

**Abstracts**  
**of**  
**Talks and Posters**

## **Drill (*Mandrillus leucophaeus*) - Time to act: a review of current status and suggestions for future conservation action**

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Drill (*Mandrillus leucophaeus*) was identified by the IUCN/SCC Primate Specialist Group in 1996 as the African primate with the highest priority for conservation action, in recognition of its taxonomic distinctiveness, restricted distribution and degree of threat from hunting and habitat destruction. Currently however, conservation initiatives for the species are hindered by our poor understanding of drill ecology and its status in the wild. With the exception of more recent drill surveys in Bioko Island, Cameroon and Nigeria, no studies of drills in the wild have taken place since early 1970s. In the absence of such studies, our understanding of drill social structure and habitat requirements is based mainly on inferences from mandrill (*M. sphinx*) studies, the drill's sole congener. This presentation reviews our current understanding of drill ecology and status and suggests ways that researchers can contribute towards future conservation actions. Improving our natural history understanding of the species, managing drill hunting with dogs, empowering local conservation workers and raising local and international awareness of drills is the way, but success depends on coordinated action. The need of establishing a network of cooperation between the few field biologists working in drill habitat is discussed and a workshop on drill conservation is proposed. Finally, upcoming research on drills in Korup National Park is briefly presented.

## **Population genetic structure of the critically endangered Cross River gorilla (*Gorilla gorilla diehli*)**

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Diversity can be described at many different levels within the primate order. At the population level, examination of the distribution of genetic diversity can be instructive for determining patterns of population structure and subdivision. We used a suite of eleven autosomal microsatellite loci to investigate population structure in the critically endangered Cross River gorilla (*Gorilla gorilla diehli*). These gorillas are increasingly threatened by population and habitat fragmentation, inbreeding, reduced variability and lack of gene flow. However, the degree to which subpopulations are in fact isolated is unclear. Microsatellite data suggest that a complex population structure is present in the Cross River gorilla. Genetic structure is evident at two levels, possibly corresponding to older patterns of variation and more recent subdivision due to habitat loss and hunting. Though levels of gene flow between certain subpopulations are low, there is evidence that reproductive contact persists between many of the subpopulations. These results are encouraging for the conserva-

tion of the Cross River gorilla population, and highlight the resiliency of these animals to anthropogenic disturbance. Conservation efforts should strive to maintain connectivity between subpopulations that are still in migratory contact and attempt to restore connectivity where it has been lost.

### **Evolutionary genetics of primate coat colour: identifying how patterns of gene expression underlie diversity**

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Primates exhibit striking inter- and intra-specific diversity in coat colour, including sexual dichromatism (e.g. gibbons), conspicuous natal coats (e.g. colobines), and marked colour differences among closely related species (e.g. callithrichids, guenons, eulemurs). This variability in hair pigmentation is likely associated with several important aspects of primate behaviour and evolution, including speciation events, species-, kin- and individual- recognition, and the trade-offs between natural and sexual selection (concealment vs. signalling). Moreover, given that sub-species and population distinctions are often based on coat colour differences, understanding how changes in hair pigmentation can be flexible and/or constrained has important implications for primate taxonomy and conservation. To better understand the molecular basis of primate hair pigmentation, we are examining plucked hairs from a range of primates to identify where in the pigmentation pathway hairs of various colours diverge in their patterns of gene expression. We selected a set of eight candidate genes known to be involved in determining coat colour in mice, as well as two control genes, one expressed in all cells and one expressed in all pigment-producing cells. We are measuring and comparing (using quantitative reverse transcriptase PCR) the relative amounts of RNA specific for each of these genes in hair follicles of different colours (white, buff, red, brown, black) from numerous primate taxa. Preliminary data suggest, for example, that the patterns of gene expression underlying red vs. brunette hair in humans may differ from those underlying red hair in orangutans vs. black hair in chimpanzees.

### **Primates on paper: philatelic phylogeny and diversity**

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The general importance of biodiversity is appreciated by both scientists and the public, but how much awareness is there, amongst the public or governments, of the diversity of nonhuman primates (NHPs)? One measure of an increased awareness is the issue of dedicated postal stamp issues; even dedicated e-mailers can be stamp collectors. Moreover, such issues, if in source countries where snail mail may still

have an important role, can raise awareness of the variety and beauty of these countries' primate populations, and help conservation efforts, especially since NHPs can serve as flagship species of particular hot-spots. "Thematics", or, in the US, "topicals" is the philatelic term for collections of stamps, which, rather than being of a given part of the world, depict specific "themes" or "topics", such as trains, sports, or wildlife. How do NHPs fare? Since the first "monkey stamp", showing an orang-utan and issued by North Borneo in 1897, more than 1300 stamps with over 1500 clearly recognizable NHPs have been issued by some 128 countries; tellingly, more than half of these date from the last decade. Of the almost 500 WWF issues, which show all vertebrate classes, almost 5% are NHPs. More than half of the world's some 350 NHP species, and some subspecies, are represented. While the great apes feature on more than 30%, increasingly, even rarer species are shown, and on source country issues. The poster will demonstrate the history of NHPs on stamps, and show some key issues as well as some of my personal favourites.

### **Inferring demographic processes in threatened primate populations: from molecules to management**

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Sustainable conservation of threatened populations involves integrating knowledge of past events, current status and future projections (the so-called 'Orlog model' for conservation biology; Bowen and Roman 2005). Many primate populations have undergone major demographic declines in the recent past, are currently isolated and demographically unstable and their prognosis is bleak. The challenge for primatologists is to apply a combination of disciplines in an attempt to understand which factors have brought about the decline, investigate current population status and responses and to make realistic, model-based predictions for future demographic trends under a variety of scenarios. Molecular genetics is integral to this process, since we are now able to utilise increasingly sophisticated models to simulate past demographic events (population expansions and bottlenecks, admixture, drift), to detect genetic structure, measure gene-flow and assign individuals to populations using contemporary molecular data and to use these results as a basis for modelling the evolution of genetic diversity and structure in the future. The approach can assist evidence-based conservation measures and allow detailed management programs to be established which have enough flexibility to change according to future events with realistic levels of monitoring. I will illustrate the approach using primate populations we are studying in the Lower Kinabatangan Wildlife Sanctuary, Sabah, Malaysia, focusing on the Bornean orang-utan, which is a flagship conservation species for the region.

## **Chimpanzee (*Pan troglodytes verus*) conservation in Guinea Bissau: first steps to the development of the regional action plan**

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The two most threatened West African sub-species of chimpanzees are *Pan troglodytes vellerosus* (Nigerian chimpanzee) and *Pan troglodytes verus*. The main goal of this presentation is to describe the first steps to develop the Chimpanzee Regional Action Plan in Guinea Bissau. The project will culminate with the development of an eco-tourism programme ("conservation community based"). Although a more detailed study needs to be done, the survival status of the Guinean Bissau chimpanzee does not seem to be improving since our first field trip (2001). Forest incursions (2003 and 2005) were performed in the southern regions of Quinara and Tombali looking for chimpanzee traces. In Quinara there was a complete absence of fresh nests, especially on the SW side, the same region we visited two years before and where we had found fresh nests and traces. Severe forest destruction was visible; its causes are identified (e.g. cashew-nut tree plantations) and are discussed. Fresh chimpanzee nests were only found in Tombali region. In both regions several villages (n=21) were visited and a questionnaire was applied to gather several data (e.g. number of hunters per village, hunting motives, bushmeat routes, cultural perceptions of the chimpanzee according the religious and ethnic groups, etc.). There were hunters in all villages. Although the majority of the villagers were muslims, that did not confer any advantage for the protection of primates in general and chimpanzees in particular. The main routes of bushmeat and pet trade and a characterization of the demand in the country are presented, along with conservation solutions for chimpanzees and other species.

## **Orangutan long call diversity: a phylogenetic approach**

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The phylogenetic relationships among orangutans on Borneo and Sumatra are controversial, although - over the past twenty years - several studies have attempted to clarify orangutan systematics based on DNA sequences and karyological and morphological data. Surprisingly, few phylogenetic studies used data from wild orangutans of exactly known provenance. Furthermore, in most studies of systematics, data from huge geographic areas (e.g. Sumatra) were pooled in the analyses, thus ignoring possibly distinct subpopulations. The present study represents a new approach to orangutan systematics, using orangutan long calls. Long calls are species-specific vocalizations produced by many nonhuman primates, and data on their acoustical structures have been used to assess relationships among, and phylo-

genies of, several primate taxa. We analyzed 78 long calls from wild orangutans of five populations from Borneo and of five from Sumatra. Besides the chiefly paraphyletic topology of cladistic results, which do not conform nor reject a Borneo-Sumatra dichotomy, bootstrap values support three monophyletic groups (Northwest Borneo: 71-72 %, Northeast-East Borneo: 62-75 %, Ketambe: 75-79 %). Shortest trees and multivariate analyses provide some support for a closer relationship among Sumatran and certain Bornean populations than among particular Bornean populations themselves, indicating that conservation management should be based on orangutans from different populations rather than on just two island-specific groups.

### **Impact of bushmeat hunting on the fate of moist forest primates in Africa**

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The loss of tropical forest wildlife through the bushmeat trade is an even greater threat than deforestation. Most wild meat consumed by humans is derived from mammals, and a large proportion of this from primates. In moist forests in Africa, all primates are hunted. The consequence of this is that primate species, including the great apes, are under increasing threat because of hunting. Resolution of this problem is complex, because of linkages between socio-economics, food security and poverty issues that lead consumers and hunters to depend on hunted species. In this paper, I review patterns of primate harvests and other mammals in African tropical moist forests from published and new field studies. Using these data, I will assess sustainability and predict extinction trends for all species. Recommendations for the conservation of primate species in African moist forests will be discussed in the context of human and wildlife needs.

### **The fossil record of primate diversity**

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The diversity in the Order Primates that we see today is but a thin veneer of an evolutionary history that extends back tens of millions of years. However, our ability to reconstruct the diversity of primates in the past is limited by the nature of the fossil record, which is a tiny sample of life in the past. Because the fossil record is limited and biased in its sampling of time, space and body parts, any effort to reconstruct past diversity is a gross underestimate and extremely speculative. Despite its limits, the fossil record demonstrates many ways in which present diversity is restricted compared with that of earlier time periods. In earlier epochs, primates as a group had a much greater geographic distribution than today, with widespread distributions in Europe and North America as well as reaching higher latitudes in South

America and Asia. Similarly, many living genera had larger geographic ranges in the past. The number of primate species alive today is much smaller than that known from the fossil record and a tiny fraction of the primate species that have ever lived. Moreover, the families of living primates are a small subset of primate families known from the fossil record. The fossil record provides many examples of primates that were larger or smaller than any extant species. Most notable is the presence of much larger primates on all continents until very recently. Although communities are nearly impossible to identify in the fossil record, it is clear that assemblages of extinct primates were striking different in taxonomic composition and patterns of adaptive diversity than extant communities.

### **A new sex identification tool: one primer pair can reliably sex ape and monkey DNA samples**

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Within the fields of molecular ecology and conservation genetics, the development of the optimal molecular sex marker is of great interest, especially methods that work across many species. Molecular sex identification is an essential tool for determining the social structure of endangered primates. There is an increasing need for identifying the sex of unhabituated primates from small amounts of non-invasive samples that are likely to include highly degraded DNA. Molecular sexing of mammals is normally done by PCR amplification of Y chromosomal fragments or co-amplification of homologous fragments from both sex chromosomes. However, existing primers are often unreliable for distantly related species due to mutations in primer regions and amplified fragments are often too long to be useful with degraded DNA. Hence, the optimal molecular sexing marker should 1) amplify diagnostic products in one step, so as to be fast and cheap; 2) produce at least one product that exists in both sexes (internal positive control); 3) amplify small products (100-300 bp); 4) amplify products that differ substantially in length (15-30 bp), to avoid ambiguity and allow quick detection on agarose gels; 5) be diagnostic in a range of primate species. We developed a marker that fulfils these requirements. Multiple alignment of distantly related mammalian species from Genbank and genome databases enabled us to identify conserved regions in the DEAD box gene. Using these conserved regions, we can target species for which we have no sequence information. We designed a single, conserved primer pair, which is useful for fast and reliable molecular sexing of humans, apes and monkeys. A single PCR yields two short fragments in males and only one in females (X 180 bp, Y 209 bp), which are easily separated using agarose gels. Amplification of separable fragments was successful in all 13 primate species tested.

## Genetic diversity of the endemic Malagasy genus *Cheirogaleus*

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Madagascar is one of the top global biodiversity hotspots with extremely high endemism rates for both flora and fauna. Surprisingly, the diversity of the endemic primates is still not completely known. Especially within small and nocturnal taxa a number of new species have been described recently. In this project we characterize the genetic diversity within the genus *Cheirogaleus*, small (130-600g) nocturnal lemurs distributed throughout the dry and moist forests of Madagascar. We use multiple genetic markers to obtain information about phylogenetic relationships of the sampled populations. In conjunction with locational data we will reconstruct the biogeography of this genus. A mitochondrial marker (cytochrome *b*) and single nucleotide polymorphisms (SNPs) on the Y chromosome provide information about female-mediated and male-mediated gene flow, respectively. Here we present preliminary data, including phylogenetic reconstructions based on cytochrome *b* sequences of the populations sampled up to date and the present state of the establishment of SNPs on the Y chromosome.

## Islands, rivers, and primates

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The category "species" is basic to all biological work. When discussing any group of organisms, in any context (be it behaviour, ecology, biogeography, or conservation), one has to refer to "species", and it is therefore essential that we are all using the term in the same way. For this, we need an operational definition, so that we can recognise the same set of species as far as the evidence allows. In effect, we are saying, a species is "a lineage with its own evolutionary role" (Evolutionary Species Concept), but how best to operationalise this? The four major concepts of species in use today are the Biological, Recognition, Genetic and Phylogenetic species concepts: BSC, RSC, GSC, PSC. The BSC asks whether they interbreed. The RSC asks how they identify potential mates. The GSC asks "how much difference is there?" The much misunderstood PSC asks "what difference is there?" I argue that only the fourth of these, the PSC, answers to the requirements of maximum repeatability and objectivity. Allopatric speciation is uncontroversial; are there other mechanisms that might generate new species too? We cannot exclude area-effect, stasipatric and even sympatric speciation; and speciation by hybridisation seems increasingly likely to be an important mode in Primates and other mammals.

## **Tools for understanding mammalian biodiversity: using the past and present to predict the future**

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Biodiversity is being lost at an unprecedented rate in human history. Critical information, such as which attributes predispose species to extinction processes, or to become invasive and cause extinctions, is largely missing. This is not surprising as modelling these systems requires the compilation of widely dispersed data on species biological characteristics, past evolutionary histories, current distributions, ecological and climate tolerances and the impact of anthropogenic change. More effective data compilation and modelling is crucial in order to facilitate proactive conservation efforts to minimize biodiversity loss and to understand the impacts on human health and ecosystem services. Mammals are perhaps the best studied vertebrate clade and provide a good candidate group for developing these biodiversity loss models. Here I review the current progress in building mammalian forecasting models by firstly exploring the tools and methodologies needed to generate the required information on species' past evolutionary histories, their biological and ecological characteristics and current distributions. I then review the currently available mammalian data and explore the methodologies required to build models of biodiversity loss to forecast and predict future loss.

## **Environmental and historical effects on primate community structure**

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Researchers often examine the factors shaping community structure from an ecological or historical context. Environmental characteristics shape the possible niches in a community, providing suitable habitats to some species and not others. Therefore, communities exhibiting similar environmental characteristics are more likely to display a more similar species composition. Additionally, as the geographic distance between communities increases, dispersal between sites is more limited and the probability of historical vicariance increases. Therefore, communities in close proximity to each other are likely to display a similar composition of species. The objective of this study was to simultaneously examine the relative effects of environmental and historical effects on primate communities in the Neotropics, Asia, Africa and Madagascar. Data for over 70 primate communities were gathered from the published literature. Partial Mantel tests were conducted to examine the relative effects of geographic distance and environmental similarity on community structure. The analyses showed that in the Neotropics and Asia there was a significant negative correlation between geographic distance and community similarity when controlling for environmental similarity. There was no environmental effect

for these continents. In contrast, in Africa and Madagascar, there was a significant positive relationship between environmental similarity and community similarity while holding geographic distance constant. There was no effect of geographic distance in these regions. These results will be discussed in the context of the evolutionary and geologic history of primates and their areas of endemism.

### **Invasive callitrichids: threatening the diversity or improving the survival of new generalists in anthropogenic landscapes?**

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In the last decades *Callithrix jacchus* from northeastern Brazil has been introduced into various regions, all the way down to the Southeast of Brazil. This callitrichid species is highly adaptive and competitive as new populations seem to be remarkably persistent and proliferating in all localities where they have been introduced. *C. jacchus* as an invasive species may generate threats to primate diversity due to hybridization with natural populations of endangered autochthonous species (*C. aurita*), displacing and / or threatening small populations of reintroduced species as a consequence of direct interference resource competition (*Leontopithecus* spp.), or introducing new diseases into small populations, that are already threatened by consequences of habitat fragmentation. Studies on the degree of hybridization and genetic introgression, on competitive abilities, the invasive potential as well as on ecological threats for the local fauna should lead to management actions in order to minimize the risk for autochthonous species. On the other hand the effect of callitrichid diversity loss, as well as the reduction of susceptibility to anthropogenic habitat alterations by hybridization with more adaptive species should be discussed. Control and eradication measurements, as suggested in the convention on biological diversity, will obtain limited popular acceptance and are already controversially discussed within local and scientific communities.

### **A model of spider monkey behavioural ecology**

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An animal can only survive in a given habitat if it has enough time to find, process and digest food whilst avoiding predation. The time it has for food acquisition is affected by the vegetation and competition with conspecifics, which depends on aggregation tendencies. We used the relationships between time allocations, on the one hand, and climatic variables (as a proxy for habitat quality) and group size, on the other, to develop a model that predicts maximum ecologically tolerable group size at different locations for spider monkeys. Spider monkeys are particularly inter-

esting because the social communities often split up into small units. Temperature variation and rainfall variation were the main determinants of time budgets. Community size and average annual rainfall determined party size. The model correctly predicted presence or absence of spider monkeys at 78-83 % of 213 New World forest sites. Within the geographical range of the species, this time-budget model predicted the presence of spider monkeys better than a model based directly on climate variables. Predicted community and party sizes were significantly larger at sites where spider monkeys are present than at sites where they are absent (medians 66 and 0 resp.). As required by the model, predicted maximum community sizes were significantly larger than observed community sizes. Only moving time was influenced by community size and this effect was relatively small, suggesting that the fission-fusion tendencies of spider monkeys successfully reduce feeding competition.

### **Coexistence of three species of Cheirogaleidae in a littoral forest in southeastern Madagascar**

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Madagascar is known for its extraordinary diversity of lemur species. Mechanisms that allow the coexistence of these species are still poorly known. Morphological, ecological and behavioural factors, which might contribute to reduced competition were studied in three species of Cheirogaleidae (*Microcebus murinus* [body mass: 70 g], *Cheirogaleus medius* [body mass: 180 g] and *Cheirogaleus major* [body mass 360 g]) in a littoral forest in southeastern Madagascar. During three rainy seasons we compared home range size, feeding behaviour and sleeping site selection of these three lemurs species. All three species used tree holes for sleeping, sometimes in the same trees. Home ranges did overlap completely, but showed differences in sizes: Home ranges of small lemurs were smaller than home ranges of bigger lemurs. All species preferred fruits for feeding. There were no differences in morphological or biochemical fruit parameters between the species. Differences were found in the vertical dimension of forest use. *Cheirogaleus major* used the upper part of the trees for feeding, resting, sleeping and travelling. *Cheirogaleus medius* used the middle part of trees and *Microcebus murinus* the lower parts.

### **Primate biogeography and its application in diversity studies**

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Biodiversity represents the complex interaction of phylogeny, ecology, and geography as determinants of organismal evolution and distribution. Biogeography is the study of the distribution and diversity of organisms in space and time. Accordingly, researchers seeking to answer biodiversity and biogeographic questions share

a strong interest in determining the best organismal unit for study. In this talk, I will discuss applications of various biogeographic models and units to studies of primate diversity, statistical issues with data autocorrelation, and suggestions for future studies. Traditionally, the units of primate biogeography have been biological species. Thus, primate diversity has been linked to variations in habitat size, range size, rainfall, latitude, and rates of cladogenesis. Use of other units, such as evolutionary significant units, and biogeographic methods, such as phylogenetic diversity, can result in different patterns of primate diversity. Some researchers have suggested that unit selection is dynamic and that taxa should be treated as research guides. However, all diversity datasets require tests and controls for phylogenetic and spatial autocorrelation. Phylogenetic autocorrelation refers to the pattern of non-independence of data among closely related taxa. Spatial autocorrelation is the pattern in which observations from nearby locations are more likely to have similar magnitude than by chance alone. Both patterns violate assumptions inherent in many parametric inferential tests. Finally, I suggest that researchers should utilize dynamic landscape models that integrate spatial processes (e.g., forest fragmentation) and patterns (e.g., primate responses to edge effects).

### **Time budgets and biogeography of African apes: a window to the past and the future**

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In order for a species to survive in a given habitat, it is crucial that each member of the group is able to meet its daily energetic requirements during a day. Energetic requirements, however, are not only influenced by climate but also by group size. In this study we use time budget models to analyse the relationship between climate, group size and time budgets in chimpanzees and gorillas. Such models enable us to identify key variables limiting the biogeographical distribution of a species and allow us further to explore the environmental constraints faced by apes in the past or future. Our models demonstrate that chimpanzee as well as gorilla distribution are highly dependent on rainfall pattern. According to our models, the suitable habitats for both species extend beyond their present distribution; however, geographical barriers may have prevented the apes from living there. We further show that while gorilla time budgets are strongly influenced by dietary variables, chimpanzees are more affected by the costs of sociality. These costs, however, can effectively be reduced by assuming a fission-fusion type of social systems, in which the group regularly splits into much smaller subgroups. This enables chimpanzees to live in habitats which would otherwise be inaccessible to them. Our findings enhance our understanding of the relationships between ecology and sociality in African Apes and have further implications about biogeography and the evolution social systems.

## **Primate abundance, hunting, and the bushmeat trade in and around Korup National Park, Cameroon**

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Korup National Park (KNP) in southwestern Cameroon, long recognized for high species richness, diversity, and endemism, is home to eight anthropoid primate species. Though designated a national park in 1986, market hunting remains widespread in Korup and may be the most significant factor influencing primate abundance in these forests. Ten line-transects, located near the town of Mundemba (park headquarters), the park village of Ikenge, and Bajo, a village on the periphery of KNP, were surveyed for primates and signs of human activity from October 2004 - June 2005. These transect sites were selected because wildlife surveys had previously been conducted in these areas. Surveys of primate bushmeat were also conducted in Mundemba, Ikenge, and Tombe/Banyu, located on the periphery of the park. Preliminary results indicate that a) primate abundance in the Korup area is low relative to other censused Cameroonian forests, b) although hunting remains widespread, transects vary in their degree of hunting pressure, and c) *Cercopithecus nictitans*, *C. mona*, and *Procolobus pennantii* comprise the top three species of primate bushmeat found in Mundemba and Ikenge. Compared to abundance estimates from previous surveys, results from this study suggest that a) *C. nictitans* remains the most frequently encountered primate species in all three transect sites, b) in the Bajo area, encounter rates for all monkey species, except *C. pogonias*, have declined considerably, with no visual or auditory evidence for the presence of the three largest monkeys (*Mandrillus leucophaeus*, *P. pennantii*, and *Cercocebus torquatus*), and c) *P. pennantii* and *M. leucophaeus* may be declining across transect sites.

## **Fast method to evaluate the security of a zoo primate enclosure**

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Directive 1999/22/EC establishes that Member States shall adopt measures for licensing and inspection of existing and new zoos in order to ensure, inter alia, the accommodation of their animals under conditions which aim to prevent escapes and, therefore, to avoid possible ecological threats to indigenous species. This legal obligation introduces the need to develop evaluation methods in order to ensure that the requirement of housing the animals in safe enclosures is accomplished. Here, we present a fast and reliable method to evaluate the security of a zoo primate enclosure. The proposed method is based on the simultaneous quantification of three complementary items for each enclosure (which include the existence of a physical barrier that does not allow the escape of the animals, the possible existence of physical contact between the public and the animals and the chance that the animals can be

released by the public) and it can easily be applied by a trained but not necessarily specialized observer. Such a method allows its utilization in a self-evaluating process, an on-site inspection or a peer review. With the aim to appraise its effectiveness, we have evaluated 284 enclosures for primates belonging to 48 zoos (which represents 100 % of the primate enclosures in Spanish zoos). The evaluation was done by three trained observers from September 2003 until April 2004. The results reveal an enclosure security index of 84 %, far below the expected 100 %. The possibility that the public can establish physical contact with the animals is the variable that obtained the worst result.

### **Species-specificity in loud calls of sportive lemurs from northwestern and northern Madagascar**

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Nocturnal primates are often difficult to distinguish by size, colour and other body characteristics. As a consequence, species diagnosis is extremely difficult. Bioacoustical studies on bushbabies have shown that social calls can be reliably used as a vocal fingerprint to discriminate sister species. To date it is not known whether this method works in the nocturnal, phenotypically similar sportive lemurs of Madagascar. The purpose of this study was therefore to compare loud calls of sportive lemurs in northwestern and northern Madagascar in order to define characters that are informative for species discrimination. The field work was conducted at six different localities, along a gradient from northwestern to northern Madagascar (Ambohimanga, Ampijoroa, Lokobe, Manehoko, Ankarana and Analamera), covering the distribution range of three known species from which we also have genetic data. Based on spectrographic and multidimensional acoustic analyses, we found that populations from all six localities share at least three distinct call types. These shared call types, however, showed prominent differences on the basis of their acoustic structure between the three species, separated by major rivers. Moreover we detected unique call types for each of these species. Altogether these bioacoustic results coincide well with those of a parallel mt-DNA study supporting species status for the respective populations. The results indicate that loud calls in particular represent a useful non-invasive tool for species diagnosis and for the monitoring of species diversity of sportive lemurs in the field.

### **Primate conservation in the 21<sup>st</sup> century – a global overview**

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Over the past two decades, wild primates have declined dramatically with the ongoing and rapid devastation of their forests, through logging and conversion to agri-

cultural land. Hunting at unprecedented scales, both subsistence and commercial, is decimating primate populations most particularly in the Congo and the forests of West Africa and Southeast Asia. Concern over the possibility of losing species before they are even described has resulted in renewed efforts to document primate diversity properly. Through careful taxonomic and systematic revisions and field expeditions, the number of primate species and subspecies has increased considerably over recent years. More than 40 new primates have been described since 1990, largely from the Neotropics, but genetic studies and the exploration of remote forests in Madagascar and SE Asia is also resulting in a number of new species. Today the IUCN/SSC Primate Specialist Group is recognizing more than 350 species and over 630 taxa. At the same time, efforts are underway to update our knowledge of conservation status and to generate new and more comprehensive actions on behalf of those most under threat. The 2000 IUCN Red List of Threatened Species recorded 27 % (166) of all primates as 'Critically Endangered' and 'Endangered', and overall 42 % (261 species and subspecies) as 'Threatened'. However, ongoing recent assessments, carried out as part of the IUCN Global Mammal Assessment, are in the process of increasing this number, and the latest results are presented. This decade is clearly a crucial bottleneck, which will demand major conservation efforts if we are to avoid the extinction of numerous species and subspecies. This presentation reviews our current knowledge of primate diversity, presents an update on conservation status, discusses the role of various primate conservation activities, especially those carried out under the Primate Specialist Group of the IUCN's Species Survival Commission, and touches on the issue of how to increase the scale of funding and conservation impact in key primate "hotspots" (e.g., Madagascar, the Atlantic Forest region of Brazil, SE Asia) and other priority areas for these animals.

### **Diversity of intestinal parasite communities in sympatric New World monkeys (*Saguinus mystax*, *Saguinus fuscicollis*, *Callicebus cupreus*)**

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Wild primates can harbour a great variety of parasites. Parasites receive increasing attention: On the one hand with respect to their negative impact on primate populations, and on the other hand because they may be important factors in maintaining genetic diversity within host species and species diversity in communities. In this study we focus on the helminth diversity and on seasonal changes of parasite emission of three species of sympatric New World primate. We collected faecal samples from 47 individuals from three mixed species groups of *Saguinus mystax* and *Saguinus fuscicollis*, and from two groups of *Callicebus cupreus* at regular intervals over a 15-months period. We explored host-specific factors influencing parasite species richness by collecting data on activity patterns, feeding and ranging, and by measuring different habitat characteristics. In 430 faecal samples from all individu-

als, we found propagules of seven different parasite taxa: eggs of one Acanthocephala (*Prosthenorchis elegans*), of two Cestodes, of three Nematodes (two morpho-species of Spiruroidea, one Rhabditean nematode) and Nematode larvae. All three host species differ significantly in parasite species richness. The prevalence of some parasite taxa of the tamarins varies both between species and between groups. The difference in parasite diversity and prevalence suggests that niche differences between the three primate species (food composition and micro-habitat use) as well as habitat factors in their respective home ranges may play a role for the composition of parasite communities. These results provide a basis for further studies on the interaction between parasites and primates, and on the role of ecological and life-history factors for primate parasite diversity.

### **Molecular studies of *Alouatta belzebul*: Analyses of population structure in different years**

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Population analyses were carried out in *Alouatta belzebul*, an interesting Neotropical primate species endemic to Brazil, distributed in Pará, Amapá, Maranhão, Pernambuco, Paraíba and Alagoas states. This species is found in two biomes, the forests of the Amazonian basin and part of the Atlantic coast. We analysed two samples from Pará state collected at two periods separated by a 14 year interval, one in 1984 during a rescue operation at the Tucuruí Hydroelectric dam reservoir (PA-1984) comprising 45 animals, and another, in 1998 (PA-1998), comprising 15 animals, six of which collected in "base 4" and nine in "Germoplasma". We also analysed a single sample of four animals from Paraíba (PB). Molecular and population analyses were based with the complete DNA sequence data of the mitochondrial gene cytochrome *b*, comprising 1,140bp. In the PA-1984 sample, 23 haplotypes were identified, 12 of which shared by more than one specimen while, in PA-1998, 11 haplotypes were identified; two of them being shared by more than one specimen. Animals from PA-1984 and PA-1998 shared three haplotypes, while the only haplotype of the PB sample was not present in the samples from Pará. Genetic distance estimates between all *A. belzebul* haplotypes varied between 0 to 1,2 %. Maximum parsimony analysis, median-joining, split decomposition and AMOVA were coincident in showing lack of geographic structure between the PA and PB samples, as well as lack of temporal structure between PA-1984 and PA-1998. Mismatch distribution analysis suggested that the PA-1984 sample had undergone a population expansion process, and that PA-1998 was in equilibrium. *A. belzebul* showed different genetic characteristics from the previously studied congeneric species *A. caraya* that showed a population structure as function of its geographic distribution, suggesting a lower gene flow and genetic variability. This study also suggested that the Atlantic and the Amazonian Forests were once connected at a non-distant past, and that the Caatinga is a recently formed vegetal formation.

## **Infectious disease and primate diversity: past, present and future**

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Biotic interactions involving hosts and parasites have been proposed to increase biological diversity over evolutionary time. Parasites can also reduce the diversity of extant host populations through negative impacts on host fitness. Thus, parasites represent a rising concern in conservation biology, with the potential for both positive and negative impacts on host diversity. To investigate the factors that drive global patterns of parasitism and disease risk in primates, I developed a bioinformatics database on infectious diseases that covers 475 mammalian host species and over 1,400 parasites and pathogens. Unprecedented in size and taxonomic scope, this geo-referenced dataset captures more than 18,000 host-parasite records spanning macroparasites (helminths and arthropods) and microparasites (protozoa, viruses, bacteria, and fungi). Using the data on nonhuman primates, comparative analyses revealed that more rapidly radiating primate lineages harbor a larger number of parasites. Further comparative tests found that increased sympatry among primate host species leads to greater parasite richness, possibly through sharing of similar parasite communities among closely related primate species. In addition, smaller geographic ranges and increases in host threat status correlate with lower parasite richness, which is consistent with the hypothesis that parasites go extinct as host populations decline in size. These results underscore the fundamental links between disease ecology and global patterns of host and parasite diversity. I conclude by showing how future disease threats to primates can be assessed using a combination of individual-based models, geographic information systems (GIS) and phylogeny-based comparative tests.

## **African Primate diversity: influenced by deep roots, dry soil, and people**

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Diversity in an animal group can be described in many ways, so that measures of diversity vary depending on the perspective adopted. Although a recent study (Grubb et al., 2003) recognized only 176 subspecies and monophyletic species of primates in Africa (excluding Madagascar) compared with 210 in the Americas and 183 in Asia, Africa may be considered as having high primate diversity in other ways, including higher-level taxonomy, ecology (such as the range of habitats occupied), and body size and form. Africa has two primate suborders, 4-6 families (depending on the classification followed), and 21-24 genera. If the concept of "zoogeographical species" or "geospecies" (Eck, 1996) is employed, Africa has 33 geospecies, compared with 25 in Madagascar, 18 in the Americas and 16 in Asia. I examine some possible reasons

for low levels of shallow diversity and high levels of deep diversity among African primates, including the ancient history of the order in Africa, the historical prevalence of dry climate on the continent, the continent's physical geography, and the distribution pattern of its vegetation. Africa's primate fauna has relatively few endangered forms compared to other regions, perhaps in part because humans have long been a part of the environment, and in part because of the prevalence of ecological generalists produced by Africa's environmental history; some forest specialists are seriously threatened, however.

**Diversity and conservation status of mouse lemurs (*Microcebus* spp.) and sportive lemurs (*Lepilemur* spp.), including the description of five new species, in northern and northwestern Madagascar**

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The number of recognized *Microcebus* and *Lepilemur* species has greatly increased during the last 15 years. Long-term studies and new methodological tools, such as DNA sequencing, have made it possible to differentiate among these cryptic nocturnal lemurs. However, the distribution range of many of these species is still unclear, and therefore their protection status hard to determine. We visited 27 forest fragments, varying in vegetation type, size and degree of human disturbance in northern and northwestern Madagascar. Most of them are unprotected and had never been investigated by researchers before. In each site, we captured between 3 and 59 individuals of the genus *Microcebus* and *Lepilemur* and took tissue samples, as well as 13 morphometric measures. The sequences of 3 mitochondrial loci (for *Microcebus*: complete d-loop, part of *cyt b* and part of the COII; for *Lepilemur*: complete d-loop, part of *cytB* and part of the ND4) allowed us to reconstruct the phylogenetic relationships in comparison to already described species. By integrating spatial, morphometric and genetic data, we determined the fine-scale distribution ranges of eight *Microcebus* and seven *Lepilemur* species inhabiting this part of the island. Three of the *Microcebus* and two of the *Lepilemur* species were previously undescribed. A comparative analysis revealed that five out of seven large rivers act as geographical barriers for gene flow in both genera. The sixth one is only a barrier for *Microcebus* and the seventh separates at least *Lepilemur*. Since distribution ranges of species are fairly limited and human pressure is omnipresent across localities, we recommend particular protection strategies for these highly endangered small primates.

**Phylogenetic relationships of primate genera**

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With at least 66 genera and about 350 species, the order Primates is one of the most diverse mammalian orders. Even though the phylogenetic relationships among major lineages are elucidated, those within families are still disputed. However, knowledge about phylogenetic relationships is of prime importance for comparative research and forms a platform to explain the development, formation and coherences of different phenotypes, social systems or diseases. Early molecular phylogenies were based on comparative studies using chromosomal, protein or DNA data. Recently SINE (Short INterspersed Element) integrations were also introduced in molecular phylogenetics and proofed to be powerful cladistic markers. The integration of a SINE at a new locus is generally thought to be unidirectional and precise excision, homoplasy or character conflicts are highly unlikely. As a result of these features, SINE integrations represent a powerful molecular tool for systematic biologists to reconstruct phylogenies and have helped to definitively clarify many evolutionary issues in vertebrate groups. We review the current status of SINE-based primate phylogenies.

### **What does the future hold for the Barbary macaque (*Macaca sylvanus*) in Algeria?**

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Until the early 20<sup>th</sup> century, the Barbary macaque colonized all of northern Africa. Over the course of time, its range has continually decreased and is currently restricted to six separated regions in Morocco and Algeria; an additional population is found on Gibraltar. An investigation of the distribution of Barbary macaque populations throughout Algeria revealed the following information: (1) re-colonization of a region, in which Barbary macaques had disappeared decades ago. This region (Djebel Bouzega) consists primarily of cork oak forests, interspersed with pistacio thickets and shrubs. The group observed in this area consisted of about 30 individuals. The future of this population is uncertain, however, because of several quarries are being established nearby. (2) observation of many (about 20) solitary young adult animals living in orchards. This "migration" took place in March 2005, perhaps in response to a cold spell in the region. We will continue to study the circumstances of this migration in more detail. (3) expansion of existing territories, for example into degraded "maccia" with water sources, which effectively increased the population size at this site. The future of the Barbary macaque in Algeria depends on a better monitoring of its populations. The creation of a distribution map and the application of new observation techniques are desirable.

## **The effect of hyaluronidase and trypsin enzymes on liquefaction of semen in capuchin monkey (*Cebus apella*)**

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The effect of the enzymes hyaluronidase and trypsin were recorded on the viscosity, motility, vigour and acrosome integrity in the semen of capuchin monkey (*Cebus apella*). The animals (n=6) were maintained at Fundação Parque Zoológico de São Paulo. Under anaesthesia semen samples were collected by electroejaculation. Immediately after the ejaculation, the semen liquid fraction was analyzed for volume (ml), pH, motility (%), vigour (0-5), concentration (cells/ml), defects (%) and percentage of intact acrosome (%). The coagulated fraction was treated with a solution of hyaluronidase or trypsin, 1mg/ml in commercial medium (199-Nutricell, Brazil) in a proportion of 1:4 and the samples were examined after 5 and 15 minutes. The Student T-Test was used to compare the treatments. There was no significant difference in the motility, vigour or acrosome integrity ( $p > 0.05$ ) between coagulated fraction diluted either in trypsin or in hyaluronidase, after 5 or 15 minutes. However, there was significant difference in motility and vigour between liquid and coagulated fraction, after 15 minutes, for both treatments ( $p < 0.05$ ), but there were no difference in acrosome integrity ( $p > 0.05$ ). In conclusion, there were no apparent effects in the coagulum for both treatments regarding motility, vigour and acrosome integrity. There were significant differences between liquid and coagulated fractions regarding motility and vigour, but not for acrosome integrity. In both enzyme treatments there were no complete dissolution of the coagulum.

## **Seminal analyses in captive capuchin monkey (*Cebus apella*) before and after bilateral vasectomy**

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The effects of bilateral vasectomy on the seminal characteristics were assessed in capuchin monkeys (*Cebus apella*). Six adult male monkeys were housed separately in outdoor pens at the Fundação Parque Zoológico de São Paulo. Semen samples were collected by electroejaculation, under general anaesthesia, 15 days before and monthly for 5 months after vasectomy. Immediately after the ejaculation, semen was analyzed for volume (ml), motility (%), vigour (0-5) and concentration (cells/ml). Before bilateral vasectomy the mean/SEM of volume, motility and vigour was  $0.7 \pm 0.1$ ;  $71.7 \pm 7.9$  and  $3.5 \pm 0.6$ , respectively. The concentration was calculated only for four males because we could not get enough semen from one individual. In addition the mean/SEM of cells/ml before the vasectomy was  $2.8 \pm 1.3 \times 10^6/\text{ml}$  and

after the first two months it was  $4.7 \pm 1.6 \times 10^6/\text{ml}$  and  $0.8 \pm 0.7 \times 10^6/\text{ml}$ , respectively. Only after the third month the number of cells/ml became zero. One month after the vasectomy we found only immobile spermatozoa in all animals. The mean/SEM semen volumes obtained from the first to the fifth month after vasectomy were  $0.3 \pm 0.2$ ;  $0.3 \pm 1.8$ ;  $0.1 \pm 0.0$ ;  $0.5 \pm 0.3$  and  $0.05 \pm 0.0$ , respectively. Our results suggest that the vasectomised males may remain potentially fertile up to 90 days after the vasectomy.

## **Primate assemblage structure in the new world tropics: from macroecology to extinction risk**

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I investigate the continental scale patterns of platyrrhine primate distribution and abundance from southern Mexico to northern Argentina, but focus on a large network of sampling sites surveyed over two decades in lowland Amazonia and the Guianan Shields. Macroecological patterns at different spatial scales are examined in terms of the historical and environmental determinants of habitat patch occupancy, local species diversity and co-existence, and geographic range size and overlap. Patterns of abundance in structurally undisturbed forest sites are examined in terms of key determinants of population densities, including forest type, forest hydrology, soil fertility and levels of hunting pressure. I show that neotropical primate assemblages are highly non-random in space, and that key species life history traits can predict the likelihood of local extinction events driven by different scales of habitat disturbance and/or direct exploitation.

## **Are pottos and bushbabies social primates?**

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Frequent revisions of the African strepsirrhines, has led to a proliferation of names for genera and species. However, there is still some controversy as to whether particular populations represent distinct subspecies or previously unrecognised species. This is true of the potto, which in spite of a vast range spanning much of equatorial Africa is still classed as one species (three subspecies) within the genus *Perodicticus*. Allen's bushbaby, formerly considered a monotypic genus, is now categorized into three species (Genus *Sciurocheirus*). This poster compares the social organization of the Central potto (*Perodicticus potto edwardsi*) and Cross River Allen's bushbaby (*Sciurocheirus cameronensis*) in Cameroon. An analysis of association patterns and home-range overlaps between animals revealed both species associated more frequently with conspecifics than expected for supposedly solitary pri-

mates. Certain male and female pottos that were seen together regularly throughout the study, but were not observed to have contact with other pottos of the opposite sex, were labelled as "pairs". These pairs were found to have higher levels of association with each other than with other conspecifics. The only affiliative and sexual behaviours observed between members of the opposite sex occurred within the pairs of pottos. Female Allen's bushbabies tended to form sleeping groups and possessed highly overlapping ranges that were overlapped by one male. Both these loriform primates live in dispersed social networks in which individuals may sleep together during the day, while tending to forage alone during the night.

### **Lorisoid phylogeny as revealed by morphological and molecular data**

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Though several studies were conducted on Afro-Asian Lorisioidea, the phylogeny of this taxon is a highly controversial. While postcranial data appear to attest without doubt to the monophyly of the Lorisidae, molecular analyses consistently portray them as paraphyletic, with the Galagidae variously placed as the sister taxon to the Asian or to the African lorises. One of the major problems that has bedevilled phylogenetic analyses of this group in the past, has been the limited number of taxa sampled for both ingroup families. In this contribution we present the results of a series of phylogenetic analyses based on 36 craniodental characters and 640 base pairs from two mitochondrial genes (12S and 16S ribosomal rRNA) representing 11 galagid species and 5 lorisid species. We used the gray mouse lemur, *Microcebus murinus*, as an outgroup. Analyses were performed on morphological and molecular data sets independently, as well as in combination. For the molecular data sets, independent and combined analyses were conducted using maximum parsimony, maximum likelihood and Bayesian analyses. The strongest clade, supported throughout our study, is the genus *Galago*, while *Galagoides* only has coherence using combined data. Our study do not provide support for the paraphyly argument: this hypothesis would require that many lorisid synapomorphies should have to be gained and then lost again during the evolution of this taxa. Finally, these results suggest, as a recommendation, to retain three genera (*Galago*, *Otolemur* and *Galagoides*) until we have additional data.

### **Adaptive radiations on continents: patterns in birds**

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There are strong correlates of primary productivity (plant biomass produced per year) with the numbers of animal species found in a locality. One explanation for

this is that in a highly productive environment unusual resources are sufficiently abundant for a species specializing on those resources to persist (i.e. there are more available 'niches'). In addition to productivity, at lower latitudes in particular, topographical diversity is correlated with species diversity. Such environmental controls on the number of species should also be controls on the rate at which species are produced. I investigate this idea using birds as a model system. Based on molecular phylogenies, a pattern of slowdown in diversification rate is observed within many genera of birds, and I suggest that this reflects ecological niche space becoming increasingly filled. The actual mechanism whereby speciation slows down is likely to be through limits on range expansions. Range expansions are seen as an essential first step in speciation because they enable further rounds of population differentiation. The most favourable situation for range expansions is in a resource-rich competitor-free environment, where inefficiently utilized or unutilized resources are available. As an environment fills up with species it becomes more difficult for new populations to become established and persist for long enough to differentiate to the level of full species. I apply these principles to the extraordinarily rich South American avifauna, which is attributable to much diversification over the last 12.5 million years. Much recent speciation has happened in the Andes, where species exploit habitats likely to have been created along with the relatively recent rise of these mountains, and ranges are easily fragmented.

### **Taxonomic revision of gentle lemur (*Haplemur griseus*) a Malagasy endemic primate, based on cytogenetics and molecular data**

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We conducted a comparative study of the cytogenetics, mitochondrial DNA and morphology of *Haplemur griseus* captured in the eastern forest from Andilamena to Andohahela and in the northern forest from Sambirano to Analamera. Our data show that (1) the animals captured in Ambolomavo-Ranomafana, *H. griseus* ssp1, presented a polymorphic diploid number (2N=54, 2N=55, 2N=56), while those captured in Sangalampona, *H. g.* ssp2 presented 2N=52 distinguishing these two forms from the other *H. griseus*. Both subspecies also presented a characteristic molecular pattern. (2) the *H. g. griseus* from Andasibe-Maromizaha and *H. g. alaotrensis* from the Lake Alaotra were characterized by the same karyotype 2N=54 and clustered together, preventing us from distinguishing them from another. However, these animals differed morphologically, *H. g. alaotrensis* being significantly greater. (3) the *H. g. meridionalis* from Andohahela could be distinguished from the other forms by their karyotype (2N=54) and their molecular pattern. We suggest to rise at a specific level *Haplemur griseus*, *H. occidentalis*, *H. meridionalis*, *H. alaotrensis*, *Haplemur* ssp1 and *Haplemur* ssp2. Even if cytogenetics and molecular data have be-

come important tools in taxonomy and the delimitation of the distribution area of the species, morphological data maintain their importance as it is illustrated by the example of *H. g. alaotrensis* in this study.

### **Regional biogeography and conservation status of the Milne-Edward's sportive lemur in the Ankarafantsika National Park, northwestern Madagascar**

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The regional distribution patterns and the conservation status of the Milne-Edward's sportive lemur (*Lepilemur edwardsi*) are poorly known. Latest results indicate that this species is restricted to northwestern Madagascar and is limited by the Betsiboka river in the West, the Mahajamba river in the East and Kamoro river in the South (Craul et al., in prep). In order to assess the regional conservation status of this species, we have studied its presence and abundance as well as human-induced fear responses at nine different localities in the largest remaining forest block in its distribution range, the Ankarafantsika National Park. We carried out nocturnal census walks along transect line about 1 km length and analyzed the vocal, locomotor and feeding behaviour of 44 collared individuals during the first two hours of their activity period. Based on nocturnal censuses, controls of potential sleeping holes and on the presence of loud calls, we found that sportive lemurs occurred at all sites. Median densities, estimated on the basis of nocturnal census walks, ranged between zero and three individuals/km with no significant correlation between loud calling activity and population density. Lemurs showed different responses to the presence of humans. 64 % of all collared individuals showed no fear-related responses despite the fact that poaching occurred at all sites, whereas the others remained in their sleeping holes or almost motionless between 30 and 100 % of the observation time. Alarm calling towards humans did not occur. These findings suggest that sportive lemurs have not yet adapted to evolutionary new predators such as humans. Consequently, even in the Ankarafantsika National Park, the Milne Edwards' sportive lemur population is highly endangered and conservation strategies are urgently needed.

### **Some like it high: Habitat diversity of two sympatric mouse lemurs, *Microcebus ravelobensis* and *M. murinus* in northwestern Madagascar**

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The distribution and abundance of two sympatric mouse lemurs, *Microcebus ravelobensis* and *M. murinus*, were investigated within the Ankarafantsika Natio-

nal Park, Madagascar in order to understand their habitat diversity, their regional distribution pattern, and to assess the regional conservation status of *M. ravelobensis*. For this purpose, a capture/recapture study and nocturnal surveys were carried out during the dry seasons from 2002 to 2004 along 22 transect lines that differed in microhabitat characteristics and altitude. *M. ravelobensis* occurred in a total of 19 sites (86,4 %) whereas *M. murinus* could be found in only 15 sites (68,2 %). Twelve of 22 sites were used sympatrically by both species. The number of captured *M. murinus* showed a significant positive correlation with altitude whereas the correlation was negative for *M. ravelobensis*. Based on capture and nocturnal census results, we estimated the density of both species in different altitude categories (low, middle, high). The density of *M. ravelobensis* was highest in low altitude habitats. In contrast, that of grey mouse lemurs generally increased with altitude. *M. murinus* was absent in 6 of 10 low altitude habitats whereas *M. ravelobensis* was missing only in 2 of 7 high altitude habitats. We conclude that these two mouse lemur species possess an uneven abundance and distribution within the Ankarafantsika National Park, possibly reflecting different microhabitat preferences (e.g. humidity). These findings furthermore suggest that a total population size of *M. ravelobensis* calculated on the basis of a total forest surface area without taking into account different types of microhabitats is not appropriate for estimating the conservation status of this species.

### **Morphometric aspects of species diversity of mouse and dwarf lemurs (Cheirogaleidae)**

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Within the past decade, the number of recognized species of cheirogaleid primates has more than doubled. Our ongoing work focuses on the diversity and distribution of the genera *Microcebus*, *Cheirogaleus* and *Mirza*, with particular focus on the eastern rainforest taxa. We use a combination of field sampling, museum work and genetic analyses to identify or verify taxonomic units. In this poster, we summarize and present results of morphometric analyses of more than 50 cranio-dental and post-cranial variables obtained from field and museum specimens, using multivariate statistical analyses. We also report on variation in pelage coloration. The overall aim of this study is to identify patterns of variation in body size and shape among populations and species from different localities. This information will complement results of genetic studies of the same taxa in identifying patterns of species diversity and distribution.

## Foraging behaviour in juvenile orangutans (*Pongo abelii*) during a re-introduction programme

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In this study eight juvenile Sumatra-orangutans, which had been confiscated because of illegal keeping were introduced into a re-introduction programme and were released at the Bukit Tigapuluh Nationalpark in Middle-Sumatra at the beginning of the fruiting season. To monitor activity patterns, foraging behaviour and social interactions, individuals were observed in full-day periods. Data were collected every two minutes from the onset until the end of daily activity. The results showed that the animals spent more than 40 % of the observed time foraging. Resting and moving were the other main activities. Social interactions predominantly consisted of social play; agonistic behaviour was rarely observed. The eight orangutans mainly foraged on fruits and leaves but there were individual differences. Some animals clearly preferred fruits, others leaves. The search and handling time for fruits was about nine times higher than for any other food item including insects. With regard to social feeding we found that the juveniles were significantly more often close to conspecifics when they ate fruits than when they chose leaves. Our preliminary results indicate that social factors may be important for foraging strategies and diet composition in young orangutans, which could affect their survival chances in the wild.

## Molecular evolution and systematics of Indochinese primates

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The evolutionary history of Indochinese primates is poorly understood and, hence, led to different classification schemes. We investigated slow loris, leaf monkey and gibbon phylogeny, using tree reconstructions on the basis of mitochondrial sequence data. The results obtained provided a clear resolution of the phylogenetic relationships among these taxa and allow clear conclusions about their taxonomic classification. Accordingly, slow lorises in Indochina are represented by the two species *Nycticebus pygmaeus* and *N. bengalensis*. The leaf monkeys of Indochina are divided into the three genera *Pygathrix*, *Rhinopithecus* and *Trachypithecus*. The douc langurs (*Pygathrix*) are represented by the three species *P. cinerea*, *P. nemaus* and *P. nigripes*. Within the snub-nosed monkeys (genus *Rhinopithecus*), the distinct species status for the four proposed species (*R. avunculus*, *R. bieti*, *R. brelichi*, *R. roxellana*) was confirmed. In Indochina, the genus *Trachypithecus* is represented by the three-species group [*T. obscurus*], [*T. cristatus*] and [*T. francoisi*]. Based on our molecular data, the only Indochinese representative of the [*T. obscurus*] group, *T. crepusculus*, is more closely related with the [*T. francoisi*] group than with the [*T.*

*obscurus*] group. The [*T. cristatus*] group is represented by the two species *T. margarita* and *T. germaini*. Within the [*T. francoisi*] group, the four taxa *T. delacouri*, *T. francoisi*, *T. poliocephalus* and *T. laotum* should be recognised as distinct species, with *T. leucocephalus* and *T. hatinhensis* being subspecies of *T. poliocephalus* and *T. laotum*, respectively. For the crested gibbons (genus *Nomascus*), we propose to recognise *N. hainanus*, *N. nasutus*, *N. concolor*, *N. leucogenys* and *N. gabriellae* as distinct species. The taxonomic classification of *N. siki* and the described subspecies of *N. concolor* remains uncertain, however.

## The diversity of neotropical primates

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Taxonomy precedes conservation, and over recent years there have been important developments in our understanding of the systematics and taxonomy of primates worldwide; in the New World stimulated and enabled in large part by the extensive revisions of the late Philip Hershkovitz. Molecular genetics, and karyological and morphological studies have resulted in considerable changes in our views of the systematics of the New World monkeys at family, genus and species levels. In addition 31 new species and subspecies have been described in the last 30 years; 29 in the Amazon basin and two in the Atlantic forest. A workshop organised by the IUCN/SSC Primate Specialist Group in Florida in February 2000, resulted in a new appraisal of the diversity of New World monkeys, but since then further information has resulted in changes in taxonomic arrangements of, notably, titi monkeys, night monkeys, bearded sakis and howling monkeys. Genetic and morphological studies have indicated strongly that the dwarf marmoset described in 1998 is a distinct genus, and has been given the name of *Callibella humilis*. The capuchin monkeys continue to be problematic, and there are currently two taxonomies in use. Building on the results of the Florida Workshop (published in 2000: Rylands et al. Neotropical Primates 8(2)), current, and certainly not definitive, taxonomic arrangements indicate five families, 19 genera, 132 species, and 201 species and subspecies of Neotropical primates.

## Inventory of the *Eulemur macaco flavifrons* population in the Sahamalaza protected area, northwestern Madagascar, with notes on an unusual colour variant of *E. macaco*

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The blue-eyed black lemur (*Eulemur macaco flavifrons*; Emf), the taxonomic validity of which was recently confirmed, was rediscovered by science only in 1983 and

is still one of the least-studied of all lemur taxa. It is only found in the sub-humid forests of the Sahamalaza peninsula and in a small stretch of forest on the adjacent mainland. In the northeastern part of its range the subspecies seems to hybridise with the nominate subspecies, *E. m. macaco* (Emm). Emf is listed as critically endangered by the IUCN. Its remaining habitat is already substantially fragmented. A protected area, including the Sahamalaza peninsula and thus the probably largest remaining population of blue-eyed black lemurs, is currently in the process of creation. As part of a long-term research and conservation programme, we counted the total number of individual Emf in two fragments of the Ankarafa forest in the southwestern part of the peninsula to be 37 individuals on 0.61 km<sup>2</sup>. We extrapolate this count to the total forested area of the national park and compare the figures with earlier population estimates for the subspecies. Moreover, we provide preliminary data on a population of *Eulemur macaco* showing an unusual fur colouration different to that of both described subspecies. These animals occur around the village of Kapany, about 12 km North of Maromandia and thus in the western part of the Emf and Emm border region. As they are homogeneous in colouration across groups and forest fragments it is unlikely that they represent subspecies hybrids.

### **Inbreeding depression in a semi-free ranging colony of mandrills: implications for conservation**

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Offspring born to closely related parents often show reduced fitness, a phenomenon known as inbreeding depression. This is typically due to increased homozygosity at loci affecting fitness, either by permitting the expression of recessive deleterious alleles or by reducing heterozygote advantage. Inbreeding avoidance is thought to underlie the evolution of sex-biased dispersal and has important implications for conservation. Many species of primate are threatened by habitat and population fragmentation, and the resulting small, closed populations may be at risk of inbreeding depression. However, studies using genetic data to examine the effects of inbreeding on individual fitness are rare in the primate literature. We investigated the relationships between inbreeding coefficients, heterozygosity and fitness correlates (growth and reproductive success) in a closed, semi-free ranging colony of mandrills (*Mandrillus sphinx*), using pedigree data for five maternal generations and 20 years of morphological and demographic data. The initial F1 generation in the colony showed increased heterozygosity, due to out-breeding between founder animals from different geographic origins. Mean inbreeding coefficient then increased and heterozygosity decreased with increasing generation number. Body mass decreased as inbreeding coefficients increased, but only for females. Reproductive success decreased as heterozygosity decreased in both sexes. These results suggest that in-

breeding can negatively influence fitness in primates, and we discuss how they might provide a model for fragmented primate populations in the wild.

### **Stepchildren of the seven sisters: the threatened primate diversity of northeastern India**

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The seven sister states of northeastern India, one of the global biodiversity hotspots, are extremely rich in primate diversity, with a total of eleven species of prosimians, monkeys and apes, including a recently-discovered macaque new to science. Yet virtually all these species are severely threatened and may even be on the verge of extinction. A distinctive feature of the lowland tropical forests in this region, now severely fragmented, is their remarkably high biomass density of primates - the highest anywhere in the Indian subcontinent and perhaps one of the highest in the world as well. What has remained virtually unexplored are the factors that have promoted such remarkable primate diversity in these small patches and allowed the populations of these species to co-exist in spite of the rapid degradation of their habitats. This is particularly true for the four species of the macaques - the Assamese, pigtailed, rhesus and stump-tailed macaques - as all of them are congeneric and are likely to compete severely for ever-dwindling resources. What features characterise the behavioural ecology of these species that have allowed them to survive without necessarily driving each other to extinction? Have they been able to minimise ecological competition through niche specialisation? What is the nature of inter-species interactions that these crowded populations display? Our studies should not only provided insights into the nature of intra- and inter-species ecological and behavioural adaptations that promote sympatry of such closely-related species, but are leading to the design of appropriate conservation strategies to ensure their survival in the future.

### **Taxonomy, biogeography, and conservation of tarsiers**

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Hill (1955) classified tarsiers into three species, each from a distinct biogeographic region: *Tarsius bancanus* from island areas of Sundaland, *T. syrichta* from islands of the southern Philippines, and *T. tarsier* (= *spectrum*) from Sulawesi and nearby islands. Multiple species and/or subspecies have been described from each region, and each of these three taxa may be a cluster of related taxa. The distribution of *T. syrichta* conforms well to the Ice Age landmass Greater Mindanao. The distri-

bution of the *T. tarsier*-complex covers the Ice Age landmass of Sulawesi, and extends to discontinuous island groups, possibly indicating a relatively ancient dispersal throughout the proto-Sulawesi archipelago. The distribution of *T. bancanus* is limited to a greatly reduced subset of Sundaland, and may indicate a Holocene range expansion from a Pleistocene refuge in Borneo. The alpha-level taxonomy of the *T. tarsier*-complex is reviewed. Acoustic evidence provides a hypothesis of at least 17 distinct taxa, 16 known acoustic forms plus the enigmatic *T. pumilus*. The distribution of tarsier acoustic forms conforms to empirical biological and geological data to form a compelling biogeographic hypothesis for Sulawesi. Congruence among tarsier acoustic, genetic, and morphologic data is reviewed. One implication for conservation is that biodiversity in Sulawesi may be underestimated by as much as an order of magnitude. Rigorous testing of the hypothesis of so many new taxa will require a large investment of resources and time, but regrettably, current rates of deforestation indicate that time may be of short supply.

### **Diversity of prey perception in nocturnal primates: lessons from bats' sensory ecologies**

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Many species of both bats and nocturnal primates are adapted to foraging for arthropods and other animal prey at night in three-dimensional forest environments. Both are faced with the problem of detecting and selecting their food in or close to vegetation under low light levels. The more than one thousand species of bat evolved an amazing diversity of sensory ecologies, providing them perceptual access to food in a wide range of niches. Diet analysis and measurements of prey sounds showed that prey conspicuousness passively limits food selection in bats. With behavioural experiments and field data, we revealed that closely related, potentially competing bat species differ in their sensory access to prey and experience reduced food niche overlap. In nocturnal primates, by contrast, much less is known about the sensory basis of prey detection, its fit to physico-chemical properties of the food niche, and its relevance for foraging and community ecology. We started investigating the sensory basis of prey detection and prey choice in mouse lemurs and galagos and found them using multimodal information, with a prevalence of audition and smell. We then explored whether rustling sounds of Malagasy arthropods - natural food of mouse lemurs - contain information on prey profitability and whether the lemurs use them to guide foraging decisions. Based on these preliminary data, and extrapolating from what is known on bat sensory ecology, we suggest that it will be promising to further assess sensory diversity in nocturnal primates and its role for food selection and niche differentiation.

## **Primate diversity in and around the Western Ghats of southern India: managing fragments is the key for their conservation**

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The Western Ghats of southern India, a "hotspot of biodiversity", and their adjoining regions harbour a variety of primate species including two macaques, four langurs and one loris. The lion-tailed macaque is an 'endangered' species, slender loris and Nilgiri langur are 'vulnerable', and in the case of the Hanuman langurs, even the taxonomy is disputed. The two subspecies of bonnet macaques are, by and large, commensal with only few populations that are genuinely forest dwelling. However, despite the habitat contiguity, the commensal bonnet macaque populations have been decreasing and becoming increasingly fragmented and clumped. The lion-tailed macaque and the Nilgiri langur are obligatory forest dwellers, inhabiting primarily the rainforests of the Western Ghats. The major conservation and management issue concerning these species is the fragmentation of their rainforest habitats. Specifically in the case of the lion-tailed macaque, many forest fragments inhabited by them are highly degraded, isolated and privately owned, located inside tea or coffee gardens. The ultimate survivorship of this species depends on improving quality, or possible linking of, these fragments, including population management such as exchange of adult males among fragments. The species of Hanuman langurs are both forest dwellers and commensal. The taxonomic confusion in recent years has added to their conservation status. Little is known about the Malabar slender loris inhabiting rainforests of the Western Ghats. However, the available information suggests that the populations are contiguous and several 'protected areas' harbour this species. On the other hand, populations of the Mysore slender loris are fragmented as this subspecies occurs in dry scrub forests and croplands mainly outside 'protected areas'. Large populations inhabit commercial plantations that can be harvested at any time, thus, endangering substantial populations of this subspecies. Therefore, the major problem of conservation of these southern Indian primates appears to be the management of fragments. In Europe, the lion-tailed macaques are distributed in several institutions and zoos. Several features of these populations, such as varied group size, unnatural age-sex ratios, forced tenures of adult males and lack of inter-troop encounters make them resemble those inhabiting forest fragments. We report population dynamics in these captive groups, and propose that such analyses may help understand the dynamics in fragmented populations in their natural habitats.

## **Assessing phylogeny and population subdivision in chacma baboons (*Papio hamadryas ursinus*)**

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Recent molecular and morphometric data suggests that chacma baboons represent the oldest, most divergent lineage within *Papio*. In a recent publication, Newman, Jolly and Rogers (2004) proposed a phylogenetic hypothesis for *Papio* based on sequence variation in the Brown region of the mitochondrial genome. Their analysis revealed 4 major lineages and identified chacma haplotypes as the oldest (1.8mya) and most divergent, being the sister clade to other *Papio* allotaxa. New data indicate two major mitochondrial lineages within chacma, divided geographically along a southwestern to northeastern transect through South Africa. Using the same dataset (representing seven geographic locations), we assess population subdivision and gene flow within and between the northern and southern clades using mitochondrial D-loop sequence, a panel of six microsatellite loci and two functional nuclear loci (MAOA, 5-HTTLPR). D-loop sequences confirm the major North/South lineage split, but further subdivide the southern clade, delineating Western and Eastern Cape populations. Northern clade samples from central and northwestern South Africa reveal substantial sequence variation but ambiguous phylogenetic resolution, perhaps due to sample size or mutation saturation. Microsatellite variation exhibits extensive, significant allele frequency differences between most, but not all, pairwise population comparisons. MAOA allele frequency variation between the northern clade and the Western and Eastern Cape subclades is significant, with three unique alleles present in the samples collected south of the Limpopo near Zimbabwe. Conclusions: 1) We found extensive mtDNA subdivision among, but limited evidence for nuclear gene flow between, chacma populations; 2) Unique MAOA alleles in the northern samples may represent local selection, or gene flow from non-chacma populations.

### **The suitability of sequence diversity found in mouse lemur microsatellite loci for the diagnosis of ESUs and species in northwestern Madagascar**

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The most common definition of an "evolutionary significant unit" (ESU) requires reproductive and historical isolation that has resulted in a significant genetic divergence among populations. In addition to standard tree-based methods, character-based approaches have been employed more recently to detect group-specific fixed mutations that may also indicate ESUs or species (De Salle 2004). In this study we investigate whether the sequences of 12 microsatellite loci from samples stemming from three different Inter-River-Systems (IRS I-III) and three different mouse lemur species (*M. murinus*, *M. ravelobensis*, *M. sp. 1*) in northwestern Madagascar show fixed mutations that can be grouped according to their geographic (IRS I-III) or phylogenetic origin and can therefore be used to differentiate ESUs or species. Group-specific mutations (GSMs) were differentiated by location (msat-motif vs. flanking region) and type (indels vs. substitutions). GSMs occurred in 7 out of 12 loci and were located in the flanking region (25 positions in 5 loci) or in the msat-motif (2

loci). GSMs in the flanking region consisted of indels (n=11) or substitutions (n=15) and motif changes comprised the loss (n=1) or the generation (n=1) of a new motif. Most GSMs (n=17 changes) distinguished between *M. murinus* on one side and the brownish species on the other side, and thus have occurred at least in the last common ancestor of these forms. As for more recent changes, 4 GSMs (2 indels and 2 substitutions) in the flanking regions of 2 loci support the monophyly of the new mouse lemur species *M. sp. 1* inhabiting IRS III, whereas 5 GSMs (4 indels and 1 substitution) support the joint monophyly of IRS I+II. Only one substitution is fixed among the alleles of IRS II+III as opposed to the alleles of IRS I and *M. murinus*. The results confirm that sequence data of microsatellite loci contain phylogenetically relevant information that could be potentially used as diagnostic tools to identify species.

### **The Cat Ba Langur Conservation Project – Conservation of the golden-headed langur on Cat Ba Island, Vietnam**

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The Golden-headed Langur or Cat Ba Langur (*Trachypithecus poliocephalus poliocephalus*) is endemic to the island Cat Ba in northern Vietnam. It is listed by IUCN as one of the world's 25 most critically endangered primate species. Poaching had reduced this species from an estimated 2,500-2,800 langurs in the 1960s to only 53 individuals in 2000. The remaining population is not only very small but is also extremely fragmented, with some isolated subpopulations consisting of individuals of one sex only. In November 2000, Münster Zoo and the Zoological Society for the Conservation of Species and Populations (ZGAP) started the 'Cat Ba Langur Conservation Project'. Immediate protection approaches included the establishment of a strictly protected langur sanctuary inside of Cat Ba National Park, the involvement of local people in protection work as langur guardians or members of commune forest protection groups, and improvement of ranger patrol work. General project objectives are to maintain and improve the protection status of the Cat Ba Langur, population management, capacity-building for staff of forest protection agencies and local conservation groups, promotion of public conservation awareness and sustainable forest management practices, and the development of sustainable conservation management structures. Poaching has been brought under control, and for the first time in decades the world population of the golden-headed langur has increased: to 62 individuals by 2005. Nevertheless, the low reproductive output, which may be due to highly disturbed social structures and very limited mate choice, needs to be increased to ensure survival of the species in the long term.

### **Genetic analyses and the impact of socio-cultural factors in human evolution**

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Humans, more so than any other primate species, are characterised by their extreme reliance on social and cultural traditions. I will present some examples of the consequences of human socio-cultural practices for patterns of human genetic diversity. I will also present an example of how analyses of genetic diversity can shed light on the origins of particular cultural practices.

### **Saving Sumatran primate diversity: a lesson learned in developing conservation strategy using a multiple-layer approach**

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Sumatra is the fifth largest island in the world with 1,800 km long and 400 km wide. It contains an extraordinary wealth of natural resources and habitat diversity includes 14 primate species with 8 endemics. The Sumatran orangutan has been categorized as critical endangered, and 6 more species, including 4 species distributed in the small Mentawai islands, as endangered. The habitat of Sumatran primates has been decreased rapidly due to habitat conversion to agriculture, logging, forest fires, local encroachment and many other anthropogenic causes. In order to reverse further deforestation in Sumatra, we have used a multi-layer approach, which is basically a combined method of socio-economic and conservation biology techniques. These techniques include the following: mapping known distribution of primate species, determine their habitat requirement (size) for long-term survival, overlay current and future (potential) land-use, development or revision of conservation strategy at the regional level, develop sustainable use options to maximize economic benefits while minimize environmental costs, conduct trade-off analysis for different targets and economic options, conduct stakeholder mapping to determine those who being working on primate conservations plus their capacity and possible roles, overlay land tenure and access rights over the areas determined as "Key Biodiversity Areas", and reviews of policy and regulations concerning wildlife to ensure that existing regulations support primate conservation. The outcome of this approach is the inclusion of primates and other wildlife into the local government decision-making processes toward better management of natural resources. These initiatives have been developed in the area of Mentawai and Northern Sumatra. The aim is to assess the appropriateness of different approaches in developing conservation programs at the local level. This pilot study is expected to be cost-effective, and it could provide leverage by being a demonstration program, allowing it to be scaled up toward larger landscape units in the future. Although local governments have sometimes emphasized the conservation of primates in their strategic planning, better integration of conservation and development planning is hampered by lack of political and financial support by both donors and stakeholders.

## **Gorilla population history - new insights from genomic data**

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In order to gain insights into the evolutionary history of the genus *Gorilla*, we sequenced 18 unlinked, non-coding autosomal loci from each of 15 West African gorillas (*Gorilla gorilla gorilla* and *G. g. diehli*) and one East African gorilla (*Gorilla beringei graueri*). These multilocus sequence data were compared to those from other great apes at the same loci, revealing a level of genetic diversity in western gorillas similar to that in other African great apes. A significantly positive Fu & Li's D was observed for western gorillas, suggesting either ancestral population substructure and/or a very recent bottleneck event. Phylogenetic analyses revealed a very close relationship of eastern and western gorillas and further coalescence simulations using a subset of the data and incorporating sequence information obtained from faecal DNA of two additional eastern gorillas support a complex evolutionary history involving an initial population split between eastern and western gorillas with subsequent gene flow until very recently.

## **The development of a non-invasive differential diagnostic for nephropathy, glucose intolerance and enteritis in captive *Callithrix jacchus***

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Chronic nephropathy, enteritis, glucose intolerance and overweight are common problems in captive *Callithrix jacchus*. It is not difficult to imagine the impact these diseases may have on the survival of captive animals released into the wild, or on the validity of experimental results. Our working hypothesis is that the captive diet, which has relatively little similarity to their diet in the wild, is the common cause. The aim of our study is therefore to develop a non-invasive diagnostic for these diseases, glucose intolerance and enteritis. The techniques we are using include ultrasound, urine and faecal analysis. Our preliminary results focus on the kidneys and show a high frequency of nephropathy related symptoms positively correlated with body weight in 33 overtly healthy animals from DPZ. Specifically 70 % (23/33) of these animals were heavier than 400 g. From the heavy weight group, 52 % (12/23) had kidney volumes >2 cm<sup>3</sup>, with 58 % (7/12) of these also showing high urinary albumin/creatinine ratios (UACR) (indicator for glomerular disease). Slightly less than half (11/23) had kidney volumes <2 cm<sup>3</sup> from which only 1 showed a high

UACR. The 10 not-overweight animals all showed a kidney volume  $< 2 \text{ cm}^3$  and only 1 had high UACR. Once we have completed our evaluation of the DPZ colony, we plan to compare the frequency and severity of these diseases in the National Primate Centre-CENP/Brazil colony, as well as in the wild.

### **Application of sperm banking to assist in genetic management of endangered neotropical primate populations in Brazil**

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A transnational collaboration (Brazil and Germany) has been established to develop a sperm bank for primates in Brazil to support effective genetic management of endangered species. In order for genetic management to have maximal impact, it is vital to optimize both the genetic diversity as well as health of captive populations of endangered species, which serve as a reservoir for the wild population. Genetic management can be made more effectively through the use of banked sperm and artificial insemination rather than the movement of animals. To achieve this goal, a comprehensive sperm bank from genetically evaluated individuals needs to be established. We are currently improving critical technical elements required for a sperm bank for Callithrichids using *Callithrix jacchus* (*C.j.*) as a model. Thereafter we plan to collect sperm and genetically characterize one captive *C.j.* population in Brazil and one in Germany. Finally we plan to test the function of our preserved sperm in an artificial insemination trial with semi-free *C.j.* groups to evaluate both the technical efficiency and the effect on dissemination of introduced genomic variability. We plan to collaborate both with Brazilian institutions involved in captive breeding and with field based projects involved in habitat protection/restoration and reintroduction. Our initial target species group will be the *C.j.* sibling species native to the "Mata Atlantica", but we are also interested to develop and apply our sperm banking strategy to other Neotropical primate species.

### **Primate Reintroductions: a special challenge for cultural species?**

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Studies of skill development in primates ranging from aye-ayes to orangutans indicate that the development of important basic ecological skills, such as food choice and food processing techniques, requires extensive learning, including critical social inputs. It is not surprising, therefore, that field observations on great apes, and to some extent on monkeys, have demonstrated considerable geographic variation in

both subsistence skills and communication signals. These studies suggest some degree of local adaptation based on innovations and maintained by social transmission on top of developmentally buffered skills with a strong genetic component. Recent work on dietary variation in orangutans indicates that for food items that require extensive processing these cultural influences on food choice and thus food intake are considerable. All this work suggests that the reintroduction of ecologically naïve individuals might lead to a period of stress, during which they need to acquire major skills. On the other hand, developmentally more plastic species may, given enough time, invent locally adaptive skills. In this presentation, I review the literature on reintroduction and translocation and test various predictions based on these ideas.

### **Preliminary results of a primate survey in the Peleonan forest, N Siberut, Indonesia**

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The 4480 km<sup>2</sup> island of Siberut belongs to the Mentawai Archipelago off western Sumatra and supports four endemic primate forms, probably representing the highest degree of primate endemism in relation to size anywhere. The Siberut Conservation project (SCP) formally protects 40 km<sup>2</sup> (approx. 90 %) of the Peleonan forest, a remote, relatively undisturbed forest area in the northern part of the island where human population density is comparatively low. In order to assess the conservation status of endemic primates in the Peleonan forest, we repeatedly surveyed 13 line transects located around SCP field station. As of September 2005, a survey effort of 81 km has been accumulated, resulting in a total of 159 primate observations (truncated to a 30 m strip). In order to obtain reliable population estimates, we assessed detection probabilities for each species using detection functions fitted to perpendicular distance data, and estimated (sub-)group sizes from observation data. Population densities of the Pig-tailed langur, *Simias concolor*, are reliably between 60-100 individuals per km<sup>2</sup>, suggesting that its population in the Peleonan forest could be ca. 2.500-4.000 individuals, far higher than previously suggested. Density estimates for the Siberut macaque, *Macaca siberu*, and the Mentawai leaf monkey, *Presbytis potenziani*, were 10-40 and 8-18 individuals per km<sup>2</sup>, resulting in population sizes of 500-1500 and 300-700 individuals, respectively. Less reliable estimates for the Kloss' Gibbon, *Hylobates klossii*, suggest a density of around 4 individuals per km<sup>2</sup> and a total forest population of 150 individuals. The results highlight the richness of the Peleonan forest in terms of its primate fauna. The data also show that conservation efforts of SCP in Siberut can help to protect significant portions of the global populations of four unique primates in this area where hunting and logging pressures are still comparatively low for the region as a whole.

## **Patterns of natal dispersal and incest avoidance among paternally related rhesus macaques**

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Most male primates leave their natal group around puberty and migrate into other social groups, probably as a means of inbreeding avoidance. Dispersal is usually associated with a high risk of injury and mortality. To maximise fitness, males are expected to co-operate with male kin during the process of dispersal and to avoid mating with close female relatives. Indeed, maternally related males are known to migrate together and support each other during dispersal, and close maternal relatives of opposite sex have been shown to avoid mating with each other. The goal of our study was to investigate the impact of paternal kinship upon male natal dispersal and inbreeding avoidance among rhesus macaques living on Cayo Santiago (Puerto Rico). Using both demographic and paternity data, we related patterns of natal dispersal with the degree of paternal kinship. Preliminary analyses suggest that males prefer to join non-natal groups with familiar paternal half-brothers (i.e., born in the same natal group), but likewise males also prefer to join groups with familiar unrelated males. However, unfamiliar paternal half-brothers (i.e., born in different natal groups) were found to be more likely to join the same non-natal group than expected by chance alone. Furthermore, males also showed only a slight trend to avoid migration into non-natal groups containing paternal half-sister/s. Our results suggest that rhesus macaques ensure benefits in terms of fitness by migrating together with, or into the group of, a paternal half-brother and likewise avoid costs by not reproducing with paternal half-sisters.

## **Evolutionary origins of Malagasy primates**

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The primates of Madagascar, commonly known as lemurs, are an extraordinarily diverse group of mammals and represent stunning example of evolutionary diversity. The typical questions asked about their evolutionary origins are: How many times did they colonize Madagascar? Have colonisations been unidirectional? When

did these colonisations occur? From what geographic point of origin did they arise? And, what have been the mechanisms of their dispersal? I suggest that these questions have been answered rather conclusively via the acquisition and analysis of DNA data from living lemuriforms. These analyses indicate that there was only a single colonization of Madagascar by non-human primates, probably in the earliest Tertiary, and moreover, that the resulting clade also encompasses the now extinct "giant" lemurs. Further, consideration of the geographic distribution of both living and fossil primates in phylogenetic context indicates that Africa would have been the geographic centre of origin for all tooth-combed primates, and thus the ancestor to the ancestral lemur. Recent studies of the living lemurs, particularly the nocturnal forms, are revealing that species diversity is even higher than previously imagined, with approximately 50 species now recognized, and probably many more to be discovered. The consideration of all of these data and patterns therefore reinforces what we already knew: The lemurs of Madagascar are the crown jewels of primate diversity.

### **The Siberut Conservation Project: integrating field research and applied conservation**

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Siberut, the northernmost island of the Mentawai Archipelago off Sumatra's west coast, is of global importance due to its rich biodiversity and high degree of species endemism. Founded in 2002, the Siberut Conservation Project (SCP) is an international collaborative effort to study and protect a forest ecosystem in northern Siberut and thereby, to contribute to the preservation of the islands unique biodiversity. The project aims to create a biological database required for development of a long-term conservation strategy in the region and to use results to raise awareness of the value of forest resources and the need to protect them. The project focuses on Siberut's four endemic primates as flagship species, but encompasses other endemic flora and fauna. While emphasising biological research and dissemination of information gained, the project is also playing a leading role in the development of a broader community-based conservation programme in the neighbouring Politcio-man region. Ongoing initiatives include improved health care, education and economic incentives based on controlled eco-tourism. By working together with Conservation International, UNESCO and other relevant stakeholders, the project ultimately aims to contribute to the development of a novel management paradigm for Siberut and the Mentawai Islands as a whole, incorporating both ecosystem protection as well as human needs.

## Bird taxonomy and conservation

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Conservation plans are often based on taxonomy. For example, the United States Endangered Species Act can apply to species, subspecies, or a new category created by the US Congress in 1996, the Distinct Population Segment (DPS). Much debate concerns the definition of species in ornithology, with many favouring the phylogenetic or evolutionary species concept, especially for conservation. An example from the Mexican avifauna shows that the biological species concept seriously underestimates species diversity. Recent molecular studies have failed to confirm the evolutionary distinctiveness of subspecies, suggesting that when they have been targeted for preservation, it has been in error. Very few studies have used the category of the DPS, and it is clear that it will be more inclusive than the subspecies, and less so than the species (on average). Recent opinion has challenged the use of mtDNA to define units for conservation, suggesting that it is too conservative. I show that mtDNA is a valid and important tool for defining conservation units in birds, and that claims that nuclear gene information will provide a better tool for conservation is misguided. MtDNA analyses suggest that units of avian conservation will be likely equivalent to phylogenetic species.

## MtDNA phylogeny and biogeography of baboons

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*Papio* baboons are widespread in a variety of different habitats throughout sub-Saharan Africa and western Arabia. Traditionally five morphotypes have been recognized, although, there may exist several more similarly valid types. The phylogenetic relationships within the genus are not clear and the taxonomic status of the various morphotypes is controversial. Hybrid zones are confirmed for two populations, but they are expected for almost all contact zones. We tried to infer the phylogenetic relationships within the genus *Papio* from nucleotide sequences of the mitochondrial partial cytochrome b-gene (645 bp), the 'Brown-region' (896 bp) and part of the HV I of the mitochondrial control region (340 bp). We included samples from all major morphotypes from 68 sites in Africa and Arabia in our analysis. DNA was extracted mainly from faecal samples. Phylogenetic tree reconstructions revealed that geography primarily explains the mtDNA relationships among *Papio* morphotypes, with morphological (taxonomic) similarity being of secondary importance. Two of the classical baboon types, olive and yellow baboons, turned out to be paraphyletic. Chacma baboons seem to constitute a "ring-species" encircling the Kalahari Desert. Guinea baboons form only one clade, as well as hamadryas baboons, irrespective of their Africa or Arabia origin. Our data suggests a South African origin of *Papio* and a secondary dispersal into the northern savannah belt.