth diversity and change of their structures within communities. Key words: Gunung Salak, human activities, impact, insect diversity

#### **P-08-5: Dung Beetles on Small Islands are not Limited by Food Availability**

Lan Qie; *National University of Singapore*

Forested land-bridge islands formed by the creation of hydroelectric reservoirs provide unique opportunities for studying the impacts of forest fragmentation on biotic communities. However very few studies based on such island systems have been conducted on a functionally important group of invertebrates – the dung beetles (Coleoptera: Scarabaeidae: Scarabaeinae). Our research was carried out on the land-bridge islands in Lake Kenyir (Malaysia). Resource limitation is one of the central rules in ecology and potentially important for island communities. Theoretically, the most important resource for these beetles is the availability of mammalian dung. Dung availability on these small islands may be limited and difficult to quantify in-situ, as the majority of mammals are not permanent residents and move between islands. Furthermore, dung resources are rapidly depleted by biotic and abiotic processes. Our previous studies, however, suggest that the species distributions of dung beetles on these islands are likely limited by dispersal. To test whether the island communities of dung beetle are limited by food availability we conducted subsequent dung supplementation experiments on 16 small islands (< 4 ha). Between Apr 2009 and Oct 2009 we dispersed 10 kg of cattle dung onto eight of the islands every 10-15 days and these islands along with eight control islands were surveyed monthly to monitor the dung beetle communities over time. Repeated surveys on these islands between Jun 2008 and Apr 2009 had already been conducted to establish baseline data. Results from generalized linear models show no significant effects of food supplementation on the dung beetle populations. This strongly suggests that dispersal limitation and stochastic processes, not food limitation, are the major drivers of the distribution of dung beetles within this island system. We also recommend translocation experiments to be conducted to test the dispersal-limitation hypothesis.

#### **P-08-6: Using Ants as an Indicator Organism, can Matrix Habitat Type Determine the Invasibility of a Forest Edge?**

Nihara R. Gunawardene, Jonathan D. Majer, Jayanthi P. Edirisinghe; *Curtin University*

Forest patches are no longer seen as islands of diversity in a sea of disturbance. An increasing number of studies now view the landscapes surrounding forest patches as heterogeneous sources and sinks of non-forest diversity. The habitats of the matrix surrounding a forest patch can affect the internal dynamics of a patch by determining the degree to which edge effects penetrate. By looking at ant assemblages within forest edges bordered by different matrix habitats, significant differences were found between assemblages within the edges. The ratios of disturbance tolerant ants to forest dwelling ants also varied with edge type and distance from forest/matrix edge. Generally, the ratio declined with distance from the forest/matrix edge but the forest adjacent to a matrix habitat with low structural similarity and high disturbance levels had much higher ratio values that did not decline to natural edge

levels, even up to 100 m from the border. It appears that even relatively large forest remnants can be affected by the surrounding matrix land uses and that encouraging the growth of structurally similar vegetation and minimising disturbance along the borders could attenuate the effect of the edge.

**P-08-7: Taxonomy, Phylogeny and Biogeography of Oriental Monolepta and Related Taxa (Coleoptera: Chrysomelidae)**

Izfa Riza Hazmi, Thomas Wagner; *University of Koblenz-Landau, Germany*

We have worked on the taxonomy, phylogeny and biogeography of Oriental Monolepta and related taxa, one of the most species-rich groups of leaf beetles (Chrysomelidae). Up to now 259 species are described for the oriental fauna. With very few exceptions, the descriptions by preceding authors have been based on external characters only, and this group was up to now not revised. On base of 18,000 museum specimens and further newly collected material, in particular from Malaysia, a revision was started two years ago. Intensive studies on genital structures and first attempt on the molecular data resulted in several taxonomic changes and new phylogenetical relationships. An example is Ochralea, a genus that been synonymised with Monolepta since 1924, but could be found as distinct group of galerucines restricted to the Oriental Region. As well as the genus Arcastes that possess very peculiar genitalic structures, is an endemic to South-East Asia. The studies on Monolepta are ongoing, and additional to the high number of described species many new taxa could be found. Next to descriptions of the taxa, including illustrations of external and genital characters, geographical distribution are compiled in maps, and identification keys are provided. The primary type specimens are photographed, and an electronic type catalogue will be available in the internet. Centre of diversity are compiled by the distribution data of the species.

**P-08-8: Effect of *Mirabillis jalapa*'s Extractions to the 3rd instar of *Spodoptera exigua* and Their Offsprings : A Study to Support IPM in *Brassica oleracea***

Anggraeni Tjandra, Didot B. Prasetyo, Rita Yuliana; *SITH, Institut Teknologi Bandung*

*Brassica oleracea* is one of many vegetables growth in Indonesia. The growing, however, is limit by the invasion of pest, especially *Spodoptera exigua*. Many efforts, including the use of pesticide has already been done, but the incursion become greater along with the time. Integrated Pest Management is an alternative solution to solve this problem, this include of the using a biological product. A research by using *Mirabillis jalapa* plant to control insect pest, *S. exigua*, was conducted. Extraction of *M. jalapa* leaf (concentration 0.05, 0.1, 0.2, 0.4 and 0.8 g/mL) was applied, by smearing it, to *B. oleracea* leaf and let the 3rd instars of *S. exigua* to eat. The result showed that in all concentrations applied there were a significant reduction in food consumption, weight and rate of growth, time for pupation, and also percentage of adult emergence of the insect. It seems that the extraction of *M. jalapa*'s leaf contain an antifeedant compounds and thus repel by the insect. Surprisingly, the effect of *M. jalapa* to *S. exigua* was not stop until the emergence adult, but it is continue to their offspring, as it showed that the number of eggs, the eggs viability, the number of larvae in each instars, the time for pupation, the weight and the viability of pupae in the first generation were decreasingly compare to the control of *S. exigua*. The conclusion from these research is that the leaf extraction of *M. jalapa* has a potency to control *S. exigua* and their offspring and thus to support integrated pest management program in *B. oleracea*.

**P-08-9: Presence of Coxal Combs is Not a Perfect Predictor of Pollination Mode in Fig Wasps**

Gang Wang, Li Zong Bo, Yang Da Rong; *Xishuangbanna Tropical Botanical Garden*

Active pollination is generally rare in nature. Active pollinators use a combination of specialized morphological and behavioural adaptations to transfer pollen. Fig wasps contain both active and passive pollinators. The model of pollination can confidently be predicted from fig traits only (anther-to-ovule ratio) or from wasp traits only (presence of coxal combs). However, presence of coxal combs

is found not to be a perfect predictor of pollination mode in some Asian fig-pollinating wasps, and some evidences will be showed here. Based on direct observation of pollination mode in 23 species, the coxal combs occurred not only in all the active species but also in 5 out of 7 passive species. The coxal combs in those passive species had either dense or sparse hairs, and the pollen pockets were closed or small ones. In contrast, the anther-to-ovule ratio was higher in passively pollinated species ( $> 0.21$ ) than in actively pollinated species ( $< 0.16$ ). So anther-to-ovule ratio was still the perfect predictor for pollination mode in fig wasps. The results suggest that more wasp traits should be used to predict pollination model besides coxal combs, pollen pockets and pollination behaviour.

#### **P-08-10: Importance of Pollinator Services of a Sacred Landscape Mosaic to Coffee Production**

Smitha Krishnan, Jaboury Ghazoul, Uma Shaanker; *ETH Zurich*

Many studies have shown that proximity to natural habitats, particularly contiguous forests enhances crop productivity and quality through the provision of pollinator services. This study was conducted in a unique landscape with a high density of forest fragments (1214 forest fragments in 4100km<sup>2</sup>) interspersed in a matrix of coffee plantations, paddy fields and human settlements. The coffee plantations are shaded with a high density of native trees ( $256 \pm 128/\text{ha}$ ). This study is unique especially because of the uniqueness of the landscape. This paper addresses the following questions: 1. does distance from the forest have an effect on pollinator abundance at a local scale, 2. do pollinators contribute to coffee production and seed quality, 3. does the adjoining forest (vegetation) type and size have an effect on pollinator abundance in coffee plantations. The study was conducted in coffee plantations at 5 distance classes ( $<10, 50, 100, 250, 500\text{m}$ ) each from the forest edge. The study was carried out at 40 forest fragments of varying dimensions (previous studies are based on observations with respect to 2-3 forest fragments). Distance from the forest did not have a significant affect on pollinator diversity or abundance on coffee flowers. Mass flowering in coffee initiated by rain attracted fewer pollinators than in sites with isolated flowering initiated by irrigation. Pollinator abundance increased fruit production and fruit quality. Size of the adjoining forest has a significant positive influence on pollinator abundance. Abundance of bees in plantations closer to semi-evergreen forests was significantly greater than in plantations adjoining moist-deciduous and evergreen forests. Our study confirms the importance of pollinator services for coffee, but finds no local distance effect of declining service with increasing distance from forest margins. Instead, pollinator services at plantation scales are better explained by the size and type of nearby forest patches.°

#### **P-08-11: Collembola (hexapods) Diversity at Various Vegetation Type at Salak Mountain, West Jawa, indonesia**

Yayuk R. Suhardjono, Woro A. Noerdjito, Hari Sutrisno; *RC for Biology, Indonesian Institute of Sciences*

Salak Mountain was a conservation area, but still lack information on soil fauna, especially on Collembola. So far, only three species has been reported to occur in this area such as *Acanthurella javana*, *Folsomia candida* and *Folsomides parvulus*. Though that Collembola has important role as a decomposer in ecosystem and can be used as bioindicator, inventory of this group is needed to explore their diversity from the area. This research conducted in five vegetation type (primary, secondary, Agathis, shrub and open area), during July 2009 and standard sampling methods were used. Total specimens number collected was 3841, consist of 14 families, 55 genera or 82 species. Each habitat type indicated different number of individual: soil (901), litter (2361) and surface floor (579). The species *Folsomia* sp. 2 was collected in high individual number (primary: 400; secondary: 500, Agathis; 59, shrubs 80, open area none). The genus *Folsomia* was inhabitant in humid litter layer, and this favourable micro habitat did not find in open area for them. The three known species from Salak were found during this investigation. The rest species (79) supposed to be new record for Salak, some for Jawa or Indonesia, and very possible some of them can be promoted as new species, but further study on taxonomical must be done. Most of the families can be found at all of vegetation type, except Arrhopalitidae (*Arrhopalites* sp.) only in shrub and Brachystomellidae in Agathis. Most of the genus

has overlapped distribution among habitat, but some of them figured seem to be typical on certain type. Some species only collected from soil samples: (*Mimoderus* (?) sp., *Lepidocyrtus* sp 6., *Hypogastrura* sp.); litter: (*Ptenothrix* sp. 1 and *Papiriodes* sp. and *Cyphoderus* sp.); and surface floor: (*Acrocyrtus eurylabialis*, *A. Javana*, *A. Javanicus*, *Lepidocyrtus callolepis*, *L. Malayanus*, and *L. Medius*). Key words: Collembola, diversity, vegetation, Salak, Jawa.

**P-08-12: Evaluation of Various Forest Conditions Based on Longhorn Beetles (Coleoptera: Cerambycidae) as Bio-indicators in Mt. Salak, West Java, Indonesia**

Woro A. Noerdjito, Yayuk R. Suhardjono, Hari Sutrisno; *RC for Biology, Indonesian Institute of Sciences*

Longhorn beetles (Coleoptera, Cerambycidae) are one of the largest groups of wood borers and therefore typical forest-dependent insects. The species diversity of these beetles may vary with species composition and age of the trees, and stability of the forests, and thus they are a useful bio-indicator for assessing forest conditions. We compared the assemblages of longhorn beetles among open area, old plantations of *Agathis damara*, secondary and primary forest in Mt Salak, West Java. Out of the 44 species of Cerambycid beetles collected during this research in 2009, small-sized (<10mm) species, such as *Ropica strandi*, *R. transversmaculata* and *Sybra fuscotriangularis* were dominant at all habitats and 30% (13 species) are endemic in Java. The species compositions and the number of individuals of beetles in *Agathis* forests at different altitudes (Citiis, 900 m asl. and Cidahu, 1,100 m asl.) are different. In five species with wide distributional ranges, i.e. *Acalolepta laevifrons*, *Egesina javana*, *Ropica transversemaculata*, *Sybra fuscotriangularis* and *Trachelophora cervicollis*, the proportion population percentages tend to decline at disturbed areas. On the other hand, *Epepeotes luscus* and *Pterolophia melanura* which can adapt well to the open areas showed high proportion population percentages in open habitats. Key world: longhorn beetles, Cerambycidae, bio-indicators, forest conditions, Mt. Salak

**P-08-13: Skip it or Keep it? The Importance of Skipper (Lepidoptera: Hesperiiidae) Immature Information to Biodiversity Assessment in Northern Indochina**

Yik Fui Philip Lo; *China Programme, Kadoorie Farm and Botanic Garden*

Species richness and composition of butterfly fauna are often regarded as indicators of habitat quality. Therefore, a complete and accurate butterfly fauna inventory can definitely make a more precise assessment of a particular site. However, we found that it is difficult to obtain a representative inventory of Hesperiiidae (skipper) in Northern Indochina solely depends on adult record because they are often under-recorded and some important species (such as endemic or habitat specialist) are often overlooked in survey. With about 3500 species worldwide, Hesperiiidae is the third largest butterfly family. But because of their stout body and plain pattern in many species, skippers are commonly regarded as moths by layman. Even for experienced butterfly watchers, observation of some skipper species is comparatively difficult due to their crepuscular behavior. For diurnal species, identification of adult skipper is still a headache in field because of many superficially similar groups involved and also their fast and erratic flight. Comparing to adult, immature stage of skipper is relatively easier to observe since almost all skipper larvae make shelter. Besides, the hosts of more than 50% of skipper species are restricted to monocotyledons that limits the searching effort. Larvae of many species can be readily identified by the form of shelter, pattern of head capsule and host. Based on multi-year butterfly surveys conducted in various sites in Hong Kong and Hainan, for more than 40% of recorded skipper species, the immature stage encountering rate is higher than that of adult stage. Moreover, 25% of recorded skipper species rely purely on immature stage observation, including endemic species, regional new records and undescribed species. These cases suggest that without surveying the immature of skipper, some essential supplementary data will be missed in habitat assessment. It is likely the case in other regions of Tropical Asia; hence, further investigation is needed .

**P-08-14: Soil Fauna at Padang Vegetation in Bangka Island**

Siti Aisyah, Sarinah, Anita, Dhonna Frilano, Eddy Nurtjahya; *Universitas Bangka Belitung*

Soil fauna population at padang vegetation in Bangka Island was conducted. Padang vegetation called Padang sapu-sapu by locals is located at Pejem hamlet, the northeast part of Bangka Island and is known as the largest of its type in Indonesia. Padang sapu-sapu, which is estimated more than 1.500 ha, its vegetation is dominated by *Baekea frutescens* L. (Myrtaceae) saplings (< 10 cm dbh) and the tallest trees reach only less than 6 m, and only one individu *Cratoxylum* sp. pole (10-20 cm dbh) recorded and none of trees ( $\geq 20$  cm dbh). Samples of six points and three replicates each were collected with pitfall trap method using 70% ethanol for 24 hours. The study recorded 13 species belong to 11 families, and 6 orders i.e. Collembola, Diptera, Homoptera, Hymenoptera, Orthoptera, and Araneida. The density is 987 ind./m<sup>2</sup> with two species ants and three species collembola as two largest components. The low total individu and species compared to other habitat reflects the poor soil and its productivity of padang vegetation. Key words: soil fauna, padang vegetation, Bangka

**P-08-15: Changes in Dung and Carrion Scarabaeid Beetle Diversity Associated with Planting of *Acacia mangium* in Grasslands**

Akira Ueda, Dhian Dwibadra, Woro A. Noerdjito, Masahiro Kon, Masayoshi Takahashi, Kenji Fukuyama; *Hokkaido Research Center, FFPRI*

Clean Development Mechanism (CDM) afforestation often involves the creation of early growing tree plantations on grasslands. Such practices have generated concern about possible impacts on local species biodiversity. Several past studies have shown that variations in dung and carrion scarabaeid beetle diversity are a particularly useful indicator of habitat quality and environmental change in tropical regions. In the present study, we compared the diversity of dung and carrion scarabaeid beetles using baited pitfall traps placed in grasslands of *Imperata cylindrical*, plantations of *Acacia mangium*, burnt natural forests, and intact natural forests, located 10–30 km north of Balikpapan, East Kalimantan, Indonesia. Species richness and Shannon-Wiener diversity index ( $H'$ ) were highest in the intact natural forests and were similar between the plantations and the grasslands. Abundance and  $J'$  evenness index did not differ among the four vegetation types. However, ordination analysis showed that the structures of beetle assemblages differed between plantations and grasslands, and that the beetle assemblages of plantations were intermediate between burnt natural forests and grasslands. The number of indicator beetles from natural forests that were collected in plantations was positively correlated with plantation area, and negatively correlated with both distance from intact natural forests and DBH. These results suggest that local native diversity of dung and carrion scarabaeid beetles is higher in CDM afforested areas compared to grasslands. Nonetheless, even with these afforestation efforts, the large differences in basic community structure between intact natural forests and plantations may hinder the restoration of rare forest species that have already declined in response to previous habitat destruction. Our results also indicate that large plantations adjacent to intact natural forests may be better able to restore native species than small, isolated plantations.

**P-08-16: Use of Inverse Models to Estimate the Dispersal Ability of Ant Queens**

Emilio M. Bruna, Thiago J. Izzo, Brian D. Inouye, Maria Uriarte, Heraldo L. Vasconcelos; *Dept. of Wildlife Ecology and Conservation, University of Florida*

Disentangling the mechanisms that maintain the diversity of biological communities is a central goal of ecology. Mathematical models of species interactions have identified several mechanisms likely to contribute to coexistence among species that compete for resources; among the most important of these are potential tradeoffs among life-history traits such as dispersal and competitive ability. In many systems, however, assessing potential "competition-colonization tradeoffs" has been hampered by difficulty in obtaining reliable estimates of dispersal ability, especially long-distance dispersal movements. We used inverse models - commonly used to quantify the dispersal kernels of seeds from mapped source trees - to estimate the dispersal ability of the queens of three ant species that establish



colonies in the domatia of two Amazonian plant species. Because there is strong competition among queens for access to seedlings with empty domatia in which to establish colonies, ant-plant systems are exceptional ones with which to investigate the potential for colonization ability to be a mechanism mediating coexistence. We parameterized inverse models using surveys of 100 vacant experimental seedlings distributed in a 9 ha plot in which all *Tococa bullifera* and *Maieta guianensis* plants hosting ant colonies were mapped and measured. Based on our models, the estimated modal dispersal distance for *Crematogaster laevis* queens was 125 m, while the modal dispersal distances for *Azteca* sp. and *Pheidole minutula* were 38 m and 20 m respectively. In addition to providing some of the first estimates of ant queen dispersal in tropical forests, these results are consistent with those predicted by a tradeoff between dispersal ability and the capacity to defend host plants against herbivores (i.e., colony defensive ability). As such, they provide evidence that competition-colonization tradeoffs could be promoting the coexistence of ant species competing for access to limited resources.

**P-08-17: Effect of Acari and Collembola on Litter Decomposition Associate with Litter Quality and Leaf Fragmentation**

Xiaodong Yang, Yang Zhao, Chen Jin, Matthew W. Warren; *Xishuangbanna Tropical Botanical Garden, CAS*

Soil mesofauna have been shown to influence litter decomposition and nutrient mineralization in humid tropical forests, but details about their functional roles and interactions with other soil functional groups and litter quality require further study. The aim of this study was to determine independent effects of two dominant mesofauna groups (Acari and Collembola) on litter decomposition, and their interactions with litter quality and mechanical fragmentation, a process associated with soil macrofauna. We used artificial soil mesocosms to incubate Acari and Collembola with fragmented and intact litter of different carbon to nitrogen (C/N) ratios. Litter mass loss, and C and N concentrations in leaf litterbags were determined after incubation periods of 50, 150 and 300 days. Acari and Collembola both significantly enhanced litter decomposition rates. Furthermore, the fauna effect on litter mass loss and C and N concentrations was amplified by litter fragmentation. Litter quality alone did not influence the effects of soil mesofauna on litter mass loss or remaining C and N contents, but there was a significant interaction among litter quality, fragmentation and mesofauna on decay rate. The fauna effect on the decomposition of high C/N litter was significantly lower than low C/N litter, but only when litter was fragmented. Our results indicate that Acari and Collembola independently contribute significantly to the decomposition of litter varying in quality; furthermore, increased fauna effects with fragmentation suggests the ecological significance of meso- and macrofauna interactions in tropical forest ecosystems.

**P-08-18: Butterflies Population and Plant Resources in Campus Area of University of Indonesia, Depok, West Java, Indonesia**

Sariyanti Mardhatillah, Eka Nurlaila, Wahyu Nirwanto; *University of Indonesia*

To determine the survival rate and reproduction of butterfly's population, a study in campus area of University of Indonesia was conducted. This study provides the first inventory of diversity of butterflies live in the coverage area of 320 ha and gives description about plant resources in that terrestrial habitat. The method was spot observation in 13 plot sampling area such as 10 faculties, City's forest and Natural Laboratory during 2 months period from October until November 2009. Result showed there are 33 species of butterflies from 4 Families, such as Papilionidae ( 6 species) , Pieridae (6 species), Nymphalidae (18 species), and Lycaenidae (3 species). Plant resource distribution may be of critical importance in butterfly population For instances, several plot sampling areas still have enough food for butterflies. Therefore, through this study it is necessary to keep the process of campus development should be always in the ecological balance. Key words: Butterfly; population; plant; resources.

**P-08-19: Butterfly (Rhopalocera: Lepidoptera) Diversity: Potentials and Challenge for Biotic Conservation in Anak Gunung Krakatau**

Tati S. Syamsudin<sup>1</sup>, Endang L. Widiastuti<sup>2</sup>, Nismah Nukmal<sup>1</sup>; 1. *School of Life Sciences and Technology ITB*, 2. *Department of Biology UNILA*

After big eruption of Mount Krakatau on 1883, the Krakatau ecosystem is one of the working hypothesis and example of succession and island biogeography theory. Since 1927, the emergence of Anak Gunung Krakatau above the sea was the result of submarine volcanic activity followed by the dynamic of geo-ecological process and biotic colonization became a unique tropical coastal rainforest system. The objective of this research was to study butterfly diversity in Anak Gunung Krakatau and its potential as ecotourism object. Survey in Anak Gunung Krakatau was conducted on different period of visits (March, May and September) on the year of 2005, 2006, 2007 and 2008. The results found that *Troides helena* and *Pachliopta* sp was the most attractive butterfly for ecotourism object. *T. helena* is one of the butterfly species protected under decree of ministry of forestry and never recorded before in this island. The colonization of these butterflies in Anak Gunung Krakatau was supported by the availability of the host plant such as *Aristolochia tagala* and other plants in the coastal forest area. Although Mount Krakatau and its surrounding has a status as a world natural heritage since 1990 by the UNESCO, the opportunity and challenge for conservation of Anak Gunung Krakatau as a geo-eco tourism object still needed for the sustainability of this unique ecosystem.

**P-08-20: Edible Lepidoptera in Papua**

Euniche R.P.F. Ramandey<sup>1</sup>, Henk van Mastrigt<sup>2</sup>; 1. *Biologi Department, Faculty of Mathematics and Sc.*, 2. *Kelompok Entomologi Papua (KEP)*

In general, insect foods are well-known as a protein source in Indonesia, especially in Papua. That province is equatorial in latitude and consists of lowland, hill and mountain habitats up to 2,300 m. About 80-100 insect species are eaten by indigenous people. Most of them are member of Lepidoptera (more than 51 species). The choice of edible Lepidoptera is focused on larger insects which do not need special equipment to capture and which are edible raw or after some roasting. Among large Lepidoptera, preferences are variable from tribe to tribe, probably based upon taste, abundance and custom. In Papua, there is broad indigenous knowledge of edible insects, reflected in local language insect names, traditions and insects habitats. In the lowlands, edible insect populations are being reduced because of deforestation. In the mountainous areas, economic development is providing alternative animal protein sources, but incidental food insect collecting is expected to continue and could be promoted as additional scientific information becomes known. Key words: Edible, Lepidoptera, Papua

**P-08-21: Does Intensive Apiculture Using Alien European Honeybee, *Apis mellifera* in Indonesia Harm to Local Species of Honeybees?**

Kasno; *SEAMEO BIOTROP*

Oriental honeybee as well as Giant honeybee are native but Western honeybee (*Apis mellifera*) is alien to Indonesia. The Western honeybee has been spread out most of subtropical and tropical countries due to its higher honey productivity. In Indonesia the honeybee has been the most dominant in Java. Small amount colonies of the species are kept on the other main islands namely Sumatra, Kalimantan, Sulawesi and Papua. Aside of alien species to Indonesia, the European honeybee has higher potential to breed. Under favorable conditions, a mated queenbee of the species may produce more than 1000 progenies daily for more than 2-3 years of life. In other side, the local honeybees namely *Apis dorsata*, *A. cerana*, *A. koschevnikovi* as well as *A. nigrocincta* have lower rate of increase. Both of native and exotic honeybees explore the same food resources in term of nectar and pollen. The establishment of Western honeybee mainly in Java may invite a worry that the species will harm to the native honeybees. Such worry is logically accepted but almost all colonies of

Western honeybee are under controlled by beekeepers. The number of colonies or population of the species is much reduced during deplete condition.

**P-08-22: Daily Pollen Collecting Activity and Pollen Identification of *Apis cerana* in Traditional Apiaries in Bali**

Lilik Muntamah, Rika Raffiudin, Endah Retno Pallupi; *Bogor Agricultural University (IPB)*

*Apis cerana* is the most important Asian honey bee in traditional apiaries in West Bali Forest. The research was aimed at studying the daily pollen collecting activity of *A. cerana* and pollen identification from traditional apiaries in two villages around West Bali forest, Sumber Klampok and Melaya. The activity of *A. cerana* that lasted for 12 and a half h, was started at 05.50 and terminated at 18.30. Daily activity of *A. cerana* varied between colonies. The peak pollen collection in Melaya occurred at 07.20-09.20 h earlier than the one in Sumber Klampok which occurred at 10.20-14.50 h. The daily activity of *A. cerana* in Sumber Klampok was more affected by the weather than the one in Melaya. Pollen was collected using pollen trap and then acetolyzed. In all colonies, 19 pollen types from 12 families were found, and 3 types were unable to be identified. Pollen of coconut (*Cocos nucifera*) and *Leucaena leucocephala* were the dominant pollens found in all colonies. Daily pollen collecting activity related to number of pupae in colony. In general, the daily activity of *A. cerana* in Melaya represented the traditional apiaries in Bali.

**P-08-23: The Effect of Temperature on Development of *Bactrocera papayae* Drew & Hancock (Diptera: Tephritidae) under Laboratory Condition**

Agus Susanto<sup>1</sup>, Tati S. Syamsudin<sup>2</sup>, I Nyoman Raga ; *1. SITH - ITB, 2. SIH - ITB*

Fruit flies, *Bactrocera* spp. (Diptera : Tephritidae) are major potential pest fruits and vegetables. The objective of this research is to find out immature development of papaya fruit fly (=PFF, *Bactrocera papayae*) on different temperature under laboratory condition. PFF collected from *B. papayae* colony and were reared on mango fruit. Each stage of immature development (eggs, larvae and pupae) were collected and separated. Experiments were conducted in incubator by placing fifty individuals of each stage at six different temperatures (10, 20, 25, 30, 35 and 40°C). Survivorship and development periods of each treatment were observed every two hours (for eggs stage) and for larvae and pupae were observed everyday's. The results showed that 70.5% of eggs were hatched after 32.83 hours at 25 °C. 56% of the larvae population was pupate during 25.79 days at 20°C. However, at 25 °C, 49% of pupation found during 11.12 days and at 30 °C, 48.5% of pupation found during 11.44 days. Most of the pupae (89.76%) were exclosed during 10.43 days at 25 °C. It is hope that these results will be useful for rearing optimization in the laboratory and for quarantine control office. Key words: *Bactrocera papaya*, temperature, development

**P-08-24: The Decline of *Ornithoptera paradisea arfakensis* (Lepidoptera: Papilionidae) Population in Mokwam Village, Arfak Mountains Resulting from Human Environmental Disturbance**

Daawia<sup>1</sup>, M. Muehlenberg<sup>2</sup>, R. Willman<sup>1</sup>; *1. University of Cenderawasih, 2. Georg-August University of Goettingen*

*Ornithoptera paradisea arfakensis* is one of the endemic birdwing butterflies (*Ornithoptera* species) in Papua which have a limited area of distribution. The population of this butterfly is decreasing continuously. The survey of the *O. p. arfakensis* population in Mokwam Village was conducted at several habitat types including primary forest, fragmented forest, mature secondary forest and cultivated area (i.e. gardens) in November 2009. This survey used "distance sampling" on a line transect and the data were analyzed using "Distance Program 5.0". The result showed that logging and shifting cultivation practices in Mokwam Village may have been responsible for habitat fragmentation that contributed to population declining of most of the *Ornithoptera* species, including *O. p. arfakensis*

in this village. Unfortunately both sexes were very rare and are therefore not easy to observe in fragmented forest. *O. p. arfakensis* males preferred to fly high around forest trees while the females sometimes even appeared in the gardens to lay eggs on the foodplants and drink nectar from flowering plants such as *Mussaenda* and *Rhododendron culminicola*. The average density of *O. p. arfakensis* in the gardens was 4.58 per ha. Both sexes preferred to occur in mature secondary and primary hill forest. The densities of *O. p. arfakensis* in the mature secondary forest and primary forest were much higher with an average density of 7.67 per ha and 8.51 per ha consecutively. Aside from logging and shifting cultivation activities, international butterfly trade seems to be another threat for the existence of *O. p. arfakensis* in the Arfak Mountains. Keywords: population decline, endemic species, distance sampling

**P-08-25: The Impact of Land-use Intensification on Ant Diversity and Composition in Southeast Sulawesi, Indonesia**

Asfiya; *University of Western Australia*

The once extensive rainforests of Southeast Asia are rapidly being lost due to deforestation and conversion to agriculture. Intensification of land management practices has a substantial negative effect on arthropod diversity, and an increasing number of studies are testing whether lower intensity land-uses, such as agroforestry, might give better biodiversity outcomes in managed landscapes. However, other evidence suggests that there are conflicting indirect effects of agroforestry management on native species, particularly due to the invasion on non-native species. The aim of the work is to investigate the impact of land-use intensification on the ant diversity and composition in the Mekongga Mountains, Southeast Sulawesi, Indonesia, where there is a range of differing agroforestry management practices. The study will test whether ant diversity has been affected by intensification of land-use management, and whether patterns of species loss are random or non-random. Finally, the study will test whether land-use intensification promotes the colonisation and/or establishment of invasive or ‘tramp’ ant species.

**Poster session: Ornithology (#09; July 20)**

**P-09-1: A Comparison of Foraging Success among Five Syntopic Species of Obligate Army-ant following Birds from Amazonian Peru**

Susan K. Willson, April Costa, Ivan Ramler, Richard Sharp; *St. Lawrence University*

We examined syntopic obligate army-ant following bird species from two families (Thamnophilidae: *Gymnopithys salvini*, *Phlegopsis nigromaculata*, *Rhegmatorhina melanosticta*, *Myrmeciza fortis* and Dendrocolaptidae: *Dendrocincla merula*) in Amazonian Peru to determine if interference competition among them affects individual foraging success. We tested three hypotheses: 1) the strict dominance hierarchy among the five species would translate to a linear decline in foraging success across species, with dominant (aggressive) birds being more successful foragers, 2) body mass is directly proportional to foraging success, and 3) the five species would show no difference in foraging success due to the ephemerality of the food source. In the field we observed inter- and intraspecific interference aggression between foraging birds at *Eciton burchellii* and *Labidus praedator* antswarms. We recorded ‘successes’ as when a given bird successfully caught a food item over a fixed observation period (approximately 1-4 minutes). We aggregated individual foraging successes into standardized blocks of time (100-500 seconds) in order to calculate a mean foraging success rate per species. We found that the woodcreeper *D. merula* had a significantly lower ( $P < 0.05$ ) foraging success than all of the other four species. As a confirmed follower of both army ants and White-lipped Peccaries (*Tayassu pecari*), we suggest that *D. merula* individuals must be foraging over White-lipped Peccaries for the other fraction of their food intake at this site.

**P-09-2: The Study on Montane Birds in Two Mountains of West Sumatra**

Janra, M. Nazri<sup>1</sup>, Novarino<sup>2</sup>, Gusman<sup>3</sup>, Aadrean, Graduate School in Andalas University; *1. Biology department in Andalas University, 2. Wilson, 3. Biology department in Andalas University*

The extreme condition of montane area in Sumatra have let this remarkable localities lay in such rarity of research efforts, including for their bird inventory. Based on the data from several previous works, the study on montane birds in two prominent mountains in West Sumatra, Mt. Merapi (2,891 m asl) and Mt. Singgalang (2,877 m asl). Each of three sites in Mt. Merapi and four in Mt. Singgalang had been surveyed within five consecutive days in the range of June to October 2009. As many as 12 mistnets (150 m in total) were set to catch lower to middle canopy cryptic species. The study found as much 230 individuals from 37 species, detailed as 170 individuals of 31 species from Mt. Merapi and 68 individuals of 17 species in Mt. Singgalang. We used Shannon-Whinner index to measure diversity index amongst study sites. Site I in Mt. Merapi is the highest with 2.34, while the lowest one 1.67 was in Site III in Mt. Singgalang. Grey-throated Babbler (*Stachyris nigriceps*, Timaliidae) was the species with the highest relative abundance in all study sites, range from 15.39%-41.67%. This initial study also raises hope for the finding of exotique species in Sumatra, such as Bronze-tailed Peacock-pheasant (*Polyplectron calchurum*), Pink-headed Fruit-dove (*Ptilinopus porphyreus*), Sumatran Trogon (*Apalharpactes mackloti*), Shiny Whistling Thrush (*Myophoneus melanurus*) and Sunda Whistling Thrush (*M. glaucinus*). We also notice the possibility for mointain lines along Sumatra to destination of migrant species by the finding of Japanesse Sparowhawkn (*Accipiter gularis*) and Siberian Thrush (*Zoothera sibirica*).

**P-09-3: Preliminary Study of Bird Species as Indicators in Disturbed Lowland Forest Habitat and Undisturbed Lowland Forest Habitat in Research and Education Center Way Cangkuk, Bukit Barisan Selatan National Park, Lampung**

Annisa Fauziah, Enung Azizah M., Savitry Pandu Wijaya, Dimas Haryo Pradana, Eka Desi Lestari; *University of Indonesia*

A preliminary study has been done on birds species as indicators of disturbed and undisturbed habitat in Research and Education Center Way Cangkuk, Bukit Barisan Selatan National Park, Lampung. Observation area is divided into 2 habitats, disturbed lowland forest habitat (40 Km<sup>2</sup>) and undisturbed lowland forest habitat (40 Km<sup>2</sup>). Data retrieval is done by using the point count method along the lines of observation. The results showed that the birds have been found as many as 33 species belong to 20 families at the observation locations. Of these 33 species, including 27 species found in undisturbed lowland forest habitat, and 20 species found in disturbed lowland forest habitat. The similarity index of both habitats are 0.426. *Platysmurus leucopterus* has the highest relative abundance in disturbed habitat (0.061). Whereas the highest relative abundance in undisturbed habitats is *Pitta guajana* (0.081). The results showed that both species can be used as an indicator species, but need to do further study. Keywords: bird indicator species, habitats disturbed, undisturbed habitats, Cangkuk Way.

**P-09-4: Bird Sex-biased Dispersal and Implications for Functional Connectivity**

Marcelo Awade, Carlos Ernesto Candia-Gallardo, Cintia Cornelius, Jean Paul Metzger; *University of São Paulo*

Animal dispersal is a key process ruling population dynamics. Dispersal affects the habitat connectivity for a species, altering population demography and genetics. Inter-patch distance is one of the key factors that may limit the dispersal success in fragmented landscapes. Furthermore, this process should be sex-biased for some species and, in such cases, management decisions must account for this gender differences. Using radiotelemetry and translocation experiments, we assessed if the dispersal behavior of an endemic rainforest bird (*Pyriglena leucoptera*) is affected by inter-patch

distances and sex. We analyzed three response variables concerning, entirely or partially, all the three stages of the dispersal process (emigration, transfer in the matrix and immigration). Results showed that dispersal movements are strongly affected by the inter-patch distance. Increasing distance reduced the probability of emigration and increased the time spent in the patch. Dispersal was sex-biased, since females presented both a higher emigration impetus and a higher efficiency during the inter-patch movements (only males were predated in the matrix). Thus, to investigate the effects of dispersal on the population dynamics considering just the immigration rates could be misleading. Both the lower emigration propensity and the higher predation risk in the matrix are essential factors to access the male's lower ability to make connections in the landscape. As a consequence, in highly fragmented landscapes it is expected that the colonization rates of empty patches may decrease, as many patches may be accessible only for females, reducing the species incidence in the landscape. Thus, we suggest that management of highly fragmented landscapes must be addressed by restoration practices aiming the intensification of the species dispersal flux, considering sex-biased movement restrictions.

#### **P-09-5: The Efficacy of Degraded Forest Reserves in Conserving Understory Birds of Primary Forest**

Zubaidah Ya'cob, Rosli Ramli; *University of Malaya*

Clearance of tropical forest either for timber exploitation or plantation establishment is considered as a serious threat for forest biodiversity. This study intends to investigate the ability of two secondary forests in Peninsular Malaysia in providing habitat for the survival of understory bird particularly primary forest species. To achieve this, a series of monthly visits (from January to December 2007) were conducted to two forest reserves in Peninsular Malaysia, i.e. Kenaboi Forest Reserve, Negeri Sembilan (KFR) and Ulu Gombak Forest Reserve, Selangor (GFR). During each visit, twenty mist-nets were setup for three consecutive days from 0900 hours until 1800 hours and were checked every hour for trapped birds. A total of 1482 birds that belong to 120 species were captured, identified, ringed and measured. More birds were captured in Kenaboi Forest Reserve (1077 individuals, belong to 109 species and 26 families) than Ulu Gombak Forest Reserve (405 birds, belong to 62 species and 16 families). Interestingly, the total captures also include 28 nearly threatened species (24 species recorded in KFR and seven species were trapped in GFR) and two vulnerable (VU) species (presence in both reserves). This indicates that both forest reserves possesses valuable habitat even after undergo severe disturbance resulted from logging activity. A total of 27 primary forest species were caught in both reserves (25 species in KFR and 19 species in GFR). The presence of these species in secondary forests are due to; a) both forest reserves are old growth forest, b) plentiful but fluctuating resources allow birds to utilized it on temporary basis, and c) some forest species are attracted to utilized forest trails and bamboo forest habitat.

#### **P-09-6: Fire Effects on Avifauna in Australian Heathlands: Approaches, Patterns and Conservation**

Eduardo Gallo-Cajiao, Culum Brown, Graham H. Pyke; *Macquarie University*

Altered fire regimes are a major threat to birds inhabiting Australian heathlands. Despite reviews which have examined fire effects on birds in this ecosystem, no work has been comprehensive or up to date. Therefore we considered the subject by analyzing the approaches implemented, synthesizing the available results, and discussing conservation implications. We found twenty-two non-experimental studies approached in different ways: observations pre and post-fire, comparison of sites at different times since the last fire, and long-term monitoring involving multiple fires. The first two approaches have been useful for understanding the effects of single fires. However, these present significant caveats due to the lack of replication and differences in fire histories across sites. The last approach has disentangled the long-term effects of fire on populations, unveiling behavioral interactions. Unfortunately, the logistics and economic costs implied make it the least adopted option. These studies show direct and indirect fire effects on birds. The former is given by death due to

conflagration whereas the latter refers to spatial rearrangement caused by vegetation changes. Fire in heathlands results in a “bird succession” with three main patterns: temporal disappearance, temporal colonization, and resilience. Since European settlement these patterns have been disrupted, with more extensive and frequent fires, leading to population declines. Although heathlands are fire-dependent, there is no consensus about fire use for conservation resulting in a “to burn or not to burn” debate. This discussion arises from studies adopting different approaches with different temporal and spatial scales. Although there is an imminent need for further research, enough empirical evidence has been accumulated to understand the key ecological processes related to fire effects on birds. One of the remaining challenges is to bridge the gap between science and conservation practice.

**P-09-7: Distribution of Black-shouldered Kites (*Elanus caeruleus*) in Carey Island, Selangor, Malaysia**

Aimi Fauzi, Rosli Ramli; *University of Malaya*

Black-shouldered kite (*Elanus caeruleus*; Family Accipitridae) is a small raptor that feed on small vertebrates including rodents. The bird has been proposed as biocontrol agent for rodents in oil palm plantation to complement Barn Owl (*Tyto alba*). Unfortunately scientific information on this bird is lacking although general information is available. To initiate information gathering process, this study intends to document distribution pattern and population size of Black-shouldered kite in Carey Island, Selangor, Malaysia. The island is dominated by oil palm plantation but also has other habitats such as shrubs, mangrove patches, biodiversity plot, and human settlements area. Direct observation technique using binoculars, telescope and video camera was made along estate roads throughout the island to survey Black-shouldered kite from April to December 2009. Whenever the bird was spotted, its location and activity were recorded. It is estimated that approximately 300 individuals of Black-shouldered kite are present in the island, mostly in oil palm plantation followed by mangrove and residential areas. Perching and flying (including hovering) are the most common activity conducted by Black-shouldered kite. Judging from population size and distribution pattern, the bird has great potential to be used as bio-control agent. However further study on feeding ecology and reproductive behavior need to be done before proposal can be made.

Keywords: Black-shouldered kite, oil palm plantation, coastal area

**P-09-8: Diversity of Understory Birds in Logged and Virgin Jungle Reserve of Triang Forest Reserve, Negeri Sembilan, Malaysia**

Ezyan Nor Hashim, Rosli Ramli; *University of Malaya*

ABSTRACT A study of understory bird's diversity was conducted in Triang Forest Reserve, Negeri Sembilan, Malaysia. The aim of the study was to document the diversity of understory birds in logged forest and virgin jungle reserve (VJR). Mist-netting method was used to record the understory bird's species richness. Monthly sampling had been done from November 2008 to December 2009. A total of 85 species with 959 individuals of birds from 23 families were captured. Seventy species of birds represented by 628 individuals were captured in logged forest while 52 species of birds represented by 331 individuals were captured in VJR. Little spiderhunter (*Arachnothera longirostra*) from the family Nectariniidae was the most abundant species in both forests. The highest number of species captured in both forest types was babblers (Timaliidae). Chestnut-winged babbler (*Stachyris erythroptera*) was the most abundance species from family Timaliidae captured in logged forest (21 individuals). Grey-throated babbler (*Stachyris nigriceps*) and Grey-headed babbler (*Stachyris poliocephala*) was the highest species from Timaliidae represented in VJR with six species. Keywords: virgin jungle reserve, logged forest, understory birds, babblers

**P-09-9: The Effects of Group Size on Nesting Success in the Cooperative Breeding Puff-throated Bulbul (*Alophoixus pallidus*)**

Phetprakhai Wonkson, Tommaso Savini, George A. Gale; *KMUTT*

In many cooperatively breeding species the presence of helpers has been shown to have positive effects on the dominant breeding pair including: 1) increased survival of both breeding adults and their nestlings; 2) reduced breeder workload; 3) and/or an increased nestling feeding rate. For this talk we present data focusing on the influence of the number of helpers on nestling survival, nestling feeding rate and breeder workload in the Puff-throated Bulbul (*Alophoixus pallidus*) in evergreen forest in northeastern Thailand. We collected data on 143 nests of 41 breeding groups during 3 breeding seasons (2007-2009). Contrary to predictions, neither feeding rate per nestling nor daily nestling survival was significantly related to the number of helpers in a group. However, in the groups with helper(s), the workload of the breeding adults in terms of provisioning food to the nestlings was reduced. Also, groups with helper(s) delivered significantly more insects and therefore presumably more protein to nestlings than groups without helper(s). We hypothesize that helpers are largely unable to reduce nestling mortality which is mostly caused by large predators, but may increase breeder survival by reducing their workloads.

**P-09-10: Diversity of Understory Birds in Selected Primary and Logged Forests in Peninsular Malaysia**

Norlelah Hassan, Rosli Ramli; *University Of Malaya*

Abstract. Logging activity had significantly contributed toward changes in habitat structure of many Peninsular Malaysia forests. Besides than timber extraction for commercial purpose, forests were also cleared for establishing human settlements or commercial crops such as oil palm and rubber trees. Deforestation by logging affects diversity and abundance of birds in particular forest. In this study, diversity and abundance of understory bird of both primary and logged forests were compared. Several field visits have been conducted to three selected forests than have both type of forests from August 2009 until January 2010. The forests are Johor National Park (Kg. Peta, Johor), Berembun Forest Reserve (Negeri Sembilan), and Pasir Raja Forest Reserve (Terengganu). In each visit 20 mist-nets were setup from 0800 hours until 1800 hours and were examined hourly for captured birds. A total of 266 birds which belong to 60 species were captured. Primary forest recorded more species (46 species) than logged forest (32 species) and 18 species were shared by both forests. Little Spiderhunter (*Arachnothera longirostra*) was the most abundant species in this study; accounts for 26% of birds recorded in primary forest and 31% of birds captured in logged forest. Simpson's Index showed that birds in primary forest are more diverse than logged forest (11.4 and 7.737 respectively). Results strongly suggest that forest disturbance and habitat degradation are two major factors that caused changes in wildlife community and species decline. Deforestation had deteriorates forest habitat, limiting food resources, and reducing environmental quality which forced understory birds to disperse to other habitats. Keywords: mist netting, forest resources, habitat structure, forest reserves.

**P-09-11: Tropical Forest Complexity and Specialized Frugivores Birds, Fine Tuning the Interactions in an Atlantic Rainforest Region of South Brazil**

Bernardo Clausi; *Research in ecology, myrtilau.com*

The tree diversity in the atlantic forest is a world record holder with 450 species per hectare in south Bahia state. In the southern states the pattern holds around 250 species per hectare. These complex communities take time to build up as a succession of seeds being deposited around, mostly deposited by bird species, as around 90% of the trees species produces small fleshy fruits. I tried to figure out the direct relation between two Cotingidae species with the complex fruit production pattern of fleshy fruited trees. These two species being the hooded berryeater *Carpornis cucullatus* and the bare throated bellbird *Procnias nudicollis*. A total of 05 different areas were evaluated. Two of these with the two species (at 900m a.s.l.), one with only the berryeater (750m a.s.l.), one with only the bellbird (fragment at 900m a.s.l.) and one without both species (smaller fragment at 900m a.s.l.). The diversity of the tree assemblages were analysed with the number of ripe fruiting trees species in a determined



period of the year, being subdivided in groups of two months. The two areas with both species shared the same tree community. The one with only the berryeater and the one with only the bellbird showed some differences in the community but could be explained by the difference in altitude. If compared the areas at the same altitude (900m a.s.l.) where both species occurred and where only the bellbird occurred a significant amount of trees were not present in the latter (at least four species). If compared the area where only the bellbird occurred with the area where none occurred a much more significant difference in the forest community occurred with at least 10 tree species not encountered in the fragment. Showing that without both species the natural regeneration of the Forest is endangered for many tree species and also for the density of tree species abundance against diversity.

**P-09-12: Differences in Bird Community Structure Resulted from Habitat Change in Ujung Kulon National Park**

Suriyanto, Irfan Fitriawan, Rizki Ramadhan, Arum Albuntana, Arief Fuadi Rizki; *University of Indonesia*

Ujung Kulon National Park is one of the few protected areas in western region of Java which is threatened by habitat destruction as a result from forest conversion. Difference in bird community structure resulted from habitat change was studied in three areas (Tanjung Lame, Legon Pakis, and Cibiuk) of Ujung Kulon National Park in July 2008. IPA method was used. Forty three species of birds included 24 families were recorded. Species biodiversity index ( $H'$ ) of the birds in Cibiuk river, Tanjung Lame, and Legon Pakis were 2,885, 2,261, 1,674. Based on Sorensen's Similarity Index, Tanjung Lame was more similar to Legon Pakis ( $S=0,385$ ). Based on the result, we know that the high biodiversity index indicates the habitat is still good or undisturbed. Key words: Habitat; bird community structure; Ujung Kulon National Park.

**P-09-13: Effect of Land Use Type on Bird Community in Gunung Kidul Regency, Province of Daerah Istimewa Yogyakarta**

Sandy Nurvianto; *Faculty of Forestry, Gadjah Mada University*

Land use changes from forested to non-forested areas for human interest have caused the avifauna population degradation in the world for years. The effective avifauna conservation plan developments need the assessment concerning the function of the human modified habitat that supports the priority species. This research was executed to examine the effect of land use type on bird community in Gunung Kidul Regency, Province of Daerah Istimewa Yogyakarta. Point count method with 50 m fixed radius was employed to identify bird community and quadrat nested sampling method was employed to measure the habitat variables in whole of research sites. The data was collected in the three observations periods; dry season, peak of dry season and wet season. The result of the research showed that the differences of community composition that occurred in the different land use type in the same season and the same land use type in the different season is caused by the differentiation on the vegetation structures and compositions ( $P<0.05$ ). The multi regression analysis on the three observations data showed that grasses, seedlings and trees density per ha gave significant effect on the birds density in the whole of research sites ( $P<0.001$ ). This result show that vegetation condition is the important habitat factor that influenced the occurrences of avifauna in all land use types. Key words: land use type, bird community, vegetation structure and composition, season, Gunung Kidul Regency.

**P-09-14: Swiftlet Birds (*Aerodramus fuciphagus*) Role Formation of Red Nest Color**

Sunu Kuntjoro, Tati Subahar S. Syamsudin, Achmad sjarmidi, Ani Mardiasuti; *Institute Technology Bandung*

The trades of edible bird's nest worldwide come from two different colors of nest i.e., the red nest and white nest. Economic value of red nest more expensive than the white nest. Unfortunately, much is still unknown about the development and formation of the red nest. The purpose of this study is to

know the process of red nest formation on swiftlet bird's (*Aerodramus fuciphagus*) naturally. Direct observations were carried out periodically in the two swiftlet houses during nest formation period in Mojokerto and Lamongan districts - East Java. Color formation was measured manually by comparing with standard color in colorimetric method. The results showed that red nest formation occurred gradually. It was started from white nest and after 5 weeks of observation the color of the nest change to light yellow (560 nm); after 7 weeks dark yellow (600 nm); after 9 weeks orange (640 nm) and after 15 weeks became red (650 nm). From the two populations studied there were no significant different in population characters such as development of nest size, egg number, nest biomass, incubation periods and nestling periods. Keywords: swiftlet bird (*Aerodramus fuciphagus*), red swiftlet bird nest

#### **P-09-15: Bird Community Structure in Karimunjawa Islands, Central Java**

Niarsi M. Hemelda, Umami S. Khusnuzon, Putri S. Pangestu, Bramantya Prayoga; *University of Indonesia*

Bird community structure in Karimunjawa Islands, Central Java, had been studied during August 2009. The aims of the study were to find out the diversity of birds and the similarity among its habitats. The observation area which has wide 1285,50 hectares were divided into 7 areas as Legon Lele forest, Nyamplungan forest, Karimunjawa village, Legon Lele village, Cikmas fish pond, Jatikerep fish pond, and Terusan shoreline. Birds were counted by point count method along existing trails. Thirty nine species of 19 Families were recorded in seven areas. *Pycnonotus goiavier* has the highest Abundance Index in Karimunjawa village and Nyamplungan forest. Bird with the highest abundant value in Legon Lele forest, Legon Lele village, Cikmas fish pond, Jatikerep fish pond, and Terusan shoreline is *Orthotomus ruficeps*, *Lonchura leucogastroides*, *Lonchura punctulata*, *Halcyon chloris*, and *Numenius arquata* respectively. *Pycnonotus aurigaster* and *Numenius arquata* were found as new records. *P. aurigaster* was considerably an introduction species. *N. arquata* is a vagrant species in Karimunjawa Islands, but it is possible to find it because it is a non-breeding visitor to Java and coastal area that found to be the suitable habitat for the bird. The Diversity Index of Legon Lele village was considerably highest among the other areas with indices of Shannon-Wiener value ( $H'$ ) 2.330607561. Cikmas fish pond and Legon Lele village were habitat with the highest Similarity Index from Sorensen (SS) 0.636364. Keywords: bird, point count, species diversity, indices of Shannon-Wiener value, abundance, habitat

#### **P-09-16: Correlates of Avian Resistance and Vulnerability in a Fragmented Rainforest**

Michael A. Patten, Brenda D. Smith-Patten; *University of Oklahoma*

The Selva Lacandona, a lowland tropical rainforest, once spanned a near-continuous swath of land in southeastern Chiapas, Mexico. Despite partial protection of the region, in the form of a biosphere reserve and various national parks and monuments, the Selva Lacandona is now fragmented considerably. Fragmentation is particularly rife at the selva's northern end, around Palenque National Park, site of famous Mayan ruins. Over the past century, 24 species have been extirpated at Palenque and populations of another 20 species have declined significantly. By contrast, populations of 14 species have increased at Palenque in the past century, and at least 16 species have colonized the area in that time. The pattern of which species are susceptible to extirpation and which are resistant to deforestation appears to be non-random, but a detailed analysis has not been undertaken. We conducted such an analysis, in which we assessed population trends (taken as the slope from a logistic regression of presence/absence data for each species from 1900–2009) for 212 bird species that have bred at Palenque with respect to that species' life history, ecology, morphology, and phylogeny. Species with a large body size, small forest insectivores, and canopy frugivores were the most vulnerable to habitat loss, whereas savannah species and omnivores have taken advantage of human-

modified habitats. Future studies will explore specific processes by which species are rendered vulnerable.

**P-09-17: Altered Microclimate as a Mechanism for Avian Extirpation in Tropical Forests**

Brenda D. Smith-Patten, Michael A. Patten; *University of Oklahoma*

A number of studies in Neotropical rainforests have documented non-random species loss in the wake of deforestation. Why some bird species or guilds should be more vulnerable and others more resistant to habitat loss remains an important question. There is some evidence that dispersal is limited in tropical forest birds, and it has been suggested that tropical birds have large home range requirements. Another key hypothesis, one largely untested despite being posited several decades ago, is that tropical forest birds are constrained physiologically to the relatively humid, cool, and dark of a forest's interior and therefore cannot tolerate the drier, warmer, and brighter conditions that inevitably develop with increasing edge exposure. We laid groundwork for testing this crucial hypothesis with surveys in southern Mexico and northern Belize. We established a series of transects perpendicular to forest edge. At 50-m intervals we censused birds within a fixed-radius and measured microclimate—wind speed and direction, relative humidity, ambient temperature, heat index, and light exposure from canopy cover—using a hand-held Kestrel 4500, a densiometer, and a light meter. Work is on-going, but preliminary data and analysis suggest, among certain forest birds, a distinct pattern of edge avoidance correlated with changes in microclimate.

**P-09-18: Long Distance Movements by Forest Hornbills in Cameroon: Implications for Congo-Basin Forest Conservation**

Thomas V. Dietsch<sup>1</sup>, Kimberly Holbrook<sup>2</sup>, Tony Chasar<sup>3</sup>, Henri Thomassen<sup>3</sup>, Francis Forzi, Tom Smith<sup>4</sup>; *1. Earthwatch Institute, 2. CSIC, 3. Earthwatch Institute, 4. UCLA Center for Tropical Research*

Until recent research in Cameroon, hornbills were thought to be sedentary primary forest residents with limited movements. These large-bodied fruit-eating birds help maintain biodiversity in African forests by dispersing the seeds for ~25% of forest tree species. However, hornbill food resources decline dramatically during the dry season. During this food lean period, there is an exodus of up to 90% of hornbills seasonally with reported movements up to 290 km from protected reserves into human-dominated forest landscapes in search of fruit. Consequently, hornbill survival and the key ecosystem services they provide depend on management activities outside protected areas. To better understand these movements, ten White-thighed Hornbills and four Black-casqued Hornbills were captured and outfitted with satellite GPS transmitters. White-thighed Hornbills moved on average nearly 100 km to the Northeast contrary to our original prediction that hornbills would move to the Southwest in the direction of greater precipitation. Black-casqued Hornbills made shorter distance movements of about 25 km. These data are providing new insights into the nature of long-distance movements made by the two largest seed-dispersing hornbills in this region of the Congo-basin rainforest. A better understanding of these movements and fruit resources used during this critical period will allow improved landscape management to help ensure that hornbills continue to maintain Africa's diverse forests.

**P-09-19: Effects of Corridors on Movement Behavior of a Rainforest Bird in Fragmented Landscapes**

Carlos E. Candia-Gallardo, Marcelo Awade, Cintia Cornelius, Jean Paul Metzger; *University of Sao Paulo*

Habitat corridors are the most popular approach to maintain connectivity in fragmented landscapes. Nevertheless, empirical evidence that corridors provide connectivity for rainforest organisms is lacking. Using experimental translocations combined with radio-tracking we evaluated the effects of

corridors and gender on interpatch movements of an understory bird (*Pyriglena leucoptera*, *Thamnophilidae*) endemic to the Atlantic forest. Individuals captured in continuous forest were released in forest patches smaller than the species' home range, considering two treatments: i) gap - patches completely surrounded by field matrices and ii) corridor - patches surrounded by field matrices but connected by a forest corridor to a larger fragment. One male and one female were released in each patch, not simultaneously. We measured the time birds remained in release patches (emigration propensity), the direction taken by dispersing individuals (dispersal direction), and the number of individuals that succeed in complete at least one interpatch movement (dispersal success). We found that corridors increased emigration propensity, directed dispersal towards nearest patches, and increased the number of individuals that succeed in performing interpatch movements. Among birds translocated to patches without corridors, males were more reluctant than females to cross patch-matrix boundaries, and females were twice as successful in performing interpatch movements. Nonetheless, both genders readily dispersed via corridors when such elements were present. Our results indicate that corridors enhance landscape connectivity for the studied species and are useful for its conservation in fragmented landscapes.

#### **P-09-20: King Vulture Foraging in an Anthropogenic Landscape**

Sandra Sibma, Tom Brand, Mathieu Charette, Sophie Calmé; *Van Larenstein Hall*

Species' tolerance to original habitat loss and fragmentation is closely linked to their capacity to use the modified parts of the landscape. We tested the propensity of King Vulture, a neotropical forest dweller, to use pastures and secondary forests for feeding. For this purpose, we placed 18 dog carcasses in mature and secondary forests, as well as in pastures, at 2, 8 and 32 km from the nearest permanent roost. The study took place in the Southern Yucatan, where forest still covers almost 80% of the landscape. We used trap-cameras to record the use of carcasses by King Vultures (yes or no), the delay (number of hours) before carcasses were used, the number of King Vultures feeding at the carcasses, and their age class. We used generalized mixed models to test the relationship between carcass use, delay before use, and number of King Vultures and the type of land cover where carcasses were placed. We included the distance to the nearest permanent roost as a covariable. We also verified whether adults and juveniles were using different sites for feeding. King Vultures fed more often at carcasses in mature than secondary forest, and more in secondary forest than in pasture, but this was a non significant trend. However, more King Vultures fed in mature and secondary forests than in pastures. Adult King Vultures detected carcasses first when they were close (<2 km) to roosts, but farther from roosts they relied on Turkey Vultures. Adults and juvenile King Vultures used the same feeding sites. This study shows that despite King Vultures can use anthropogenic landscapes, they tend to avoid the more disturbed parts of the landscape and prefer to exploit patches close to or within, forest. The existence of a forest cover threshold at which feeding rate drops remains to be uncovered.

#### **P-09-21: Composition and Diversity of Ramphastos Toucan Foraging Flocks at La Selva, Costa Rica**

Ryan E. Callahan, Michael A. Patten; *University of Oklahoma*

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 session: Herpetology (#10; July 20)

### P-10-1: Assemblages of Lizards and Amphibians in Two Types of Organic Shade-Coffee Plantations in Mexico

Belem Díaz, Ellen Andresen; *CIECO-UNAM*

Diversity of some groups of animals living in shade coffee plantations, such as birds and bats has been well studied. However, relatively little is known about the diversity and abundance of the herpetofauna in such systems. The goal of this study was to quantify the richness and abundance of amphibians and lizards in two kinds of shade coffee plantations, traditional polyculture and commercial polyculture, and in a forest site. The traditional polyculture plantations have a greater complexity in vegetation structure and composition, when compared to the commercial polyculture plantations. Six coffee plantations and one forest site were studied in the municipality of Cuetzalan, in the Sierra Norte de Puebla, Mexico. Abundance, richness and diversity of amphibians and lizards were evaluated using an active capture method. A total of 435 individuals were registered during ten sampling sessions, belonging to 21 species: 14 amphibians and 7 lizards. Abundance of amphibians and lizards did not show statistically significant differences between the two coffee-growing systems. Lower abundances of both amphibians and reptiles were observed in the commercial polyculture, when compared to the forest site. Observed species richness of amphibians and/or lizards was similar among the three habitats. However, in terms of amphibian estimated total species richness we observed the following pattern: forest > traditional polyculture > commercial polyculture. The commercial polyculture showed greater equitability, and as a consequence had higher values for the diversity index, when compared to the commercial polyculture and the forest. Shaded coffee plantations in this area of Mexico, where very little natural vegetation remains, constitute very important sites for the conservation of the herpetofauna.

### P-10-2: Herpetofauna Diversity at Bengkulu, Sumatra, Indonesia

Umilaela, Rosita Elianur, David P. Bickford, Djoko T. Iskandar, Dewi I. Roesma, Angga Rachmansah, Adi Prayogo, Dio A. Hadisaputro, Erawan Pialo; *Institut Teknologi Bandung*

Land conversion in Sumatra has been increasing rapidly in the recent years especially to palm oil, rubber, coffee, and cacao plantation. Bengkulu is one of capital province in Sumatra that is seriously affected by that activity and causing habitat loss. We performed survey on July, 2007 at Air Putih (540 m asl), Bukit Kaba (1300-1700 m asl), and Batu Layang (400-470 m asl) that were considered locally as good habitat in order to assess the herpetofaunal diversity as an indicator for environmental condition of the region. The total number of anuran, caecilian, and reptilian observed during our survey was 35, 2 and 24 species subsequently. In addition, we also obtained information of 13 fish species. As secondary forest, Air Putih is a better habitat compared to Batu Layang. It was shown by the total number of herpetofauna observed in Air Putih (40 species), in contrast to Batu Layang (24 species). Batu Layang needs more attention than Air Putih in order to conserve its habitat, as *Thaumatorhynchus brooksi* that has never been recorded since the original description, was found during our survey. Furthermore, Bukit Kaba with 15 herpetofaunal species recorded during the survey, also needs conservation priorities. Extensive farming in Bukit Kaba evidently caused poor herpetofaunal diversity of this area. However, some species from this location was considered as new species such as *Philautus* sp1, *Philautus* sp2, *Pedostibes* sp, *Bronchocela* cf. *crisatela* 2, and *Cyrtodactylus* sp2. Some conservation priorities should be managed to preserve those habitats such as evaluating “protected” forest status and conducting community environmental education.

**P-10-3: Activity of Frogs in the Brazilian Atlantic Rainforest: When are They Predominantly Active?**

Carlos Frederico D. Rocha, Siqueira, Ariani, Vrcibradic, D. M. Guedes, M. C. Kiefer, M. Almeida-Gomes, P. Goyannes-Araújo, V. Borges-Junior & M. Van Sluys; *Universidade do Estado do Rio de Janeiro*

In general, anurans tend to be nocturnal, though diurnal activity is characteristic of some groups. Studies on frog activity tend to deal specifically with calling (breeding) activity, with fewer cases where activity is assessed in a different way, particularly in community-scale surveys. In the present study we evaluate the general activity period of 68 frog species in anuran assemblages from nine Atlantic Rainforest areas in Rio de Janeiro State, southeastern Brazil, based on intensive field surveys. At each locality we employed similar sampling effort during diurnal, crepuscular and nocturnal transects (120 transects = 60 hours of search, being 40 per period or 20 hours of search/period/locality) searching for frogs (totaling 1412 transects in 706 hours of sampling). The data provided the richness of frogs active at each period of day and species specific abundance of active frogs at each period. We also pooled data from all localities for each period sampled (day, dusk and night) and estimated the proportion of frogs of each species active at each period based on the total number of individuals and on the number of species found during all surveys for that period. We recorded a total of 806 individual frogs from 68 species during the study. Species richness was highest at night (mean =  $11.3 \pm 4.8$  species; N = nine sites), intermediate at dusk (mean =  $7.9 \pm 3.5$ ), and lowest during the day (mean =  $4.0 \pm 1.9$ ). The total number of individual frogs found (all species pooled) was also highest during nocturnal (53.1% of the total) surveys and lowest during diurnal ones (14.4%). Analyzing each species separately, the number of individuals recorded was consistently higher at dusk and night for most species. Our study evidence a trend for crepuscular and nocturnal activity for most Atlantic Rainforest frogs, with few species having primarily diurnal habits. Those results may favor future studies of autoecology and conservation with specific species.

**P-10-4: Evolutionary Impacts of Invasive Cane Toads on Australian Crocodiles**

Ruchira Somaweera, Jonathan Webb, Mike Letnic, Rick Shine; *University of Sydney*

Cane toads (*Bufo marinus*) are large South American anurans currently spreading through tropical Australia; their toxins are fatal to many native Australian frog-eating predators, including freshwater crocodiles (*Crocodylus johnstoni*). Freshwater crocodiles have low physiological resistance to cane toad toxins, and consequently, some individuals can die following the ingestion of large cane toads. In certain parts of the northern tropics, cane toads caused massive population declines of freshwater crocodiles, with numbers declining by 77% following toad invasion. Currently, we do not know how long it will take for crocodile populations to recover following toad invasion hence determining whether the cane toad invasion selects for toxin resistant crocodiles, or selects for toad avoidance in crocodile populations may give insight to how soon populations may recover after invasion. If such changes occur rapidly (in a few years), then crocodile populations will likely recover quickly; if such changes take long-time periods to occur, crocodile populations will need to be carefully managed to ensure their long term survival. In this study we compared toxin resistance and feeding responses of freshwater crocodiles from toad free areas in Western Australia to areas which have recently been invaded by toads (Victoria River) and which have had cane toads for more than 10 years (Daly River) in the Australian tropics.

**P-10-5: Herpetofaunal Abundance and Diversity in Secondary Forests and Non-native Plantations in Hong Kong**

Yik-Hei Sung, Billy C.H. Hau, Nancy E. Karraker; *The University of Hong Kong*

Southern China has been extensively deforested over the past few centuries. In Hong Kong, approximately 450 km<sup>2</sup> of the land area is protected, and in these reserves, reforestation efforts have consisted of planting exotic tree species on degraded lands after intensive deforestation during the Second World War. Yet we have little understanding as to the effects of plantation forestry on herpetofaunal communities in Southeast Asia. In this study, we compared the herpetofauna between paired exotic plantations and secondary forests at four sites using visual encounter surveys along transects, coverboards, and pitfall trap arrays including drift fences and funnel traps.

Over 18 months, we conducted 266 visual encounter surveys, 6240 trap-nights using pitfall trap arrays, and regular checking of coverboards. We recorded 442 amphibians and reptiles (secondary forests: 242; plantations: 202) of 17 species (secondary forests: 12; plantations: 12). The two forest types were similar in terms of species richness, reptile abundance and species composition. However, secondary forests supported significantly higher total abundances of herpetofauna and amphibians. Of the three sampling methods used, drift fences with pitfall and funnel traps documented the highest abundance (n=310), followed by transect sampling n=114), while the coverboards sampled the fewest individuals (n=20). Pitfall trap arrays recorded the same diversity (n=14) as transect sampling, while coverboards detected the lowest number of species (n=5). Despite very low capture rates, coverboards revealed species not sampled by the other two techniques.

We found that secondary forests may be a more important habitat to herpetofauna especially amphibians in Hong Kong, and this result yields important implications for future forest management in the region. We propose to enrich our current exotic plantations by planting native species and provide more space for native tree species by thinning exotic trees in plantations to enhance the herpetofaunal assemblages in Hong Kong and southern China.

#### **P-10-6: Biodiversity of Amphibian and Reptiles from Labuan Bajau, Pini Island and Haloban-Asantola, Tuangku Island**

Reksa K. Robi; *University of Indonesia*

Study about biodiversity of amphibian and reptiles were conducted in Labuan Bajau, Pini Island and Haloban-Asantola, Tuangku Island. Both are from eastern island group of Sumatra. Survey were conducted in peat swamp forest and lowland forest from 12-27 July 2009. Visual encounter survey used as methods for sampling. Totally, 32 species of reptiles 9 species of amphibian were recorded during survey. There are 16 species of reptiles and 6 species of amphibian recorded in Labuan Bajau, 21 species of reptiles and 4 species of amphibian recorded in Haloban-Asantola, and 7 species of reptile with 2 species of amphibian recorded in both island. Biodiversity measurement using Shannon - Wiener index results 2,48 for Labuan Bajau and 2,96 for Haloban-Asantola. Beside of its diversity, Ecological factor in island habitat and impact from geological history to amphibian and reptiles community in eastern island groups of Sumatra also should be proposed in further studies. Both factor can cause great impact that lead to declination in amphibian and reptiles community in eastern island groups of Sumatra.

#### **P-10-7: Parental Care of Amphibians in Southeast Asia**

Sinlan Poo; *National University of Singapore*

In the past, studies of parental care in amphibians have been conducted with emphasis on species in Central and South America. This comes as no surprise, for the neotropics contain over 50% of all known amphibian species, and has both the largest number of species exhibiting parental care and the greatest diversity of modes of care. However, the high number of cases may be partially attributed to the fact that more studies were conducted in the neotropics compared to other tropical regions. Discussing the evolution of parental care, McDiarmid (1978) suggests that up to 10% of amphibians may exhibit some type of parental care. Still, despite the growing number of studies conducted in Southeast Asia, the proportion of species with parental care remains extremely low in this region. Only a few new reports have been made in the past several decades and even fewer studies examined

whether the observed behavior actually increased the survivorship of the offspring. Though it is possible that parental care simply did not evolve in as many amphibian species in this region, it is more likely that such behavior is present but not yet documented. The latter assumption is supported by some Southeast Asian species with characteristics, such as derived modes of reproduction, that are often found concurrently with parental care. In response, a novel approach to determine species that may have parental care can be found in Ecological Niche Modeling. Niche parameters of species known to exhibit parental care can be used to identify similar species that may be prone developing such behaviors. In doing so, focused investigations can be conducted on these species to increase our knowledge of parental care in Southeast Asian amphibians, leading to a better understanding of how parental care may have co-evolved with other behavioral and morphological traits, and, in turn, help reveal the original selective factors and processes that contributed to the evolution of parental care.

#### **P-10-8: Molecular Phylogeography, Species Boundaries, and Conservation Status of Mindanao River Toads**

Marites Sanguila<sup>1</sup>, Cameron D. Siler<sup>2</sup>, Arvin C. Diesmos<sup>1</sup>, Olga M. Nuñez<sup>1</sup>, Rafe M. Brown<sup>3</sup>; *1. Fr. Saturnino Urios University, 2. University of Kansas, 3. University of Kansas*

Taxonomists have considered Philippine toads of the genus *Ansonia* an unremarkable pair of species from Mindanao. The most recent taxonomic assessments have considered Mindanao populations as most likely representing two species (*A. muelleri* from eastern Mindanao, and *A. mcgregori* from the western portions of the island). The most recent IUCN assessment classified both Philippine *Ansonia* as “Vulnerable” because of specific threats to their preferred habitat, but the presumed widespread distribution of the two species prevented their elevation to higher threat categories. We used molecular phylogeographic analyses of two mitochondrial gene regions to investigate species boundaries of these Mindanao river toads. Our data strongly reject the hypothesis of two species (with an east-west split between them) and instead diagnose a minimum of between four and eight highly divergent evolutionary lineages that we presume will be recognized as species. The majority of the putative species breaks are associated with low elevation valleys of Mindanao, suggesting that the complex topography of the island has contributed to the evolutionary process of diversification. Our data emphasize the need to reevaluate the conservation status of many Philippine amphibians in order to incorporate new distribution data into conservation status assessments of the country’s endemic amphibians.

#### **P-10-9: A pH/Temperature Synergism in Amphibians**

Daniel Ng, David Bickford; *National University of Singapore*

Many amphibian populations are declining worldwide. With industrialisation in many parts of Asia, acid deposition is rapidly increasing. The global average temperature experienced is on the rise with global warming. Research has revealed that both acid rain and global warming are factors that can drastically impact amphibian populations. In this study, survival and developmental time of Dark-sided chorus frog (*Microhyla heymonsi*) was investigated under a 2 by 4 experimental design under two temperatures (control and +3oC) and four pHs (control, 4.5, 4.0, 3.5) with replicates for location and clutch effect controls. Larval mortality is 100% at the lowest pH under both temperature regimes while survival is considerably higher for all other treatments. Synergistic effect between low pH and higher temperature significantly decrease larval survival compared with either factor alone was experimentally confirmed. Higher temperature hastens embryonic development while low pH impairs it. This study highlights the fact that different stressors can potentially interact to detrimentally impact their survival and projects that acid precipitation coupled with global warming will have grave implications to the regional amphibian populations in the near future.



## Poster session: Primatology (#11; July 22)

### P-11-1: Effects of Environmental Variation on Calling Frequency in Javan gibbons (*Hylobates moloch*)

Soojung Ham<sup>1</sup>, Susan Lappan<sup>2</sup>, Dones Rinaldi<sup>1</sup>, Jae Chun Cho<sup>1</sup>; 1. *Ewha Womans University*, 2. *Appalachian State University*

The Javan gibbon is an endangered primate found only in intact forest areas in the western and central regions of Java. We investigated 2 habituated Javan gibbon groups from July 2009 to February 2010 using a combination of behavioral observations and ecological monitoring in the Gunung Halimun-Salak National Park, Indonesia. This is the largest remaining mountainous tropical rain forest in the whole of West Java and is believed to harbor the largest remaining population of wild Javan gibbons. While most gibbons produce vocal duets involving both adult males and females, Javan gibbons (*Hylobates moloch*) are distinctive because adults of each sex sing separately, with females producing the most songs. The goals of our study are to collect ecological information about the gibbon's habitat, to examine the factors affecting calling frequency such as weather and food availability, and to estimate population abundance and distribution using vocalization surveys for conservation management. Monthly maximum and minimum temperatures showed no significant variation, but maximum temperature tended to decrease in the rainy season. Mean annual rainfall in the study area was over 3,000 mm with a relatively dry season from May to September and a wet season from October to April. Food availability changed over time and it tends to decrease in the rainy season. The average number of female songs was 0.3 per day and singing activity peaked between 7:00-8:00 hr. Javan gibbons seemed to avoid singing during rain or fog, and monthly song frequency appeared to be positively related to food availability. In addition, 33% of agonistic interactions accompanied calling behavior and calling seems to be affected by the presence of neighbors in the context of defense of territory or food resources. Keywords: gibbon, song, frequency, environment

### P-11-2: Updating Conservation Status and CITES Appendix for Endemic Primates at Schmutzer Primate Center, Ragunan, Jakarta

Ade Septian, Luthfirda Sjahfirdi; *University of Indonesia*

Updating conservation status of Indonesia's endemic primates has been conducted at Schmutzer Primate Center, Ragunan, Jakarta. The purpose is to update the primates' conservation status according to IUCN Red List (2009) and to provide CITES data for species listed. Data collection and update were conducted during three months, from 21st April to 21st June 2009. The subjects are Indonesia's endemic primates. The method used in this study was by collecting conservation status data and taking photos from the outside of the cages. The acquired data were being compared with the IUCN Red List (2009) and categorized them into appendices of CITES. The results showed that eight species have no changes in their conservation status, such as *Macaca fascicularis* is still least concern; *Trachypithecus auratus* is still vulnerable; *Presbytis comata*, *Presbytis melalophos*, *Hylobates agilis agilis*, *Hylobates agilis unguis*, *Hylobates klossi*, and *Symphalangus syndactylus* are still endangered. Four species have their conservation status raised from least concern to vulnerable (for *Macaca hecki* and *Macaca tonkeana*); from endangered to critically endangered (for *Macaca nigra*); from least concern to near threatened (for *Trachypithecus villosus*). Two species have their conservation status reduced from critically endangered to endangered (for *Hylobates moloch* and *Pongo pygmaeus*). One species, *Nasalis larvatus*, has no conservation status information in this captivity. Eight species above are listed in Appendix II of CITES and seven species are listed in Appendix I of CITES. Keywords: conservation status, endemic, primates, Schmutzer Primate Center.

### P-11-3: The Locomotor Behaviour of Wild Orang-utans (*P. p. wurmbii*) in Disturbed Peat Swamp Forest, Sabangau, Central Kalimantan, Indonesia

Kirsten L. Manduell, Morrogh-Bernard, Helen C., Thorpe, Susannah K.S.; 1. *University of Birmingham LEBL, School of Biosciences, University of Birmingham*

The study of orangutan positional behaviour contributes to our understanding of the complex relationship between the largest arboreal primate and its environment. This study examined the locomotor behaviour of a population of wild Bornean orangutans (*P.p.wurmbii*) in disturbed peat swamp forest in the Sabangau Catchment, Indonesia. The main objectives were to identify key associations between orangutan locomotion and support use and to assess whether support use mirrors support availability within the environment. A total of 18,220 instantaneous observations of positional behaviour were obtained, with 2,874 of locomotion. Twenty two individuals were observed, including all age-sex classes. Log-linear modelling was used to identify key associations between orangutan locomotion, body size, height in the canopy and support use. Whilst all variables in the model were found to influence locomotion to varying degree, support type and support diameter were found to have the strongest associations with locomotor repertoire. This supports the hypothesis by Thorpe and Crompton (2005) that orangutans have evolved specific modes of locomotion in order to solve problems associated with traversing a complex arboreal environment. Torso orthograde suspensory locomotion, where the body is held in an upright position, dominates orangutan locomotion concurring with studies in mixed dipterocarp forest. Data indicate that orangutans in disturbed peat swamp forest employ higher frequencies of tree-sway which is an energetically efficient means of traversing the arboreal environment. This mode of travel is easily exploitable in the Sabangau given the high density of small, and by the nature of their size, compliant trees. Habitat data indicate that orangutans use trees for travel in similar proportions to what is available within the environment with regard to crown shape, crown position relative to the neighbouring canopy and presence of lianas within the tree crown.

#### **P-11-4: Nest Structures in Bornean Orangutan**

D. Prasetyo, Utami S., Supriyatna J.; *University of Indonesia*

Nest building techniques processes consist of: choosing the trees, building basic structure, making layers, nest locking system and adding nest with accessories. There are lacks of data about pattern of orangutan nest and only van Schaik (1995) described four variations of nest structure. By following 22 orangutans with focal animal instantaneous method, 19 vertical nest structure variations are found and horizontally orangutan nest forming butterfly pattern. *Elaocarpus mastersii* are tree species that mostly used by orangutan to build nest with type of branch direction and height of first branch as the reasons. Nest is built in 5-9 meters height and they are seldom reuse or rebuilt old nest. They also seldom develop their nest in the last fruit trees to avoid night predators

#### **P-11-5: Dietary Diversity amongst a Guild of Exudativorous Primates, Asian Slow Lorises (*Nycticebus sp.*): Implications for Captive Management and Release**

Richard S. Moore<sup>1</sup>, Carly R. Starr<sup>2</sup>, K. Anna. I. Nekaris<sup>1</sup>; 1. *Oxford Brookes University*, 2. *University of Queensland*

Slow lorises (*Lorisidae: Nycticebus*) range throughout Southeast Asia from Northern India to the Philippines. Recent studies have shown this genus to comprise multiple species diverse in their behaviour and ecology. Here we review accounts of slow loris diet in the historic literature, and present new observations on diet of three slow loris species (*N. pygmaeus*, *N. coucang*, and *N. javanicus*). A radio tracking study of *N. pygmaeus* conducted in Mondulkiri Province, Cambodia provides the first observations of the diet of this species in the wild, whilst observations of captive wild-born *N. coucang* and *N. javanicus* in Bogor, Java provide further insight into the dietary preferences of these little-known lorises. Historic studies reveal the importance of animal prey in loris diet, without which most captive animals perished. Lorises in our study consumed bats, birds, small lizards and variety of insect prey; these were killed with lightening fast capture techniques, with larger prey often shared amongst individuals. Pygmy lorises opened dead bamboo with their toothcomb to

extract insects. Captive Javan and Sumatran lorises preferred insect prey to fruit whenever it was offered, although fruit, preferably *Lansium domesticum*, was also consumed. Pygmy lorises consumed floral nectar and fruits, including *Salacia chinensis*, which is also used in local traditional medicines. As has been observed in other recent studies of slow lorises, exudates including gum and sap play a key role. Both captive and wild slow lorises consumed gum via active gouging of substrates. Gum licks are sites of complex social interactions, and provide a year-round defensible resource, especially in times of food scarcity. Many captive institutions keep their lorises on almost exclusively fruit-based diets. We discuss the implications of this diet for dental health, obesity, and reduction of stereotypies, and how data from the wild can be used to improve captive management and plan release programmes.

**P-11-6: Java Leaf Monkey (*Trachypithecus auratus*) Movement in a Fragmented Habitat, at Bromo Tengger Semeru National Park, East Java, Indonesia**

Hari Subarkah, Djuwantoko, Novianto Bambang Wawandono; *Faculty of Forestry, UGM,*

This was a reality that how a group of Java leaf monkeys can survive in a piece of land faced of pressure from a densely human population. Line Transect method was employed for data collection. There were four (4) groups of monkeys, which were consist of 12 members of group A, 16 members of group B, 15 members of group C, and 12 members of group D. The study areas were dominated by secondary forest and fragmented by edge of villages, farmland, permanent road, degraded forest areas, permanent trails and can be accessed freely. Daily activities of these leaf monkeys such as 31.82 % of eating, 30.97 % of resting, and 31.79 % of moving. They have used vertical vegetation structure which was 50.53 % on top canopy, 41.99 % middle canopy, 4.98 % of lower canopy, and 2.49 % on the ground. The study areas are about 89 ha, and average extend areas which were used by each groups were 20 ha for A group, 22 ha for B group, 23 ha for C group, and the last 25 ha for D group. It seem that all of the groups can able to growth and develop normally, but in the future might have problem concerning to the viability of their populations. Hopefully, habitat improvement should be the first priority in the conservation effort. Key words : Java leaf monkeys, densely, daily activities, conservation.

**Poster session: Animal ecology and conservation (#12; July 22)**

**P-12-1: The Comparison of Earthworm Diversity and Their Dynamics between Dry Evergreen and Dry Dipterocarp Forest at SERS, Nakhon Ratchasima, Thailand**

Pattana S. Somniam<sup>1</sup>, Ponthep S.<sup>2</sup>; *1. Uttaradit Rajabhat University, 2. Suranaree University of Technology*

The diversity and dynamic of terrestrial earthworms in dry evergreen and dry dipterocarp forests were compared in Sakaerat Environmental Research Station (SERS). Four replications of earthworm and soil samples were collected in the 30x30x30 cm<sup>3</sup> sampling sites, once a month in 2006. Identification of terrestrial earthworms was based on external and internal morphology. Thirteen earthworm species in four families were found in this area, nine species of Megascolecidae, two species of Octochaetidae, one species of Glossoscolecidae, and one Moniligastrid species. The earthworm diversity were not different, nine species in dry evergreen forest and eight species in dry dipterocarp forest. However, earthworm density was significantly higher in dry evergreen forest (46.53 ind/m<sup>2</sup>) than dry dipterocarp forest (13.43 ind/m<sup>2</sup>). The highest density was found in August (163.9 ind/m<sup>2</sup>) in dry evergreen forest, while the highest density (66.7 ind/m<sup>2</sup>) of dry dipterocarp forest was found in October. Earthworm number was low in dry season and not present in February and December. Earthworm density was positively correlated with rainfall, relative humidity, soil moisture, nitrogen content and calcium content, but negatively correlated with soil temperature.

**P-12-2: Size Effect of Forest Reserves on Insectivorous Bat Assemblages in Peninsular Malaysia**C.L. Joann, Serafina C. Fletcher; *Forest Research Institute Malaysia*

The virgin jungle reserve (VJR) network was institutionalized about 50 years ago as a conservation effort by the Malaysian government. These patches of primary forest are meant to be a natural arboretum that controls for the exploited and siculturally-managed surrounding forest. However, the overall effectiveness of VJRs is still unclear as we lack sufficient scientific information for evaluation. This study hypothesises that larger-sized VJRs will more effectively help recover insectivorous bat assemblages in adjacent logged-over forests. The study which was conducted over a span of 18 months consisted of six VJRs of various size classes across Peninsular Malaysia; <50 ha, 50–100 ha, 101–300 ha, 301–700 ha, 701–1000 ha and >1000 ha. A total of 958 individuals of 27 insectivorous bat species were captured over 486 trap nights. The 101–300 ha class had the most number of captures with 29.33% and the < 50 ha class had the highest species richness with 19 species. All the sites were dominated by either Hipposiderids or Rhinolophids. The results indicate that bat abundance does not have a linear relationship with increasing VJR size class. However it is learned that each forest site exhibited a distinctive bat assemblage including Near Threatened (NT) and Vulnerable (VU) species such as *Phoniscus atrox*, *R. sedulus*, *Nycteris tragata* and *Murina rozendaali*. In conclusion, this study postulates that forest size alone does not determine the species richness of insectivorous bats, but there may be other confounding factors such as forest surroundings, topography and anthropogenic disturbances that may influence the type of bat assemblages in a forest.

**P-12-3: Long-term Monitoring of Tropical Bats for Anthropogenic Impact Assessment: Gauging the Statistical Power to Detect Population Change**

Christoph Meyer<sup>1</sup>, Ludmilla Aguiar<sup>2</sup>, Luis Aguirre<sup>1</sup>, Julio Baumgarten<sup>1</sup>, F. Clarke, J.-F. Cosson, S. Estrada, J. Fahr, D. Faria, N. Furey, M. Henry, R. Hodgkison, R. Jenkins, K. Jung, T. Kingston, T. Kunz, C. MacSwiney, I. Moya, J.-M. Pons, P. Racey, K. Rex, and 6 others; *1. University of Lisbon, 2. Universidade de Brasília, Brasília, Brazil*

Bats are ecologically important mammals in tropical ecosystems, however, their populations face numerous environmental threats related to climate change, habitat loss, fragmentation, hunting, and emerging diseases. Thus, there is a pressing need to develop and implement large-scale networks to monitor trends in bat populations over extended time periods. Using data from a range of Neotropical and Paleotropical bat assemblages, we assessed the ability for long-term monitoring programs to reliably detect temporal trends in species abundance. We explored the magnitude of within-site temporal variation in abundance and evaluated the statistical power of a suite of different sampling designs for several different bat species and ensembles. Despite pronounced temporal variation in abundance of most tropical bat species, power simulations suggest that long-term monitoring programs ( $\geq 20$  years) can detect population trends of 5% per year or more with adequate statistical power ( $\geq 0.9$ ). However, shorter monitoring programs ( $\leq 10$  years), have insufficient power for trend detection. Overall, our analyses demonstrate that a monitoring program extending over 20 years with four surveys conducted biennially on five plots per monitoring site would have the potential for detecting a 5% annual change in abundance for a suite of bat species from different ensembles. The likelihood of reaching adequate statistical power was sensitive to initial species abundance and the magnitude of count variation, stressing that only the most abundant species in an assemblage and those with generally low variation in abundance should be considered for detailed population monitoring.

**P-12-4: A Population Density Estimate of the Asian Tapir *Tapirus indicus* from a Selectively Logged Forest in Peninsular Malaysia**

Mark Rayan Darmaraj, Shariff Mohamad, Leejiah Dorward, Sheema Abdul Aziz, Christopher Wong; *WWF-Malaysia*

Although recently classified as Endangered under IUCN's Red List, little is known about the population ecology of the Asian Tapir (*Tapirus indicus*). In an attempt to produce a robust population estimate through a capture-recapture framework we utilised camera-trapping data to identify individual tapirs from a study which was intended for tigers in the selectively logged forest of Gunung Basor Forest Reserve, Kelantan. We employed a capture-recapture framework to obtain a robust density estimate of tapirs. A trap effort of 2,664 trap-nights resulted in 106 tapir photos yielding 68 detections of tapirs. For the purpose of positively identifying individuals, 22 detections were discarded from the analysis. The number of individual tapirs captured ( $M_{t+1}$ ) was 17. Using the Mh jackknife estimator, the average capture probability per sampling occasion ( $p$ ) was 0.16 and the corresponding tapir population size estimate ( $N$ ) was 24 with a standard error (SE ( $N$ )) of 5.05. The overall probability of "capturing" a tapir present in the sampled area ( $M_{t+1}/N$ ) was 0.71. Using the half absolute maximum distance moved approach based on distances between photo-captures, a buffer width ( $\hat{W}$ ) of 3.43 km and an effectively sampled area,  $A(\hat{W})$  of 249.803 km<sup>2</sup>, was estimated, which resulted in a density ( $D(SE)$ ) estimate of 9.61 (2.02) adult tapirs/100 km<sup>2</sup>. Our results show that camera traps can serve as a useful tool to gain information on the population ecology of the Asian Tapir. Other mammal studies which employ camera-traps could potentially provide useful data to refine the population estimates given here and aid in updating the Asian Tapir's distribution so that specific conservation management strategies could be formulated within the country or region. Keywords: Capture-recapture, camera-trapping, Peninsular Malaysia, population, selective logging, *Tapirus indicus*

#### **P-12-5: Investigating Key Processes Shaping the Natural History of the Komodo Dragon**

Tim Jessop<sup>1</sup>, Claudio Ciofi<sup>2</sup>, Deni Purwandana<sup>1</sup>, Achmad Ariefiandy<sup>1</sup>, Dave Forsyth, Jeri Imansyah, Heru Rudiharto, Andrew Gormley, Andy Phillips; *1. University of Melbourne, 2. University of Florence*

The cadence at which island populations diverge or evolve is a complex interplay between multiple evolutionary and ecological mechanisms acting on genetic and demographic processes. Understanding the contributions of these respective factors and their interplay is fundamental to describing the natural history of island animals but also increasingly the ability to manage and conserve island biodiversity. Here, we attempt to estimate these contributions using a 5 year integrative study in the Komodo dragon, the world's largest lizard predator ( $\approx 80$  kg) that persists on five islands in eastern Indonesia. We assessed the effects of dispersal and the relative abundance of ungulate prey on genetic, phenotypic and demographic variation in Komodo dragons at 10 sites across four islands. A combined capture mark recapture (CMR) framework was used to estimate intersite dispersal, survival and population density : a subsample of these dragons was tracked using telemetry to estimate high resolution movement patterns. Microsatellite markers were used to estimate population genetic parameters. Multivariate morphological measures were used to assess spatial variation in body shape. Both multistate dispersal modelling and GPS telemetry estimated a remarkably high level of spatial fidelity over our 5 year study with no intersite movement detected. Among sites there was significant differences in body shape, survival and density which was highly correlated with ungulate prey availability independent of neutral genetic relationships. This suggests that an ecological, rather than any neutral genetic, process is a more important determinant of dragon morphology and demography. We conclude that the low rate of dragon dispersal has led to genetically distinct sub-populations within the Komodo archipelago in which variation in density, survival and morphological phenotype is subsequently determined by the abundance of ungulate prey.

#### **P-12-6: Species Richness of Understorey Birds and Small Mammals Inhabiting Oil Palm Plantations and Neighboring Forests**

Rosli Ramli, Nur Farhanah Bahruzzaman, Muhammad Rydza Khairy Othman; *University of Malaya*

Generally it is agreed that forest conversion to agricultural areas such as oil palm plantation had caused severe depletion to tropical biodiversity. This general agreement was derived from

comparative studies on species diversity in oil palm plantations and primary forests. However, very few studies have been concurrently conducted to compare biodiversity of oil palm plantations and its neighboring forests. The aim of this study is to gather more information on understory birds and small mammal species richness inhabiting two oil palm estates and its neighboring forests. A total of ten visits have been conducted to two oil palm plantations (Kota Gelanggi 5 and Lepar Utara 11) and its neighboring forests (Krau Games Reserve, Tekam Forest Reserve, and two forests islands within Lepar Utara 11) from July 2009 to January 2010. Mist-nets were used to sample bats and understory birds while box-traps were used to trap rodents. Results shown that forested areas are more diverse than oil palm plantation in term of species richness (52 and 26 species respectively). Forested areas have 35 species of understory birds, eight species of bats and nine species of rodents (40 species occupy in this habitat only) while oil palm plantations only have 16 species of understory birds and seven species each of bats and rodents (13 species are limited to this habitat only). Complexity of habitat (which provides more resources such as food and shelter for wildlife) and minimal human activity may attract more species to occupy forested areas instead of oil palm plantation.

**P-12-7: Sperm Quality of 12 Hours bull (*Bos indicus*) cadaver : a Model for a Founded Dead of Big Mammalian Tropical Endanger Species Conservation**

Yulia Sistina, Amelia Fadlila, Ika Anambang Febriasari, Ratri Widya Wardhani; *Unsoed*

Cauda epididymis spermatozoa of 12 hours post mortem bull (*Bos indicus*) has been proven having good quality for In Vitro Fertilization (IVF). This conclusion derived from several studies employing simple equipment, chemical medium and methods that even can be conducted in any simple small laboratory. This study was modelled for new approach in conservation when an endangered animals have found already dead. The scrotum can be rescued in order to collect the spermatozoa, important cells in animal reproduction. Epididymis sperm quality from the cadavers were assessed for motility, progresivity, viability (using vital staining method), and acrosomal status after Bryan staining applied only for those treated with caffenin-rich medium for acrosome reaction induction under light microscopic assessment. The results showed that more than 50% of the spermatozoa were motile and viable, either after in vitro culture in Ringer medium, Tris-citrate (TC) with or without 20% egg yolk extender, or Phosphat Buffered Saline (PBS) medium with or without caffenin at different concentrations i.e., 0; 2.5; 3; 5; 6; 7.5; 9 mM. The highest motility and viability of the spermatozoa were 75.5% and 83.5% consecutively, which was very significantly different ( $p < 0.01$ ). The best caffenin concentration resulted in highest sperm with acrosomal loss (acrosome reacted one) of 60.65% was the 9 mM and after 30 minutes incubation in PBS medium. TC with 20% egg yolk medium was the best medium for further preserved the bull cadaver spermatozoa after 3 days at temperature of 4-90C. This resulted in the highest motility of 73.67% and viability of 81.83%. Biotechnology application for biodiversity to rescue big endangered mammals such as bull has been available for further improvement. This report supports the idea that death of endangered animals are not the end to maintain species conservation.

**P-12-8: Improved Strategy for Conservation of the White Spotted Buffalo of Tana Toraja in South Sulawesi**

Endang Tri Margawati; *RC for Biotechnology-LIPI*

Tedong buffalo or white spotted buffalo is well known as a typical buffalo distributed only in Tana Toraja (TATOR) of South Sulawesi, Indonesia. This buffalo has a special cultural meaning in local religious ceremonies and attracts extreme economic values with price of between US\$1,000 to 100,000 per head depending on the degree and type of white coat patterns. The local religious ceremonies also are major international tourist and attractions and provide significant economic wealth to the region. There is a strong recent concern that the population of Tedong buffalo is continuously decreasing and in danger of becoming extinct, 12,000 population in 1984 and decreased 1,895 population in 2004. Reproductive performance of the Tedong buffalo is very poor, heat detection difficult (silent estrus), elite bulls slaughtered for religious ceremonies and not used for

breeding. It has also been documented in the field and in research breeding programs that a lethal condition has been observed when spotted bulls are mated to spotted females which have been associated with full white calves. The reasons for poor reproductive performance are partially known, but management tools to improve this performance have not yet been investigated. Existing technology of artificial breeding technologies, such as estrus synchronization, artificial insemination, gamete and embryo preservation, and embryo transfer need to be implemented in breeding and conservation systems to generate additional offspring and preserve this endangered genetic resources. In the future, it may need to introduce biotechnology tool to study of the pattern of white spotted buffalo since it is different from other domestic species. There is a paucity of information in buffalo on the inheritance of color patterns and inheritance of the lethal associated with white calves to improve breeding management decisions. Keywords: White spotted buffalo, conservation,

**P-12-9: Habitat Preference of the Sunda Colugo (*Galeopterus variegatus*) in Tropical Forests of Singapore**

Norman T-L. Lim<sup>1</sup>, Xingli Giam<sup>2</sup>; 1. *University of California, Davis*, 2. *Princeton University*

Colugos are arboreal folivores and are found in tropical rainforests of Southeast Asia. Despite their discovery roughly 200 years ago, colugos attracted relatively little scientific attention. Here, we investigate the habitat preference of the Sunda Colugo (*Galeopterus variegatus*) in the tropical forests of Singapore. We use Bayesian generalized linear mixed models to identify environmental correlates for the occurrence of colugos. The occurrence of colugos increased with percentage canopy cover, distance from edge, and ratio of medium-sized trees (2cm < DBH < 10cm). However the most parsimonious model based on Deviance Information Criterion contained only percentage canopy cover. We discuss the biological significance of this important variable within the context of this animal's life-history strategy, and make recommendations for the conservation of this enigmatic mammal.

**P-12-10: Conservation Status of Philippine Cave Bats: an Assessment of Four Karst Regions**

Jodi L. Sedlock<sup>1</sup>, Hemres Alburo<sup>2</sup>, Phillip A. Alviola<sup>3</sup>, Mariano Roy Duya, Reizl Jose, and Lisa Marie Paguntalan; 1. *Lawrence University*, 2. *State College of Science & Technology* 3. *University of the Philippines-Los Banos Lawrence University*

Currently 76 species of bats are recognized in the Philippines, and more are likely to be described. Approximately one third of these are particularly vulnerable because of their need for two, separate and equally threatened habitats—lowland forests and caves. Unfortunately, the vast majority of large caves in lowland karst areas of the Philippines lie outside of protected areas, and despite their formal protection through the government's Cave Act, many are heavily disturbed by swiftlet nest gathering, treasure hunting, guano collecting, and mineral mining. As a result, dramatic population declines have been documented in individual caves, and more declines are suspected given the extensive staining in caves currently devoid of bats. As such, there is a need to collate existing knowledge of cave bat populations in order to more precisely define the problem and hone conservation efforts. Here, we do this by pooling cave bat data from four karst regions of the Philippines—northern Luzon, Pollilio Island, Cebu Island, and Bohol Island—in order to assess the importance of different cave disturbance regimes to bats and their prevalence, and whether regions differ with respect to the nature and magnitude of human cave disturbance and bat population sizes. We also assessed whether or not bat population size across all regions was associated with surrounding habitat type, cave size, presence of water, and degree of cave disturbance. Our analysis is the first step towards a broader effort to assess the status of cave bats and their threats nationwide.

**P-12-11: Bioprospecting Study of Porcupine (*Hystrix sp.*) and Domestication Effort for Sustainable Utilization**

Wartika Rosa Farida, T.H. Handayani; *Research Center for Biology, Indonesian Institute of sciences (LIPI)*

In some areas in Indonesia, the meat of porcupine is used as foodstuff, while its spine, blood, and liver are believed as containing special quality or virtue as medicine and also as the material in making some souvenir. This fact has driven the increasing of hunting activities to this animal. Beside, the extent of land clearing caused the damage of porcupine's habitat. The uncontrollable illegal hunting and locally using without conservation motives to this animal also threatened the existence of porcupine. Based on the facts describing above, and also to preserve the existence of porcupine, it is important to do the monitoring of hunting activities to this animal, especially in the areas with the high rate of the using of porcupine. To reach the accurate understanding of the value of bioprospection contained in porcupine, it is urgent to do observation activities in the laboratory. The using of animal with the status of protected, especially for the commercial purposes, could give begin at F2 generation. The result showed the meat of porcupine contains 59.91% protein, higher than that of other animals. The same fact is also happened for porcupine's liver, spine, brain, and tail. The fat and cholesterol contents of porcupine's meat is lower than those of beef. Fatty acid omega DHA of porcupine's meat is higher than that of salmon and herring. Spine and liver contain aspartate acid, glutamat acid, hystidin, leusin, and phenilalanin which are higher than those contained in the meat of calf, duck, and tuna, and also in chicken's liver. Isolation activities shows that from 100 g spine can be produced 34.60 g chitin. Test aphrodisiac activities of porcupine's tail extract towards the libido of male white mouse with the dose of 10,000 ppm shows high activities of that animal in the effort to approach its female. Keywords : Bioprospecting, porcupine, *Hystrix sp.*, domestication, utilizing

#### **P-12-12: Mammalian Biodiversity Loss after Fire Disturbance in Way Canguk National Park, Lampung, Indonesia**

Abdul Basir, Indartono Sosro Wijoyo, Jaka Ramadhan, Okky Rulistya Perwitha, Hanum Puspa Dhiani, Fitriani Anggraini; *University of Indonesia*

Nowadays, tropical rainforest are threatened and decrease in size. Several factors are contributed due to the loss of rainforest, namely illegal logging, plantation, and fire. Currently, forest fire occurred frequently and responsible for the decrease of rainforest and tropical biodiversity as well. However, research on fire's impact on the forest's biodiversity is still limited. In 1997, a severe forest fire took place in the Way Canguk National Park of Lampung. In the January 2010, we have conducted a research to investigate the impact of forest fires toward mammal biodiversity. Method used in this study was line transect in which consisted of eight transects. Each transects covered 400,000 m<sup>2</sup> area. The result showed only nine mammal species, while three of them are endemic species (*Symphalangus syndactylus*, *Presbytis melalophos*, *Elephas maximus sumatranus*), five non-endemic species (*Ratufa sp*, *Lutra sp*, *Lariscus sp*) and one common species (*Sus scrofa*). Frequency of mammals encounters were dominated by non-endemic species 50%, wild boar 35%, and endemic species 15%. The low number of endemic species diversity related to the habitat degradation as result of forest fire. The high number of non-endemic species may indicate the secondary stage of the forest after fire respectively. Our findings confirm that forest fire can reduce the mammalian biodiversity and alter species composition. Therefore, conservation planning need to integrate the fire risk in forest and the strategy should combine with reforestation to return the ecosystem function in balance. Keywords: tropical rain forest, forest fire, Way Canguk National Park, transect, mammal's biodiversity lost, low number of endemic species, conservation planning, reforestration.

#### **P-12-13: Earthworm Diversity in Tab Lan National Park, Thailand**

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The assessment of earthworm diversity in many land use types of Tab Lan National Park in Thailand was conducted six times in 2007 and 2008. Digging and hand-sorting method was employed. From



1,586 samples, 23 earthworm species in 4 families were identified. *Metaphire houlleti* was the most abundant followed by *Pontoscolex corethrurus* and *Metaphire planate* respectively. Soils around office areas contained the most diverse species of earthworm of 15 species whereas dry dipterocarp forest had only 4 species. More earthworm species and number were found in 2008 than those in 2007. Numbers of earthworm were varied by month depending on soil moisture and rainfall.

**P-12-14: In the Dead of Night All is not What it Seems: a Cautionary Tale of Habitat and Resource Use & the Management of a Threatened 'Rainforest Specialist'**

David A. Westcott<sup>1</sup>, Natasha M. Kreitals<sup>2</sup>, Adam McKeown<sup>1</sup>; 1. *CSIRO Sustainable Ecosystems*, 2. *Centre for Forensic Science, U Western Australia*

In an era when threats to biodiversity are pressing, resources are scarce and politically-driven conservation process demand immediate action, there is growing pressure for rapid decision making based on limited data. But what are the consequences for our science and the value of our decisions from such approaches? In this paper, I compare our past understanding of the ecology of the threatened spectacled flying-fox (*Pteropus conspicillatus*) with new data on the species' population dynamics, movement, habitat and resource use. Despite very clear evidence to the contrary, past work on the species focused on an assumed rainforest specialisation by the species with this eventually being incorporated into a rain forest conservation agenda and into policy. Recent work using methods as varied as casual observation, population surveys, telemetry, faecal analysis and stable isotope analysis all clearly point to a very different story and, as a consequence, to mistaken policy. I use this comparison to reflect on how our research translates into policy and management decisions, and, how a failure to follow very basic scientific protocols can result in flaws in these processes, sometimes with lasting repercussions. I argue that good scientific hygiene is a fundamental underpinning of high quality conservation advice and that scientists need to help managers to recognise its value, to recognise it in their every day work and to demand it of their information suppliers.

**P-12-15: Bats as Indicators of High Conservation Value Areas in West Kalimantan, Indonesian Borneo**

Sephy Noerfahmy<sup>1</sup>, Matthew J. Struebig<sup>2</sup>, Tigga Kingston<sup>1</sup>, Sabastian van Balen<sup>1</sup>; 1. *Fauna and Flora International-Indonesia Programme*, 2. *Queen Mary University of London / Universiti Brunei*

The long-term conservation of Borneo's rainforests is of critical biodiversity importance, yet is undermined by failing protected areas, and insufficient consideration of the value of well-managed production areas. To overcome these ambiguities the High Conservation Value approach (HCV) has been adopted by a wide range of corporations and NGOs, and has created huge demand for biodiversity assessment. However, the accuracy of these assessments remains limited by time constraints, insufficient capacity, and an incomplete knowledge of species diversity. Bats have been advocated as a promising indicator taxon for biodiversity evaluations because they combine high species richness with diverse ecological requirements, provide critical ecosystem services, and are experiencing dramatic population declines throughout Southeast Asia. Moreover, the forest-dependent species can readily be sampled with a standardized protocol facilitating comparisons among habitats. Here we report the findings of surveys of bats in logged lowland dipterocarp forests, candidate REDD sites in logged peat swamps, and protected areas. The surveys were conducted as part of standard HCV assessments in West Kalimantan, a relatively understudied region of Borneo, on the cusp of extensive land-use change. We compare patterns of assemblage structure and diversity as well as taxon -specific HCVs (threatened, protected, and/or endemic species), among habitats. Our preliminary results suggest that peat swamps support lower bat abundance and species richness than lowland dipterocarp sites. For comparison, we compare the biological indicator value of bats with conclusions drawn from bird surveys conducted at the same study sites. We then discuss implications for HCV assessment and prioritisation of conservation efforts in managed areas on Borneo.

**P-12-16: Can Frugivores Adapt to Deforestation in the Tropics?**Matthew S. Luskin, Matthew D. Potts; *UC Berkeley*

To test flying fox adaptations to a habitat mosaic with extreme deforestation, the abundance, habitat choice and feeding behavior of the Pacific flying fox, *Pteropus tonganus*, were investigated across 16 islands of the Yasawa archipelago, Fiji. The habitat mosaic is formed by 4.3 percent tropical dry forest and 3.3 percent farmland, leaving exotic grasslands and stands of *Leucaena leucocephala* to overrun the vast majority of land. *P. tonganus* abundance was high (5757 bats) despite deforestation and hunting pressure. However, roosting sites were restricted to remnant native forest fragments. Grasslands and stands of *L. leucocephala* were completely void of bats at all times. The mean foraging density in farmland was four times higher than in forests and foraging competition was routinely observed in farmland but was extremely rare in forests. The author suggests that during the study, extensive foraging in farmland was supporting the high *P. tonganus* population. Additionally, the preferential foraging in farmland was responsible for the low foraging densities within forests and dramatically less intraspecific competition for forest resources. This result shows that flying foxes, which are native mammals and keystone seed dispersers throughout the Pacific region, are utilizing farm-derived food sources and thriving. This scenario raises several questions about the prospect of crops being dispersed into native forests, native fauna plasticity to deforestation and the conservation value of farmland to both flying foxes and to ecosystem function. In this presentation, we will also apply what we have learned on the Yasawas to hypothesize about native frugivores capacity to adapt to deforestation in other systems, namely oil palm.

**P-12-17: Community Structure of Bats In Selected Forest Reserves In Peninsular Malaysia**Siti Syarifah Akma Ibrahim, Rosli Ramli; *University of Malaya*

Permanent forest reserves have been established in various parts of Peninsular Malaysia to conserve different species of wildlife including bats. However without comprehensive data on diversity and species distribution, the efficiency of forest reserve in conserving bat species is unpredictable. Therefore the aim of this study is to examine the diversity and distribution of bat in four forest reserves in Peninsular Malaysia. These reserves are Pasir Raja (Trengganu), Gunung Berembun (Negeri Sembilan), Tekam (Pahang) and Endau-Rompin National Park (Johor). Two harp traps and twenty mist-nets were used in documenting species diversity in each forest reserve from August 2009 to January 2010. A total of 248 bats belong to 22 species (that can be further classified as frugivores, insectivore and nectarivore bats according to their feed guilds) were captured. More bats (particularly insectivorous species) were captured by Harp traps (64.52% or 160 individuals) than mist nets (35.48% or 88 individuals). Diversity values (Simpson and Shannon-Weiner indices) indicate that bats species are more diverse in Gunung Berembun (7.429 and 2.194 respectively) than other areas. However, species that commonly found in other forests such as Spotted-Winged Fruit Bat (*Balionycteris maculata*) was not recorded in this forest. On the other hand, species that are abundant in Gunung Berembun such as Grey Fruit Bat (*Aethalops alecto*) was absence from other forests. This study indicates bat species distribution is unpredictable and its community structure is strongly affected by forest disturbance and availability of resources such as food, shelter, competition level, and the presence of predator (including human disturbance). Further study is on-going to gather more information needed in formulating management and conservation program. Keywords: forest reserves, feeding guilds, harp traps, mist netting, bat diversity.

**P-12-18: Which Biological Features Determine Tolerance to Forest Fragmentation among Small Mammals of the Brazilian Atlantic Forest?**Fernando A.S. Fernandez<sup>1</sup>, Paula K. Lira<sup>2</sup>, Camila S. Barros<sup>1</sup>, Alexandra S. Pires<sup>1</sup>; *1. Universidade Federal do Rio de Janeiro, 2. Universidade de São Paulo*

Tolerance of small mammals to forest fragmentation can be enhanced by several biological features which include tolerance to habitat edges, ability to keep high population densities in fragments,

smaller and overlapping home ranges in remnants, and ability to use the open habitat matrix. Hypotheses on the importance of each of these four factors were tested in an eleven year capture-mark-recapture and radiotracking study on marsupial and rodent populations in Brazil. The study was located in a set of eight small (1.3-13.3 ha) Atlantic Forest fragments, the “Ilhas dos Barbados” (Howler Monkeys’ Islands), in Poço das Antas Reserve, Rio de Janeiro state. Trapping was also carried out at the grassy matrix surrounding fragments and at a control grid in the Reserve’s main forest block. Trapping resulted in 5,530 captures of 21 species; individuals of three marsupial species were radiotracked. All common species either tolerated or even preferred edges. Population abundances were higher in fragments than at the control for most species. All species studied were able to present small home range sizes and/or overlapping ranges. Populations of most species were connected, either by individuals moving between fragments across the matrix, or by the existence of resident populations at the matrix. Besides, some marsupials obtained supplementary food resources at the matrix. In summary, all four hypotheses were corroborated for most species investigated. Therefore, the features described above can be seen as a syndrome that explains tolerance to fragmentation among Atlantic Forest small mammals. This finding can be useful to forecast expected changes and to plan management policies for mitigating local extinctions in this biodiversity hotspot.

**P-12-19: Evaluating the Impact of Reticulated Python Predation on the Fauna of Singapore**

Anne Devan-Song; *National University of Singapore*

Wild reticulated pythons (*Broghammerus* [Python] *reticulatus*) frequently come into contact with humans in Singapore, where 95% of original forest cover has been removed and the snakes have effectively adapted to the urban environment. Until recently, pythons have been culled based on the premise that they are a danger to humans and native wildlife. In this study, food habits of the pythons were analyzed to assess their impact on Singapore’s wildlife. Data were collected from >90 wild-caught pythons ranging from juveniles (from 0.2kg, <1m SVL) to large adults (up to 30kg, >4m SVL). The majority of the snakes’ diet consisted of common *Rattus* species (75%) with an ontogenetic expansion of prey items to include birds (12%) and larger mammals (11%) observed in snakes exceeding 2m. Most of these additional prey items were introduced species, common native mammals, zoo exhibits or domestic zoo animals. Excluding wild pythons caught within the open range zoo, no relationship between diet and the location of capture was detected. Results indicate that pythons found in urban habitats in Singapore are unlikely to be of any threat to native wildlife, and instead provide the service of controlling rat populations. Future initiatives to re-instate the culling of these snakes should take into account small pythons’ near-exclusive diet of rats and the fact that larger individuals are more of a threat to introduced species and zoo animals than native ones.

**P-12-20: The Clouded Leopards and Small Cats of Sumatra: Conflict Mitigation in the Face of a Quickly Rising Human Population**

Jennifer L. McCarthy, Todd K. Fuller; *University of Massachusetts Amherst*

Indonesia hosts one of the highest levels of biodiversity in the world, yet a rapidly growing human population has led to increased conflict with wildlife in protected areas. Although significant controversies with other wildlife species have been reported, human conflict with clouded leopards and other small felids has been largely ignored. However, in 2009 a survey was initiated to formally assess the extent and character of conflict between humans and four species of felid; the Sundaland clouded leopard (*Neofelis diardi*), the marbled cat (*Pardofelis marmorata*), the Asiatic golden cat (*Catopuma temminckii*), and the leopard cat (*Prionailurus bengalensis*). The survey showed that a high level of livestock depredation was attributed the target felids, with correspondingly high levels of retribution killing by local villagers. These findings established human-felid conflict as a significant challenge to effective conservation of these species in Indonesia. To address this issue, we have developed a program to: 1) initiate mitigation strategies in order to limit depredation of livestock by clouded leopards and other small felids, and 2) to increase general knowledge of the target species among local villagers. These efforts are intended to decrease retribution killings, increase local

interest in the species, and contribute directly to the conservation of clouded leopards and other threatened felids in Sumatra.

**P-12-21: The Impact of Fragmentation on the Distribution of Grizzled Giant Squirrel in Kaveri Wildlife Sanctuary**

Ipsita Herlekar; *Tata Institute of Fundamental Research*

This study examines the impact of canopy fragmentation on the distribution of the grizzled giant squirrel (*Ratufa macroura*) along linear riparian habitat in the Cauvery Wildlife Sanctuary, Karnataka, India. The grizzled giant squirrel is endemic to southern India and Sri Lanka. In southern India it occurs in a few, small, isolated forest areas in the states of Karnataka, Tamil Nadu and Kerala. It is classified as “near threatened” by the IUCN and is listed under Schedule II of the Wildlife Protection Act (1972) of India. The distribution, abundance and persistence of this arboreal mammal are highly influenced by the spatial structure of forests and fragmentation of canopy would have an impact on its survival. To assess the influence of fragmentation on distribution the study uses an occupancy approach, which estimates the probability of a species occurring in a landscape while incorporating variation in detectability across the landscape. Grid cells larger than the home range of the squirrel are marked to enable estimation of true occupancy. Each grid cell is sampled by walking and the sightings and signs of presence (dreys). Ecological variables, namely habitat structure and density and phenology of food tree species, which are the main hypothesized mechanisms for the way in which fragmentation can impact an arboreal species, are being quantified. Other variables such as human disturbance and canopy connectivity are also being recorded. The study will also discuss the relative influence of these variables on the occurrence and relative abundance of this species in the landscape. Along with assessing the impacts of fragmentation on an arboreal species, this study aims in generating reliable information on the distribution of grizzled giant squirrels in the area and the factors influencing it, which would help in making appropriate management plans for the conservation of the species.

**P-12-22: Use of Spool Track to Study Local Movement of *Polypedates leucomystax* and *Rhacophorus margaritifer***

Neneng Muliya, Neneng Sholihat, Mirza Dikari Kusriani, Yeni Aryati Mulyani; *Institut Pertanian Bogor (IPB)*

Studies of amphibian movement, especially in developing countries such as Indonesia, are usually limited by lack of resources for expensive equipment such as radio tracking devices. Spool track method has been used as a cheaper yet useful alternative in the studies of amphibian local movement. However, application of spool might considerably restrict the movement of individual, thus affect the result of the study. Therefore, spool design is an important consideration, and it might vary between species. We studied the application of spool track on *Polypedates leucomystax* and *Rhacophorus margaritifer* to examine responses of the species to spool application. We assembled spools from mostly re-used materials, such as plastic caps of perfume bottles, small plastic bottles, metal and plastic bobbin, straw, and cotton thread. PVC glue and small wire were used to attach spool to frog's body. Spools were attached to frog's body by using PVC glue and threadlike wire. No negative response from female *P. leucomystax* attached by 4 g spool for 24 hours, while males could adjust to 1.5 g spool. However, no weight measurement was conducted for *P. leucomystax*. Using the wire to attach the spool had caused bruises to frogs after 24 hours. Covering the wire with elastics and aluminum prevented proper attachment and made the spool fell off. PVC celotape was successful, although it left pale mark. *R. margaritifer* responded negatively to spool used for *P. leucomystax*. Weight lost of more than 15 % was observed. Smaller and lighter spools were applied for *R. margaritifer*. Females adjusted to 0.9-1.1 g spool while males adjusted to 0.3-0.5g spool. Less than 15% weight lost was observed. Only PVC celotape was used to attach the spool to *R. margaritifer*. It also left pale mark on the body.

**P-12-23: Global Biodiversity of Canopy Birds, Mammals, and Amphibians**

Brett R. Scheffers, Xingli Giam, Navjot S. Sodhi; *National University of Singapore*

After centuries of scientific exploration, numerous species are still being discovered. Considered the “next frontier” to biological inquiry, forest canopies may harbor many undescribed species, yet the difficulty of accessing towering canopy trees has left canopy communities largely neglected from ecological study. Herein, we quantify the total global biodiversity of birds, mammals, and amphibians that are canopy dwelling. Using a Geographic Information System (GIS), three global databases of species traits, species accumulation curves and predictive models, we evaluate the discoveries of new species in these three taxonomic groups that are canopy specialists and link species discoveries with species traits (e.g., size, range-size) and geographic location. Lastly, we discuss the extent of wide-spread disturbance of forest canopies in causing the extinction of undiscovered arboreal species.

**P-12-24: The Diversity and Role of Cave-Dweller Bat Species in Tuban’s Karst Area of Eastern Java**

Tatag Bagus Prakarsa, Satino, Muhammad Fajri Rohmad; *Faculty of Mathematic and Science, Yogyakarta State University*

Indonesia is a tropical country which has so much incredible biodiversity. It is also supported by the Indonesia’s territory which has a variety of natural landscape. One of the varieties of natural landscape in Indonesia is a Karst area which lies from the west to the east of Indonesia. Up until now, the Karst area is still considered as a poor area which cannot suffice the needs of people who live around it. It also produces only natural resources of group-C which tend to be easily destructed by mining activities. That case is also happened in Tuban’s Karst area. It is occurred because the lack of data and knowledge of the people. In fact, the Karst area becomes the important part of the natural diversity in the earth. The Karst area has a high biodiversity and endemism. One of the endemic species is bat. But recently the information toward to these species is still far from enough, including its composition, density, distribution, diversity, ecological roles and also the its role for human society. There are about 15 species of bats found in the Tuban’s Karst area. Those bats are found widespread in all parts of Tuban’s Karst area. Looked from its distribution and population number, a kind of bats from sub-order Megachiroptera is very effective in seeds dispersal and pollinating plants with a high economical values. Besides, this species from sub-order Microchiroptera is also effective in controlling agricultural plants’ pests. Thus, the bat’s existence will be very helpful in determining the planting pattern of agricultural plants. Keywords: variety, roles, bats, and tuban’s Karst

**P-12-25: Saltlicks and Their Use by Malay Tapirs**

Boyd K. Simpson, Carl Tracholt; *Copenhagen Zoo*

Very little is known of the wild habits or habitat use of the globally endangered Malay tapir (*Tapirus indicus*). Camera trapping results from Krau Wildlife Reserve and Taman Negara National Park, Malaysia, however show that tapirs make frequent use of naturally occurring mineral licks (salt licks) throughout the year. These studies, in conjunction with telemetry work in Krau Wildlife Reserve, indicate that tapirs will travel up to 15 km between salt licks, and will leave their “normal” home range to reach a specific salt lick before returning. Different salt licks may be visited throughout the year although not all salt licks seem equally “suitable”, as tapirs visit a number of known licks while avoiding others. Results from camera and video traps suggest that Malay tapirs only drink the water from such licks, rather than engaging in geophagy, although this requires confirmation. The exact role of salt lick water and its targeted use has not been established, although salt licks probably fulfill a number of vital functions including supplying essential elements lacking from the diet. Analysis (using inductively coupled plasma mass spectrometry) of soil and water samples from six salt licks in Taman Negara National Park reveal that such licks can be enriched in a number of macro-nutrients

and trace elements, including Na, K, Mg, P, Ca, Cu, Fe or Mo. The elemental composition of licks (even those in close proximity) need not necessarily be the same and specific licks may be enriched with specific elements. Further work is required to determine the specific role of salt licks, as an important resource, for Malay tapirs.

**P-12-26: Prey Identification of Javan Leopard *Panthera pardus melas* Using a Micrography Technique Application in Mount Tilu and Mount Patuha , Bandung**

Dwi Ratna Sari, Achmad Sjarmidi; *Institut Teknologi Bandung*

research on the prey of Javan Leopard has been conducted in Mount Tilu nature reserve and Mount Patuha Protection Forest by identifying prey remains found in the leopard's feces. Feces samples taken from areas known to have been visited by leopards and their prey reference's samples were taken from animals at the zoo. fecal analysis was done by Deedrick (2004) methods with modification using the printed scales on the hair found in leopard's prey with the reference. the results showed that the leopards prey consist of rats (50%), lutung (22.7%), wild boar (9.09%), deer (9.09%), and gibbon (9.09%). all feces from the field had been identified which indicate that printing techniques of hair scale is quite effective. in the area of Mount Tilu nature reserve and mount patuha protection forest leopards have a variety of prey and survive mainly in the conservation area despite interference from humans. keywords: *Panthera pardus melas*, prey, micrographic techniques, scale cast

**P-12-27: Small Mammal Community Structure along a Strong Rainfall Gradient in Northeastern Brazil**

Alexandre R.T. Palma, Diego Astúa de Moraes, Paulo H. Asfora Lopes Peres, Anna Ludmilla C. P. Nascimento; *Universidade Federal da Paraíba*

The northeastern corner of South America has a strong rainfall gradient that is responsible for dramatic changes in the vegetation, which ranges from moist tropical forests (Brazilian Atlantic Forest) near the coast to semi-arid shrublands (Caatinga) in the hinterland. Small mammal communities are also highly variable along this gradient. The objective of this study was to compare the species composition, community diversity and relative abundances within guilds along this rainfall gradient. We sampled 20 communities in 9 areas. The sites studied included different habitats, such as forests on coastal sand dunes, secondary moist evergreen forests, secondary semi-deciduous forests, savanna patches in a forest/savanna mosaic and xeric shrublands that included well-preserved areas and others suffering from desertification. This study lasted 2 years, and included the La Niña (rainy) and neutral phases of the ENSO cycle. We made a total trap-effort of 12222 trap-nights. At each site we set one transect with traps at ground level and another in the understory, and we had two goals: at least 500 trap-nights and to capture 10 individuals from each site. To assign species to functional groups, we used diet and arboreality. We captured 241 individuals within 23 species (10 marsupials in the Didelphidae and 13 rodents in the Muridae and Echimyidae). The highest abundances were found in well-preserved xeric shrublands, while abundances in the Atlantic Forest sites were usually low. Diversity was highest in the wettest forest and in sites in a semi-deciduous forest/savanna mosaic. MDS and cluster analysis showed communities separated in two groups: xeric shrubland communities and forest/savanna communities. The latter group was further divided into the following subgroups: "core forest" communities occupying the wettest forests and in the forest/savanna mosaic, and impoverished "peripheral communities" on coastal sand dunes and close to the forest/xeric shrubland limits.

**P-12-28: Exploration of Plants Species as Food Plants Sources of**

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Abstract Studies on plants species as food plants sources of ground-dwelling victoria crowned pigeon or Mambruk (*Goura victoria* : Columbidae) in Buare Village, Mamberamo was conducted from March to April 2008. This study used survey and interview methods. The result showed 34 species and classified in to 20 family of plants used as Mambruk food plants sources. Parts of the plants being consumed were fruits ( 82.35%), seeds ( 14.71%) and crusted liquid (2.94%). Direct threat for food plants conservation were due to slash and burn cultivation and illegal logging. Key words : Mambruk, food plants sources, crusted liquid, Mamberamo, Papua.

**P-12-29: X-ray Anatomical Observation of Deciduous Teeth in the Celebes Babirusa (*Babyrousa celebensis*)**

Masaaki Ito, I Wayan Balik; *Babirusa Foundation-Tokyo*

Dental chronology in the domestic pigs (*Sus scrofa*) has been reported by many morphologists (Weaver et al. 1962, Weaver et al. 1966, Waver et al. 1969, Tonge and McCance 1973, Bivin and McClure 1975, Bivin and MacClure 1976). However, very little information is available in the literature on the processes of tooth development and growth in the Celebes babirusa (*Babyrousa celebensis*) which also belongs to the family Suidae (Groves 1985). It is because the babirusa has been protected under Indonesian law since 1931, and additionally listed in Appendix I of CITES since 1982. Fortunately, we had a good opportunity to observe a formalin-fixed specimen of a female Celebes babirusa piglet at 18 days of age. In this research, we aimed at investigating growth of its teeth, especially canine teeth using direct and X-ray anatomical observation. As the result of this research, we obtained several findings concerned with the deciduous dentition of the Celebes babirusa; 1. The formula for the deciduous teeth of the Celebes babirusa is considered to be:  $2(Di3/3, Dc1/1, Dm3/3)=28$ . This is the same as the deciduous teeth of the domestic pig. 2. The eruption of the deciduous second incisor tooth (I2) in both jaws is decidedly slower than the first incisor tooth (I1) and the third incisor tooth (I3). 3. The maxillary deciduous I3 looks like the deciduous canine of the domestic pig in appearance. 4. At 18 days of age, the maxillary deciduous canine is an embedding tooth that lies within the maxilla in the anterior-posterior direction slightly ventrally, showing the crown in the rostral side. 5. At 18 days of age, there are 4 molar teeth in each dental arch, and the deciduous first premolar (PM1) is small in size. 6. The fourth molar in the most caudal part of the dental arch is considered to be permanent first molar (M1).

**P-12-30: Effects of Land Use on Mammal Biodiversity in the Tarangire Ecosystem, Northern Tanzania**

Maurus Msuha<sup>1</sup>, Chris Carbone<sup>2</sup>, Sarah Durant<sup>1</sup>; *1. Tanzania Wildlife Research Institution, 2. University College London*

Many wildlife species, especially large carnivores are threatened by changes in land use practices because their survival depends upon large and intact habitats. Such habitats are increasingly becoming scarce due to land use change as a result expanding human populations. We investigated effects of land use practices on carnivore and non-carnivore biodiversity in the Tarangire ecosystem. Camera traps were used to determine species richness in three land use types with increasing human pressure, namely (1) land within the Tarangire National Park, (2) pastoral grazing areas outside the park; and (3) cultivated areas outside the park. Results showed that species detectability, seasonal movements and land use practices appeared to be important factors influencing species richness. Overall there was little difference in carnivore species richness between the park and the pastoral grazing areas. 19 carnivore species were photographed in the park and 17 in the pastoral grazing areas. Carnivore richness was lowest in the cultivated areas where 6 species were photographed. Non-carnivore species richness also varied between land use types. It was highest in the pastoral grazing areas, where 22 species were photographed, medium in the park, where 18 species were photographed and lowest in

cultivated areas, where 14 species were photographed. Most large mammals were not found in the cultivated areas, demonstrating that large mammals were more sensitive to habitat change than smaller mammals. Although the park holds a rich mammal community and is fully protected, pastoral grazing areas outside the park also held significant mammal community and is therefore important for overall conservation of wildlife in the ecosystem. However, the increasing cultivation of pastoral rangelands outside the park is a major threat to wildlife in the Tarangire ecosystem.

**P-12-31: Disease Surveillance and Epidemiology of Water Buffalo (*Bubalus bubalis*) Surrounding Ujung Kulon National Park for Conservation Program of the Javan Rhinoceros (*Rhinoceros sondaicus*) in Indonesia**

O.K. Khairani, Andriansyah, Candra D., Ramono W.S., Priambudi A., Sectionov, R. Radcliffe; *Yayasan Badak Indonesia-YABI (Rhino Foundation of Indonesia)*

Javan rhinoceros in UKNP is critically endangered species (IUCN Redlist) and an estimated population in 2009 is 35-50 animals. Aside from increasing human activities, other threat concern is transmission diseases from livestock who lived around Honje Mountain-UKNP. A study on the prevalence of several infectious diseases was carried out in 2009 in 19 buffer villages surrounding Honje Mountain. The species of particular interest was water buffalo, since these is the species most likely to have contact and share habitat space or resources with the rhinos. We carried out a cross-sectional study to determine the disease prevalence at one point in time. The study was conducted on 100 water buffalo in 10 villages, which were selected in the study area using a Probability proportional of Size (PPS), followed by simple random sampling. In July - September 2009, blood and fecal samples were taken. Serum samples were tested for antibodies of *Pasteurella multocida* (Hemorrhagic Septicemia-HS) with an ELISA technique and antibodies of *Leptospira* sp with MAT technique. None of the animals was found to be positive for HS and only 2 (2%) were positive for *Leptospira* sp (*L.bataviae* and *L.pyrogenes*). Blood smears were examined for *Anaplasma* sp, *Babesia* sp, *Theileria* sp and *Trypanosoma* sp. Positive result was 8 (8%) for *Anaplasma* sp, 9(9%) for *Babesia* sp, 17(17%) for *Theileria* sp. None of animals was found to be positive for *Trypanosoma* sp. Fecal samples were examined for *Salmonella* sp with bacterial culture and Internal parasite with floatation and sedimentation method. Positive result was only 2 (2%) for *Salmonella* sp and for Intestinal parasite; the intestinal fluke *Paramphistomum* sp were the most frequent helminth 91 (91%), followed by the liver fluke *Fasciola* sp 48 (48%) and *Strongyle* sp 3 (3%). This study clearly showed that fluke infection is the most common infestation among water buffalo population in surrounding Honje Mountain-UKNP. Attention should be taken to improve the health status of water buffalo to mitigating disease outbreaks at the village level before they could enter and affect the rhinos.

**Poster session: Microbiology (#13; July 20)**

**P-13-1: PlikU as a Food and Health Product, as well as a Farm Feed that is Used within the Aceh Community**

Rahmat Pramulya; *Research Institute, University of Teuku Umar*

The various applications of natural substances as an anti microbe is usually in basic forms of herbs, spices, "jamu", and oils. The coconut (*Cocos nucifera* L) is one plant that has been used by people for hundreds of years, especially its flesh and oil. The Aceh people have been using traditionally fermented coconut oil as cooking oil and medicine, while the coconut dregs as cooking ingredient or chicken feed. The purpose of fermentation is to preserve food so that they may have longer storage time, and this can effect the nutrition quality of the foods being preserved. The Aceh oil is known as minyeuk pliek u (minyeuk simplah or minyeuk brok), while the dregs that is left from the the process of making the oil is called pliuik u, that the people often use as cooking spices, chilly paste, and even chicken feed. The people of Aceh use fermented coconut oil (minyak pliek u) as a medicine to cure



fever, sore joints, headaches, stomachaches, and other topical and digestive cures. The presentation will explain in detail about product development conditions in this product's role within the social economy of the Aceh people.

**P-13-2: Can We Keep the Lakes Blue? Cyanobacterial Blooms at Lake Atitlan, Guatemala**

Eliska Rejmankova<sup>1</sup>, Jiri Komarek<sup>2</sup>, Margaret Dix<sup>1</sup>; 1. *University of California, Davis*, 2. *University of South Bohemia, Czech Republic*

Accelerated land use change and resulting cultural eutrophication has become the primary water quality issue for most freshwater and coastal ecosystems in the world. Excessive input of nutrients, particularly phosphorus (P) and nitrogen (N), increases primary production, reduces water transparency, and often causes algal community shifts towards bloom-forming cyanobacterial species that can be toxic. Lake Atitlan's situation is a case in point. This lake located in the highlands of Guatemala and described by many as one of the most beautiful lakes in the world, is facing a serious problem with increasing water pollution. Over the last several decades, the uncontrolled nutrient input into the lake has led to high P levels and low N:P ratios, i.e., conditions ideal for the dominance of cyanobacteria. Indeed, the first bloom occurred in December of 2008, followed by a more extensive one in October 2009. The blooms are formed by cyanobacteria from the planktic *Lyngbya hieronymusii* complex. Remote sensing images documented that at the maximum bloom development, 40% of the 137 square km of the lake area were covered by dense patches of *Lyngbya*, with the chlorophyll a concentration reaching over 100 µg/L. Trace levels of cyanotoxins cylindrospermopsin and saxitoxin were detected. Nitrogenase activity assessed by the acetylene reduction technique was minimal during the day, but reached 2.2 nmol C<sub>2</sub>H<sub>4</sub> /µg Cha /hour during the night -- a pattern expected in non-heterocytous cyanobacteria. This, together with the information on delta 15N of -0.86 ‰ confirmed that *Lyngbya* is actively fixing nitrogen. A well designed and executed lake monitoring program, strict control of nutrient input into the lake, and public education are necessary prerequisites for prevention of even more severe future blooms. Scientific as well as socio-economic issues of Lake Atitlan will be presented in the context of protection of other oligotrophic tropical and temperate lakes.

**P-13-3: Isolation, Characterization and Antimicrobial Screening of Endophytic Bacteria from *Eichhornia crassipes* and *Arundo donax* Found in Marikina River, P**

Nilda W Balsicas, Francis E. Ansing, Glenn Mark C. Victorino, Alex T. Malones; *Pamantasan ng Lungsod ng Pasig*

This study was conducted to investigate the possible endophytes in water hyacinth (*Eichhornia crassipes*) and wild cane (*Arundo donax*) that thrive in Marikina River. The objective is to characterize and screen using antibiotics the bacteria isolated from selected root and stem of water hyacinth and wild cane. Plant samples were collected from five (5) sampling sites in Marikina River. Plants' stem and roots parts were aseptically homogenized. Homogenates were subjected to standard protocols in isolating bacteria. One hundred eighty (180) plant isolates were characterized culturally and subjected to staining tests. Selected isolates were subjected further to biochemical tests. Data from Biochemical, KOH and Acid-fast tests were subjected to similarity coefficients. Results showed eight (8) kinds of strains from water hyacinth and seven (7) kinds of strains from wild cane. Generally, bacteria from both plants exhibited the biggest zone of clearing in ciprofloxacin and smallest in ampicillin. This study would significantly contribute to the present knowledge and microbiological studies on endophytic bacteria. Also, these microorganisms may be useful for bio-control, bio-indicators, and other applications.

**P-13-4: Biocontrol of Dry Rot Disease on Potato by *Bacillus megaterium***

Arya Widyan, Adyatma Santosa, Mahmoud Hosni El Komy, Younes Yousef Molan; *King Saud University*

Inhibition effect of Plant Growth Promoting Rhizobacteria, *Bacillus megaterium*, against soilborne fungi, *Fusarium solani*, causal agent of dry rot disease on potato was observed. The bacterium was not only able to inhibit the growth of the pathogenic fungi and reduce the sporulation in vitro, but was also able to inhibit the fungi growth on the potato tuber disc (in vivo). These results suggest that *B. megaterium* can be utilized as a biocontrol agent in plant disease management in order to prevent food shortage and to support biodiversity-friendly agriculture. In advance study, which is still being conducted, we also expect that the bacterium is able to induce the production of plant defense enzymes, such as peroxidases.

#### **P-13-5: Purification and Characterization of a Chitinase from *Streptomyces* sp. IK**

Agustinus Joko Nugroho; *Research Center for Biology-LIPI*

*Streptomyces* sp. IK isolated from compost inoculant, could produce extracellular chitinase in a medium containing 0.2% (w/v) colloidal chitin, fermented for 96 hours at 30°C. The enzyme was purified by a combination of ammonium sulphate precipitation, and DEAE-Cellulose anion-exchange chromatography. On SDS-polyacrylamide gel electrophoresis analysis, the purified enzyme showed a mass of 71 kDa. Chitinase was optimally active at pH of 6.7 and at 37°C. Km value and Vmax of the protein for colloidal chitin were 2.92 mg/ml and 4.26 µg/h. Key words: chitinase, *Streptomyces*, purification, characterization

#### **P-13-6: Diversity of Phosphate Solubilizing Bacteria in Forest Affected Fire and its Possible Role in Ecosystem Recovery**

Suliasih; *Research Center for Biology - LIPI*

The effect of forest fires on species diversity of Phosphate Solubilizing Bacteria (PSB) and the activity of phosphomonoesterase were studied in forest soils of Bukit Bangkirai East Kalimantan. Three permanent plot were established in each of the non affected fire (K-plot), The lightly fire affected (LD-plot) and the hardly fire affected forest (HD-plot). Soil samples were taken at two different depths (top soil, 0 – 20 cm and sub soil > 20 cm) and collected from ten points from each plot. The purpose of this study was to survey the impact of forest fires on diversity of PSB and the activity of phosphomonoesterase in soil. 52 isolates of PSB were isolated and 8 species of these bacteria have been identified as *Azotobacter* sp.; *Bacillus* sp.; *Chromobacterium* sp.; *Citrobacter* sp.; *E. coli*, *Klebsiella* sp., *Listeria* sp., *Nitrosomonas* sp. And *Serratia* sp. The bacterial number was indicated by viable count and its ranged from  $76 \times 10^4$  to  $155 \times 10^4$  cfu g<sup>-1</sup> of soil. The activities of acid and alkaline phosphomonoesterase ranging from 19.16 to 65.87 µg p-nitrophenol g<sup>-1</sup>h<sup>-1</sup>, and from 2.68 to 10.46 µg p-nitrophenol g<sup>-1</sup>h<sup>-1</sup> respectively in the top soil. The acid and alkaline phosphatase ranged from 19.49 – 59.82 µg p-nitrophenol g<sup>-1</sup>h<sup>-1</sup> and 0.47 – 5.51 µg p-nitrophenol g<sup>-1</sup>h<sup>-1</sup> respectively in the sub soil. The acid and alkaline phosphatase and bacterial number decrease with depth. The bacterial activities in K-plot were significantly higher compared with LD-plot and HD-plot. Considering that high number of PSB and their activities, we assume that those bacteria could be important for stimulating mineralization of phosphate and finally stimulate plant growth.

#### **P-13-7: Species Diversity and Phosphate Solubilizing Character of Bacteria Isolated From Several Ecosystem Types**

Sri Widawati; *Research Center for Biology, Indonesian Institute of Sciences*

The objective of this study was to verify species diversity and physiological characters of phosphate solubilizing bacteria (PSB) in Laki Island through culture dependent technique. Soil, water, sand and plant rhizosphere were collected randomly from mangrove, sea water, sea sand, and agricultural land. Population of phosphate solubilizing bacteria was affected by cultivation media and sample type. The

highest bacterial population was encountered in the rhizosphere of *Ipomea aquatica*, and in this rhizosphere several important PSB strains which are able to solubilize calcium phosphate of about 18,59 mg.l<sup>-1</sup>, Al-P of about 18,31 mg.l<sup>-1</sup>, and rock phosphatase of about 5,68 mg.l<sup>-1</sup> after 7-days incubation. Phosphate solubilizing capacity was highest in Ca-P medium. Strain No. 13 and 14 having highest Phosphomonoesterase activities (about 2,01 µgNP.g<sup>-1</sup>.h<sup>-1</sup> and 1,85NPµg.g<sup>-1</sup>.h<sup>-1</sup>), and they were identified as *Serratia marcescens*, and *Pseudomonas fluorescens* respectively. Those strains were isolated from *Amaranthus hybridus* and *Ipomea aquatica* respectively, which were commonly observed in coastal ecosystem. The presence of those microorganisms and their ability to solubilize various types of phosphate species may indicate that they play important role in supporting plant growth in coastal ecosystem. Key words: Phosphate solubilizing bacteria and coastal ecosystem

#### **P-13-8: Soil Enzymes Activities of System of Rice Intensification**

Maman Rahmansyah, I Made Sudiana; *Research Center for Biology-LIPI*

The system of rice intensification (SRI) is gaining popularity. But the mechanism by which methane is generated and emission is inhibited have not yet clearly understood. Our work was intended to evaluate the soil enzyme activities, especially those enzymes responsible for mineralization of carbon, nitrogen and phosphorous. The result show that there was significant fluctuation of soil enzymes activities both in system of rice intensification and conventional system. Augmentation of microorganism having phosphate solubilization capacity show that phosphatase activities is greater in augmented treatment which may indicate that phosphate solubilizing organism important in phosphate mineralization. The relation between soil enzyme activities and methane emission is further verified. Keyword: Soil enzymes, SRI, and phosphate solubilization microbe

#### **P-13-9: Exploration of Yeasts Diversity in Conserve Area (Rawa Aopa and Bogani Nani Wartabone National Park) Sulawesi**

Atit Kanti; *Research Center for Biology-LIPI*

Fungi have significant functions in ecosystem and are found in all kind of habitats. Yeast are the important group of fungi but their physiology is less understood than that of other higher fungi group. They are ubiquitous in nature, present in both aquatic and terrestrial. Fungal biodiversity plays important roles in ecosystems and has a big potential for bioprospecting endeavor. Various habitats are among the under-explored microbial ecosystem in Indonesia, which are threatened for biodiversity loss. To date, there is very little information on species diversity of Indonesian indigenous yeasts and yeasts like fungi. We collected soil samples from 2 conserve area in Sulawesi namely Rawa Aopa and Bogani Nani Wartabone National Park to investigate the biodiversity of yeast and yeasts like fungi in Indonesia using molecular identification based on D1D2 region of LSU rDNA and internal transcribed spacer (ITS). Yeast isolation technique were developed aimed to verifying maximum yeast diversity in the sample. The yeast isolation technique developed was based on media modification for enriching cultures. The defined medium consist of Yeast Nitrogen Base and 20% of glucose. These isolation technique was succes obtaining 20 isolates yeast in Rawa Aopa National Park which further classified into 3 groups namely group I consist of *Pichia guilliermondii*, group II consist of *Candida tropicalis*, group III consist of *Cryptococcus laurentii*. While from Bogani Warta Bone National Park was success to obtain 30 isolates which further classified into 3 groups, namely group I consist of *Pichia guilliermondii*, group II consist of *Candida tropicalis*, group III consist of *Candida viswanathii*. This technique able to isolate mostly Ascomycetous group while for Basidiomycetous group we should develop other isolation technique. Key words : yeast, soil, Rawa Aopa National Park, Bogani Warta Bone National Park

#### **P-13-10: Toxicity of Acetaminophen in Yeast *Candida tropicalis***

Heddy Julistiono; *Research Center for Biology-LIPI*

We have been exploring cost effective methods of for antioxidant screening methods through utilization of yeast. This method is considered to be simple and cheap. For that proposes we develop yeast *Candida tropicalis* as a tool for evaluation of anti- or pro-oxidant property of substances in cell level, toxicity of an analgesic drug acetaminophen in the yeast have been preliminary studied. Incubation of yeast cell suspension in the presence of 0.3 % acetaminophen for 2 hours significantly decreased cell viability. Malon dialdehyde, a biochemical marker for cell oxidative damage, increased. Acetaminophen of 0.1 % decreased when added in cell yeast suspension for 1 hour. The data indicated that toxicity of the drug in the yeast could be compared to that of mammalian cell where the drug is metabolized mainly by cytochrome P-450 and followed by oxidative stress in cells caused by metabolite byproduct. Toxicity of the drug in the yeast could be related to the formation of reactive oxygen species. These preliminary data promises new method on the use of the yeast for screening antioxidant property of substances. Key words: *Candida tropicalis*, antioxidant, acetaminophen, model cell

### **P-13-11: Characteristic and Kinetic Parameter of *E.cloacae* $\beta$ -Galactosidase Isolated from Fruit Originating Salak Mountain**

Tatik Khusniati<sup>1</sup>, Abdul Choliq<sup>2</sup>, Sulistiani<sup>1</sup>; *1. Microbiology Division, Research Center for Biology-LIPI, 2. Research Center for Biology*

$\beta$ -Galactosidase enzyme help human which have "lactose intolerance" in hydrolyzing lactose to be glucose and galactose in human ulcer. Fruit containing a lot of nutrition were used as media for the growth of various bacteria including bacteria producing  $\beta$ -galactosidase. Characteristic of  $\beta$ -galactosidase bacteria originating from fruit haven't reported. To know the characteristic of  $\beta$ -galactosidase bacteria originating from fruit, characteristic and kinetic parameter of *E. cloacae*  $\beta$ -galactosidase isolated from fruit originating Salak mountain, Sukabumi were researched. Optimazion of *E.cloacae*  $\beta$ -galactosidase was conducted by detection of enzyme activity in optimum condition (incubation time, pH, temperature, substrate concentration), and kinetic parameter was based on formula of Michaelis Menten and Lineweaver Burk. The research results show that there were the differences in  $\beta$ -galactosidase characteristics between *E.cloacae* and *Lactobacillus bulgaricus* as control bacteria. The highest *E.cloacae* b-galactosidase activity was in 40% ammonium sulphate precipitation, and the optimum condition was reached at incubation time: 5', pH: 7.0 and temperature: 46 oC, while the highest *Lactobacillus bulgaricus* b-galactosidase activity was in 80% ammonium sulphate precipitation, and the optimum condition was reached at incubation time: 25', pH: 5 and temperature: 40oC. Furthermore, kinetic parameters of *E. cloacae* b-galactosidase with 40% ammonium sulphate precipitation, based on curves of Michaelis Menten and Lineweaver Burk show that the values of Km: 3.149 mM and Vmax: 3717 U/mL. Key words: b-Gactosidase, *Enterobacter cloacae*, *Lactobacillus bulgaricus*, kinetic parameter, fruit, Salak mountain.

### **P-13-12: Isolation and Determination of Dominant Microorganisms in Traditional Fermentation of Ambonese Arrack and Optimization of Controlled Fermentation using *Pichia polymorpha* and *Kloeckera javanica***

Dea Indriani Astuti, Ferymon Mahulette; *School of Life Sciences and Technology, ITB*

Ambonese arrack is a traditionally fermentation product of coconut sap. This alcoholic beverage has inconsistent taste and quality, but the consumption is huge in Ambon City. This fact encourages the local government to standardize the taste and ethanol content within. The low quality of arrack produced traditionally is caused by an uncontrolled fermentation process which results in involvement of microbes which do not play role in the process. This research was conducted to standardize the arrack quality. The first stage of the research was isolation of microorganisms involved in arrack fermentation. The results showed that there were 8 microorganisms found during traditional fermentation of ambonese arrack, including 3 yeasts and 5 bacteria. Among those, *Pichia polymorpha* and *Kloeckera javanica* were dominant during the whole process and considered play an important role in ambonese arrack fermentation. Both yeasts than were used in the second stage of this research,

i.e. the controlled arrack fermentation using inoculums comparison of *Pichia polymorpha* and *Kloeckera javanica* (P:K) 1:1, 1:2, and 1:3. The ethanol content from fermentation broth (palm wine) was 0.0113 g/L; 0,011 g/L and 0,009 g/L produced by consortium of P:K = 1:3, 1:2 and 1:1 respectively, meanwhile ethanol content in the uncontrolled traditional fermentation broth was 0,10%. The fermentation broth was then distilled to obtain arrack. The ethanol content after distillation was 30.04%, 28.96% and 27.90% which was produced by P:K = 1:3, 1:1 and 1:2, respectively. The content of ethanol was almost similar with the alcohol content of traditional arrack, which was 28.93%. The organoleptic test of arrack from traditional and controlled fermentation showed that the best arrack quality (scent and taste) was produced by consortium of P:K = 1:2, but the optimization result which was closest to the taste of traditional arrack was from the consortium of P:K = 1:3.

### **P-13-13: Making Fermented Foods using Indigenous Microbes Isolated from Their Ingredients**

Pingkan Aditiawati, Veronica D.S.A., Puti Utari Emilia, Hidayat Fathoni Amrullah; *Institut Teknologi Bandung*

Fermentation is the oldest method of food processing. Three of fermented foods with role of indigenous microbes are Honey Wine, Honey Tea Cider, and Ikan Samu. Honey is one of the alternatives used as sugar replacement with better benefit. Honey wine is a fermentation beverage made of honey. The honey fermented by yeast has a unique flavor. The flavor has produced distinctive character depending of the type of honey used. From Randu honey that is used in this research, we isolated two indigenous yeast, *Zygosaccharomyces bailii* and *Pichia membranaefaciens* that are used as inoculum. From mix culture inoculum of 10% v / v (2 : 1), the results were: pH was 3.35, the number cell was  $0.8 \times 10^4$  CFU / mL and  $29.1 \times 10^4$  CFU / mL, the sucrose solution 19.60 g / 100 g solution, and alcohol contents were 9.9%. Another fermentation product from honey is honey tea cider. From honey tea cider starter, we isolated two kinds of yeast : *Zygosaccharomyces rouxii* (K1) and *Brettanomyces* sp. (K2) and one kind of acetic acid bacteria: *Acetobacter xylinum* (B). The optimum condition for fermentation of 'Honey Tea Cider' was gained using mixed culture of pure isolates with inoculum ratio of B : K1 : K2 is 5 : 1 : 1 and inoculum 10% (v/v), and honey concentration 10% (v/v). Ikan Samu is the fish that is added with salt and roasted rice, then it is left in a closed container during two or three days. Five halophilic bacteria isolates are obtained from Snakeskin Gourami Samu fermentation and identified as *Bacillus*, *Halomonas*, *Marinococcus*, *Micrococcus halobius*, dan *Chromohalobacter*. Five halophilic bacteria isolates are also obtained from Snakehead Murrel Samu fermentation and identification result shows they are *Bacillus*, *Halomonas*, *Marinococcus*, *Chromohalobacter* and *Planococcus*. Based on organoleptic test, it is found that the Snakeskin Gourami Samu product that is preferred by the panelist is made with Sodium Chloride level = 15% w/v and inoculum of 10 % (v / v).

### **P-13-14: Chitinase Activity of Bacteria Isolated from Hot Spring of Pancar Mountain, Bogor**

Nunuk Widhyastuti; *Research Center for Biology-LIPI*

Chitin, a  $\beta$ -(1,4)-linked polymer of N-acetyl D-glucosamine (GlcNAc), is the second most abundant biopolymer in nature and particularly occurred as a structural polysaccharide in fungal cell walls, in the exoskeleton of arthropods, the outer shell of crustaceans, etc. Chitinases (EC 3.2.1.14) hydrolyzing chitin, occur in a wide range of organisms including microorganism, plants, and animals. Chitinase have a broad range of applications such as preparation of pharmaceutically important chitooligosaccharides and N-acetyl D-glucosamine, control of pathogenic fungi and insect, treatment of chitinous waste, and control of malaria transmission. The wide applications of chitinase make the screening for chitinase producing microorganisms an interesting and important task. Several bacterial species have been studied for the production of chitinase. However, only a few thermostable chitinase from bacteria are known.

The chitinase of bacteria isolated from hot spring located at Pancar Mountain, Bogor was studied. The potency of the isolates for chitinase production was determined on the basis of clearing zone (CZ) and

colony size (CS) ratio on chitin agar plate. Ten isolates had chitinase activity and the selected bacteria producing high chitinase was identified by molecular approach (16S rDNA). *Bacillus licheniformis* GPT2.4 produced high chitinase activity in liquid media containing 1% chitin with initial pH media of 6.0-8.0, at 40 °C, 120 rpm for 4 days incubation. Chitinase of *B. licheniformis* GPT2.4 had optimum activity at 60 °C, pH 5.0, and stable at 50 °C, but unstable at 60 °C. Addition of 10 mM Ca<sup>2+</sup> to the enzyme increased not only its stability at 60 °C, but also its activity about 60%. Cu<sup>2+</sup> and Hg<sup>2+</sup> ions inhibited the chitinase activity, while Na<sup>+</sup> and K<sup>+</sup> ions had no effect on the activity.

Key words : chitinase, *Bacillus licheniformis*, characterization

### **P-13-15: Exploring Raw Starch-Degrading Bacteria from Plant Tubers in Central Kalimantan for Oligosaccharides Production**

Achmad Dinoto, Purwaningsih, Sri, Joko; *Indonesian Institute of Sciences (LIPI)*

We have successfully isolated indigenous bacterial strains from several plant tubers in Central Kalimantan that capable of degrading raw starch. The total numbers of starch-degrading bacteria in *Colocasia* sp., *Dioscorea* sp., *Canna* sp., *Manihot* sp., *Ipomea* sp., and *Xanthosoma* sp. tubers were relative high ranging from 2.7 to 9.8 x 10<sup>(7)</sup> c.f.u/g, where the highest population of bacteria was found in *Canna* sp. tuber. The enzymatic assay for amylase showed that three of forty bacterial strains have the highest activity, i.e DU024 (0.122 U/mL), DU017 (0.117 U/mL), and DU031 (0.116 U/mL), and those strains were then selected to intensive investigation for the capabilities of oligosaccharides production by enzymatic reaction. Positive oligosaccharides-producing strains were confirmed by thin layer chromatography after enzymatic reaction of the mixture containing starch. As the results, all tested bacterial strains were capable of producing oligosaccharides as important substance for the industries. Furthermore, we clarified the taxonomy status of potential bacterial strains by partial 16S ribosomal DNA analysis and the results showed that those starch-degrading and oligosaccharides-producing bacterial strains were closely related to *Bacillus* groups (> 99% similarity). To the best of our knowledge, these results demonstrated the diversity of indigenous bacteria in Central Kalimantan that capable of degrading raw starch, and also showed the bio-prospecting aspects of enzymatic technology for oligosaccharides synthesis.

### **P-13-16: Phylogenetic Diversity of Yeasts Associated with *Apis cerana*-visited Flowers in West Java**

Wellyzar Sjamsuridzal, Adi Basukriadi, Novia Rachmayanti, Ariyanti Oetari; *Department of Biology, University of Indonesia*

There is only little information on yeasts associated with honey bee visited flowers from tropical region. We reported the phylogenetic diversity of yeasts isolated from *Apis cerana* Fabr. visited flowers in Depok and Bandung, West Java. Yeasts were isolated from stamens and pistils of *Calliandra calothyrsus*, *Brugmansia sueveolens*, and *Mimosa pudica* from Bandung; and *Jatropha integerrima* and *Cosmos caudatus* from Depok. Molecular identification based on ITS regions sequence data showed that the yeasts were closely related to *Aureobasidium pullulans*, *Bullera* sp., *Bullera sinensis*, *Candida* sp., *Candida* cf. *azyma*, *Candida floris*, *Candida hawaiiiana*, *Cryptococcus* sp., *Cryptococcus flavescens*, *Cryptococcus heveanensis*, *Cryptococcus rajasthanensis*, *Debaryomyces hansenii*, *Exobasidiomycetidae* sp., *Kodamaea ohmeri*, *Pichia caribbica*, *Pseudozyma* sp., *Pseudozyma antarctica*, *Pseudozyma aphidis*, *Pseudozyma hubeiensis*, *Rhodotorula mucilaginosa*, *Sporobolomyces koalae*, *Sporidiobolus ruineniae*, *Tremellales* sp., *Ustilago drakensbergiana*, *Ustilago esculenta*, *Ustilago sparsa*, and *Ustilago tragona*. Undescribed yeasts of the genera *Bullera*, *Candida*, *Cryptococcus*, *Exobasidiomycetidae*, and *Pseudozyma* were discovered in this study. We found that some yeast species were commonly found in honey bee visited flowers from the same area. For example, yeast species of *Candida hawaiiiana* was found in flowers of *Calliandra calothyrsus*, *Brugmansia sueveolens*, and *Mimosa pudica*; species of *Bullera sinensis* was found in flowers of *Calliandra calothyrsus* and *Mimosa pudica*; and *Candida* cf. *azyma* was found in *Calliandra*

calothyrsus and Brugmansia sueveolens. These flowers were located in the same mountainous area in Ciburial, Bandung. Our study revealed that Apis cerana plays important role as vector of yeasts on these flowers. The phylogenetic analysis showed that the yeast isolates were distributed within the phyla of Ascomycota and Basidiomycota. All yeast isolates were grouped into classes Hemiascomycetes and Euascomycetes of the phylum of Ascomycota; Urediniomycetes, Ustilaginomycetes and Hymenomycetes of the phylum of Basidiomycota. Several yeasts species were clustered with other known yeasts associated with bees or other insects and flowers.

**P-13-17: Optimization of Glucose Content as Cosubstrate in Sulphur Removal during the Process of Coal Liquefaction by *Phanerochaete chrysosporium***

Ayu Amalia Irsyam, Pingkan Aditiawati, Rifka Fadilah; *Institut Teknologi Bandung*

Energy plays an important role in the human life because most of human activities requires energy. It is estimated that in the next 30 years energy demand will increase almost 60%. However, oil and natural gas that is currently used as main source of energy will come to an end. Therefore, coal that is available in huge amount and can be found in wide spread locations in Indonesia can be used as an alternative energy. Liquefaction of coal using biological process can be conducted by utilizing microorganisms that have capability to degradate solid coal to become liquid. The microorganisms have enzym system that can decompose lignin inside coal. One of the microorganisms is *Phanerochaete chrysosporium*. This study is conducted to investigate the influence of glukose content of the medium in sulphur removal during the process of coal liquefaction. *P. chrysosporium* is grown in potato medium and coal using three variations of glucose content; 5g/L, 10g/L dan 15g/L. The medium is then incubated at room temperature and shaken at 100 rpm. Analysis is then conducted to investigate the amount of cells, pH, sulfate content, humic acid content, and fulvic acid content. Increase of sulfate content indicates decrease in sulphur content. The optimum rate of change in sulfate content is obtained when *P. chrysosporium* is grown at medium with 10% of glucose content. In this condition, increase of 59.08 ppm of sulfat per day with value of humate acid absorbance of 0.7597 is observed on the 12th day. The highest value of humate acid absorbance, 2.1536, is obtained on the 6th day. This result shows that *Phanerochaete chrysosporium* can decompose coal into humic acid and fulvic acid in sulphur removal during coal liquefaction process.

**P-13-18: The Effects of The Three Producing Methods of Virgin Coconut Oil to The Quality of Virgin Coconut Oil Product**

Yuni Satitiningrum, Cininta Amandari Suharmoko, Dea Indriani Astuti; *SITH Institut Teknologi Bandung*

A research has been carried out to assess the quality of three kinds of virgin coconut oil (VCO) which was produced from three different methods. The three methods were: the inoculation of coconut milk by using microorganism starter (VCO B), by using coconut oil (VCO 0), and by using the mixture of both (VCO O+B). The microorganism starter of VCO B consists of local isolates i.e. *Rhizopus oryzae*, *Rhizopus oligosporus*, and *Bacillus sp.* The coconut milk were inoculated with 10% of each starter. The VCO B, 0, and O+B product were 20%, 15%, dan 25% by volume respectively. The antimicrobial tests of VCOs were then conducted to bacteria *Escherichia coli* and *Staphylococcus aureus* by using Kirby-Bauer and plate count method. The Kirby-Bauer method did not detect any antimicrobial substances that was shown by negative inhibition zone. The plate count method, on the other hand, successfully showed the growth inhibition of *E. coli* and *S. aureus*. The decreasing growth of *E. coli* and *S. aureus* were determined by plate counting every 3 hours during 24 hours of observation. The growth inhibition rate of VCO B, 0, and O+B of *E. coli* were 0,011/hour; 0,016/hour; and 0,015/hour respectively. And the growth inhibition rate of VCO B, 0, and O+B of *S. aureus* were 0,00914/hour; 0,0102/hour; and 0,00714/hour respectively. In other words, the three VCOs inhibited *E. coli* more effectively than *S. aureus*. The quality of the three VCOs was determined using several parameters such as: lauric acid, iodine number, saponification number, free fatty acids, density, and refractive index. In general, the quality meet the VCO standards according to Badan Standarisasi

Nasional, Badan Pengawas Obat dan Makanan, and The British Standards. It can be concluded that the three methods produce three kinds of VCOs with similar quality based on the test results.

### **P-13-19: Perspective on Biofuel Based Biodiesel Production from Algal Lipid**

Joko Sulistyono, Rita Dwi Rahayu, Achmad Dinoto, Sri Purwaningsih; *RCB-LIPI*

Microalgae have been considered as potential source of new renewable energy feedstock. They are capable of producing high levels of total fatty acid for biodiesel production. Biodiesel is a very attractive biofuel and has various beneficial effects like low CO<sub>2</sub> emission and toxicity, favourable energy balance renewability. The biodiesel from algal biomass containing lipid is produced by transesterification of algal lipid with methanol in the presence of alkali or enzyme catalyst. However mass cultures of microalgae have disadvantages of higher cost for biomass production. We, therefore, proposed an integrated production system incorporating producing biodiesel fuel using different biodiesel preparation methods, including oil extraction followed by alkali or enzymatic transesterification of algal biomass. Since microalgae primary comprise of proteins, carbohydrates, fats and nucleic acids, we, therefore investigated the use microalgae as for production of bioethanol, to remove pollutants from wastewaters, to assay water quality, and as indicators of environmental change. Algae have a tendency to have a much different makeup than does most feedstocks used in ethanol, such as corn and sugar cane. Bioethanol from algae is possible by converting the starch and cellulose (polysaccharides). Microalgae are the optimal source for second generation bioethanol due to the fact that they are high in polysaccharides and thin cellulose walls. The real problem is that there are so many more valuable products to produce from it, such as carrageenan, agar, and dozens of valuable compounds. In comparison, bioethanol is a low-priced product. However, there have been limited investment opportunities so far in the microalgae biofuel arena despite all its promise and potential. Keywords : Microalgae, biodiesel, bioethanol, enzymatic catalyst, transesterification.

### **P-13-20: The Role of Hydrocarbons Degradation Bacteria, Phosphate Soluble Bacteria, rhizobium and mycorrhizae to Remediate Oil-Contaminated Soils**

Yuni Sri Rahayu, Yuliani; *Biology Department, FMIPA, UNESA Surabaya*

Rhizoremediation is the use of microbial populations present in the rhizosphere of plants for environmental cleanup. The idea of this work that bacteria in the rhizosphere of a nitrogen-fixing leguminous plant, could take part in the degradation of harmful hydrocarbons from oil-contaminated soils. In addition, the biodegradation process on soil contaminants will be increased by using a vegetation on 0-20 cm depth of rhizosphere. In addition the quality of rhizodeposition depend on the vegetation grown on this area. The main aims of this study were to describe the role of microbial present in the rhizosphere of leguminous plant to remediate oil-contaminated soil. A series experimental designs were conducted divided by two steps. Firstly, five different randomized completely (or block) experimental designs were conducted separately to find the optimal concentration of phosphate soluble bacteria (*Pseudomonas aeruginosa* or/and *Bacillus subtilis*) and to find the effectiveness of hydrocarbons degradation bacteria (*Achromobacter xylosoxidans* or/and *Arthrobacter polychromogenus*), nitrogen-fixing bacteria (*Rhizobium japonicum* or/and *Rhizobium phaseoli*), and vesicular arbuscular mycorrhizae (*Glomus aggregatum* or/and *Glomus etunicatum*) to reduce the total petroleum hydrocarbons (TPH), soil C/N and to increase phosphate, nitrogen available in treatment oil-contaminated soils. Secondly, two different randomized completely block experimental designs were conducted separately to find the effectiveness of the interactions among these soil bacteria and mycorrhizae on leguminous plant survive grown on oil-contaminated soil. The results reveals that the optimum concentration of phosphate soluble bacteria, *Pseudomonas aeruginosa* and *Bacillus subtilis*, in treated soil were 108 and 109 cell/mL respectively. In addition, treatment by two different hydrocarbon degradation bacteria (*Achromobacter xylosoxidans* and *Arthrobacter polychromogenus*), two different *Rhizobium* (*Rhizobium japonicum* or/and *Rhizobium phaseoli*), or two different vesicular arbuscular mycorrhizae (*Glomus aggregatum* or/and *Glomus etunicatum*), including the interaction between them had an optimal result in decreasing THP and C/N ratio also



increasing N and P content in the treated oil-contaminated soil, including the increase of mycorrhizal root infection, active root nodule and the leguminous plant biomass.

Keywords: remediation, oil-contaminated soil, hydrocarbons degradation bacteria, phosphate soluble bacteria, nitrogen-fixing bacteria, vesicular arbuscular mycorrhizae, leguminous plant.

### **P-13-21: Metabolic Diversity of *Monascus purpureus* Indicated By Its Citrinin And Pigments Production**

Nandang Suharna, Yulinery T., Triana E., Nurhidayat, Kasim E.; *RC for Biology-LIPI*

Microorganism biodiversity in Indonesia and its potential as bioactive substances producer not yet revealed much. Biodiversity research at our laboratory at now concerned towards *Monascus purpureus* diversity. This fungus has been used for production of fermented product. Metabolic substances produced by this fungus especially lovastatin has been continuously studied at recent as its role on inhibition cholesterol synthesis. Citrinin is a toxic metabolic substance also produced by *Monascus purpureus* certainly need paid attention to as angkak, a fermented product by this fungus can contain this toxic at risk level. In Indonesia, angkak can be used as herb for therapy of dengue haemorrhagic fever in practice. At the beginning we just start to evaluate this metabolic diversity of *M. purpureus* together with its pigments. Our previous research data showed that our *Monascus* fungus genetically unique compared to the same species have been published. Physiological studies on growth and secondary metabolite synthesis of those fungal strains have revealed the potency of bioactive substances, lovastatin and citrinin. *M. purpureus* JmbA, for instance, with 0.9% lovastatin yield, in vivo, was able to inhibit cholesterol synthesis, enhance immunity response and quality of component in blood circulation. An analysis result on 21 strains of *Monascus purpureus* for pigment yields spectrophotometrically and citrinin yield by means of High Performance Liquid Chromatography (HPLC) was reported. Genetic determination by analysis on pksCT gene expression on citrinin production also was carried out to confirm citrinin biosynthesis by citrinin-producing strains. The result showed that pigments and citrinin production by the 21 strains of *M. purpureus* were various. However, there was no correlation between pigment and citrinin production. This study reported that two *Monascus* SKW2 and Serasi Strains produced citrinin at low concentration at 0.31 and 0.35 ppm respectively.

### **P-13-22: Impact of Different Land Use on Population of Denitrifying Microorganisms and Their Activities Including N<sub>2</sub>O Emissions**

Dwi Agustiyani, Nur Laili, Nunik Sulistinah, Hartati Imamuddin, Sarjiya Antonius; *Research Center for Biology, Indonesian Institute of Sciences*

The intensification of agricultural production and the subsequent increase in global synthetic N input have resulted in substantial N pollution and ecological damage. Nitrate leaching and N<sub>2</sub>O emissions from agricultural soils are recognized as significant environmental threats. Partial denitrification is a significant contributor to emissions of N<sub>2</sub>O, which is involved in destruction of the stratospheric ozone layer and in global warming. In this study, we investigated population of denitrifying bacteria, and potentials denitrification activity from three different soils, organically farmed soil, intensive farmed soil and forest soil. Our objectives were to explore spatial gradients of denitrifying populations from different soil ecosystem. We examined whether populations density and its potential activity was related to soil biochemical properties (C/N ratio, Ammonia, Nitrate) of different land use and determine the potential emission of gas N<sub>2</sub>O. The results indicated that strong biological functional differences between these three different soil ecosystems. Organically farmed soil had the highest population density of denitrifying bacteria and also had significant potential denitrifying activities. The highest potentials denitrifying activity in the soil affected to the lowest emission of N<sub>2</sub>O gas. The lowest potential denitrifying activity was measured in the intensive farmed soil. Surprisingly, the population of denitrifying bacteria in the forest soil was low, but population of nitrate respiring bacteria was high. Those conditions resulted in low potentials denitrification and higher potentials

emission of N<sub>2</sub>O gas. Denitrifying and nitrate respiring population density, as well as environmental factors, may contribute to the variability of potential denitrification activity and potentials emission of N<sub>2</sub>O gas in these three ecosystems. Key words: denitrifiers, nitrate respiring bacteria, potential of denitrification activity, potential of N<sub>2</sub>O emission

## Poster session: Mycology (#14; July 20)

### P-14-1: Phosphate Solubilizing Fungi Isolated from Buffer Zone of Gunung Salak, National Park

A. Sugiharto; *Research Center for Biology - LIPI*

Fungi play important role in solubilization of bot organic P and inorganic P. The objective of our study was to explore speciesf diversity of P solubilizing fungi from Buffer Zone of Gunung Salak, National Park. We isolated several fungi that also to solubilized both Ca-P and P bound phosphate. Two species belonged to *Aspergillus* sp and *Acremonium* sp were able to stimulate plant growth both under laboratory condition and green house experiment. The ability of these isolates to promote plant growth are then verified. The presence of phosphate solubilizing fungi in forest ecosystem not only important for the plant growth and maintaining ecosystem health but also forest are very important resources, and thus reinforce the importance of ferest conservation.

### P-14-2: Fully Developed Fruitbody of *Phallus Lauterbachii*

Dewi Susan; *Herbarium Bogoriense, RCB-LIPI*

*Phallus lauterbachii* has been known as an endemic species from Papua New Guinea. In Indonesia, this fungus was found three times around 1920 but was described only from eggs. Recently on Widya Nusantara Expedition to Raja Ampat Islands in Papua, this fungus was firstly found in a fully developed fruitbody. New information on morphology is provided for *P. lauterbachii*.

### P-14-3: Tropical Macrofungi of Papua

Supeni Sufaati, Verena Agustini; *Biologi Department , Faculty of Mathematics and Sc*

Papua is the area which has highest biodiversity in Indonesia, including fungi. So far, only a few data are available. Therefore, this preliminary study was done to explore the biodiversity of macrofungi in Papua (Manokwari, Jayapura and Keerom) using survey method. About 90 species of macrofungi were observed, consisting of 20 families. However, 11 samples were unidentified yet. Some of these are edible and are sold in traditional markets; i.e.: *Pleurotus* sp, *Volvariella volvaceae*, *Auricularia polytricha*, *Schizophyllum commune*, and *Scleroderma sinamariense*. *S. sinamariense* is also known as mycorrhizal fungi, associated with *Gnetum gnemon* and *Dipterocarpaceae*. Ecologically, most of the macrofungi are organic decomposers. Further taxonomical study is needed to unveil the mystery of fungal diversity in Papua and its anthropological role in Papuan society.

Key words: macrofungi, Papua, biodiversity, edible and decomposer.

### P-14-4: Partial Mecanism Evaluation of Antifungal Anticancer Activities of Actinomycetes Isolated from Raja Ampat Island, Papua

Arief Nurkanto<sup>1</sup>, Heddy Julistiono<sup>2</sup>, Andrea Agusta<sup>1</sup>; *1. Research Center for Biology-LIPI, 2. RC for Biology*

The diversity of microbes, especially Actinomycetes at tropical region, is a source of new antibiotics and drugs that are hunted by the world pharmaceutical industry and the business who have contributed significantly in improving the health status. The new microbes believed to be the source of new drugs, including antibiotics and anticancer. Research biodiversity expedition in Raja Ampat Island, Papua, organized by Research Center for Biology, Indonesia Institute of Sciences (LIPI), was conducted. One of objective of this research expedition is drug discovery for antifungal anticancer based on Indonesia's Actinomycetes. Antibacterial and antifungal activities by 300 actinomycetes isolated from Raja Ampat, West papua have been conducted. Approximately 40% of them had bioactive compounds that inhibit bacterial and fungal pathogens. We selected a strain that produces bioactive compounds with the highest activity that inhibit not only gram (+) and gram (-) bacterial but fungal as well. These metabolites could be purified using dichloro methane and methanol (15:1) solvent. Molecular structure elucidation of pure metabolite was done by LCMS, 1D-and 2D-NMR. Pure bioactive compound have activity against some fungal (*Candida albicans*, *Saccharomyces cerevisiae*, *Rhodotorula minuta*, *Aspergillus flavus* and *Aspergillus niger*). Compared with nystatin and kabicidin, as antifungal commercial, MIC (Minimum Inhibitor Concentration) of bioactive compound produced by actinomycetes is the same or higher. Evaluation of morphological changes in yeast cells investigated by Scanning Electron Microscopy (SEM) and the cell leak was detected using HPLC. Activities against various cancer cells were conducted, while cancer cells inhibited are: MCMB-2 (IC50 value = 104 ug / mL), Leukemia (IC50 value = 81.62 ug / ml), and T47 D (breast cancer) (IC50 value = 0.0036 ug / ml%2

#### **P-14-5: Bioinduction Increased Agarwood (gaharu) Production of Aquilaria and Gyrinops**

Maman Turjaman, Erdy Santoso, Ragil S.B. Irianto, Irnayuli R. Sitepu; *FORDA*

One tropical tree family currently a focus of international attention is Thymelaeaceae. This tree family is important as they provide agarwood (gaharu) for the forest community in South and Southeast Asia. Thymelaeaceae consists of 50 genera with *Aquilaria*, *Gyrinops*, *Aetoxylon*, *Enkleia*, *Gonystylus*, *Phaleria*, and *Wikstroemia* producing agarwood. Agarwood plays an important role in gaining foreign exchange and as a source of income for people living in around and inside the forest in Indonesia. However, at the mean time, its production has declined rapidly, due to lack of technology and limited dissemination of the bioinduction technology. If no serious action to be taken, agarwood production would not be sustained. As a consequence, pressure on the natural forest will increase significantly. Today *Aquilaria* and *Gyrinops* were placed on Appendix II of the Convention on the International Trade in Endangered Species (CITES) and considered to threaten according to the IUCN Red. Objective of the project is introducing bioinduction technology to forest communities living in and around on the forest area. Bioinduction of pathogen has been carried out intensively in forest area with specific purposes Carita, Banten and Kandungan District, South Kalimantan. For this purpose, four isolates that have shown efficient induction were used, namely isolate from Gorontalo, Jambi, Padang, and West Kalimantan. Additional induction was also conducted in Kotabaru (South Kalimantan), Jambi, Lombok (West Nusa Tenggara), Flores, Sanggau and Seram (Mollucca). Target for tree induction is at least 500 trees. Agarwood products between 1, 2 and 3-year after bioinduction showed distinct differences by color and weight. Three year old induction has darker color and is heavier than that harvested from 1.2-year induction. Bioinduction of pathogen appears to be a promising way to increase the production of agarwood which are economically and ecologically important for forest community in Indonesia.

Key words : agarwood (gaharu), bioinduction, pathogen, *Aquilaria*, *Gyrinops*.

#### **P-14-6: Molecular Identification of Gaharu-Inducing Fungi by 28S rRNA Gene Sequencing**

Irnayuli R. Sitepu, Maman Turjaman, Sarah Faulina, Erdy Santoso; *FORDA*

Gaharu (agarwood or eaglewood) is a highly commercial resinous wood used as incense, perfume additive, and essential oil for religious, cultural, and medicinal activities. This valuable nontimber

forest product is an important source of income for forest communities and outsiders. However, gaharu-producing tree species is rapidly disappearing due to overexploitation in their natural habitat, and is under threat of extinction. Two important genera of *Aquilaria* and *Gyrinops* have been enlisted in CITES, Appendix II since October 2004. Therefore, it is important to understand the formation process of gaharu for sustainable production. Gaharu is formed through a unique pathological process initiated with infection of fungi on the tissue of certain tree species. We have isolated 36 fungal isolates from infected gaharu tree from 17 provinces in Indonesia. This study was aimed at identifying gaharu-inducing fungi by means of 28S rRNA partial gene sequencing. We used FUS1 and FUS2 primers that enabled amplification of up to 460-bp fragment. Most isolates identified were members of *Fusarium solani* species complex. One isolate, FORDACC-02375 originated from East Kalimantan showed high similarity to *Fusarium oxysporum*. This study highlighted a rapid molecular identification protocol for gaharu-inducing fungi over the conventional measure.

**P-14-7: Inhibitors of the ATPase activity of RNA Helicase of Japanese Encephalitis Virus produced by Actinomycetes isolated from Kutai National Park, East Ka**

Shanti Ratnakomala, Puspita Lisdiyanti, Andi Utama; *Research Center for Biotechnology, LIPI*

Japanese encephalitis virus (JEV) is a major cause of acute viral encephalitis in humans. No specific antiviral therapy is currently available and therefore, the development of an effective drug is needed. One approach to find the candidate of antiviral drug is to discover the inhibitor of enzymes that essential for virus replication, such as protease, RNA helicase or RNA polymerase. Since RNA helicase not only possesses RNA helicase activity, but also RNA binding and ATPase activities, this enzyme seems providing potential targets for anti-JEV agents. The objective of this study is to investigate the inhibitory effects of the ATPase activity of JEV RNA helicase for drug candidates from Indonesian actinomycetes. Two hundred ninety six isolates of actinomycetes were isolated from soil and leaf litter samples at Kutai National Park, East Kalimantan by 4 isolation methods. Those isolates were then tested for inhibition of ATPase activity of RNA helicase from Japanese encephalitis virus (JEV), in order to identify a drug candidate for the treatment of JEV infection. The supernatant of actinomycetes cultures were used to screen inhibitor of ATPase activity of JEV RNA helicase. The amount of free inorganic phosphate (Pi) moiety released from ATP was measured by colorimetric ATPase assay. Results revealed that 19 isolates have relatively high inhibition-activity against ATPase activity of the JEV-RNA-helicase, which range from approximately 41.0-66.5% inhibition. The highest inhibition-activity was showed by isolate ID06-287 and identified as *Streptomyces* sp. with 66.5% of inhibition-activity. Key words: Actinomycetes, Japanese encephalitis virus (JEV), RNA helicase, ATPase inhibit

**Poster session: Phylogeny, biogeography and phylogeography (#15; July 20)**

**P-15-1: Genetic Variation of *Melia azedarach* Linn. in Community Forest of West Java Assessed by RAPD**

Yulianti, Iskandar Z. Siregar, Nurheni Wijayanto, IGK Tapa Darma, Dida Syamsuwida; *Bogor Agriculture University*

*Melia azedarach* Linn. or mindi is one of widely planted exotic species in Indonesia. Minda is valued for its high quality timber and its leaves and fruits are promising for bio-insecticide. Due to its multi-purpose benefits the species has become a priority species in community forests of West Java. To improve the productivity of mindi plantation it should be an assessment on their genetic resources. The present work was aimed to assess genetic variation of mindi by using RAPD. Outcome of the activities is to suggest appropriate conservation and management strategies in order to support the

establishment of seed sources. Six population of mindi in the community forests have been chosen for this research i.e Nagrak, Megamendung, Gambung, Purwakarta, Sumedang and Kuningan. Leave samples were collected from 20 trees of each population. Three primers (OPA-07, OPY-13 and OPY-16) were analysed for 120 selected mother trees. The overall genetic variabilities were low, the observed number of alleles per locus ranging from 1,3404 to 1,5319, and Percentage of Polymorphic Loci ranging from 34,04% to 53,19.%. The levels were low for all populations (He range 0,0742 to 0,1548), but the mean level of genetic diversity between population (Hst ) was 0.2954. Cluster analysis showed three main groups where the first group consist 4 population i.e Gambung, Kuningan, Wanayasa and Megamendung, the second Nagrak and the third Sumedang. The low level of genetic variation in the community forests, might be the farmers used seeds for plantation taken from only 1 to 5 trees and its consequence of small size population. Key words: *Melia azedarach*, RAPD, community forest

**P-15-2: Evolution of Filiform Bracteoles and Bract in Selfing Bat Flower (*Tacca*, Dioscoreaceae): a Phylogenetic Analysis**

Ling Zhang<sup>1</sup>, Hong-Tao Li<sup>2</sup>, Lian-Ming Gao<sup>1</sup>, Jun-Bo Yang<sup>1</sup>, De-Zhu Li, Jin Chen, Qing-Jun Li; *1. Xishuangbanna Tropical Botanical Garden, CAS, 2. Kunming Institute of Botany, CAS*

Most species in the genus *Tacca* feature nearly black flowers, conspicuous and remarkable range of inflorescence bracts (involucres) shapes, whisker-like filiform bracteoles, and diverse types of blossom morphology. This study aims to reconstruct the molecular phylogeny of this genus to infer the evolution of its inflorescence traits and to examine evolutionary trends in their conspicuous blossoms. Maximum parsimony, maximum likelihood, and Bayesian analyses were performed on separate and combined *atpA*, *rbcL*, *trnL-F*, *trnH-psbA* and ITS sequences to reconstruct the phylogenetic tree of the genus. Involucres and bracteoles characters were then mapped onto the phylogeny to analyze pathways of floral evolution in *Tacca*. In all analyses, *Tacca* species form a monophyletic group; species distributed in Southeast Asia with showy involucres and bracteoles form the most derived clade. Phylogenetic inference on inflorescence characters indicated that ancestral *Tacca* had small involucres and short bracteoles, viz. less conspicuous inflorescence structures, while the evolution of *Tacca* was from short-filiform type to showy and long-filiform types of bracteoles. This study suggested that the showy blossoms in *Tacca* might not be a “relict” trait; as the predominant selfing mating systems were observed in the species of *T. chantrieri* and *T. integrifolia* which were in the most derived clade, we propose that the elaborate blossoms in *Tacca* may result from the evolution of facilitating selfing.

**P-15-3: Floristic Diversity and Phytogeography on the Coralline Islands of the Farsan Archipelago, Red Sea, Saudi Arabia**

Khalid Al Mutairi<sup>1</sup>, Magdy I. El-Bana<sup>2</sup>, Mashhor Mansour<sup>1</sup>; *1. Universiti Sains Malaysia, 2. King Saud University*

The coral islands of the Red Sea are regarded as having a high national and international conservation value because of the diversity of marine and terrestrial habitats. However, urban development, pollution and increasing pressures of commercial and recreational use of resources pose serious threats to the biodiversity of these habitats. In the present study, the flora of twenty two coral islands of Farsan was surveyed and classified in terms of life form spectrum and phytogeography. A total of 191 flowering plants that belong to 53 families and 129 genera. The most species-rich families were Poaceae (14.4%), followed by Convolvulaceae (6.9%), Fabaceae (6.3%), and Capparaceae (5.9%). The life forms ranged from climbers to phanerophytes with the dominance of therophytes (36.7%). Geophytes and chamaephytes dominate the saline habitats, while climbers, therophytes and hemicryptophytes dominated the sandy formations and rocky plains. The results of this study indicated that the flora of the study area has a transitional character where the Saharo-Arabian Desert, Sudanian and Tropical vegetation exchange.

**P-15-4: Geographic Distribution and Phylogenetic Relationship of Genus *Fejervarya* from Indonesian Sunda Land Inferred from the 16S rRNA Gene**

Nia Kurniawan<sup>1</sup>, Tjong H. Djong<sup>2</sup>, Takeshi Igawa<sup>1</sup>, Masayuki Sumida<sup>1</sup>; *1. Hiroshima University, 2. Andalas University*

In order to elucidate geographic distribution and phylogenetic relationships among genus *Fejervarya* (Bolkay) from Indonesian Sunda land, molecular analyses was carried out using 163 frogs collected from 29 populations in Sumatra, Kalimantan, Java, Bali and Sulawesi Islands, Indonesia. A set of primers; F51-R51 was used to analyze the 16S rRNA gene. The molecular phylogenetic tree based on 34 haplotypes of the 16S rRNA gene showed that the genus *Fejervarya* from Indonesia Sunda land consisted of four groups: *Fejervarya cancrivora* large-type, *F. cancrivora* Sulawesi-type, *F. limnocharis* and *F. iskandari* group. Sequence divergences within groups were  $0.65 \pm 0.28\%$ ,  $2.16 \pm 1.49\%$ ,  $1.04 \pm 0.74\%$  and  $1.04 \pm 0.74\%$ , in *F. cancrivora*, *F. cancrivora* Sulawesi-type, *F. limnocharis* and *F. iskandari* respectively. The average sequence divergences between *F. cancrivora* large-type and others three groups (*F. cancrivora* Sulawesi-type, *F. limnocharis* and *F. iskandari*) were  $7.41 \pm 1.37\%$ ,  $14.12 \pm 0.52\%$  and  $12.55 \pm 0.44\%$ , respectively. The average sequence divergence between *F. cancrivora* Sulawesi-type and other two groups (*F. limnocharis* and *F. iskandari*) were  $13.7 \pm 1.05\%$  and  $11.55 \pm 1.14\%$ , respectively. The average sequence divergence between *F. limnocharis* and *F. iskandari* was  $10.77 \pm 0.70\%$ . The distribution of *F. cancrivora* large-type was in 14 localities from Sumatra, Kalimantan, Java and Bali Islands and the distribution of *F. limnocharis* was in 16 localities from Sumatra, Kalimantan and Java Islands. The distribution of *F. iskandari* was in 3 localities from Java Island, while the distribution of *F. cancrivora* Sulawesi-type was in 4 localities from Sulawesi Island. The present results suggest that *F. cancrivora* large-type and *F. limnocharis* are widely distributed sympatrically in Sumatra, Kalimantan and Java, that *F. iskandari* is distributed only in Java Island, and that *F. cancrivora* Sulawesi-type is distributed mostly in Sulawesi Island, and can be regarded as distinct species.

**P-15-5: A Nested-PCR Assay to Detect the Prevalence Level and the Diversity of Avian Malaria in Coastal Birds of Yogyakarta, Indonesia**

Pramana Yuda; *Universitas Atma Jaya Yogyakarta*

I used a nested-PCR assay to detect the prevalence level of hematozoan parasites in coastal birds of Yogyakarta, Indonesia. In total 125 blood samples were extracted from 22 species which were catch on February and July 2010. The amplification of cytochrome b of mtDNA revealed that the prevalence level of avian malaria in the coastal area birds was low (8%)..and only five bird species were infected. The positive samples were sequenced and further phylogenetic analysis revealed that seven new and unique DNA sequence lineages: . one haplotype of *Haemoproteus*, five haplotypes of *Plasmodium*, and one haplotype of *Leucocytozoon*.

**P-15-6: *Sonneratia ovata* Backer - A Genetically Depauperate Mangrove Species**

Renchao Zhou, Suo Qiu, Meng Zhang, Miaomiao Guo, Sufang Chen; Suhua Shi; *Sun Yat-Sen University*

It is expected that geographically widespread and outcrossing tree species usually have high level of genetic variation. In this study, we sequenced three chloroplast regions and six nuclear genes to assess genetic variation of a mangrove species *Sonneratia ovata* from China and Thailand. No nucleotide polymorphism was found both in the three chloroplast regions and in the six nuclear genes from all of the four populations examined. The depauperation of polymorphism in *S. ovata* compared with moderate polymorphisms of other congeneric species is surprising particularly considering high level of polymorphism in the past and relatively wide geographic distribution at present. Since multiple independent loci are surveyed in this study, the most plausible explanation for our observation is that

*S. ovata* has experienced severe demographic bottlenecks in the Pleistocene glaciation, followed by subsequent recolonization by sea currents in China and Southeast Asia regions. It may be also attributable to its small population size despite wide geographic distribution.

**P-15-7: Long-term Change in Terrestrial Ecological Communities on Caribbean Islands**

David W. Steadman; *University of Florida*

Fossils provide evidence for long-term changes in plant and animal communities. On tropical islands, fossils from flooded limestone sinkholes are well preserved because of deposition in anoxic salt water. Holocene (<10,000 yr BP) peats recently discovered in a sinkhole on Abaco, Bahamas, have yielded abundant plant macrofossils (leaves, seeds, fruits) and microfossils (pollen, spores) that document transitions between pine woodland and tropical dry forest. Vertebrate fossils in the peat feature two extinct species (tortoise *Chelonoidis alburyorum*, caracara *Caracara creightoni*), two extant species that no longer live on Abaco or anywhere else in the Bahamas (Cuban crocodile *Crocodylus rhombifer*, Cooper's or Gundlach's Hawk *Accipiter cooperii* or *A. gundlachii*), and many other species (especially of birds) that still inhabit Abaco. Analyses of stable carbon and nitrogen isotopes in tortoise and crocodile fossils suggest that both species functioned mainly in the terrestrial rather than aquatic or estuarine food webs. Before human impact, the largest browsers and carnivores in the Bahamas were reptiles, rather than mammals as on continents. This helps to explain the vulnerability of insular plant and animal communities to non-native mammalian herbivores and carnivores. On a ledge in the same sinkhole, an older (late Pleistocene; >12,000 yr BP) sediment deposit represents an ancient owl roost with fossils of 37 species of reptiles, birds, and bats. Among 11 extinct or locally extirpated species, only one has been found in the younger peat deposit where tortoises and crocodiles are so common. Changing climate and land area might account for the Pleistocene-to-Holocene biotic turnover, whereas human impact may have driven the floral and faunal changes within the Holocene. This long-term understanding of climate vs. human impact on ecosystems is critical for management and conservation of tropical biodiversity.

**P-15-8: AFLP Diversity and Conservation Strategy of the Epiphytic Shrub *Hoya multiflora* Blume (Asclepiadaceae)**

Sri Rahayu, Rochadi Abdulhadi, Cecep Kusmana, Muhammad Jusuf, Suharsono; *State University of Malang*

Plants of the Asclepiadaceae that include epiphytic *Hoya multiflora* Blume are rich in alkaloids or glycosides. *Hoya multiflora* is valuable sources of medicine to treat arthritis rheumatism which have been predicted to be potential as a new HIV drug. As it is one of the ornamental plants with the economic importance in Indonesia, therefore, conservation of this species is a critical issue. As a means for developing a conservation strategy for this species, the population genetic diversity study is needed. Genetic diversity of *Hoya multiflora* Blume have been studied by using AFLP-DNA markers from 6 populations of Bodogol and Ciapus-Taman Sari, Bogor, West Java Indonesia. Total of 61 DNA fragments were scored in SAGA software for AFLP. The scored data then run in POPGENE 3.1 for Nei's Genetic Diversity (H) and Genetic differentiation (Gst). The Nei's Genetic Diversity (H) were vary from 0.1621 to 0.2964; while the genetic differentiation (Gst) was 0.2287, indicating high variation among population and low genetic diversity that means more populations needs to be conserved. Dendogram based Nei's Genetic distance via UPGMA method modified from neighbor procedure of Phylip version 3.5 showed the genetic distance among the population was separated by the habitat condition rather than the space distance. Key words: AFLP, genetic diversity, *Hoya multiflora* Blume, Asclepiadaceae, conservation strategy.

**P-15-9: Phylogenetic Relationships of Cockatoos (Aves: Psittaciformes) Based on DNA Sequences of the Seventh Intron of Nuclear  $\beta$ -fibrinogen Gene**

Dwi Astuti; *R.C. for Biology-Indonesian Institute of Sciences*

Some previous authors have made grouping and evolutionary relationships of cockatoos based on morphological characters, isozyme, and mitochondrial DNA. However, their relationships are still controversial, especially concerning the position of *Nymphicus hollandicus*. Since the nuclear  $\beta$ -fibrinogen gene has been recognized useful for phylogenetic studies of some birds, this study employed the DNA sequence of seventh intron of this gene (fibint7) to construct phylogenetic relationships of cockatoos based on neighbor-joining (NJ) and maximum-parsimony (MP) methods. The results indicated that several indels were found in the sequence data of fibint7 in cockatoos. Due to the presence of indels, the sequence length varied among taxa. Transitions substitution seemed to be unsaturated over transversions and transversions did not appear to be saturated over genetic distances. The tribe Cacatuini composed of three genera *Cacatua*, *Eolophus* and *Callocephalon* was monophyletic. Although the relationships between species of the genus *Cacatua* were not resolved well, *C. alba*, *C. galerita*, *C. goffini*, *C. sanguinea*, *C. moluccensis* and *C. sulphurea* were grouped together and *C. leadbeateri* was relatively distant from other congeneric species. The tribe Calyptorhyncini consisting of *Probosciger* and *Calyptorhynchus* was paraphyletic and genus *Calyptorhynchus* was likely diverged earlier than *Probosciger*. *Calyptorhynchus* seemed monophyletic. *Nymphicus* (tribe Calopsittacini) seemed to be a basal clade of cockatoos. The phylogenetic trees suggest that cockatoos originated from Australia and then diverged in the Pacific region including the Indonesian Archipelago. Key words: phylogenetic relationships, cockatoos, Aves, Psittaciformes, DNA sequences, nuclear  $\beta$ -fibrinogene gene.

#### **P-15-10: Biogeography and Diversification of Chrysobalanaceae in America and Africa**

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Understanding the reasons that led to the current composition and distribution of tropical plant families has long interested evolutionists and ecologists. It is crucial to evaluate the relative contributions of historical biogeography and diversification to infer this evolutionary history. Here we focused on South American and African species of the pantropical family Chrysobalanaceae (Malpighiales). We generated a phylogenetic hypothesis from the ITS, *rbcLa* and *trnH-psbA* sequences. Our phylogeny allowed us to make several inferences. It suggested an African origin for this family. American clades appeared to be derived from several trans-Atlantic dispersal events. African genera have fewer species than American ones, indicating that diversification rates were greater in American genera: this may be a result of higher extinction rate and/or lower speciation rate in Africa. Sampling more species and sequencing more coding plastid genes would allow us to go into more details concerning the evolutionary history of this plant family.

#### **P-15-11: Habitat-Related Differentiation in Mangrove Associate *Hibiscus tiliaceus* as Revealed by Retrotransposon-Based SSAP Marker and Physiological Study**

Tian Tang, Weijing Li, Yucheng Yang, Yixin Zhao, Suhua Shi; *Sun Yat-sen University*

Mangrove associates are the intermediate taxon between mangroves and their terrestrial relatives occupying the divergent environments of intertidal wetland and inland. In this study, RNaseH-LTR region of Ty1-copia retrotransposon (RTN) were cloned and used to develop retrotransposon sequence-specific amplified polymorphism (retrotransposon SSAP) technique in *Hibiscus tiliaceus*, a pantropical mangrove associate. SSAP was used to detect the genetic variability of RTN in eight *H. tiliaceus* populations in Southern China, representing two kinds of divergent habitats (intertidal zone and inland). There was higher insertional polymorphism in mangrove populations than inland populations, probably suggesting the activation of retrotransposons by stress and environmental factors. An analysis of molecular variance revealed that 8.86% of the genetic variance could be explained by the differentiation between habitats, as compared to only 4.86% to geographical effects among four sites. The lower differentiation among mangrove populations ( $\Phi_{ST} = 0.115$ ) compared



with inland populations ( $\Phi_{ST} = 0.152$ ) indicated frequent gene flow occurring among mangrove populations by floating seeds. In comparison with the inland plants, the intertidal *H. tiliaceus* have a high level of betaine and keep higher  $K^+/Na^+$  ratios when stressed by high salinity. The proline content and photosynthesis rate also showed different salt-induced pattern of variation between intertidal and inland plants. The molecular diversity partition and physiological studies suggested that the habitat-related differentiation in *H. tiliaceus* may be associated with local adaptation to mangrove swaps with high salinity.

**P-15-12: Which Historical Processes Led to the Actual Genetic Organization in *Virola* Species (Myristicaceae) in French Guiana?**

William Montaigne, Caroline Scotti-Saintagne, Ivan Scotti; *INRA*

Noncoding sequences of the chloroplast genome provide important evolutionary information in molecular systematics, phylogeographic inferences, and population genetic studies in plants. The organization of genetic diversity at noncoding chloroplastic regions in *Virola* species (*V. michelii*, *V. surinamensis*, *V. kwatae*, *V. sebifera* and *V. multicostata*) from several sites in French Guiana has been investigated. *Virola* species belong to the ancient, widely distributed Neotropical botanical family Myristicaceae and show differences in their environmental optima. Their distribution and the mechanisms having led to their expansion in the Neotropics represent therefore a good model for the study of tropical biodiversity. We will discuss evolutionary relationships between *Virola* species, as reconstructed based on chloroplast sequences. The phylogeographic patterns observed at the intraspecific level will also be discussed, based on a comparative approach that has allowed us to infer demographic processes leading to the present-day genetic structure. These historical processes will be discussed in regard to the literature on the past perturbations in the Guiana shield.

**P-15-13: *Apis koschevnikovi*: Cytochrome b Mitochondrial DNA Variations and Diminishing Status in South and East Kalimantan**

Jaziratul Fitriyati, Rika Raffiudin, Tri Atmowidi, Randall Hepburn; *Bogor Agricultural University*

*Apis koschevnikovi* is one of native honey bees species and having a diminishing population in Kalimantan. As shown in our exploration in South and East Kalimantan during 2004-2009 revealed that we hardly found population of *A. koschevnikovi* due to the deforestation that converted the ever green forest in Kalimantan into palm oil plantation and coal mining. Only 29 *A. koschevnikovi* colonies were collected during our several excursions; all colonies was found in primary forest region. Out of all samples, we found seven haplotypes based on cytochrome b gene. This study implicated that genetic variations occurred in *A. koschevnikovi* population, since based on morphometric analysis, a homogenous morphocluster for all bee populations occurred throughout Southeast Asia population.

**P-15-14: Genetic Diversity of Rice Stem Borer *Scirpophaga incertulas* based on 16s Ribosomal Mitochondrial Gene**

Ruth Martha Winnie, Rika Raffiudin, I Made Samudra; *Bogor Agricultural University*

This study was the first report of 16S ribosomal mitochondrial gene of rice stem borer *Scirpophaga incertulas*. A total of 325 base pairs of partial of 16S ribosomal gene was characterized. Surveyed of the 16S variations were carried out in Bogor, Karawang, Indramayu dan Cirebon (West Java, Indonesia). Among the populations, three haplotypes were observed; haplotype 1 was found in almost all locations (Karawang, Indramayu dan Cirebon). Haplotype 2 was only found in *S. incertulas* Cirebon samples and it characterized by a transition of A (in haplotype 1) into G at the nucleotide number 154. The third haplotype from Bogor sample showed a "T" deletion at nucleotide number 129 compared to that of haplotype 1. This study revealed a genetic differentiations within the same locations and among locations of yellow stem borer. Hence, an intraspecies variations occurred in this

main rice pest based on 16S ribosomal gene. Those three haplotypes of *S. incertulas* 16S ribosomal gene were submitted to Genbank under Accession Number of adalah GU191881, GU191882, GU191883, respectively for *S. incertulas* 16S ribosomal gene haplotype 1, 2, dan 3.

**P-15-15: Analysis of Genetic Variability of *Agathis loranthifolia* Salisb. in West Java Assesed by RAPD**

Edje Djahuri, Iskandar Z. Siregar, Mariyana Ulfah, Tedi Yunanto; *Department of Silviculture, Faculty of Forestry, B*

*Agathis loranthifolia* Salisb. is one of forest tree species which produces non wood product in the form of resin (copal). Copal production, besides being determined by internal and external factors, is also affected by the presence of agathis trees lacking of resin production. According to that reason, there is a need to carry out a specific tree improvement program for resin production. Understanding the patterns and variation of resin production of tree population is important as initial step of tree improvement including investigation on the degree of genetic variation harboured in the population. In this experiment, RAPD was used to assess the genetic variation of populations based on regions (two populations) and copal production (four populations/categories). Plant materials of *A. loranthifolia* were sampled in the form of leaves collected in plantation population from Cianjur and Garut Forest Management Units (FMUs) of Perum Perhutani in West Java. Based on the region of collected samples, it was shown that genetic variation in Cianjur FMUs ( $He = 0.1952$ ) was higher than that of Garut FMUs ( $He = 0.1125$ ), while based on copal production, genetic variation of non producing copal trees (so-called locally as “Lanang trees”;  $He = 0.2105$ ) was the highest among the other categorys (“Plus trees”  $He = 0.1075$ ; “check trees”  $He = 0.1285$ ; “random trees”  $He = 0.0756$ ). Based on the results of this study, population of *A. loranthifolia* in Cianjur FMUs may be converted into seed source production area in the near future. Key words: RAPD, resin (copal), plus trees, *A. loranthifolia*

**P-15-16: Isolation and Characterization of Microsatellite Markers for Population Structure Analyses in an Endangered Frog, *Odorrana ishikawae* (Anura: Ranidae)**

Takeshi Igawa, Masaru Okuda, Shohei Oumi, Seiki Katsuren, Atsushi Kurabayashi, Tetsuya Umino, Masayuki Sumida; *Hiroshima University*

*Odorrana ishikawae* is an anuran species endemic to only two small islands (Okinawa and Amami Isl.) in South-West Japan and sometimes described as the most beautiful frog in this country. Because of its small extent of occurrence (less than 15,000 Km<sup>2</sup>), over-exploitation, and environmental destruction over the last several decades, *O. ishikawae* has been listed as a class B1 endangered species in the IUCN Red List, and designated as a natural monument in both Okinawa and Kagoshima Prefectures. The most major threat of this species is fragmentation of the distribution range caused by deforestation along with development around stream areas where this species uses as egg-laying sites. As an initial step of conservation for this species, we must know whether populations in different localities are genetically different or not (i.e., isolated very recently by ongoing fragmentation). For this issue, we isolated and characterized specific microsatellite loci of the Okinawa and Amami populations of this species by three different methods and conducted genetic population analyses by using these microsatellite loci. Based on the results, we discussed the effective isolating method for microsatellite loci and evaluated the genetic variation and genetic structure of this species.

**P-15-17: Effect of Island Size, Elevation and Endemism on Island Biogeography of Caribbean Spiders**

Paul D.Klawinski; *William Jewell College*

Classical island biogeography theory posits that species richness on islands is determined by rates of colonization and extinction which are affected by island size and distance from the mainland,

respectively (MacArthur and Wilson 1967). While this accounts for a great deal of variation in species richness among islands, other factors might be important (variation in habitat diversity, resistance to inundation during interglacial periods, etc.) Ackerman et al. (2007) examined orchid species richness in the Caribbean and found that species:area relationships were largely due to relationships among “montane” islands (> 300 m maximum elevation) and was driven by endemic species. I examined the relationship between log(spider species richness) and log(island size) (slope of this relationship =  $z$ ) for Caribbean islands and examined this relationship for all combinations of island type and endemism. The species area relationship for all species and all islands was significant but the  $z$  value was low ( $z=0.08$ ). Removing nonendemic species led to an increase in  $z$  (0.63) while non-endemics alone produced a non-significant  $z$ . When examining the effect of island topography, montane islands had  $z$  significantly greater than zero and this relationship increased when only endemic species were included ( $z = 0.67$ ). Nonendemic species showed no significant relationship with island size regardless of the type of island examined. Calcareous islands had weak relationships between island size and species richness. I conclude that topography is crucial to understanding patterns of species richness across archipelagoes as higher islands have more species largely due to increases in topographic diversity and increases in levels of endemism due to in situ speciation.

#### **P-15-18: Phylogenetic Signal in the Acarodomatia of Neotropical Lianas**

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Acarodomatia represent mite dwellings that are often present on the axils of leaves of tropical plants. Despite the ecological importance of these structures, very little is still known about the biology, ecology and phylogenetic history of these structures. Here, we surveyed leaves of over 15 families of neotropical lianas for acarodomatia and classified the domatia into several distinct categories in an effort to standardize terminology of leaf-borne acarodomatia. Overall, we found wide variation in the types of domatia encountered but a clear phylogenetic signal at the generic level. These results indicate that acarodomatia represent a great tool for field identification of vegetative samples to genus, and suggest an important role for acarodomatia in the diversification of tropical lianas as a whole.

#### **P-15-19: Genetic variation in natural Eucalyptus deglupta populations across Malesia**

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*Eucalyptus deglupta* is an unusual eucalypt that is not found on the Australian continent but is distributed across the eastern part of Malesia on the Indonesian islands of Sulawesi, Seram, and Papua as well as the southern Philippines, Papua New Guinea and New Britain. *E. deglupta* differs from other *Eucalyptus* species in its preference for wet habitats without a pronounced dry season. The species has been reported to show variation in morphology and physiology across the range. Analysis of the population structure of *E. deglupta* using molecular markers is being used to test the hypothesis that *E. deglupta* dispersed and evolved from an ancestral lineage on the Australian craton. As it is thought that this dispersal may have been aided by periods of low sea level and terrane movements, molecular data will be interpreted in the context of the complex geological history of the region. Although *E. deglupta* is a very interesting candidate for such a biogeographical study, the lack of a suitable specimen collection that can be used for molecular analysis has meant that these questions have not been addressed until now. Currently we are assessing the chloroplast JLA+ region for suitability for this study. In addition, the position of *E. deglupta* in the genus *Eucalyptus* is not completely clear. In some studies, *E. deglupta* has been placed in the subgenus *Minutifructus*; however, it has also been suggested that *Minutifructus* may lie within the subgenus *Symphyomyrtus*. Therefore, phylogenetic markers (ITS and ETS) are also being sequenced from this specimen collection in order to clarify the relationships between this species and other members of the genus.

## Poster session: Agriculture (#16; July 20)

### P-16-1: Carbondioxide, Organic Carbon and Nitrogen during Composting Water Hyacinth Using Several Decomposers

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The trend of making compost is to achieve the way to produce compost in the short period. The compost quality obtained from the short composting period was not different with the long period composting, however its impact on carbondioxide (CO<sub>2</sub>) emission was never studied. In this study, one kg of water hyacinth with and without decomposers (earthworm *Eisenia fetida* and fungus, *Trichoderma harzianum*) was placed in the sterofom with size 39x 25x17 cm. By using chamber, CO<sub>2</sub> gases were caught with NaOH solution, and then it was titrated using HCl to measure the amount of mg CO<sub>2</sub>. The NaOH solution were changed and titrated daily. After 25days, the composts were harvested. The result showed that the cumulative emission CO<sub>2</sub> gases of the compost using earthworms were higher than cumulative CO<sub>2</sub> emission in the compost without decomposer and with *T.harzianum*, but its carbon organic content was lower significantly compare other treatments. Using mixed decomposers (*E.fetida* and *T.harzianum*) in composting hyacinth reduced the emission CO<sub>2</sub> significant lower than if the decomposers applied separately. However, the weight of earthworm in the mixed decomposer compost was lighter than the weight of earthworm without adding *T.harzianum*. Nitrogen content of compost without decomposer was not significantly different with compost using decomposers, however it was lower than N content in compost using decomposers.

### P-16-2: Assymmetric Leaves 1(AS1) Gene Isolation of Broccoli (*Brassica oleracea* var. *Italica* Plenck)

Pratiwi Prananingrum, Nuning Winaris, Dwi Listyorini; *State University of Malang*

ABSTRACT In Indonesia Broccoli (*Brassica oleracea* var. *Italica* Plenck) is widely cultivated and consumed as vegetable. Broccoli produces numerous chemical substance which gives beneficial for human health, e.g. sulphoraphane and erucine that have been known as an active components of anticancer (You et. Al, 2007; Cho et.al, 2006). Broccoli cultivation in Indonesia face several problem especially on disease eradication. Assymmetric Leaves 1 (AS1) gene, a gene that responsible for adaxial-abaxial axis leave development, has been known to be a regulator for fungi and bacterial pathogens on plant. Loss of AS1 function increases protection against necrotrophic fungal pathogens; AS1 operates as a negative regulator of inducible defense responses against these pathogens by occupying the promoters of a subset of defense genes, damping their expression. In contrast, AS1 operates as a positive regulator of disease resistance against bacterial pathogens (Numberg et. al. 2007). In this study our aim is to isolate *Brassica oleracea* var. *Italica* Plenck Asymmetric Leaves 1 (AS1) gene which will be used for further study on transgenic technology in order to improve Broccoli resistance to bacterial pathogen. AS1 gene was isolated from Broccoli using Polymerase Chain Reaction (PCR) amplification method. The primer used was adopted from one for amplification of Asymmetric Leaves1/Rough Sheath2/Phantastica (ARP) gene from Ruschioideae member (Illing et.al 2009) with such modification. Forward primer is 5'-GTTAGGVAAGTGGTGGGAAGT-3' and reverse primer is 5'-CCATTGATCAGCCARYTTCTG-3'. The sequencing result shows that pair of primer amplify approximately 609 bp. BLAST analysis showed that sequence was part of Asymmetric Leaves1 gene which mostly match to *Arabidopsis thaliana* AS1 and *Cardamine hirsuta* AS1 genes. Keywords: *Brassica oleracea* var. *Italica* Plenck, Asymmetric Leaves 1 (AS1) gene

### P-16-3: Edible Wild Plants to Preserve Biodiversity

Hayu D. Patria; *Mantasa*

This world has an enormous amount of plant species, but for the last decades for consumption there has been over-dependence of consumption on a few plant species. And the result is 80% of total dietary energy intake, globally, is obtained from only twelve domesticated species, they are eight cereals (barley, maize, millet, rice, rye, sorghum, sugar cane and wheat) and four tubers (cassava, potato, sweet potato and yam). This focus on few cultivars poses significant problem, which is decline of local knowledge of local community. When local community lost their ability to sustain themselves with local resources around them and start depend themselves with outside input then not only local knowledge that going disappear but also we risk to lose important plant species that had sustain people's live for hundred of years. The disappearance of these plant species not only the disappearance for biodiversity but also will lead into the disappearance of food security among local community. Promoting edible wild plants after decades abandoned is not easy. Identification of edible wild plants based on their availability in nature as well as identification their role in culture and social system is very important. Study in Jatiarjo village, East Java has shown that at least there are two hundreds edible wild plants exist around this village. Identification was held by interviewing old generation (age more than 50 years old) and also from old references.

#### **P-16-4: The Importance of Pollination Services in Traditional Indonesian Homegardens**

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Pollinators provide vital ecosystem services to crops but are today threatened by habitat and land-use change. While agroforestry systems are often cited as important for conserving biodiversity, the role of tropical homegardens are often neglected. Pollinators play an important role in cacao and coffee production in Indonesia, but their importance in multi-cropping systems like traditional homegardens is unknown. To evaluate the importance of animal pollination for crop production in traditional homegardens, we reviewed the level of pollinator dependence of crops grown in Indonesian homegardens. In total, we assessed 190 crop (here including all useful plant species) grown in 50 randomly selected homegardens in Central Sulawesi at the eastern margin of the Lore Lindu National Park. We found 118 crop species being depended to some degree on animal pollination, while only 32 crop species were producing without the intervention of pollinators. For the remaining 40, mainly medicinal and wood species, the breeding and pollination system has not yet been identified. When only taking into account the most frequently grown crop species present in over 50% of all homegardens (n=22; e.g. cocoa, coffee, guava, cassava and chilli), 18 species (82%) respond with reduced yield in absence of pollinators, including five highly depended species which would not set a marketable crop when producing without pollinators. Overall, we find a high pollinator dependence of homegarden plants in Indonesia. This number is higher (82% for the most important crop species) to that estimated for the most important global crops (74%) and for tropical regions in general (70%). To understand the role of pollinators and to identify the drivers of pollinator-dependent crop diversity in homegardens, ecological and socioeconomic variables and their trade-offs need further assessment.

#### **P-16-5: Invasion of *Acacia nilotica* (L.) Willd. ex Del to Growth of Wildlife Feeding in Bekol Savannah, Baluran National Park**

Suhadi; *State University of Malang*

*Acacia nilotica* (L.) Willd. ex Del represent plant coming from Egypt and expand in African southerly Mozambique and Natal. The Plant in introduce to Zanzibar, Pemba, India, Arabia and expand in Australian continent enter Indonesia year 1850. In the year 1963 introduction to zone buffer of crop of *Tectona grandis* L (teak) which border on National Park of Baluran functioning as partition burn furthermore. Growth of plant of *Acacia nilotica* (L.) Willd. ex. Del depress growth of grasses so that wide of savannah more and more to narrow. Wide of savannah in National Park of Baluran 9500–10000 hectares having important role for the wildlife. Grasses which is required by wildlife is

*Dichanthium caricosum* (L.) A. Camus, *Heteropogon contortus* (L.) Beauv. ex & S., and *Sorghum nitidum* (Vahl), its growth difficult. Wide of savannah more and more to narrow effect of invasion of *Acacia nilotica* (L.) Willd. ex. Del so that palatable grasses is pursued of growth Method, grasses samples have been taken by *Acacia nilotica* (L.) Willd. ex. Del age 1 year, 3 year, 5 year and 7 year by 4 replication, clumped distribution with distance of plant of *Acacia nilotica* (L.) Willd. ex. Del : 0 cm, 33 cm, 99 cm, 165 cm and using quadrates of 192 cm x 33 cm Conclusion, (1). *Acacia nilotica* (L.) Willd. ex. Del age 3 year at random distribution important value of grasses of feeding source between 29,30%–40,49%, important value of grasses of nonfeeding source 159,41–170,70%, (2) *Acacia nilotica* (L.) Willd. ex. Del age 3 year at random distribution is productivity of feeding source between 4,53– 6,27 ton/hectares/year, grasses of nonfeeding source between 24,72–26,46 ton/hectare/year. (3). *Acacia nilotica* (L.) Willd. ex. Del age 3 year still required to shade tree of grasses, (4). *Acacia nilotica* (L.) Willd

### **P-16-6: Modelling the Impacts of Future Oil Palm Expansion in Colombia**

John Garcia-Ulloa, Lian Pin Koh, Jaboury Ghazoul; *ETH Zürich*

Colombia is the fifth largest producer of oil palm in the world (and the largest in the Americas), with a total cultivated area of 316,402 ha and annual crude palm oil production of 732,445 tons. The Colombian government has identified oil palm farming as a key economic sector. The country's agricultural development policies include a substantial increase of oil palm-planted area (to 1 million ha by 2020) that aims to consolidate the country as the largest oil palm producer in the region. However, one of the main challenges the country faces is to expand its oil palm sector with minimal impact on the environment (forest loss and carbon emissions) and the food production capacity of the country. Based on a spatially-explicit scenario analysis, we modelled the expansion of oil palm farming in Colombia under six different expansion scenarios: 1) Null model (random expansion), 2) Land sparing (expansion on optimal areas for oil palm production), 3) Food production (avoiding optimal areas for rice and maize farming), 4) Natural ecosystem protection (avoiding expansion in areas with natural vegetation), 5) Carbon conservation (avoiding carbon-rich areas) and 6) a hybrid-scenario that combines scenarios 2-5. Preliminary results show that each of the single-priority scenarios resulted in trade-offs in terms of losses in natural areas and carbon biomass, and threats to food security. However, results for the hybrid-scenario suggest that the environmental and social impacts of oil palm expansion in Colombia could be avoided by adopting a well-planned and science-based land-use allocation strategy.

### **P-16-7: Agriculture and Wildlife Conservation in the Upper Gangetic Plain, India**

Malvika Onial, A.P. Balmford, R.E. Green; *Department of Zoology, University of Cambridge*

The conversion of natural habitats to agricultural land and its intensifying use is amongst the greatest threats to biodiversity worldwide. It is detrimental to species that mainly rely on unconverted habitat or can only persist in farmland at low density. Increased intensity of use may eliminate species from the landscape or reduce population density. Such effects raise concerns over the consequences of high-yielding agriculture. Although intensive farming methods have certainly resulted in increased crop yields to satisfy world food demand, and may also reduce the requirement for natural habitats to be converted to farmland, agricultural production has still to be increased substantially to provide for a fast-growing human population. Increasing intensification of land use to meet this demand for food and other agricultural commodities is expected impact biodiversity. Two contrasting approaches that address this issue are 'wildlife-friendly farming' and 'land sparing'. The wildlife-friendly farming approach advocates retaining natural habitat patches and maintaining less intensive farmed land within the agricultural landscape while the land-sparing argument suggests increasing yields on existing farmland, thus preventing further loss of non-farmed habitat and creating the potential for making farmland available for restoration to a more natural condition. Our study aims to inform the assessment of these two contrasting approaches by analysing the responses of biodiversity across low to high yielding land-use intensities through an empirical study of the relationship between

agricultural yields and population densities of birds and trees. Results indicate that many bird species dependent on forest and wet grassland and a majority of native tree species would be likely to have higher regional populations under 'land-sparing' rather than under low-yielding 'wildlife-friendly' farming.

#### **P-16-8: Key Questions for High 'Impact Factor' Oil Palm Research**

Sophie V. Persey; *Zoological Society of London*

Oil palm continues to expand across the tropics, with research to date sufficient to demonstrate that monocultures of this crop are only capable of supporting a fraction of the biodiversity found in the diverse lowland forests they frequently replace. The increasing global dominance of such production landscapes has led to growing recognition that efforts to conserve biodiversity depend on how these human-modified landscapes are managed. Strategies capable of reducing the impact of palm oil production on biodiversity are urgently needed, yet there is currently insufficient guidance on how this can be achieved effectively. It is therefore crucial that further research on oil palm is directed towards questions with the greatest practical application, both in terms of quantifying unknown impacts that may need to be addressed and providing the information needed to develop effective strategies to mitigate known impacts. Based on a thorough literature review and consultation with academics, conservation practitioners and palm oil producers who are experts in this field we identify several key questions for further research on oil palm. We believe that directing research efforts towards these questions will help to maximise the 'impact factor' of future oil palm research for biodiversity conservation.

#### **P-16-9: Caffeine Altered Agronomic Traits and DNA Profile of *Impatiens balsamina* L**

Made Pharmawati; *Udayana University*

In Bali, flowers of *Impatiens balsamina* L. are highly used to make offering in Hindu religion ceremonies. Therefore, alteration of characters of *I. balsamina* L. is needed to increase diversity of this flower. In this study, caffeine was used to modify agronomic traits of *I. balsamina* L. Seeds were treated by soaking for 24 hours in caffeine solution with different concentrations which were 0.2%, 0.4%, 0.6%, 0.8% and 1%. As a control, seeds were soaked in aquadest. Seeds were then transferred to pot filled with top soil with randomised block experimental design. Results show that caffeine treatments do not affect chromosome number observed at root tip of *I. balsamina* seedlings. The number of chromosomes observed were  $2n=12$ . This number differs than that previously reported by other researchers where they found that the chromosome number of *I. balsamina* was  $2n=14$ . Several agronomic traits were affected significantly by caffeine. Soaking seeds with 0.2%, 0.4%, 0.6%, 0.8% and 1% caffeine for 24 hours increased plant height, number of leaves, length and width of leaves, number of branches, number of bud flowers, number of flower. This change in morphological characters because of the nature of caffeine which is reported to be similar to cytokinin. Other characters such as stomatal number, chromosome number, flower size and chlorophyll concentration showed no significant difference between plants from caffeine-treated seeds and control plants. DNA analysis using PCR-RAPD showed that there were differences between DNA profile of control plant and treated plants.

#### **P-16-10: Community Structure of Soil Macrofauna and Nitrogen Mineralization in Small-Holder Cocoa Plantation in Konawe Selatan District, Indonesia**

Laode M. Harjoni Kilowasid, Tati-Subahar S. Syamsudin, Endah Sulystiawati, F.X. Susilo; *Institute Technology Bandung*

Soil biodiversity above and belowground play an important role in controlling of terrestrial ecosystem process, such as nutrient releasing from the relative recalcitrant compounds and become more simple form and able to uptake by plants. The objectives of this research were to find out the relationship

between community structures of soil macrofauna and nitrogen mineralization in small-holder cocoa plantation in Indonesia. Soil fauna were collected by hand sorting methods from different ages of cocoa plantation in Konawe Selatan District. Nitrogen mineralization at each site were measured following in situ incubation. The results showed that 13 order found at cocoa plantation that were Coleoptera, Hymenoptera, Lumbricidae, Dermaptera, Symphyla, Diplura, Thysanoptera, Plecoptera, Isoptera, Milipedes, Arachnida, Blattodea, and Oppiliones which consist of four trophic groups (predator, omnivores, detritivores and fungivores). The omnivores are the dominance of trophic group found every site, although fungivores was found only in 16 years of plantation. The diversity of soil macrofauna at seventh years of plantation was the highest, and at 4 years age was the lowest. The role of ecosystem engineers of soil macrofauna such as ants, earthworms, and termites seems the most important. Ants was found in all cocoa plantation; earthworms and termite were found only at specific site. Nitrogen mineralization found at 5 and 16 years age of plantation, while at the other site only immobilization of nitrogen. We concluded that soil macrofauna played an important role in facilitation of nutrient cycling in small-holder cocoa plantation. Keywords: biodiversity, conservation, ecosystem engineers, facilitation, nitrogen mineralization, small-holder cocoa plantation, soil macrofauna.

**P-16-11: Leaf Epidermal Characteristics of Bali Salak Cultivars (*Salacca zalacca* Var. *Amboinensis* (Becc.) Mogeia) (Arecaceae)**

Ni Made Gari<sup>1</sup>, Betsy Jackes<sup>2</sup>, Leone Bielig<sup>1</sup>, Michelle Waycott<sup>1</sup>; *1. Department of Biology, Faculty of Math and and Natural Sciences, Udayana University, Bali, 2. Tropical Plant Sciences, School of Marine and Tropical Biology, James Cook University*

Leaf epidermal micro-morphology of *Salacca* cultivars from Bali was observed by using SEM (scanning electron microscope) to study the characteristics of epidermal cells and stomata. The adaxial leaf surfaces consisted of regularly curved square to rectangular cells with depressions on their surfaces, with the patterns of anticlinal cell walls were straight to undulate with ridges. Periclinal cell walls were found to be smooth or with cuticular folds, usually covered with particles of epicuticular wax. The abaxial leaf features showed sculptured abaxial surfaces and the characteristic of abaxial cells, such as anticlinal and periclinal cell walls, and subsidiary cells which surround the stomata, were difficult to determine due to the thick epicuticular folds and wax ornamentations that covered the epidermal surfaces. Stomata presented only on the abaxial epidermis, with elliptical or round in shape. The outlines of the pair of guard cells were broadly elliptical and the outer stomatal ledges or rims were conspicuous, but the structure was poorly developed as the poral walls were thin and not raised. The guard cells of Bali salak cultivars were raised above the leaf surface but in some samples observed were level with the surrounding epidermal cells. Key words : *Salacca zalacca* Var. *Amboinensis* (Becc.) Mogeia, epidermal characteristics, stomata, SEM.

**P-16-12: Study of Semanggi (*Marsilea crenata*) in Wild and Cultivation Lands in Surabaya City (Efforts to Make Conservation)**

Fida Rachmadiarti; *Surabaya State University*

Semanggi (*Marsilea crenata* L.) was known to contain phytoestrogens that have the potential to prevent osteoporosis, leaves and stems of semanggi to efficacious as urine. Therefore need to be conserved. The plant is used as a vegetable (food). In the city of Surabaya rare plant began its existence. Semanggi cultivation of land currently only about one hectare. So to meet the needs of semanggi in the city of Surabaya brought from another town. The purpose of this study to describe the morphology of semanggi and environmental conditions that support on wild land and land cultivation. This research is a descriptive study conducted in three locations, namely Ketintang, Wiyung, and Kandangan. The measured parameters is growing semanggi morphology on the different land cover morphology roots, stems and leaves, as well as environmental factors. Data were analyzed descriptively. The results showed that the cultivation of semanggi on the land have morphological



roots, stems and leaves and larger than the semanggi that grows in the wild land. Keywords: Plant semanggi (*Marsilea crenata* L.), morphology, environmental factor

### **P-16-13: Identifying Candidate Domestication Genes for Crop Improvement**

Jeanmaire Molina, Jonathan Flowers, Michael Purugganan; *Center for Genomics & Systems Biology, New York University*

Domesticated Asian rice (*Oryza sativa*) is one of the oldest domesticated crop species in the world, having fed more people than any other plant in human history since its origin 9000 years ago. Understanding the genomic architecture of domestication provides insights into the genetic basis for yield increases in crop species. We aimed to elucidate the evolutionary dynamics involved in the domestication of rice from its wild ancestor, *O. rufipogon*, by identifying domestication genes in rice through selective sweep mapping which scans the genome for regions of significantly reduced nucleotide diversity. We also compared the sweep regions in the two rice cultivars, *O. sativa* ssp. *indica* and *O. sativa* ssp. *tropical japonica* and determine if the same genomic regions were the targets of selection during their independent domestication. We amplified and sequenced ~500 bp fragments every 50-100 kb in known domestication quantitative trait loci (QTL) underlying domestication traits in chromosomes 3 and 4 and scanned the entire chromosomes 8, 10, and 12 to also detect sweeps that have not yet been identified in QTL studies. We sampled ~20 accessions for wild rice and for each of the two rice cultivars and included *O. meridionalis* as an outgroup. The chromosome scans revealed several at least 200 kb sweeps defined by fragments where  $\pi$  ( $\Pi$ ), a measure of nucleotide diversity, plummets across consecutive fragments. Targeted sequencing of regions harboring QTLs for domestication traits in chromosome 4 similarly revealed evidence for extremely large selective sweeps (up 1.2 Mb) in these regions suggesting that QTLs for agronomic traits were subject to intense selection early in the domestication process. These sweep regions may harbor candidate domestication genes which could be investigated further to improve rice yield to feed an ever-growing world population. Some of these promising genes include genes that control panicle length (*pl4.1*) and percent seed set (*pss10.1*).

## **Poster session: Human aspects of Conservation (#17; July 20)**

### **P-17-1: Growing National Concern for Plant Conservation through Development of New Botanic Gardens in Indonesia**

Irawati, Sutrisno; *Indonesian Institute of Sciences, Bogor Botanic Garden*

Establishment of new botanic gardens in various regions of Indonesia has been started since 2002. The main focus of this program is to conserve local plant diversity for further development, including environmental education to promote public awareness towards plant conservation, research to support plant conservation activities and plant usages, and green recreation especially for the local people. After almost a decade of development, 16 new botanic gardens have been initiated with varying degrees of developmental progress. Support from the local government is the key for the success of this long-term program. However, since the capacity of local government is commonly limited, generous support from all reliable sources to assist with ideas and involve in this particular ex situ conservation plan in Indonesia will be greatly appreciated. Current progress of new botanic garden development in Indonesia (Jambi, Baturraden, Balikpapan, Enrekang, Liwa, Kuningan, Katingan, Pucak, Lombok, Batam, Solok, Minahasa, Kendari, Sambas and Danau Lait) is presented.

### **P-17-2: Management and Conservation of the Red Fruit Pandan Cultivar (*Pandanus conoideus* Lam.) By Dany tribe in Papua, Indonesia**

Lisye I.Z. Zebua, Jatna S., Eko W., Tatik Ch.; *Univ. Indonesia*

Study on the management and conservation of the red fruit Pandan had been conducted in Wamena region, Jayawijaya district. The aim of this study is to explore the Dani tribe's knowledge in identifying, managing, and conserving the red fruit Pandan variations. Sampling in this research used interview and observation method. Informant selection was chosen by using purposive sampling technique and snowball sampling. Then, the obtained data was analyzed descriptively. The results of this study indicated that Dani tribe knew approximately 20 cultivars planted in their house yard. They could distinguish each cultivar of the red fruit Pandan based on the size, seed, and colour of the fruit. Utilization of the red fruit Pandan were highly varied, i.e. for health, traditional ceremonies, and animal feed. Therefore, the red fruit Pandan must be conserved, because it has social, health, and economic function for Papua communities. Keywords: Management, conservation, Red fruit Pandan cultivar, Dani tribe, Papua.

### **P-17-3: Efficiency and Distributional Impacts of Protected Area Planning Using PES Schemes in the Biosphere Reserve “Podocarpus-El Cónдор”, Ecuador**

Byron Maza, Jan Barkmann, Frank Von Walter, Rainer Marggraf; *Georg-August Universität Göttingen*

Ecuador is one of the countries with the richest biodiversity globally. 18% of the national territory are protected areas. Still, Ecuador has the highest annual deforestation rate in South America (1.7%; 198 000 ha) with much land being converted to pastures and crop land. Payment for Ecosystem Services schemes (PES) are an incentive-based alternative to a "command and control"-type establishment of protected areas. They are voluntary transactions between a buyer and a seller referring to a well defined ecosystem service. PES have been applied in Latin America to biodiversity protection, water supply protection, and carbon sequestration.

This paper investigates the effects of differing conservation instruments fostering a forest conversion ban in mountainous southern Ecuador (including PES schemes) on cost-efficiency and poverty alleviation. The instruments differ with respect to being either mandatory or voluntary, and if all farmers are compensated by the same fixed payment rate per hectare or if the compensation equals opportunity cost stipulated to be known by the analyst. Such schemes can be approximated by the auctioning of PES contracts. Additionally, a dedicated 'pro-poor' PES was designed restricting payments at a fixed rate to the poorest households. In all cases a fixed budget of ~25,000 USD/yr is dispensed. Empirical opportunity cost data stem from a sample of 130 local farming households living at the northern edge of the Biosphere Reserve “Podocarpus-El Cónдор” in southern Ecuador.

As expected, a voluntary PES paying just the opportunity costs can cover most of the relevant forest area (305 ha; 36%). In contrast, a mandatory approach covering all farms and compensating at an average opportunity cost of 156 USD/ha/yr only secures 136 ha. This approach also fares worst with respect to poverty alleviation with most payments being dispensed to the relatively least poor farmers and even the GINI coefficient rising slightly to 0.488. Voluntary approaches fare better in this respect with a maximum contribution to household incomes of about 10% for the three poorest household quintiles and GINI coefficients of ~0.477. If payments are restricted to these quintiles at rates between 150 and 300 USD/ha/yr, only 168 to 84 ha forest are covered but the GINI coefficients drops to 0.47-0.462. While mandatory approaches appear worst, we conclude that severe trade-offs between cost efficiency and poverty alleviation are likely to impact PES application in the study area.

### **P-17-4: Modeling Livelihood Impacts in the Context of Land Use Changes from Biofuel Expansion in Indonesia**

Janice S.H. Lee, Jaboury Ghazoul, Lian Pin Koh; *ETH Zurich*

Cultivation of oil palm for food and fuel is likely to expand due to global demand for vegetable oils and a growing market for palm oil biodiesel. In my research, I will focus on the social drivers and

future social-ecological interactions of oil palm expansion in rural communities surrounding oil palm estates. The main research objectives of my study include identifying socio-economic determinants of oil palm adoption among rural communities, identifying determinants of the financial returns from small scale oil palm farming and understanding the trade-offs resulting from converting different land uses into oil palm plantations. The goal of this study is to improve our understanding of how small scale oil palm agriculture can be improved and to model the livelihood outcomes of different land uses in a local context. Results from this study can be used to improve regulations and management of smallholder farmers, such as developing agricultural micro-insurance schemes, in the oil palm industry.

### **P-17-5: The Role of Religion in Conservation Biology**

Religion and Conservation Biology Working Group (RCBWG) of the Society of Conservation Biology

"Since the roots of our trouble are so largely religious, the remedy must also be essentially religious, whether we call it that or not." (Lynn White, 1967)

Lynn's article and comments on the role of religion, in particular Christianity, in the ecological crisis of mankind was one of the earliest articles published in a major international scientific journal on the role of religion in conservation biology. In a world where we face tremendous environmental and ecological challenges such as climate change, massive rates of species loss and a shortage of energy sources just to name a few, the advancements of science and technology can only help solve our environmental conundrum to a limited extent. To truly remedy the situation, it is imperative that we make active decisions to change our attitudes, behaviour and lifestyle in the direction of environmental consciousness and greater responsibility over our planet's resources. Faiths, in that sense, are important and appropriate tools to relay these messages of conservation and environmental consciousness to the masses. With the current controversies between evolution and creationism, it may be difficult to see the link between religion and conservation. In this poster presentation, we hope to introduce the concept of religion in conservation biology, provide examples of successful partnerships and list possibilities for greater collaboration. With urgent environmental issues at hand, it is pertinent to explore various ways of influencing human behaviour towards the environment and to re-look at how faith can be used as a tool for promoting the cause of nature conservation.

### **P-17-6: Perceptions of Rainforest Biodiversity: which Animals Have the Lion's Share of Environmental Awareness?**

Jake L. Snaddon<sup>1</sup>, Edgar C. Turner<sup>2</sup>, William A. 1; *1. University of Zurich, 2. University of Cambridge*

The world's population is increasingly disconnected from nature, living in human-dominated landscapes that are expanding at the cost of the natural environment and biodiversity. This has been referred to as the "extinction of experience", a consequence of which is the "shifting baselines syndrome" where past experiences of the state of the environment shape people's expectations of the environment. Such awareness is important for conservation, as without appreciation of their value and conservation status, species and ecosystems are unlikely to receive adequate conservation protection. Changes in land-use often result in significant reductions in abundance and diversity of the flora and fauna as well as alterations in their composition. Despite this, there is little public perception of which taxa are most important in terms of their total biomass, biodiversity or the ecosystem services they perform. Here we present studies on children's perceptions of rainforest biodiversity. We quantified children's understanding of a rainforest environment by recording the frequency at which children drew different climatic, structural, vegetative and faunal components in pictures of their ideal rainforest. We compared the relative abundance of the taxa drawn with the actual contributions made by these taxa to total rainforest biomass and global biodiversity. We found that children's perceptions of the rainforest incorporate many habitat features and a diverse range of animals. However, several taxa were under-represented (particularly insects and annelids) relative to their contribution to total

biomass and species richness. Children's preferences for taxa are strongly correlated with their representation in modern culture. The values we place on biodiversity and ecosystems must be raised to encourage conservation. Although awareness will not guarantee protection, lack of awareness will make achieving conservation of endangered ecosystems and species difficult.

**P-17-7: The Ethnobotanical Study of Pandanaceae in Papua and Papua Barat, Indonesia**

Yohanes Purwanto; *Research Center for Biology-LIPI*

The ethnobiological study of Pandanaceae in the Indonesian Provinces of Papua and Papua Barat was proceeded in the Dani-Baliem valley for five years started in 1990 as a part of the Ethnobiology research of the Dani-Baliem society. The study then expanded incorporating wider areas; Mimika area in Timika (2001), Cyclops Nature Reserved and adjacent areas (2003), the island of Yapen (2006-2007), the Raja Ampat Archipelago (2007-2008), and the Sorong District (2008). The study records more than 66 taxa of Pandanaceae in Papua, in which many, mainly from the genus *Pandanus* are used by the local communities as sources of food, medicine, handicraft, ornamental plants, and building materials. The plants offer a wide range of environmental purposes including control of coastal erosion, windbreak, protection of food crops from salt spray, soil fertility and organic matter levels improvements, shading, and nesting ground for birds. This paper describes the results of ethnobiological analyses of Pandanaceae found in Baliem Valley, Timika, Cyclops Mountain, Yapen Island, and the Raja Ampat Archipelago. Key words: Ethnobiology, Pandanaceae (*Pandanus*, *Freycinetia*, and *Sararanga*), Papua, Indonesia

**P-17-8: The Chances and Threats of Local People's Perception and Knowledge in Conserving Nipah Forest at Pulau Rimau District Banyuasin, South Sumatra**

Dwi Puspa Indriani; *University of Sriwijaya*

As one of dominant mangrove in Pulau Rimau district Banyuasin South Sumatra, Nipah forest has the important roles for local people, but had been threated in losing its quality of ecological functions. The alternative strategy to conserve the resources is management based on community. The knowledge and environment awareness of local people is the most important thing to develop sustainable conservation. The objective of research was to identify knowledge and perception of local people about role and conservation needs of nipah forest to their life. The research used interview and semi-opened questionnaires which involved 180 respondents from 6 orchards in Penuguan village. Sampling was taken at Agustus until September 2009. The parameters were knowledge about etnobotany, correlation of nipah forest to fish production, and perception about conservation nipah based on potential economic value. The result showed that 71.7% were farmers, 65% elementary graduated, 82.8% were married, and 54.4% had productive age (18 – 35 years old). The knowledge about nipah was still low. 1.7% respondents knew about the alcohol product, and 100% didn't know about the economic value of it. 42.2% knew about the brown sugar product, and only 25% knew about the economic value, 3.3% knew about as medicine material, and 11.1% knew as traditional property. The result showed there were positive perceptions about nipah forest conservation. 92.8% said the nipah forest is important, 76.7% agreed to conserve them. 53.3% choosed not to cut them, 35% agreed with regulation of harvest, and 5.5% agreed to cultivate them. 65.5% revealed there is correlation between nipah forest with fish production, and 44% catching fish nearby nipah forest. It could be concluded that the knowledge, perception and dependence of people were potential as threats or chances in conserving the Nipah forest. Key words : knowledge, perception, economic value, nipah, conservation

**P-17-9: Self-Organizing Fallows Maintain Resource Concentration and Ecosystem Services in Pre-Columbian Raised Fields of Guianan Coastal Savannas**

Delphine Renard<sup>1</sup>, Jago J. Birk<sup>2</sup>, Stephen Rostain<sup>1</sup>, José Iriarte<sup>1</sup>, Bruno Glaser, Doyle McKey; *1. University of Montpellier II, 2. University of Bayreuth*

Our studies in seasonally flooded savannas of the Guiana coast suggest that pre-Columbian farmers and natural ecosystem engineers have combined to construct a unique kind of self-organized ecosystem. The functioning of this system shows how using ecological principles to couple human actions to those of natural engineers can amplify the effects of ecological engineering and render them self-sustaining. These savannas present thousands of small earth mounds that are the vestiges of pre-Columbian raised fields, constructed to permit sedentary agriculture in these constraining environments. Almost a millennium after being abandoned, these mounds are still present. Our data show that ecosystem engineers, notably social insects, earthworms and woody plants, are strongly concentrated on mounds, attracted by their well-drained soils. Their actions—transport of organic and mineral matter to mounds, modification of the properties of mound soils that reduce their erodibility—compensate the substantial erosion we have demonstrated in this landscape. We explore the functioning of these ecosystems and develop potential applications in ecological engineering. Among other findings, our results indicate how to create a system in which resource concentration in cultivated surfaces is maintained during fallow periods. Exploiting natural resource-concentration mechanisms driven by ecosystem engineers could help us to design agroecosystems that are resilient to anthropogenic disturbance and climate change, and that combine agricultural production with the maintenance of ecosystem services and savanna biodiversity. Experiments in rehabilitating raised-field agriculture indicate that productivity per unit land surface is high. However, continuous cultivation may not be feasible. Engineering fallows that are self-organized may reduce the required labor input, which is the factor most likely to limit the adoption of raised-field agriculture by today's farmers.

**P-17-10: Using Camera Traps to Engage Local People in Participatory Biodiversity Monitoring: An Example from Southern China**

Jay Wan; *China Programme, Kadoorie Farm & Botanic Garden, Hong Kong*

We here evaluated how local park wardens in Yinggeling Nature Reserve of tropical Hainan changed their awareness and attitudes to their routine besides gaining scientific knowledge via a biodiversity monitoring project. Camera trap survey was started in March 2009 to investigate the diversity and relative abundance of mammalian fauna under various anthropogenic threats. As all park wardens are local villagers, camera trapping teams were formed basing on their geographic sections. Photo sharing from successful studies in SE Asia gave high visual impact to the teams, who got engaged to this remote-sensing technique soon. Other wardens were encouraged to provide animal signs information to the team for a higher capture rate. By the end of the one-year project, teams contained the highest number of species and individuals recorded would be awarded of photographic field guides and field equipment. Experienced “ex-hunters wardens” were highly respected of their indigenous knowledge on the activity and distribution patterns of local wildlife. Monthly meetings with the teams kept them updated on the overall achievements and discuss how to resolve practical and technical difficulties. In perspective of nature reserve management, camera trap monitoring did not only provide current distribution of mammals but also help park managers to quantify patrolling efforts of wardens. Results and feedbacks from frontline teams in return helped the reserve management to adjust future monitoring and patrolling strategies. Wardens gained job satisfaction from this project. Some started not to treat the reserve simply as “working office”. They became interested in field skills like taxonomic and survey knowledge. Potential candidates were even trained to be parataxonomists. Professional and authority image of trained wardens were reinforced at community level as they are not regarded as “ex-hunter” only. Problems faced in this project, precautions and improvements were also discussed.

**P-17-11: Prospects for Biodiversity Conservation in the Atlantic Forest: Lessons from Aging Human-Modified Landscapes**

Marcelo Tabarelli; *Universidade Federal de Pernambuco*

Recent global assessments have shown the limited coverage of protected areas across tropical biotas, fuelling a growing interest in the potential conservation services provided by anthropogenic landscapes. Here we examine the geographic distribution of biological diversity in the Atlantic Forest of South America, synthesize the most conspicuous forest biodiversity responses to human disturbances, propose further conservation initiatives for this biota, and offer a range of general insights into the prospects of forest species persistence in human-modified tropical forest landscapes worldwide. At the biome scale, Atlantic Forest ranged across elevations below 800 masl, which still concentrate most areas within the major centers of species endemism. Unfortunately, up to 88% of the original forest habitat has been lost, mainly across these low to intermediate elevations, whereas protected areas are clearly skewed towards high elevations above 1,200 masl. At the landscape scale, most remaining Atlantic Forest cover is embedded within dynamic agro-mosaics including elements such as small forest fragments, early-to-late secondary forest patches and exotic tree monocultures. In this sort of aging or long-term modified landscapes, habitat fragmentation appears to effectively drive edge-dominated portions of forest fragments towards an early-successional system, greatly limiting the long term persistence of forest-obligate species. Many elements of human-modified landscapes (e.g. patches of early-secondary forests) may offer excellent conservation opportunities, but they cannot replace the conservation value of protected areas and hitherto unprotected large patches of old-growth forests. Finally, the biodiversity conservation services provided by anthropogenic landscapes across tropical forests can be significantly augmented by coupling biodiversity corridor initiatives with biota-scale attempts to plug existing gaps in the representativeness of protected areas.

**P-17-12: National Park Benefits to Surround Community, and People in other Parts of the World: Economic Valuation of Natural Resources in Gunung Palung NP**

Hendra Gunawan, Rahmi Ananta W.K.; *Gunung Palung National Park*

Gunung Palung National Park (GPNP) is one of the most important conservation areas in West Kalimantan, characterised by high biodiversity and a wide range of ecosystems with their associated flora and fauna communities. The park also provides ecological, economical, and social benefits to surround community, and people in other parts of the world. In order to find out other GPNP advantage, we did an Economic Valuation of Natural Resources study for several typical GPNP commodities, which are the GPNP existence, Orangutan Conservation, Utilization of Water for Household, Carbon Absorption, and the Durian fruit. Contingent Valuation Method is used to give an overview to the respondents of the assessed commodities, so that eventually the respondents will provide or not provide an assessment through their ability to pay for these products (WTP). The data was collected through direct survey using questionnaires in 23 buffer villages around GPNP area with the number of respondents as many as 345 people. Meanwhile the Productivity Approach is used to calculate the economic value of the Carbon absorption and the economic value of Durian fruit. In order to determine the factors that influence respondents WTP values, we conducted statistical analysis using regression logiystic in some aspects that may affect the WTP value, namely knowledge, work, education, perception, and respondents income. The result of economic valuation study in GPNP, shows the estimated value of household water is IDR 81,910,717,056/year, the economic value of GPNP area existence is IDR 2,387,006,391/year, the economic value of Orangutan conservation is IDR 3,685,201,583/year, the economic value of Carbon absorption is IDR 428,272,992,900/year, and the economic value of Durian fruit is IDR 35,919,854,640 /year. Based on the logistic regression analysis result, WTP respondents' values are not significantly affected by knowledge, employment, education, perception, and respondents income.

**P-17-13: Conservation of Local Fruit Trees in Cisarua an Effort to Improve Catchments Area of Ciliwung River in Bogor Region**

Tri Handayani, Sugiarti, Melani K. Riswati, Yuzammi; *Bogor Botanic Gardens, LIPI*

The Ciliwung River has important values for Bogor Botanic Gardens, particularly during dry season. It is used for watering the plant collections. Besides the Ciliwung River is also importance to people live nearby for domestic, agricultural and industrial purposes. Forest destruction and land converted, particularly in the catchments area of the river, have caused environmental problems such as lack of water in dry season and flooding as well as soil erosion during rainy season. An effort to improve the catchments area of the Ciliwung River has been conducted by planting 1000 specimens of local fruit trees. Nature Laboratory School was established in three of Elementary School in Cisarua viz. SDN Gunung Mas, SDN Cikoneng and SDN Kopo 3. Bogor Botanic Gardens gave lesson of plant conservation education to elementary school children so they know more about the important of their environment. Study on seed viability and grafting in different rootstock have been carried out in the Bogor Botanic Gardens nursery. The result showed that the highest seed viability is 98 % and the lowest 36 % founded in *Sandoricum koetjape* and *Antidesma bunius*, respectively. The best grafting found on *Pouteria duclitan* (scion) grafted on *Lucuma petaloides* (rootstock); grafting experiment *Syzygium polycephalum* grafted on *Syzygium polycephaloides* showed good compatibility by or without added plant hormone. There are 6.000 seedlings of local fruit trees are now available in the Bogor Botanic Gardens. Key words : conservation, local fruit trees, catchments area and Ciliwung River.

**P-17-14: Mobilizing Community Support for In-Situ Philippine Crocodile Conservation in the Northern Sierra Madre, the Philippines**

Myrna Cauilan-Cureg<sup>1</sup>, Jan van der Ploeg<sup>2</sup>, Marites Balbas-Gatan<sup>1</sup>, Merlijn van Weerd<sup>1</sup>; *1. Isabela State University, 2. Leiden University*

‘Croc devours preggy Ilocana!’ reads the headline in the local newspaper. A crocodile attack on a three-month pregnant 24-year old woman in February 2010 has caused a drawback on efforts to mobilize public support for in-situ Philippine crocodile conservation in northeast Luzon, the Philippines. The sensationalized media attention has resulted in the resurfacing of negative feelings and fear of crocodiles. Over the past 10 years an intensive communication, education and public awareness (CEPA) campaign has aimed to inform local communities on Philippine crocodile conservation in the northern Sierra Madre. This paper presents an quantitative assessment of the impact of the public awareness campaign in terms of outputs, outreach and cognitive and affective outcomes through a counterfactual comparison. It documents that most of the people living in Philippine crocodile habitat now know that the species is protected by law. People take pride in the occurrence of a rare and critically endangered species in their village and actively support in-situ conservation action. But the recovery of the Philippine crocodile population leads to more human—crocodile conflicts; thereby posing new challenges for effective environmental communication.

**P-17-15: Seeking Wisdom and Humility in the Selection of Tools, Methods, and Approaches for Working in a World of Trade-offs**

Zachary Anderson<sup>1</sup>, Paul D. Hirsch<sup>2</sup>, Sheila O'Connor<sup>1</sup>, Terry Sunderland<sup>1</sup>; *1. CIFOR, 2. Maxwell School of Citizenship and Public Affairs*

There is a growing awareness within the conservation community of the complex trade-offs that exist between the goals of biodiversity conservation and human well-being and development. As a result of the fragmented landscapes within which most conservation initiatives take place multiple trade-offs, economic, ecological, political and social in nature, must be taken into consideration. Trade-offs occur at a variety of scales, from local to international, and often have to be negotiated across boundaries, both physical and institutional. The selection of tools, methods, and approaches for understanding and negotiating trade-offs, is an important decision that is rarely reflected upon adequately. This project is the result of a collaboration between the Center for International Forestry Research (CIFOR) and the “Advancing Conservation in a Social Context: Working in a World of Trade-offs” initiative (ACSC), and is intended to diffuse and expand work on the “Tools, Methods, and Approaches for Trade-off Analysis and Negotiation” project that is being undertaken as part of the ACSC initiative. We

conducted a “meta-analysis” of case study data collected in the Lower Mekong region by CIFOR researchers using the ACSC’s Integrative Framework. Based on the context of this case study and what is known about the trade-offs present within and between conservation and human well-being, this analysis explored the possibilities and constraints involved in the selection and utilization of different tools, methods, and approaches for understanding and negotiating the trade-offs. Additionally we engaged in a “reflective” process of documenting the challenges and insights experienced attempting to “bridge the gap” between academic research and NGO/practitioner realities.

**P-17-16: Medicinal Herbs of Pasir Mayang, Jambi**

Hilman Affandi, N. Arif, S.B. Prayogo; *Seameo-Biotrop*

This article presents the results of an investigation concerning the use of herbal medicinal plants by the people of Pasir Mayang, sub-District (Municipality) of VII Koto, District of Tebo, Jambi Province, Sumatera. The data collection was based on interviews with the healers and other villagers of Pasir Mayang who possess knowledge of the different plants and their medicinal uses. The study recorded 57 species of medicinal plants used in Pasir Mayang. The detailed uses of the 57 medicinal plants are given. All plant species were subjected to phytochemical analysis and toxicity tests, and the outcome of the analysis on the presence of alkaloids, saponins, steroids/terpenoids, and the level of toxicity against brine shrimp (*Artemia salina*) are presented. A comparison with other studies reported in the literature seems to indicate that a high frequency of the use of leaves in therapy may be a part of a larger cultural phenomenon among the tropical forest tribes of Southeast Asia.

**P-17-17: Developing a Local-Based Forest Monitoring in Mbeliling, East Nusa Tenggara, Indonesia**

Walesa Edho Prabowo; *Natural Resources and Environmental Management, University of Hawai'i at Manoa*

Local based or participatory monitoring has been acknowledged as a valuable tool for the conservation action. This method would help locals to see the trends in their environment and would give a better management approach for the area. The involvement of the local community is essential because this group directly interacts with the forest on a daily basis. The establishment of this simple local-based forest monitoring that benefited the local stakeholder is needed in Mbeliling, East Nusa Tenggara, Indonesia, for better future management in this area. This paper provides information on how this method is developed, implemented, the lessons learned so far and the future expectations of this approach. The steps taken to develop the method are: 1. Literature review and species selection, 2. Group discussion, 3. Try out and evaluation, 4. Finalization. The processes generated a list of combined birds, mammals and signs of forest resource use activities, that are monitored once every 3 months by the local community. The development of this simplified-monitoring method, especially in the selection of monitoring aspects is determined by the local-based knowledge in the local community. The capability to develop a method that is practical for locals but also provides valuable data for scientific purposes has been the biggest challenge for developing this method. The future implementation and the continuity of the forest monitoring depends on the sense of belonging and the joint-commitment of these local stakeholders. Key words: local-based forest monitoring, participatory forest monitoring, Mbeliling forest.

**P-17-18: Tiger Translocation in Sumatra, Indonesia**

Dolly Priatna; *ZSL Indonesia*

Human-tiger conflict is one of the key problems in tiger conservation, leading to direct fatalities and reduced support for conservation. Translocating problem tigers to an area of forest far from the conflict zone has been tried to alleviate such conflict. This work aims to support the conservation of



Sumatran tigers through providing recommendations to the Indonesian government on the suitability of tiger translocation as a means of conflict mitigation and conservation. Using a combination of GIS analysis and GPS collaring data to evaluate the establishment of home ranges of translocated tigers, camera trapping to determine the ecology of existing tigers and prey in the area and a questionnaire surveys This study investigates the ecology of translocation and its implications for local communities living around translocation site. Key words: translocation, Sumatran tiger, gps collar, home range, camera trapping, ecology, local communities

**P-17-19: Singing Quiet from Salak Mountain, West Java: Conservation Base on Local Belief and Ritual Tradition**

Mohammad Fathi Royyani, Eko Baroto Walujo; *Research Center for Biology-LIPI*

Salak Mountain in west Java have an important position as for catching area of water, rain forest, and bank of biodiversity. To protect and to conserve this area from damaging, Indonesian government by Forest Departement develop Salak Mountain to be National Park. Local people who life at surrounding of Salak Mountain has local wisdoms about the useness of plant and local perspective about mountaint to manage biodiversity. Their perspective as in order of daily life by local people because its as ancestral heritage and as the religion and custom thruth. For local people, Salak Mountain is not only to keep their daily needs but also to save their history and legend about their ancestor. To collect data, we conducted indepth interview with local peple, observed and involved their ritual. People who life at surrounding of Salak Mountain has Ritual tradition and local belief about Salak Mountain, so the Salak mountain area is still protected and sustainable to be conserved.

**Poster session: Education and Biodiversity Informatics (#18; July 22)**

**P-18-1: Biodiversity Surveys in Indonesia and Discovery of Health and Energy Solution**

Elizabeth A. Widjaja<sup>1</sup>, Daniel Potter<sup>2</sup>, Kate Scow<sup>1</sup>, Kyria Boundy-Mills<sup>1</sup>, Len Bjeldanes, Andrew Engilis, Jeanine Pfeiffer; *1. Botany Division, Research Centre for Biology, 2. University California, Davis*

Sulawesi is known to have a high rate of species endemism. An inventory of flora, insects, vertebrates, and microbes at various elevations in the Mekongga mountain region is being performed as part of a US NIH-funded project from 2008 to 2013. Specimens are being deposited in collections in Indonesia and the U.S. Vertebrate survey: We collected 34 bird specimens, and 59 species of bird were observed. Among these, 15 bird species are endemic to Sulawesi. Other vertebrates include two endemic rats, 40 bat specimens including three endemic fruit bats, one Macaca, one wild pig, one lizard, one frog and one Prosciurillus. Flora survey: 280 specimens of flora were collected and 365 voucher specimens were recorded. We found at least two new species of Begonia, one new genus of bamboo, and several species that were not previously recorded in Sulawesi. Three samples of trees belonging to the family Moraceae and Euphorbiaceae were collected for therapeutics screening. Insect survey: To date we have collected approximately 22,000 specimens of insects, including Lepidoptera, Odonata, Vespidae, parasitic wasps, Vespidae wasps, Coleoptera, Orthoptera, and many others. Microbe survey: Microbes were collected from soil, plant surfaces, leaf litter and insect gut, and include 339 bacteria, 154 actinomycetes, 112 filamentous fungi, and 140 yeasts. Screening: Microbe and plant samples are being assayed for anti-cancer, anti-HIV/AIDS, anti-inflammatory and neurological activity at UC Berkeley and ITB. Microbes are also being screened for energy applications including cellulase activity and high lipid content. Local impact: The history of the settlement, agriculture, and forestry in the area has been documented as well as traditional uses of native plants and animals. Conclusions: The biodiversity of Mekongga region is still very good, despite illegal logging and

cacao plantation. These data will be used to support biodiversity preservation and watershed conservation programs.

### **P-18-2: Development of a New Biology Program Focused on Tropical Sustainable Development**

Juan M. Posada, María Martínez-Agüero; *University of el Rosario*

Terrestrial tropical ecosystems play a key role in the maintenance of global biodiversity; they help regulate the world climate and are a source of food, fiber and medicines for billions of people. However, their sustainability is at a high risk due in large part to an increase in human population size, higher local and global per-capita resource consumption and social inequity. The development of educational and research programs in the tropics, which focus on understanding the drivers of change in social and ecological systems can greatly contribute to the reversal of this downward trend in human use of tropical biotas. We are currently developing a new Biology program (BP) that will study tropical socio-ecological systems from a scientific perspective, with the goal of attaining a sustainable development that secures long-term conservation of ecosystem services while maintaining/improving the well-being of society. The BP will open its doors to undergraduate students in fall 2011 and to Master and PhD students in 2012-13 and our objective at the ATB-2010 meeting is to get valuable feedbacks from experienced tropical biologists regarding course contents, pedagogical approaches and our future research lines. Undergraduate students will have a solid basic formation as biologists, have the tools to work on complex problems, a multidisciplinary/transdisciplinary formation and strong ethical compromise. Basic and applied research programs will gravitate around four general lines: 1) ecology and ecosystem services, 2) health and environment, 3) governance, environmental law and ecological economics and 4) molecular biosciences. We expect that this inter/transdisciplinary research on socio-ecological systems will strengthen the link between science and policy, favor necessary adjustments in socio-economic systems, increase participatory approaches and create innovative conservation principles in tropical countries.

### **P-18-3: The Angiosperm Phylogeny Website: Mark Two**

Amy E.Zanne, Peter F. Stevens, Campbell O. Webb; *University of Missouri – St. Louis*

We need tools to keep abreast of the rapid development of hypotheses for evolutionary relationships of seed plants to better integrate them with work in other fields (e.g., conservation, ecology). The Angiosperm Phylogeny Website (<http://www.mobot.org/MOBOT/research/APweb/>) allows researchers in systematics, ecology, and other disciplines convenient access to current and past literature on their plant groups, provides a novel synthesis of ideas, and is an educational tool for teachers and students alike. Importantly, it helps biologists across disciplines to communicate, as it is readily accessible, frequently updated, and uses a consistent terminology. We aim to make the information in APWeb more readily available to researchers for direct querying so that they can answer questions dependent on the hierarchically-structured information provided there. This entails conversion of the site from Hypertext Mark-up Language to Extensible Markup Language, which will allow data in the site to be automatically parsed by the user. Important new tools will include a complete generic synonymy for flowering plants that will depend on feedback and updating by the botanical community at large; this will greatly enhance communication among botanists of all persuasions.

### **P-18-4: Papua New Guinea Institute of Biological Research**

Gamui Banak, Miriam Supuma; *Papua New Guinea Institute of Biological Research*

The Papua New Guinea Institute of Biological Research (PNGIBR) is a Papua New Guinea (PNG)-based not for profit association formed to ensure a biologically sustainable future for PNG. We 1) conduct much needed research, 2) give national biologists and conservationists the skills they need to

preserve their biodiversity, 3) ensure information is shared with policy makers, landowners and PNG citizens, and 4) integrate traditional knowledge and customs with modern concepts of conservation to come up with models that will work in PNG. We are currently conducting research on nest box occupancy by birds and mammals, long-beaked echidnas, hunting sustainability, biodiversity surveys, and protected area monitoring for birds, mammals, plants and insects. We fund and mentor Honours students in association with the University of PNG, seeing students through all aspects of their degrees including project design and proposal, field work, data analysis and write-up, oral presentation and defense, and essays. We also hold training courses for up to two dozen university students and biology professionals to teach project design, field techniques (including mammal trapping and handling, bird and bat mist-netting, plant plot work and collection, etc), data analysis, and report write-up and presentation. We welcome collaborators who share our mission and would like a Papua New Guinea partner; we maintain two research stations and our eight PNG staff scientists have Masters degrees from the US, Australia, New Zealand and the UK and extensive PNG field experience with birds, mammals, plants, insects, setting up and running field camps, and liaison and negotiation with local landowners throughout PNG.

#### **P-18-5: Developing a Digital Flora for Gunung Palung National Park**

Endro Setiawan, Acun Heri Yanto, Campbell O. Webb; *Balai Taman Nasional Gunung Palung, Ketapang*

Gunung Palung National Park in West Kalimantan, Indonesian Borneo contains many habitats, from montane to mangrove, and is among the top parks for total plant diversity in Indonesia. We have been collecting (higher) plants there since December 2008, and have visited nine separate sampling locations. Besides standard herbarium specimens we have been recording each collection with a series of ca. 20 high-resolution digital photographs, of full twig, stipules, leaf, inflorescences, and dissected flowers and fruits. The images are then cropped and uploaded with metadata to a biodiversity informatics platform (<http://phylodiversity.net/xmalesia/>). We have taken over 10,000 images from over 700 species. Silica-gel dried samples are also analyzed in an Indonesian Institute of Sciences lab in Cibinong, Jawa, to produce DNA barcodes (matK and rbcL) for most specimens. We hope that the field methods and digital photography can be used by parataxonomists (park rangers) at other parks in Indonesia to create a free, widely accessible and powerful resource for plant identification and inventory in Indonesia.

#### **P-18-6: GenStat Free Use for Teaching World-Wide and Free Use for Research to the Developing World**

Stewart Andrews; *VSN International*

VSNi believe that research is central to understanding the world's major biological challenges and that the researcher's ability to fund the right tools should not be wealth driven. Man's demands on land, sea, environment continue to grow, placing significant pressure on food production, ecosystems, our climate's predictability and man's way of existence. Our aim is to support all bioscientists, researchers, farmers and agriculturists in their work, even those with no budget, through our successful GenStat for Teaching and GenStat Discovery programmes. GenStat for Teaching is free to educators and students across the globe. GenStat Discovery is provided free to not-for-profit research organisations, charities and educational institutes based in the developing world. In all, every student worldwide, and all but commercial organisations from the world's 101 less wealthy countries, can access first world menu-driven analysis tools absolutely free. VSNi is a prime supplier of data analysis software for the biological and life sciences markets worldwide. We were formed in 2000 as a spin off from Rothamsted Research (RRES) and the Numerical Algorithms Group (NAG). We are backed by UK government through RRES being the largest land-based research institute in the UK and arguably the original home of statistics in biology. As a result we are uniquely placed to provide statistical software to the agricultural and wider biology markets. Our ethos is collaboration and partnership, ingrained within our psychology from our government links.

## Poster session: Conservation Biology (#19; July 22)

### P-19-1: The Conservation Genetics and Demography of *Tahina spectabilis* a Recently Discovered Monospecific Palm Genus from Madagascar

Heather E. James<sup>1</sup>, Mijoro Rakotoarinivo<sup>2</sup>, William J. Baker<sup>1</sup>, John Dransfield<sup>1</sup>, Alison Shapcott; *1. University Sunshine Coast, 2. Royal Botanic Gardens Kew, Madagascar*

The recent discovery of the giant fan palm *Tahina spectabilis* from the foot of a small outcrop of 'tsingy' (karst limestone) in remote northwestern Madagascar caused great excitement in the world's press. The crowns of the palms are so large that they are visible using Google Earth. The species is the only member of a newly described coryphoid palm genus with its closest relatives in Asia; the palm is thus genetically and physically isolated. It flowers only once with a massive compound terminal inflorescence; after flowering and fruiting the individual palm dies. We undertook a complete survey of the population structure of *T. spectabilis* and mapped the relative locations of all known individuals to determine the size of the population and the distribution of size classes of individuals. We also made collections of mature leaf material from all plants in the population that were greater than 30cm in height and from a selection of smaller seedlings. We thus sampled a total of 110 plants from three sites for analysis to determine the genetic variation within the species and the genetic relationships among the individuals within the population. The majority (85 out of 87) of the plants 30cm and taller and all the seedlings were found in a single population. Preliminary results will be presented.

Together these results will be used to assess the long term viability of the species and to assist with its conservation management. There has been considerable interest in this species and local conservation management has been established; our results will be useful to guide further actions such as possible introductions of the species to new sites.

### P-19-2: Macadamia janseni Recovery Project

Alison Shapcott, M. Powell; *University Sunshine Coast*

The endangered *Macadamia janseni* (Proteaceae) is only known from one population of 60 plants currently conserved within an Australian national park. The population is located close to a park boundary and vulnerable to threats from weeds, fire and human interference. All macadamia species are found within rainforest habitat. The commercial edible macadamia nut is closely related to *M. janseni* and wild populations of three macadamia species are located to the south of this species. This project involves collaboration between the Australian macadamia industry (AMS), University researchers, National Parks, Queensland Herbarium and traditional owners the Gidarjil to assist with recovery of this species. Genetic analysis and habitat modelling are being used to design a reintroduction program to create new populations to reduce the extinction risk for this species. A targeted search program to look for more populations is also being developed.

### P-19-3: How Much Can a Forest Bear?

Markus P. Eichhorn, Sofia , Frank v. Walter , Jan Barkmann; *School of Biology, University of Nottingham*

UNESCO Biosphere Reserves (BR) are based on the idea that both biodiversity and local human populations benefit from regional land use management. They consist of strictly protected core areas, and successively less restrictive buffer and transition zones. The application for the BR Podocarpus–El Cóndor in South Ecuador was approved in 2007. It covers one of the most species rich areas of the tropical Andes biodiversity hotspot. As a contribution to regional infrastructure and land use planning, we conducted an ex ante assessment of a proposed road building project. We focus on habitat impacts

for the Andean Bear (*Tremarctos ornatus*), a threatened flagship and umbrella species of the area. As geographical base data, we used a Maximum Likelihood-land cover classification map based on Land-Sat ETM+ imagery (30\*30m resolution, 888.7 km<sup>2</sup> extent). A conditional logit-model was estimated to quantify key factors (slope, altitude, cost distance to regional markets, distance to next village, distance to next path or road) correlated with current land-use types (forest, bushland, pasture, settlement; pseudo R<sup>2</sup>=0.2943). If the road of ~19 km length between the villages of Imbana and Sabanilla was built, 611 ha of forest are predicted to be converted to pasture. This represents the habitat requirements of about two female bears. In turn, the additional pasture could provide subsistence livelihoods for about 41 average-sized farming households, albeit generating only poverty level family incomes. The substantially worsened habitat connectivity between the BR core area and the wider forest matrix additionally argues against accepting this trade-off.

#### **P-19-4: The History of Land Use Change and Land Management and Conservation Policy in Sabah**

Glen Reynolds; *Royal Society SEARRP*

ABSTRACT??

#### **P-19-5: The Species Extinction Calculator: A Novel Approach for Predicting Biodiversity Loss by Incorporating Matrix and Edge Effects**

Lian Pin Koh<sup>1</sup>, Tien Ming Lee<sup>2</sup>, Navjot S. Sodhi<sup>1</sup>, Jaboury Ghazoul<sup>1</sup>; *1. Institute of Terrestrial Ecosystems, ETH Zürich, 2. Department of Ecology and Evolutionary Biology, Yale University*

Species-area (SA) models have been central to assessments of biodiversity decline and conservation planning. These applications of SA models hinge on two fundamental assumptions: the resultant landscape matrix is inhospitable to the taxa of interest, and edge effects do not factor into extinction risks. Despite growing consensus that these assumptions are unrealistic, the SA approach continues to be used to predict biodiversity loss resulting from habitat loss.

We propose an overhaul of the SA approach by accounting for taxon-specific responses to landscape-specific matrix quality and deleterious effects of habitat edges. Our improved models, when compared to the conventional SA model, more realistically predict extinction and endangerment of bird and mammal species across 15 biodiversity hotspots.

Based on our new model, we developed an online tool that can be used to advise policymakers on the biodiversity outcomes of various land-use and development decisions ([www.SpeciesExtinctionCalculator.com](http://www.SpeciesExtinctionCalculator.com)). Crucially, since the model accounts for the sensitivity of species to each habitat in a landscape matrix and to edge effects, it can be used to demonstrate how the negative impacts of land-use change on biodiversity might be ameliorated (or how biodiversity could even be enhanced) by improving matrix quality and increasing connectivity among forest remnants.

#### **P-19-6: Conservation Case Study: The Economic and Ecological Impact of a *Dipteryx micrantha* Management Plan in Infierno, Peru**

Gabriela Sosa, Gavin Miculka, Patricia Mullins; *Texas A&M University*

In the lowland forests of southeastern Peru, *Dipteryx micrantha* is a hardwood species that is being exploited through current logging practices. These trees are primarily found in low elevation old growth forests, and are ideal habitat for numerous endemic mammals, insects, and birds in the Peruvian Amazon rainforest. In particular, some species like the scarlet (*Ara macao*) and red-and-green (*Ara chloropterus*) macaws are especially reliant on the natural cavities that are created as a result of branches breaking off. Past studies indicate that approximately 88% of macaw pairs in this region use these cavities for nesting; therefore these trees are vital for the continual presence of

macaw populations. However, *Dipteryx* wood is frequently harvested and sold by the local people because of its high quality and durability. In addition to providing lumber, this hardwood resource is also utilized to make charcoal. This practice has been further exacerbated by the Peruvian government which has been encouraging the harvests of *Dipteryx* for charcoal in lieu of fossil fuels. As the threats to these ecologically valuable trees rise, it becomes increasingly more important to create a management plan to protect them from further exploitation. This study offered a plan for the management of *Dipteryx* in the native community of Infierno, a mixed-ethnic community of Ese'jea Indians and mestizos located along the lower Tambopata River in the Department of Madre de Dios, Peru. The study was part of a broader conservation project underway by the Applied Biodiversity Science program, and it aimed to separate the ecological and economic impacts of conservation. Landscape imagery and socio-economic surveys of individuals within two similar communities was proposed as an approach to effectively compare how management and its absence impact the conservation of *Dipteryx*.

**P-19-7: The Siberut Conservation Programme: Linking Animals, People and Their Environment to Help Safeguard an Island under Threat**

Muhammad Agil<sup>1</sup>, Marcel Quinten<sup>2</sup>, Keith Hodges<sup>1</sup>; *1. Bogor Agricultural University, Damarga, Indonesia, 2. German Primate Centre, Goettingen, Germany*

Largely due to its long period of separation from mainland Sumatra (at least 0.5 my), the Mentawai archipelago has evolved an unusually high degree of biological richness and species endemism. Forming part of the Sundaland Hotspot of Biodiversity, the Mentawai islands have been referred to as the Galapagos of Southeast Asia. Of mammal species, for example, at least 17 are endemic, most remarkable of which are the primates, representing 5 distinct species (Kloss's gibbon, two langur species and the Mentawai macaques), all of which are endangered and unique to the Mentawais. Of the 4 main islands comprising the archipelago, Siberut is the largest and most northerly, and although substantial areas of forest habitat still survive, it is under increasing threat from land conversion for agriculture and palm oil plantations as well as by illegal and legal logging activities. The Siberut Conservation Programme (SCP) was established in 2002 as a collaborative venture between the German Primate Centre and Bogor Agricultural University. Its aim is to combine field research and community-based conservation measures in order to contribute to the preservation of the remaining forest ecosystem in Northern Siberut. The programme's main focus is a 5500 ha area of primary rain and coastal swamp forest, currently protected on the basis of contracts with local clans and Indonesian officials. Fieldwork is carried out in an 11 km<sup>2</sup> core study area at the Pungut field research station, whereas community-based conservation activities are centred around the nearby village of Politcioman. In addition to conducting basic primatological research and the establishment of a conservation-relevant biological database, programme activities include community education, health and hygiene programmes, development of sustainable land-use practices, enhanced marketing of local agro-forestry products and the implementation of controlled eco-tourism.

**P-19-8: Options for the Biodiversity Conservation of Gunung Lumut Protection Forest East Kalimantan**

Tri Wira Yuwati<sup>1</sup>, San Afri Awang<sup>2</sup>, Petrus Gunarso<sup>1</sup>; *1. Forestry Research and Development Agency (FORDA), 2. faculty of Forestry Gadjah Mada University*

Gunung Lumut protection forest in East Kalimantan is the home of diverse flora and fauna. It is reported that many plant species were being endemic and new to science. Mushrooms and birds were also reported to have a high diversity. Nevertheless Gunung Lumut has facing problems due to forest fire, illegal logging, encroachment for settlements and agricultures and conversion to oil palm plantation. Limited or no alternative funding, a weak management design and no involvement of local people in the management are the causal factors. Protection forest with an important role to protect the area underneath and providing environmental service is no longer "protected". This paper presented options for the management of Gunung Lumut protection forest which ensure the conservation of its

biodiversity and at the same time providing alternative livelihood for local people. Key words: Gunung Lumut, East Kalimantan, protection forest, co-management, biodiversity conservation

**P-19-9: Animals Overhunted or Animals Hiding?**

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The most commonly used method to assess vertebrate populations in the tropics is visual sightings along line transects. Statistical models and software programs use these counts to derive measures of occupancy, abundance, diversity, density, biomass and population size. Managers use these measures to define conservation status and needs; ecologists use them to describe cascading effects of “defaunation”. Errors or biases that enter during data collection influence these derived applications. We assess the validity of using sighting counts to estimate vertebrate population parameters by comparing counts of sightings vs. sign encountered along stratified linear transect arrays for 255 species in 16 naturally vegetated areas of a 30,000 km<sup>2</sup> region of Amazonia. We walked a total of 13,216 km over 128 transects, 6,608 km for sightings and an equal number for sign over 12 to 20 months per site. For 6 ungulate species we recorded 6 to 70 times more sign than sightings, for 4 armadillo species from 84 to 166 times more sign, and similar trends for 3 out of 5 rodent, 6 out of 8 carnivores, and 6 out of 6 feral/domestic species. The relationship was reversed for 6 out of 7 primate species and for almost all bird, reptile and amphibian species. 25,000 sign data points were collected vs. 12,000 sightings; numbers were highly positively correlated for 11 of 12 of the most hunted animal species. Overall abundance and spatial distribution patterns for many species varied across heavily hunted, lightly hunted and un hunted sites depending if one examined the sign or sighting data; animals were not only present but abundant in areas where they would have been reported as rare or extinct based only on sighting data. The use of sighting data alone can thus result in gross underestimates of the presence, rarity and abundance of many species.

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