

EDITORIAL

Are you in favor of conservation? Do you know how conservation is viewed by the academic world? I raise these questions because they are central to current issues facing primatology in general and prosimians specifically.

The Duke University Primate Center is in danger of being closed because it is associated with conservation. An internal university review in 2001 stated that the Center was too focused on conservation and not enough on research. The reviewers were all researchers from the "hard" sciences, but they perceived conservation to be a negative. The Duke administration had similar views and wanted more emphasis on research and less on conservation. The new Director has three years to make that happen.

We at the Duke Primate Center specifically and primatologists in general have failed to get the information out that what we are doing is "conservation biology" and not "conservation". What is the difference? Conservation biology is studying the individuals and their environment to prevent the extinction of either (benefits more than just one species). Conservation is the safekeeping or preserving of a species (benefits only one species and by definition takes away opportunities of other species). Most of us and most administrators know the later, but few of us (and certainly not most administrators) know what conservation biology entails. And, as with most things, the bottom line is money and research translates into dollars while conservation apparently does not.

It is time for us to change our way of thinking and then to make sure that administrators, granting agencies, and our colleagues are educated about the correct terminology and what that terminology means. I consider myself a conservation biologist and not a conservationist, but that does not mean that I have sold out to big dollars. Doing research (ecological, behavioral, physiological) is still what I value, but I need to do a better job of public relations, i.e., getting the message out or what is called "marketing" or "spin".

What are you (conservationist or conservation biologist) or more important how do you market yourself? Your next grant or job may depend on your answer to this question.

Kenneth Glander

Duke University, Dept. of Biological Anthropology & Anatomy, Box 90383, Durham, NC 27708, USA,
glander@duke.edu

NEWS and ANNOUNCEMENTS

Lemur News online

Volumes 3 -present are available online at

www.dpz.gwdg.de

Conservation International's President Awarded Brazil's Highest Honor

In recognition of his years of conservation work in Brazil, CI President Russell Mittermeier was awarded the National Order of the Southern Cross by the Brazilian government. Dr. Mittermeier received the award on August 29, 2001 at the Brazilian Ambassador's residence in Washington, DC. The National Order of the Southern Cross was created in 1922 to recognize the merits of individuals who have helped to strengthen Brazil's relations with the international community. The award is the highest given to a foreign national for service in Brazil.

For the past three decades, Mittermeier has been a leader in promoting biodiversity conservation in Brazil and has conducted numerous studies on primates and other fauna in the country. During his time with the World Wildlife Fund (1978-1989), he played a key role in putting Brazil's Atlantic Forest, one of the planet's highest-priority hotspots, on the international conservation agenda. He became well-known throughout the country after, with Ademar Coimbra-Filho (then of the Rio de Janeiro Primate Center), successfully mobilizing international support for the endangered lion tamarins, and with Célio Valle (then Professor of Zoology at the Federal University of Minas Gerais), creating similar national and international attention for the muriquis; campaigns that sparked a newfound pride in the country's native animals. Mittermeier was also instrumental in the creation of Conservation International-Brazil, which has since become one of the country's leading conservation advocates.

Patrick Johnston

Conservation International, 1919 M. Street NW, Suite 600, Washington, DC 20036, USA, p.johnston@conservation.org.

L'atelier sur l'évaluation et plans de gestion pour la conservation de la faune de Madagascar: "CAMP 2001"

Madagascar constitue une des priorités mondiales pour la conservation de la biodiversité. Avec principalement les pressions exercées par l'homme, force est de constater que la régression des forêts s'accompagne d'une perte considérable de ces ressources naturelles. Afin de définir les actions prioritaires pour du moins freiner sinon arrêter de processus de perte de la biodiversité, un atelier scientifique sur "l'évaluation et plans de gestion pour la conservation de la faune de Madagascar" ou Conservation Action and Management Plan (CAMP) a été organisé à l'Hôtel l'Hermitage à Mantsoa du 20 au 25 Mai 2001. Les groupes des lémuriens, des autres mammifères des reptiles des amphibiens et des poissons d'eau douce y ont été étudiés

Cet atelier a vu la participation de 118 scientifiques de terrain (de plusieurs pays) dont une vingtaine du groupe des Primates et la collaboration de plusieurs institutions et organisations nationales et internationales

Les objectifs de ces rencontres étaient de:

d'identifier et prioriser les actions de conservation et de gestion des espèces menacées avec une attention particulière pour celles qui n'existent que dans une seule aire protégée;

d'évaluer les complémentarités entre les sites de conservation et de gestion pour les différentes espèces étudiées; d'identifier et programmer les priorités de conservation régionales sur la base du document préliminaire du Plan de Gestion du réseau des Aires Protégées (AP) ou Plan-GRAP.

Avec ses 53 espèces et 64 taxons, Madagascar est le deuxième pays le plus riche au monde par sa diversité spécifique. Ainsi, la conservation des lémuriens fait de ce groupe l'une des priorités mondiales.

Méthodologie

Avant l'atelier

Une recherche bibliographique a été effectuée. Les documents étudiés relatifs à chaque taxon comprennent les textes publiés incluant sa description morphologique, son écologie, sa biologie, sa physiologie, sa génétique, son histoire naturelle. Plusieurs documents concernent des monographies régionales, les analyses des effets et impacts des pressions exercées sur ceux-ci.

Par ailleurs, des fiches de données sur chaque taxon (Taxon Data Sheet ou TDS) ont été remplies afin d'avoir une synthèse des informations sur chaque espèce. Ces TDS regroupent les données nécessaires comme le nom scientifique, la distribution, la description, le(s) synonyme(s), le(s) nom(s) vernaculaire(s), la biologie du taxon, sa démographie, l'évolution de la population, l'utilisation par l'homme, les menaces, le statut actuel et proposé de conservation, la législation concernant l'espèce, les recherches effectuées sur l'espèce, la bibliographie. Cette fiche donne enfin les informations sur les personnes qui ont contribué à son remplissage.

Enfin, 3 cartes de référence: (i) carte de végétation (Faramalala), (ii) carte des forêts naturelles de l'IEFN (Eaux et Forêts) (iii) carte de priorité de conservation de la Diversité Biologique (ONE, DEF, ANGAP, PNUD, CI) ont été mises à disposition des participants.

Au cours de l'atelier

Afin de pouvoir coordonner les actions proposées conformément au PlanGRAP, les groupes de travail taxonomiques et régionaux ont été mis en place. Il s'agissait de:

- ré-évaluer le statut IUCN de chaque espèce;
- définir les priorités et les programmes de conservation pour chaque espèce et principalement pour celles qui sont les menacées;
- définir un programme d'actions urgentes pour toutes les espèces considérées.

Sur la base des documents, des TDS et des cartes mis à disposition et de critères bien définis comme la présence ou non d'espèce(s) dans une seule AP, le degré de menace d'une espèce donnée mais qui n'est présente dans aucune AP.

Résultats

Les résultats de ce CAMP ont donné une série de priorités d'actions et de recommandations.

Le statut IUCN

sur les 64 taxons considérés:

- | | |
|----|--|
| 10 | sont gravement menacés, |
| 20 | sont menacées, |
| 13 | vulnérables, |
| 4 | quasi-menacés, |
| 11 | sont estimés de préoccupation mineure, |
| 6 | ont des données insuffisantes, |
| 0 | considéré disparu, |
| 0 | non évalué. |

Les actions et activités prioritaires

Créer de nouvelles AP pour les espèces menacées et gravement menacées qui ne sont pas encore présentes dans le réseau actuel des AP et en même temps, y intégrer la protection des corridors;

Effectuer des recherches pour la conservation: recensement des populations, études biogéographiques et inventaires dans les zones peu ou mal connues, dynamiques des

populations, études des conditions écologiques, éthologie et études taxinomiques par la morphologie et la génétique

Réaliser des recherches taxinomiques pour le genre *Cheirogaleus* et le taxa *Indri indri*, *Eulemur fulvus*, *Propithecus verreauxi coronatus* et *P.v.deckenii*.

Continuer l'inventaire des primates.

Les recommandations

Afin d'atteindre les objectifs de conservation, l'atelier recommande:

Une meilleure gestion des AP par l'application de ce CAMP.

Une meilleure communication des résultats de recherche entre les différents acteurs: les chercheurs, les responsables et la population locale;

Une attention particulière pour les espèces gravement menacées présentes dans une ou deux localités seulement. Il s'agit de

Eulemur macaco flavifrons (du sud de la rivières Andranomalaza à la rivière Sandrakota),

Propithecus tattersalii (Daraina),

Propithecus diadema ssp. (Tsinjoarivo),

Hapalemur griseus alaotrensis (Alaotra),

Microcebus berthae (Menabe, Analabe, Kirindy).

Une meilleure sensibilisation de la population locale afin de les impliquer en tant qu'acteurs de la conservation.

Cette sensibilisation devra être précédée d'une étude socio-éthologique des populations touchées.

Conclusion

Pour assurer la survie de ces espèces uniques au monde, il est essentiel en premier lieu d'arrêter le processus de perte d'habitat provoquée par l'homme. Viennent ensuite les activités permettant leur conservation et ceci sur la base des recherches réalisées. Il est toutefois primordial d'impliquer effectivement et activement les populations locales en tant que partenaires de la conservation qui est incontestablement une affaire de tous et de chacun.

Le rapport de cet atelier sera publié en 2002.

Chantal Andrianarivo

Responsable de la recherche et de la Biodiversité, Association Nationale pour la Gestion des Aires Protégées, B.P. 1424, 101 Antananarivo, Madagascar, val@dts.mg

Follow-up meeting of CAMP 2001

On November 13 and 14, 2001 Conservation International had organized a Madagascar Round-table Biodiversity Meeting in Antananarivo. The meeting was a sort of brainstorming of people from different fields (plants, insects, fishes, herps, birds, mammals) to prioritize important areas that are not protected yet. Recommendations used to prioritize areas were based on: ecosystems that are underrepresented in the present system of protected areas, the occurrence of critically endangered species outside of the existing protected areas, and areas in which endangered species from different taxonomic groups overlap. At the end of the meeting, the participants came up with 10 areas proposed to be new priority areas in the PE III. These were: Tsaratanana, Daraina, Menabe, Mahavavy-Kinkony, Ibity-Itremo, Ankaratra, Fiherenana-Mikea, Makira, Corridor Ranomafana-Andringitra, the Corridor Zahamena-Mantandia, and Analavelona.

Jonah H. Ratsimbazafy

Interdepartmental Doctoral Program in Anthropological Sciences and the Department of Anthropology, SUNY at Stony Brook, Stony Brook, NY 11794-4364, USA, jratsimb@ic.sunysb.edu.

PrimateLit Now Available for Searching

PrimateLit is the key bibliographic database for searching the nonhuman primate research literature. Approximately 200,000 citations are indexed. Coverage is from 1940 to date. The National Center for Research Resources supports open access to this database for everyone in the national and international scientific communities. **No fees or passwords are required.** We encourage everyone with an interest in primates to use this resource.

Key PrimateLit features

Supports full database or Current Primate References searches.

Allows subject, author and key word searches.

Can limit results by date, species and country.

Search results can be saved, e-mailed or printed.

Authors and keywords (in full record) are search links.

History function allows for combining search results.

Has Books Received module with P-S Book Reviews.

Recent Updates

Links have been added from citations in PrimateLit to corresponding Abstracts in the National Library of Medicine's PUBMED database. Only citations added in the last few months have these links, but a project is underway to match all candidate records to their equivalent PUBMED abstracts: PUBMED links look like this: PMID 1837747 [Links to NLM-PubMed Abstract].

Locations of publications held in the Reprint File at the Wisconsin Primate Research Center have been added to the records. When a publication is held in the reprint file at the UW Primate Center, this field will appear in the full record display: LOCATOR WI 20656.

Links to the full text of articles from Laboratory Primate Newsletter, approximately 1984 to date are being added.

Links to full text of electronically available government-related publications, such as, the *IUCN Red Data Book* are also being linked to PrimateLit records.

A MODIFY SEARCH button which allows you to return to your current search strategy is now functional.

Future enhancements

Ability to display up to 100 records at a time (pending).

Fixed month options for searching Current Primate References (in development).

Record display/save/print and e-mail output enhancements (in development).

Access to the PrimateLit Thesaurus of index terms (in development).

Feedback welcome

We would very much appreciate feedback from members of Primate-Science. While we may not be able to accommodate all user needs, comments and suggestions on how Primate Lit can be modified and improved are most welcome.

PrimateLit is supported by NCCR Grant RR15311, Coordinated Information Services to Support Primate Research. The database is indexed by the Primate Information Center at the Washington Primate Research Center in Seattle and managed by the Wisconsin Primate Research Center and the UW Libraries at the University of Wisconsin-Madison. Special thanks go to Nolan Pope, Sue Dentinger, Mark Foster and Rose Smith of the University of Wisconsin-Madison Libraries who have worked with Jackie Pritchard and Chico Otsuka-Gooding of the Primate Information Center to oversee the migration of PrimateLit to Madison and to deal with

the countless details that attend remounting a large database. Please take a critical look - we need your feedback. Send your comments to me or Jackie Pritchard, PIC Manager, plj@u.washington.edu. Supported through NCCR Grant RR15311, Coordinated Information Services to Support Primate Research. primatelit.library.wisc.edu/.

Larry Jacobsen

Director, WRPRC Library and Information Service, Wisconsin Regional Primate Research Center, University of Wisconsin-Madison, 1220 Capitol Court, Madison, WI 53715-1299, USA. jacobsen@primate.wisc.edu.

Revised Red List Criteria

The new improved categories and criteria used for listing plants and animals on the IUCN Red List of Threatened Species are now available after a four-year review, called for by IUCN members. The review, coordinated by SSC, involving broad consultation with users and organizations from around the world, has produced a clearer, more open, and easy-to-use system for assessing species. With particular attention paid to marine species, harvested species, and population fluctuations, the review has refined the effectiveness of the Red List categories and criteria as indicators of extinction risk. The Red List Categories and Criteria booklet (in English, French and Spanish) is now available on the SSC website in pdf.:

www.iucn.org/themes/ssc/redlists/RLcategories2000.html.

This is the only version that should be used and distributed. The previous version in Word had an error in the citation. The correct citation is: IUCN. (2001). *IUCN Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK. ii+30 pp. The booklet is available through info@books.iucn.org.

Draft Guidelines for Non-Human Primate Re-Introductions

A draft document prepared by the SSC Re-introduction Specialist Group, "Guidelines for Non-Human Primate Re-Introductions", is available for comment on the SSC website at www.iucn.org/themes/ssc/programs/rsg.htm.

These guidelines were developed in response to the increasing number of primate re-introduction projects worldwide. They are based on the *IUCN Guidelines for Re-introductions* (1998), *IUCN Guidelines for the Placement of Confiscated Animals* (2000), a review of case histories, and consultation across a range of disciplines. From: *IUCN Species Survival Commission (SSC) E-Bulletin - March 2001*. Anna Knee, Communications Officer SSC/IUCN.

New Head Announced for the IUCN/SSC Species Programme

Dr Sue Mainka has been appointed as the new Coordinator for IUCN's Species Program, responsible for supporting an increasingly active 7,000-member Species Survival Commission. Dr Mainka is already familiar with the role, having served as Acting Coordinator for the past four months while her predecessor, Dr Simon Stuart, served as IUCN's Acting Director General. He is being seconded by IUCN to a new position at the Center for Applied Biodiversity Science (CABS) at Conservation International, Washington, DC, where he will help expand the activities of the IUCN/SSC Red List Program.

In 1997 Dr Mainka joined SSC as Deputy Coordinator of the Program and since then, has been involved in all aspects of

SSC's work. She also served as Acting Coordinator for part of 1998. She will work closely with SSC's Chair, Mr. David Brackett, and the Commission's Executive and Steering Committees in implementing SSC's new Strategic Plan.

New Deputy Coordinator for IUCN's Species Programme

Dr. Jean-Christophe Vié has been appointed as the new Deputy Coordinator of the IUCN Species Programme and started work in Gland, Switzerland, on 15 October 2001. Jean-Christophe is French, a qualified veterinarian, and has a PhD in evolutionary biology and ecology. He has worked for IUCN as the Programme Coordinator of the Guinea-Bissau office and his broad-ranging expertise includes coastal planning, protected area management, and translocation of species. Jean-Christophe's experience includes the directorship of an NGO dedicated to the study and conservation of Guianan wildlife. His career has also taken him to Saudi Arabia, Gabon and the USA, and he speaks French, English and Portuguese. Jean-Christophe will be responsible for general operations and management of the Species Programme and network support. *From: IUCN Species Survival Commission (SSC) E-Bulletin - August 2001, Editor, Anna Knee.*

Species Survival Commission (SSC) Publications Catalogue

The Species Survival Commission (SSC) Publications Catalogue (July 2001) is now available. An electronic version (in MS-Word) can be downloaded from:

194.158.18.4/intranet/DocLib/Docs/IUCN1062.doc.

This catalogue provides a comprehensive list of SSC publications, but may not include some of the early titles from the 1950s or '60s which are no longer available. It provides a comprehensive list of SSC's published work and includes short summaries of all Action Plans and Occasional Papers. Throughout the catalogue, publications are listed in chronological order with the most recent first.

SSC Publications can be ordered from: IUCN Publications Services Unit, 219c Huntingdon Road, Cambridge CB3 0DL, UK, Tel: +44 1223 277894, Fax: +44 1223 277175, info@books.iucn.org, www.iucn.org/bookstore. Some of the "Out of Print" titles may be available on CD-ROM or as photocopies. Please contact: Cécile Thiéry, Librarian, IUCN-The World Conservation Union, Rue Mauverney 28, CH-1196 Gland, Switzerland, Tel: +41 22 999 01 35, Fax: +41 22 999 00 10, cet@iucn.org.

Mariano Gimenez Dixon

Programme Officer/SSC, IUCN-The World Conservation Union, Rue Mauverney 28, CH-1196 Gland, Switzerland. mgd@hq.iucn.org.

CITES: A Conservation Tool Updated Edition Available

The IUCN/SSC Wildlife Trade Program has completed the seventh edition of "CITES: A Conservation Tool, a guide to amending the Appendices to the Convention on International Trade in Endangered Species of Wild Fauna and Flora." This publication guides the CITES Parties through the Convention's articles and resolutions. It covers the process for the submission, presentation, and adoption of pro-

posals to amend the Appendices for the 12th CITES Meeting of the Conference of the Parties (CoP), 3-15 November 2002 in Chile. The seventh edition has been produced in a booklet form and on CD for the first time. Both CDs and booklets have been distributed to CITES Parties in time for their preparations for the 12th CoP. The guide is available in pdf version in English, French and Spanish via the IUCN/SSC Wildlife Trade Programme web page at: www.iucn.org/themes/ssc/programs/trade.htm.

Newly Launched Wildlife Community Website

WildlifeDecisionSupport.com is proud to announce the launch of its online wildlife community website. The site gives access to specialized information for the wildlife professional, including rehabilitators, veterinarians, ranchers, researchers, game capturers, managers and students.

The website, WildlifeDecisionSupport.com, includes the full text of the current edition of the *Capture and Care Manual* which is out of print. The Manual, a combined effort by 22 specialist authors, has become the definitive reference on the translocation of African wildlife. The site also enables people to share their knowledge and experiences with one another in an interactive, immediate manner. Topics covered in WildlifeDecisionSupport.com include: Capture and care issues (darting, handling, loading, transportation, temporary accommodation, etc.); husbandry in more permanent captivity (zoos, safari parks, etc.); wildlife management issues; rehabilitation; capture and translocation equipment; and telemetry-techniques and technology. Further, a regular newsletter is sent to members which includes: Reviews or lists of recent articles in journals/magazines; notes on updates to the community website; reviews of new products and publications (e.g., book reviews); who's who-people and NGOs; NGO news (especially serious conservation/management projects); letters to the Editor; toolbox-equipment, electronics, etc.; report backs, symposia, etc.; wildlife diary (meetings and conferences); and other issues of interest to the wildlife professional. For more information, visit

WildlifeDecisionSupport.com, or call Riley O'Brien at 012-991-3083, ranger@WildlifeDecisionSupport.com.

Stephen Nash Art Lecture Now on Tape

A video tape of the opening lecture of the 2000 Primate Pathology workshop, held in Madison, Wisconsin, given by Dr. Stephen Nash is now available on loan from the WRPRC. This great presentation, "Primates in Art", was taped by the American Society of Primatologists. To borrow the tape please contact: Ray Hamel, Reference and Special Collections Librarian, hamel@primate.wisc.edu. Call number for the tape: vt0674. Title: Primates in Art: Stephen Nash Lecture. Source: Produced by the IMDC, University of Wisconsin-Madison for the Wisconsin Regional Primate Research Center PHYSDS: VHS; col., sd.; 49 min.: 2000.

ARTICLES

Species and Subspecies of Primates Described Since 1990

Anthony B. Rylands

Center for Applied Biodiversity Science at Conservation International,

Russell A. Mittermeier, and William R. Konstant

Conservation International, 1919 M. Street NW, Suite 600, Washington, DC 20036, USA.

Key words: Primates – Taxonomy

Thirty-six primates (species and subspecies), have been described in the last ten years: ten from Madagascar, eight from Africa, seven from South-east Asia, eight from the Brazilian Amazon (seven of them marmosets), and three from the Brazilian Atlantic forest. Froehlich *et al.* (1998) record the existence of a new macaque species occurring in the Central Sulawesi peninsula, Indonesia, but its formal description has yet to be published (see also Supriatna and Hendras, 2000). Please note that this list is presented without any judgement as to the validity or otherwise of the various primates described.

Table 1:?????

Prosimians	
<i>Pseudopotto martini</i> Schwartz 1996	False potto
<i>Tarsius diana</i> Niemitz, Nietsch, Warter and Rumpler 1991	Dian's tarsier
<i>Galagoides rondoensis</i> Honess 1996	Rondo dwarf galago*
<i>Galagoides udzungwensis</i> Honess 1996	Matundu dwarf galago*
<i>Microcebus ravelobensis</i> Zimmerman, Cepok, Rakotoarison, Zietemann and Radespiel 1998	Lac Ravelobe or golden-brown mouse lemur
<i>Microcebus tavaratra</i> Rasoloarison, Goodman and Ganzhorn 2000	Northern rufous mouse lemur
<i>Microcebus sambiranensis</i> Rasoloarison, Goodman and Ganzhorn 2000	Sambirano mouse lemur)
<i>Microcebus berthae</i> Rasoloarison, Goodman and Ganzhorn 2000	Berthe's mouse lemur
<i>Cheirogaleus ravus</i> Groves 2000	Large iron-grey dwarf lemur)
<i>Cheirogaleus minusculus</i> Groves 2000	Lesser iron-grey dwarf lemur)
<i>Phaner furcifer pallescens</i> Groves and Tattersall 1991	Western fork-crowned lemur)
<i>Phaner furcifer parienti</i> Groves and Tattersall 1991	Sambirano fork-crowned lemur)
<i>Phaner furcifer electromontis</i> Groves and Tattersall 1991	Amber mountain fork-crowned lemur)
<i>Avahi unicolor</i> Thalmann and Geissmann 2000	Unicolor avahi)

*The first descriptions were in "Honess, P. E. (1996). Speciation Among Galagos (Primates: Galagidae) in Tanzanian Forests. Ph.D thesis, Oxford Brookes University, Oxford, UK". While here attributed to Honess (1996), both forms were described and illustrated in Kingdon (1997). Not accepting the validity of a doctoral thesis as a formal published description, the authorship is also attributed to "Honess, 1997" by Groves (2001), referring to the descriptions in Kingdon (1997). Honess and Bearder (1996) also published the descriptions of these species, but issue 2(2), 1996, of *African Primates* was in fact published after Kingdon (1997).

Table 2: ??????

Old World monkeys	
<i>Miopithecus ogouensis</i> Kingdon 1997	Northern talapoin
<i>Cercopithecus cephus ngottoensis</i> Colyn 1999 (Ngotto moustached monkey
<i>Cercopithecus erythrogaster pococki</i> Grubb, Lernould and Oates 1999	Nigerian white-throated guenon
<i>Macaca pagensis siberu</i> Fuentes and Olson 1995	Siberut macaque
<i>Colobus badius semlikiensis</i> Colyn 1991	Red colobus
<i>Procolobus badius epieni</i> Grubb and Powell 1999	Niger Delta red colobus
<i>Presbytis melalophos bicolor</i> Aimi and Bakar 1992	Sumatran sureli
<i>Semnopithecus auratus ebenus</i> Brandon-Jones 1995	Wulsin's ebony leaf monkey
<i>Pygathrix nemaus cinerea</i> Nadler 1997	Grey-shanked douc langur
<i>Rhinopithecus roxellana hubeiensis</i> Wang, Jiang and Li 1998	Hubei golden snub-nosed monkey
<i>Rhinopithecus roxellana qinlingensis</i> Wang, Jiang and Li 1998	Qinling golden snub-nosed monkey

Table 3: ????????

New World monkeys	
<i>Callithrix nigriceps</i> Ferrari and Lopes 1992	Black-headed marmoset
<i>Callithrix mauesi</i> Mittermeier, Ayres and Schwarz 1992	Maués marmoset
<i>Callithrix argentata marcai</i> Alperin 1993	Marca's marmoset
<i>Callithrix saterei</i> Souse e Silva Jr and Noronha 1998	Sateré marmoset
<i>Callithrix humilis</i> Van Roosmalen, Van Roosmalen, Mittermeier and Fonseca 1998	Black-crowned dwarf marmoset
<i>Callithrix manicorensis</i> Van Roosmalen, Van Roosmalen, Mittermeier and Rylands 2000	Manicoré marmoset
<i>Callithrix acariensis</i> (Van Roosmalen, Van Roosmalen, Mittermeier and Rylands 2000	Rio Acari marmoset
<i>Leontopithecus caissara</i> Lorini and Persson 1990	Black-faced lion tamarin
<i>Callicebus personatus barbarabrownae</i> Hershkovitz 1990	Blond titi
<i>Callicebus coimbrai</i> Kobayashi and Langguth 1999	Coimbra-Filho's titi monkey
<i>Cebus kaapori</i> Queiroz, 1992	Ka'apor capuchin

Acknowledgments

The authors thank Ardith Eudey, Jörg Ganzhorn, Thomas Butynski, Douglas Brandon Jones, Jatna Supriatna and Jeffrey Froehlich for help in compiling this list.

References

- Aimi, M.; Bakar, A. 1992. Taxonomy and distribution of the *Presbytis melalophos* group in Sumatra, Indonesia. *Primates* 33: 191-206.
- Alperin, R. 1993. *Callithrix argentata* (Linnaeus, 1771): Considerações taxonômicas e descrição de subespécie nova. *Bol. Mus. Para. Emilio Goeldi, Sér. Zool.* 9(2): 317-328.
- Brandon-Jones, D. 1995. A revision of the Asian pied leaf monkeys (Mammalia: Cercopithecidae; Superspecies *Semnopithecus auratus*), with a description of a new subspecies. *Raffles Bull. Zool.* 43(1): 3-43.
- Colyn, M. 1991. L'importance zoogéographique du bassin du fleuve Zaïre pour la spéciation: La cas des Primates Simiens. *Koninklijk Museum voor Midden-Afrika, Tervuren, België, Annalen. Zoologische Wetenschappen* 264: i-ix, 1-250.
- Colyn, M. 1999. Étude populationnelle de la super-espèce *Cercopithecus cephus* habitant l'enclave forestière Sangha-Oubangui (République Centrafricaine). Description de *C. cephus ngottoensis* subsp. nov. *Mammalia* 63(2): 137-147.
- Ferrari, S.F.; Lopes, M.A. 1992. A new species of marmoset, genus *Callithrix* Erxleben 1777 (Callitrichidae, Primates) from western Brazilian Amazonia. *Goeldiana Zoologia* (12): 1-3.
- Froehlich, J.W.; Supriatna, J.; Hart, V.; Akbar, S.; Babo, R. 1998. The Balan of Balantak: A possible new species of macaque in Central Sulawesi. *Trop. Biodiv.* 5(3): 167-184.
- Fuentes, A.; Olson, M. 1995. Preliminary observations and status of the Pagai macaque. *Asian Primates* 4(4): 1-4. (See Groves, C.P. 1986. The nomenclature of the Tanzanian mangabey and the Siberut macaque. *Austral. Primatol.* 10(4): 2-5.) (See also: Whitten, A.J.; Whitten, J. E.J. 1982. Preliminary observations of the Mentawai macaque on Siberut Island, Indonesia. *Int. J. Primatol.* 3: 445-459)
- Groves, C.P. 2000. The genus *Cheirogaleus*: Unrecognized biodiversity in dwarf lemurs. *Int. J. Primatol.* 21(6): 943-962.
- Groves, C.P. 2001. *Primate Taxonomy*. Smithsonian Institution Press, Washington, DC.
- Grubb, P.; Powell, C.B. 1999. Discovery of red colobus monkeys (*Procolobus badius*) in the Niger Delta with the description of a new and geographically isolated subspecies. *J. Zool., Lond.* 248: 67-73.
- Grubb, P.; Lernoold, J.-M.; Oates, J.F. 1999. Validation of *Cercopithecus eythrogaster pococki* as the name for the Nigerian white-throated guenon. *Mammalia* 63(3): 389-392.
- Hershkovitz, P. 1990. Titi, New World monkeys of the genus *Callicebus* (Cebidae, Platyrrhini): A preliminary taxonomic review. *Fieldiana, Zoology* (55): 1-109.
- Honess, P.E. 1996. Speciation Among Galagos (Primates: Galagidae) in Tanzanian Forests. Ph.D thesis, Oxford Brookes University, Oxford, UK.
- Honess, P.E.; Bearder, S. 1996. Descriptions of the dwarf galago species of Tanzania. *African Primates* 2(2): 75-79.
- Kingdon, J. 1997. *The Kingdon Field Guide to African Mammals*. Academic Press, San Diego.
- Kobayashi, S.; Langguth, A. 1999. A new species of titi monkey, *Callicebus* Thomas, from north-eastern Brazil (Primates, Cebidae). *Revta. Bras. Zool.* 16(2): 531-551.
- Mittermeier, R.A.; Schwarz, M.; Ayres, J.M. 1992a. A new species of marmoset, genus *Callithrix* Erxleben 1777 (Callitrichidae, Primates), from the Rio Maués region, state of Amazonas, Central Brazilian Amazonia. *Goeldiana Zoologia* (14): 1-17.
- Nadler, T. von. 1997. A new subspecies of douc langur, *Pygathrix nemaeus cinereus* ssp. nov. *Zool. Garten N. Z.* 67(4): 165-176.
- Niemitz, C.; Nietsch, A.; Warter, S.; Rumpler Y. 1991. *Tarsius diana*: a new primate species from Central Sulawesi (Indonesia). *Folia Primatol.* 56: 105-116.
- Queiroz, H.L. 1992. A new species of capuchin monkey, genus *Cebus* Erxleben 1777 (Cebidae, Primates), from eastern Brazilian Amazonia. *Goeldiana Zoologia* (15): 1-3.
- Rasoloarison, R.M.; Goodman, S.M.; Ganzhorn, J.U. 2000. Taxonomic revision of mouse lemurs (*Microcebus*) in the western portions of Madagascar. *Int. J. Primatol.* 21(6): 963-1019.
- Schwartz, J.H. 1996. *Pseudopotto martini*: A new genus and species of extant lorisiforme primate. *Anthropological Papers of the American Museum of Natural History* 78: 1-14. (See also Groves, C.P. 1997-1998. *Pseudopotto martini*: A new potto? *African Primates* 3(1-2): 42-43; Bearder, S. 1997-1998. *Pseudopotto*: When is a potto not a potto? *African Primates* 3(1-2): 43-44; Sarmiento, E. 1997-1998. The validity of "*Pseudopotto martini*". *African Primates* 3(1-2): 44-45.)
- Silva, J.S.Jr.; Noronha, M. de A. 1998. On a new species of bare-eared marmoset, genus *Callithrix* Erxleben, 1777, from central Amazonia, Brazil (Primates: Callitrichidae). *Goeldiana Zoologia* (21): 1-28.
- Supriatna, J.; Hendras, W.E. 2000. *Primata Indonesia*. Yayasan Obor Indonesia, Jakarta. 332 pp.
- Thalmann, U.; Geissmann, T. 2000. Distributions and geographic variation in the western woolly lemur (*Avahi occidentalis*) with description of a new species (*A. unicolor*). *Int. J. Primatol.* 21(6): 915-941.
- Van Roosmalen, M.G.M.; Van Roosmalen, T.; Mittermeier, R.A.; da Fonseca, G.A.B. 1998. A new and distinctive species of marmoset (Callitrichidae, Primates) from the lower Rio Aripuanã, state of Amazonas, central Brazilian Amazonia. *Goeldiana Zoologia* (22): 1-27.
- Van Roosmalen, M.G.M.; Van Roosmalen, T.; Mittermeier, R.A.; Rylands, A.B. 2000. Two new species of marmoset, genus *Callithrix* Erxleben, 1777 (Callitrichidae, Primates), from the Tapajós/Madeira interfluvium, south central Amazonia, Brazil. *Neotrop. Primates* 8(1): 1-18.
- Wang Y.; Jiang X.; Lid D. 1998. Classification and distribution of the extant subspecies of golden snub-nosed monkey (*Rhinopithecus [Rhinopithecus] roxellana*). In: *The Natural History of the Doucs and Snub-nosed Monkeys*, N. G. Jablonski (ed.), pp.53-64. *Recent Advances in Human Biology*, Vol. 4. World Scientific Publishing Company, Singapore. (See also: Wang Y., Jiang X., Lid D. 1994. Classification of existing subspecies of golden snub-nosed monkey, *Rhinopithecus roxellana* (Colobinae, Primates). In: *Handbook and Abstracts. XVth Congress of the International Primatological Society*, 3-8 August 1994, Kuta, Bali, Indonesia, p. 277. Abstract).
- Zimmermann, E.; Cepok, S.; Rakotoarison, N.; Zietemann, V.; Radespiel, U. 1998. Sympatric mouse lemurs in north-west Madagascar: A new rufous mouse lemur species. *Folia Primatol.* 69: 106-114.

How Do Black-and-White Ruffed Lemurs Still Survive in a Highly Disturbed Habitat?

Jonah H. Ratsimbazafy

Interdepartmental Doctoral Program in Anthropological Sciences and the Department of Anthropology, SUNY at Stony Brook, Stony Brook, NY 11794-4364, USA.
jratsimb@ic.sunysb.edu

Harisoa V. Ramarosandratana

Departement de Botanique, Faculte des Sciences, Universite d'Antananarivo, (101) Antananarivo, Madagascar, micet@dts.mg

Rigobert J. Zaonarivelo

Departement de Paleontologie et d'Anthropologie Biologique, Faculte des Sciences, Universite d'Antananarivo, (101) Antananarivo, Madagascar, gerp@dts.mg

Key words: Lemurs, *Varecia variegata*, cyclones, habitat disturbance

Introduction

In Madagascar, habitat disturbance is not only restricted to anthropogenic pressures, as natural disturbances are also a concern (Jolly 1989; Richard and O'Connor 1997; Wright 1997). However, little has been written about the impact of natural disasters [e.g. flood (Peres 1997); chronic wind (Laurence 1997); cyclone (Wright *et al.* in prep.)]. The island of Madagascar is within the cyclone belt (10°-20° S) and forest ecosystem must endure these stochastic catastrophes (Donque 1975; Ganzhorn 1995). Therefore, the rain forests of Madagascar are a good location for studying the behavioral response of lemurs to an environment with a history of stochastic wind throw damage from the annual cyclone season (Balko 1998).

Background

Manombo forest is one of the last remaining tracts of coastal lowland forest in southeastern Madagascar. On January 24, 1997 the area was hit by Cyclone Gretelle with winds of over 245 km per hour extending over a 12 hour period. This monumental climatic event caused extensive damage. Post-cyclone botanical transect studies revealed 85% canopy loss. Population densities of two diurnal lemurs, the black-and-white ruffed lemur (*Varecia v. variegata*) and the white-collared brown lemur, (*Eulemur fulvus albocollaris*) were diminished by half (Wright *et al.* in prep.). Following this event, an eighteen month post-cyclone study was conducted at Manombo on the behavioral ecology of black-and-white ruffed lemur, the southernmost population of this species. Very little has been published on the effects of habitat disturbance on the behavioral ecology of *Varecia*. Studies in Ranomafana National Park have shown that *Varecia* is absent from the most intensively disturbed site (White *et al.* 1995; Balko 1998).

Study Site

Manombo forest is located in the Province of Fianarantsoa at 23°02'S and 47°44'E (Fig. 1). The Manombo Special Reserve and Classified Forest cover 14,000 hectares, but only 9,000 hectares remains forested (Ratsimbazafy, in prep.). The elevation ranges from 0 to 137 meters. Mean annual temperature is 23°C (range 31-13°C). Mean annual precipitation is 2500 mm. February is the wettest month (690 mm) and July is the driest month (79 mm) (Donque 1975). During January through March, the area is subject to cyclones from the Indian Ocean that cause flooding, stream-course changes, and extensive tree blow-downs. Wind damage and dry-season fires put this isolated lowland forest and the surrounding deforested grassland in jeopardy. Manombo forest is home to eight sympatric species of prosimian primates and a variety of rodents, raptors and carnivores. Manombo has the highest diversity of land snails of any rainforest in the world (Emberton 1995). Many of the plants at Manombo are found nowhere else in the world (Wright *et al.* in prep.).

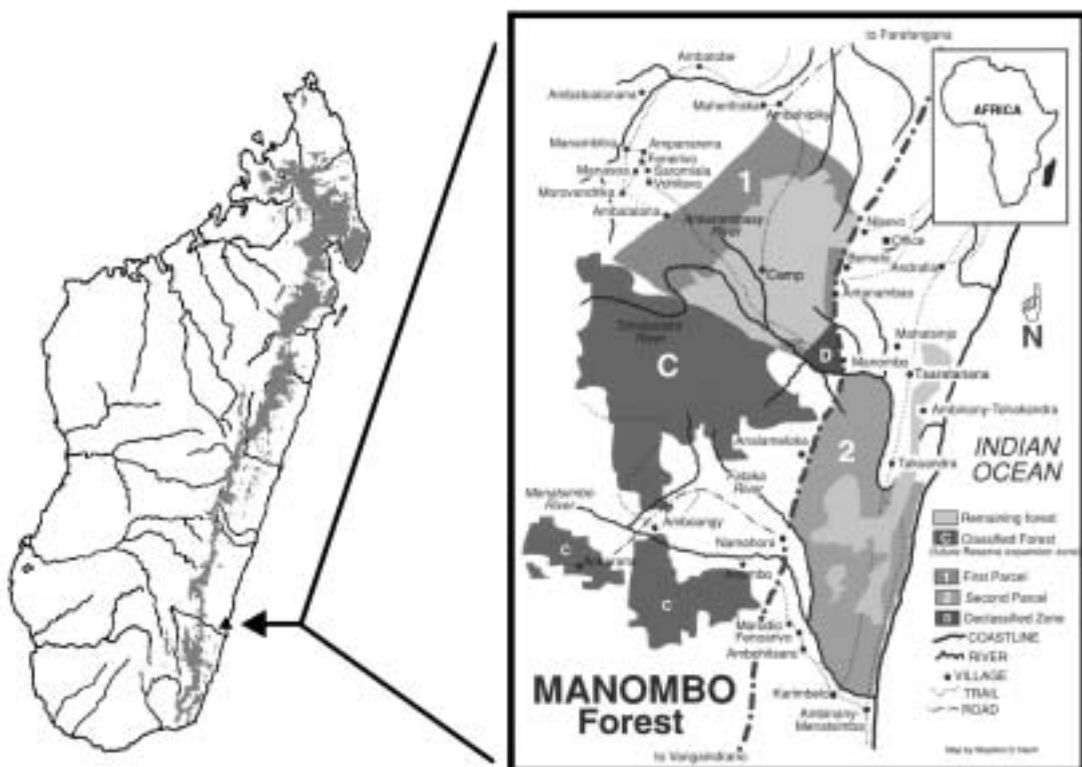


Fig.1: Manombo Forest.

Objectives

The research objective was to study the effects of changes in food supply, through natural catastrophe and anthropogenic disturbances on the behavioral ecology of black-and-white ruffed lemurs. *Varecia* is highly frugivorous, but it can supplement its diet with small amount of other items (e.g. nectar, leaves, flowers, buds, shoots, and fungi) when preferred food is scarce (see Morland 1991; Rigamonti 1983; White *et al.* 1995; Vasey 1998; Balko 1998). *Varecia* is thus an ideal candidate for this natural experiment. This study allowed us to determine the effects of habitat degradation on *Varecia v. variegata* and their adaptive response. In this study, we investigated the differences in grouping patterns and foraging group size, diet composition, activity budgets, number of offspring produced, and infant survival of ruffed lemurs.

Methods

Behavioral data was collected on two groups within the sites at Manombo forest. Data collection procedures involved focal animal sampling (Altmann 1974). The activity of a focal animal was recorded at 5-minutes intervals for an entire day, or as long as possible. Behaviors were described at a general level (forage, feed, travel, rest, other). The food item and the part eaten were categorized and described as ripe or unripe, new or mature leaves, flower parts or miscellaneous materials (dirt, bark, etc.).

The ecological sampling methods were the same as those used by Balko (1998) on *Varecia* in Ranomafana National Park. Bi-monthly records of fruits, flowers and leaf availability and abundance were made for each tagged phenology tree. Daily temperature and daily rainfall were recorded.

Results

Cyclone Gretelle destroyed more than 50 % of the woody vegetation in the entire forest. The damage involved the uprooting of trees, breakage of trunks and large branches, and extreme defoliation and loss of twigs particularly in the upper layers of the forest. Five months after the cyclone, botanical transects revealed 85 % canopy loss. Many trees which survived the immediate effects of cyclone died within 36 months. In addition, 95 % of trees taller than 15 meters stopped flowering and fruiting after the cyclone.

Clearly, this cyclone caused about 50 % reduction of population density of the black-and-white ruffed lemur and brown collared lemur. The 1995 and 1996 *Varecia* census results estimated a total of 552 animals in both the Reserve and the Classified Forest (Wright *et al.* in prep). Populations of *Varecia* thirty-six months after the cyclone were estimated at less than 264 animals (0.04 individuals per hectare), including both the Manombo forest blocks (Ratsimbazafy unpub.)

During the eighteen-month study (February 1999 to July 2000), a total of 1477 hours of behavioral data were collected. For the *Varecia*'s activity pattern, they spent 68 % of their time on resting, 25 % on feeding, 6 % on traveling and 1% on social interactions (mutual grooming and others).

We identified trees belonging to 268 different species and 68 families at Manombo. During the study, we recorded 86 species of plants eaten by *Varecia*. The most commonly utilized families of food plants are Moraceae, Palmae, Annonaceae, Sapindaceae, Clusiaceae, and Euphorbiaceae.

Among the 86 species that were food-sources for *Varecia* (Table 1), 62 % of them are exploited by people for different purposes (firewood, canoes, construction, furniture, etc).

The diet of *Varecia* was composed mainly of fruits, followed by leaves and nectar. Even living in a highly disturbed habitat, *Varecia* are still primarily frugivorous, despite the lowered availability of ripe fruits normally preferred by this species. Fruits composed 73 % of their diet, but at Manombo

Table 1: Food sources for *Varecia v. variegata*.

Family	Scientific name	Vernacular name	Part eaten
Annonaceae	<i>Monanthes pilosa</i>	vahatsimatra	Fr
Annonaceae	<i>Polyalthia oligosperma</i>	ramiavitoloaha	Fr, Lv
Annonaceae	<i>Xylopi</i> sp.	fotsivony	Fr
Apocynaceae	<i>Landolphia platyclada</i>	vahateso	Fr
Apocynaceae	<i>Plactanea</i> sp.		Fr
Aspleniaceae	<i>Asplenium nidus</i>	betoboka (velomiato)	Lv
Burseraceae	<i>Canarium madagascariensis</i>	ramy	Fr
Clusiaceae	<i>Symphonia urophylla</i>	haziny	Fr, Lv
Clusiaceae	<i>Garcinia aphanophebia</i>	kimba	Fr, Lv
Clusiaceae	<i>Mammea</i> sp.	kimba	Fr
Clusiaceae	<i>Garcinia chapelieri</i>	kimba	Fr
Combretaceae	<i>Hirtella tamenaka</i>	tamenaka	Lv
Combretaceae	<i>Terminalia mentaly</i>	masomposaina	Fr
Connaraceae	<i>Agelae pentagyna</i>	vahibe	Lv
Cunoniaceae	<i>Weinmania rodoxylon</i>	varikanda	Fr
Cyperaceae	<i>Cyperus latifolius</i>	harana	Fr
Ebenaceae	<i>Diospyros platicalyx</i>	hazomainty	Lv
Erythroxylaceae	<i>Erythroxylon sphaeranthum</i>	menahihy	Lv
Euphorbiaceae	<i>Uapaca louvelii</i>	voapaky	Fr
Euphorbiaceae	<i>Anthostema madagascariensis</i>	baby (raloto)	Fr
Euphorbiaceae	<i>Cecropia peltata</i>	tanatana	Fr
Euphorbiaceae	<i>Cleistanthus bovinianum</i>	taimbarika	Lv
Fabaceae	<i>Cynometra cloiselii</i>	variotra	Lv
Fabaceae	<i>Calliandra alternans</i>	ambilazona	Lv
Flacourtiaceae	<i>Aphloia theaformis</i>	fandramanana	Fr
Flacourtiaceae	<i>Hemalium</i> sp.	tsimbotry	Fr
Hypericaceae	<i>Harungana madagascariensis</i>	harongana	Fr
Icaninaceae	<i>Apodytes</i> sp.	malanimanta	Fr
Lauraceae	<i>Cryptocaria</i> sp.	vitano	Fr, Lv
Lauraceae	<i>Ocotea</i> sp.	varongy	Lv
Lianaceae	<i>Hugonia</i> sp.1	vahamavo	Fr
Melastomaceae	<i>Clidemia hirta</i>	voatrotrokala	Fr
Melastomaceae	<i>Memecyclon</i> sp.	tomizo	Lv
Menispermaceae	<i>Burisia madagascariensis</i>		Fr
Moraceae	<i>Ficus baroni</i>	amontana	Fr
Moraceae	<i>Ficus reflexa</i>	laza	Fr
Moraceae	<i>Ficus rubra</i>	vahinonoka	Fr
Moraceae	<i>Bosqueia boiviniana</i>	kivozoala	Fr, Lv
Moraceae	<i>Pachytrophe dimepate</i>	andrimena	Fr
Moraceae	<i>Treculia</i> sp.	hazosavao	Fr
Myrtaceae	<i>Eugenia emimense</i>	rotra	Fr
Myrtaceae	<i>Syzygium</i> sp.1	rotra fotsy	Fr, Lv
Oleaceae	<i>Norohnia myrtoides</i>		Fr
Oleaceae	<i>Norohnia</i> sp.2	silaitra	Fr
Palmae	<i>Dypsis gracilis</i>	varaotry	Fr
Palmae	<i>Dypsis nauseosa</i>	mangidibe	Fr, Ex
Palmae	<i>Vonitra thoursii</i>	vonitra	Fr
Palmae	<i>Dypsis</i> sp.1	vakaky	Fr, Br, Ex
Pandanaceae	<i>Pandanus</i> sp.1	tsiriky	Fr
Pandanaceae	<i>Pandanus</i> sp.2	tsiriky	Fr
Polyporaceae (fungus)	<i>Polyporus</i> sp.	olatra	other
Rubiaceae	<i>Coffea</i> sp.1	maranitrantany	Fr
Rubiaceae	<i>Rothmania</i> sp.1	bevoa	Fr
Rubiaceae	<i>Rothmania</i> sp.2	fotsikatry	Fr
Rubiaceae	<i>Gaertnera stipula</i>	belakevo	Fr
Rubiaceae	<i>Breonia chinense</i>	valotra mainty	Fr
Rubiaceae	<i>Breonia</i> s.p1	valo-drano	Fr
Rubiaceae	<i>Gaertnera</i> sp.	hazondambo	Fr
Rutaceae	<i>Vepris</i> sp1	kalavelo	Fr
Sapindaceae	<i>Sapindacus</i> sp.	hazomby	Lv
Sapindaceae	<i>Macphersonia madagascariensis</i>	sanirafotsy	Fr
Sapindaceae	<i>Prothorus ditimena</i>	sandramy	Fr
Sapindaceae	<i>Prothorus sericea</i>		Fr
Sapindaceae	<i>Tina</i> sp.1	lanary	Lv

Family	Scientific name	Vernacular name	Part eaten
Sapotaceae	<i>Labramia louvelii</i>	nato	Fr
Sapotaceae	<i>Gambeya madagascariensis</i>	harongampa nihy (rahiaka)	Fr
Sarcolaenaceae	<i>Schizolena cauliflora</i>	foto	Nr
Sterculiaceae	<i>Dombeya lucida</i>	hafomena	Fr
Sterculiaceae	<i>Dombeya</i> sp.	hafotra	Fr, Lv
Sterculiaceae	<i>Sterculia tavia</i>	aboladitra	Fr
Strelitziaceae	<i>Ravenala madagascariensis</i>	ravinala	Nr
Tiliaceae	<i>Grewia</i> sp.	hafopotsy	Fr
Ulmaceae	<i>Trema orientalis</i>	andrarezina	Fr
Verbenaceae	<i>Vitex cauliflora</i>	mazambodiala	Fr
Unknown	11 unknown spp.		Fr

Fr: Fruit; Lv: Leaves; Nr: Nectar; Br: Bracte (modified leaf in the inflorescence); Ex: Exudate

most of those fruits were unripe. *Varecia* ate enormous amounts of fruits from two non-endemic invasive plant species, *Clidemia hirta* (Melastomataceae) and *Cecropia peltata* (Euphorbiaceae). Although these two alien plant species constituted only 8% of the total fruit trees used by the two study groups, the lemurs spent 75 % of their time feeding on them. A species of fungus, *Polyporus* sp. (Polyporaceae) was very appreciated by *Varecia* when available. An attempt was made to estimate the number of food items consumed, but it was not possible to determine the actual number of fruits eaten per animal. Most fruits eaten were very small (85 % of fruits taken were less than 3 cm long). *Varecia v. variegata* group size was much smaller in Manombo forest than in Ranomafana National Park/Valohokaka (pristine forest). In Manombo, mean group size was 2.5 (n = 8), whereas in Ranomafana National Park mean group size was 7. During the study, we never found any group with more than four individuals. A single animal foraging was often observed when food is scarce. Group daily travel distance varied between 30 to 400 meters during cold weather, when food resources are limited. However, in warmer weather, individuals may travel over 2000 meters to forage between patches of preferred food. The study groups have not produced any infants in the three years since the cyclone, and six other groups observed also had no infants.

Discussion

Most of the preferred food trees of *Varecia* were destroyed or suffered substantial damage to their crowns when cyclone Grettele tore through Manombo forest in January 1997. There was a marked drop in production of flowers and fruits among trees, and flowers among shrubs, shortly after the cyclone. Most big trees are still producing new branches and leaves to assure their survival from photosynthesis; however, fruit production is still limited. In consequence, due to the long-term shortage of food supply, the *Varecia* at Manombo have apparently become opportunistic feeders. The two alien plant species, *Clidemia hirta* and *Cecropia peltata*, became major food sources of *Varecia v. variegata*, because both species have greater reproductive potential. Fruits of *Clidemia hirta* are available all year-around and *Cecropia peltata* starts to produce fruits from December until July, whereas most of the native fruit trees produce fruits only two or three months a year or every other year. As noted by a number of authors (e.g., Pollock 1975; Hemingway 1995; Overdorff 1996) very few common plants fruit every year, and fruiting patterns show long periodicity and irregularity in Malagasy rain forests. Therefore, although those alien plants are undesirable because they decrease the diversity of native flora, they were consumed more frequently as "food of last resort" (Terborgh 1983). The *Varecia*'s ranging patterns reflect their adoption of an "energy minimizer" strategy with short path lengths and re-

liance on food from lianas, shrubs, and epiphytes. We believe that the ability to supplement their diet opportunistically with other food resources is one of the reasons that *Varecia* still persists in Manombo's highly disturbed habitat. The asynchronous fruiting pattern of the major food trees and the absence of potential competitors also reduce the vulnerability of the *Varecia* population and help them persist in Manombo.

However, small group size, and/or frequently-solitary foraging, are good indicators of persistent stress. The groups have not had any reproductive success in the three years since the cyclone. It is possible that the available food resources were not sufficient for the females to conceive and/or sustain pregnancies. Our results reflect the links between environmental variability and female fertility as found by Richard *et al.* (2000) in wild *Propithecus verreauxi* at Beza Mahafaly. They found that females lost significantly more mass than males during the drought, and lighter females were more unlikely to give birth in the following birth season.

Acknowledgments

We would like to acknowledge the National Association for the Management of Protected Areas (ANGAP) and the Department of Waters and Forests (DEF) for permission to work at Manombo Special Reserve and the Classified Forest. Thanks to the Malagasy Institute for the Conservation of the Environment Tropical (MICET), and in particular Benjamin Andriamihaja for logistical assistance. We are grateful to the Department of Anthropology and the Department of Botany of the University of Antananarivo, and in particular to Dr. Berthe Rakotosamimanana and Dr. Vololoinaina Jeannoda. Our thanks also go to Dr. Patricia Wright and the staff of the Institute for the Conservation of Tropical Environments (ICTE) at SUNY Stony Brook. We appreciate the help and advice of numerous colleagues in the United States, notably Sukie Zeeve, Mitch Irwin and Stephen Nash. I gratefully thank to Liz Balko and Natalie Vasey. This study would not possible without the assistance of Paul Rasabo, Faly Razafy, Ramarolahy Tranga, Lezo, Jean Denis, Tsilefa, Edward Louis, Eileen Larney, Guy Randriatahina, Noromalala Ravololomanana, Rakotonirina Benja, Roger Lala, Rabarison, Roger Edmond, Hery, Mbinina, Serge Ratsirahonana, Jennifer Burns, Ranelson and the late Romule. Funding and support for the project have been provided by: the Wildlife Trust; the Rockefeller Foundation; the Margot Marsh Biodiversity Conservation Foundation; the Primate Conservation Inc.; the Wildlife Conservation Society; and the Brookfield Zoo.

References

- Altmann, J. 1974. Observation study behavior; sampling methods. *Behavior* 49: 227-267
- Balko, E.A. 1998. A behaviorally plastic response to forest composition and habitat disturbance by *Varecia variegata variegata* in Ranomafana National Park, Madagascar. Ph.D diss. State University of New York - College of Environmental Science and Forestry, Syracuse, NY.
- De Thoisy, B.; Richard-Hansen, C. 1997. Diet and social behavior changes in red howler monkey (*Alouatta seniculus*) troop in a highly degraded rain forest. *Folia Primatol.* 68: 357-361.
- Donque, G. 1975. Les cyclones tropicaux des mars malgaches. *Madagascar Revue de Geographie* 27:9-63.
- Emberton, K.C. 1995. Land-snail community morphologies of the highest-diversity sites of Madagascar, North America, and New Zealand, with recommended alternatives to height-diameter plots. *Malacologia* 36 (1-2): 43-66.
- Estrada, A.; Coates-Estrada, R. 1996. Tropical rain forest fragmentation and wild populations of primates at Los Tuxtlas, Mexico. *Int. J. Primatol.* 17(5): 759-783.

- Foerg, R. 1982. Reproductive behavior in *Varecia variegata*. *Folia Primatol.* 38: 108-121.
- Ganzhorn, J.U. 1994. Lemurs as indicators for habitat change. Pp. 51-56. In: *Current Primatology, Vol I: Ecology and Evolution*. B. Thierry, J.R. Anderson, J.J. Roeder, N. Herrenschmidt (eds.) Strasbourg, University of Louis Pasteur.
- Ganzhorn, J.U. 1996. Effects of selective logging on the reptile fauna of the Kirindy forest with special emphasis on the flat-tailed tortoise (*Pyxis planicauda*). Pp. 189-202. In: J.U. Ganzhorn, J-P. Sorg (eds.). *Primate Report 46-1*. Göttingen.
- Ganzhorn, J.U.; Wright, P.C.; Ratsimbazafy, J.H. 1999. Comparisons of primate communities in east and west Madagascar. Pp. 75-89. In: *Primate Communities*. J. Fleagle, C. Janson, K.E. Reed (eds). Cambridge University Press, Cambridge.
- Green, G.; Sussman, R. 1990. Deforestation history of the eastern rain forests of Madagascar from satellite images. *Science* 248: 212-215.
- Hemingway, C.A. 1995. Feeding patterns of the Milne-Edwards'sifaka in relation to phenological patterns and forest composition. P. 28. In: *Environmental Change in Madagascar*. B.D. Patterson, S.M. Goodman, J.L. Sedlock (eds). Chicago: The Field Museum of Natural History.
- Janson, C.H.; Goldsmith, M.L. 1995. Predicting group size in primates: foraging costs and predation risks. *Behav. Ecol.* 6: 326-336.
- Johns, A.D. 1983. Wildlife can live with logging. *New Sci.* 99: 206-211.
- Johns, A.D. 1991. Forest disturbance and Amazonian primates. Pp. 115-135. In: *Primate responses to environmental change*. H.O. Box (ed.). New York: Chapman & Hall
- Johns, A.D.; Johns, B.G. 1995. Tropical forest primates and logging: long-term coexistence? *Oryx* 29: 205-211.
- Jolly, A. 1989. The Madagascar challenge: human needs and fragile ecosystems. Pp. 198-215. In: *Development strategies for a common agenda*. M.J. Leonard (ed). Transaction Books, New York.
- Laurence, W.F. 1997. Hyper-disturbed parks: Effects and the ecology of isolated rainforest reserve in tropical Australia. Pp.71-83. In: *Tropical forest remnants: ecology, management, and conservation*. W.F. Laurance, R.O. Bierregaard, Jr. (eds.). University of Chicago Press, Chicago.
- Morland, H.S. 1989. Infant survival and parental care in ruffed lemurs (*Varecia variegata*) in the wild. (Abstract) *Am. J. Primatol.* 18: 157.
- Morland, H.S. 1991. Social organization and ecology of black-and-white ruffed lemurs (*Varecia variegata variegata*) in lowland rain forest, Nosy Mangabe, Eastern Madagascar. Ph.D dissertation, Yale University.
- Morland, H.S. 1993. Reproductive activity of ruffed lemurs (*Varecia variegata variegata*) in a Madagascar rain forest. *Am. J. Phys. Anthropol.* 91: 71-82.
- Overdorff, D.J. 1996. Ecological correlates to social structure in two lemur species in Madagascar. *Am. J. Phys. Anthropol.* 100: 487-506.
- Peres, C.A. 1997. Effects of habitat quality and hunting pressure on arboreal folivore densities in neotropical forests: A case study of howler monkeys (*Alouatta* spp.). *Folia Primatol.* 68: 199-222.
- Plumptre, A.J.; Reynolds, V. 1994. The effect of selective logging on the primate populations in the Budongo Forest Reserve, Uganda. *Journal Appl. Ecol.* 31: 631-641.
- Pollock, J.I. 1975. The social behavior and ecology of Indri. Ph.D. thesis, London, University.
- Porton, I.J. 1989. International Studbook Ruffed Lemur, *Varecia variegata*. St Louis Zoological Park.
- Ratsimbazafy, J.H.; Ratsirahonana, S.H. 1998. Effects of Forest Composition and Habitat Disturbance on the Social Organization and Feeding Ecology of Black-and-White Ruffed Lemurs (*Varecia variegata variegata*) at Manombo Special Reserve, Madagascar. VIIth Congress IPS. Antananarivo, Madagascar.
- Ratsimbazafy, J.H. 2001. Managing for Recovery from Catastrophic Habitat Reduction. XVIIIth Congress IPS. Adelaide, Australia.
- Richard, A.F.; O'Connor, S. 1997. Degradation, transformation and conservation: The past, present, possible future of Madagascar's environment. Pp: 406-418 In: *Natural change and human impact in Madagascar*. S.M. Goodman, B.D. Patterson (eds). Smithsonian Institution Press, Washington, DC.
- Richard, A.F.; Dewar, R.E.; Schwartz, M.; Ratsirarson, J. 2000. Mass change, environmental variability and female fertility in wild *Propithecus verreauxi*. *J. Hum. Evol.*, 39: 381-391.
- Rigamonti, M.M. 1993. Home range and diet in red ruffed lemurs (*Varecia variegata rubra*) on the Masoala Peninsula, Madagascar. Pp. 25-39. In: *Lemur Social Systems and Their Ecological Basis*. P.M. Kappeler, J.U. Ganzhorn (eds). Plenum, New York,
- Rylands, A.B.; Keuroghlian, A. 1988. Primate populations in continuous forest and forest fragments in Central Amazonia. *Acta Amazonica*, 18: 291-307.
- Skorupa, J.P. 1986. Responses of rain forest primates to selective logging in Kibale Forest, Uganda: a summary report. Pp. 57-70 In: *Primates: The Road to Self-sustaining Populations*. K. Bernirschke (ed.). Springer-Verlag, New York.
- Sussman, R.W.; Green, G.M.; Sussman, L.K. 1994. Satellite imagery, human ecology, anthropology and deforestation in Madagascar. *Hum. Ecol.* 22: 333-54.
- Terbogh, J.; Janson, C. 1983. *Five New World Primates: A Study in Comparative Ecology*. Princeton University Press, Princeton.
- Tilden, C.T 1993. *Reproduction Energetics of Prosimians*. Ph.D. dissertation, Duke University.
- Vasey, N. 1998. *Community ecology and behavior of Varecia variegata rubra and Lemur fulvus albifrons, on the Masoala Peninsula, Madagascar*. PhD dissertation, Washington University, St. Louis, MO.
- WPTI/Newsletter 1998. Madagascar – A World Apart. In: *On The Edge*. No. 61.
- Wright, P.C. 1997. The future of biodiversity in Madagascar: A view from Ranomafana National Park. Pp: 381-405. In: *Natural Change and Human Impact in Madagascar*. S.M. Goodman, B.D. Patterson (eds). Smithsonian Press, Washington, D.C.
- Wright, P.C. 1999. Lemur Traits and Madagascar Ecology: Coping with an Island Environment. *Yearbook Phys. Anthropol.* 42: 31-72.
- Wright, P.C.; White, F.J. 1990. The rare and the specialized: Conservation needs of rain forest primates in Madagascar. *Am. J. Phys. Anthropol.*, 81 (2, Annual Meeting Issue): 320.
- Wright, P.C.; Ratsimbazafy, J.H.; Shah, N.; Johnson, S.; Stumpf, R.; Kitko, R. in prep. Cyclone damage to forest structure and lemur populations in coastal lowland rain forest in Madagascar: Manombo Reserve (Farafangana).

Probable pollination of *Brexia madagascariensis* (Lam.) Ker Gaul. by *Eulemur fulvus* at Ambila-Lemaitso, Madagascar

Chris Birkinshaw

Missouri Botanical Garden, Madagascar Research and Conservation Program, BP 3391, Antananarivo 101.

chrisB@malagasy.com

Key words: Lemurs - Pollination

To date thirteen lemur species have been reported to consume nectar (sometimes with pollen) from 23 species of plant native to Madagascar in 16 different families and from three alien species in three families (Birkinshaw and Colquhorn in press). In some cases the lemur comes into contact with the anthers and stigmas, does not damage the reproductive parts, and visits the flowers of several individuals in a short period of time, and thus probably effects pollen transfer (e.g., *Ravenala madagascariensis* and *Parkia madagascariensis* [Birkinshaw and Colquhorn 1998]). However, in other cases, the lemur fails to satisfy these conditions and therefore does not pollinate the species; indeed it may reduce the fecundity of the individual exploited (e.g. *Symphonia* spp. [Kobinah Abdul-Salim pers. comm.]). As a contribution to the literature on the lemur pollination an account is presented here of the probable pollination of *Brexia madagascariensis* by *Eulemur fulvus* at Ambila-Lemaitso (18°49' S, 49°08' E; Toamasina Prov.).

Previously, the genus *Brexia* has been placed in several families (Escalloniaceae, Saxifragaceae, Grossulariaceae, and in the monogeneric family Brexiaceae), but recent molecular data suggest that it should be included in Celastraceae (Schatz 2001). *Brexia madagascariensis* is reported from Madagascar, Tanzania, Comores and Seychelles, where it normally grows in littoral forest (Perrier de la Bâthie 1933). It is a large many-branched shrub growing up to 10 m high with large, simple, leathery leaves (toothed on young plants, untoothed later) and umbellate inflorescences comprising up to 5 flowers borne on a tough flattened strap-like peduncle up to 5 mm wide and 8 cm long. The inflorescence tends to lie on top of the foliage with the flowers orientated downwards. The flowers consist of 5 small fused sepals, and 5 thick pale-green petals that form a bowl shaped corolla ca. 2.3 cm in diameter, 5 exerted stamens that open towards the centre of the flower, a nectary disc with a lacerate fringe, and a superior ovary with single exerted style and lobed stigma (Fig. 1). At the time of the observations (early morning) sweet-tasting nectar filled the base of the corolla bowl and gathered on the petals in large drops.



Fig. 1: Inflorescence of *Brexia madagascariensis*.

At 07.00 on 26 September 2000 a group of 5 *Eulemur fulvus* were seen travelling directly to a flowering plant of *Brexia madagascariensis*. They climbed into the plant from adjacent vegetation and manipulating the inflorescence in their hands they licked-up the nectar from the open flowers. They exploited several inflorescences on the plant before moving on to visit inflorescences of two neighbouring plants about 10 m away. While drinking the nectar the lemurs did not damage the flower and its snout came into contact with the flower's stigma and anthers. At 07.30 the lemurs left the *B. madagascariensis* plants and began to eat the fruits of a nearby fig (*Ficus* sp.).

On the basis of the criteria given above it seems probable that *E. fulvus* pollinates *B. madagascariensis*. However, given the large number of lemur species that have been reported to exploit nectar, the extensive distribution of *B. madagascariensis* in Madagascar and the easy accessibility of its nectar, it seems likely that the flowers of this plant are also visited and pollinated by other lemur species. In addition, several characters of *B. madagascariensis* suggest that its flowers may also be exploited by fruit bats, which could likewise effect pollination, i.e.: the colour and shape of the flower, the presence of nectar in the early morning (suggesting nocturnal secretion), the position of the inflorescences outside the foliage where they would be easily accessible to a volant mammal, and its occurrence in littoral forest (a habitat particularly favoured by feeding fruit bats [van der Pijl, 1957]).

References

- Birkinshaw, C.R.; Colquhorn, I. 1998. Pollination of *Ravenala madagascariensis* and *Parkia madagascariensis* by *Eulemur macaco* in Madagascar. *Folia Primatol.* 69: 252-259
- Birkinshaw, C.R.; Colquhorn, I. in press. Lemur food plants. In: *The Natural History of Madagascar*. S.M. Goodman, J. Benstead (eds.) University of Chicago Press. Chicago.
- Pijl, L. van der 1957. The dispersal of plants by bats (chiropterochory). *Acta Botanica Néerlandica* 6: 291-315
- Perrier de la Bâthie, H. 1933. Les Brexiées de Madagascar. *Bull. Soc. Bot. France* 80: 198-214.
- Schatz, G. 2001. *Generic Tree Flora of Madagascar*. Missouri Botanical Gardens & Royal Botanic Gardens, Kew.

Why *Propithecus verreauxi deckeni* and *P. v. coronatus* are valid taxa - quantitative and qualitative arguments

Urs Thalmann

Anthropological Institute, University of Zürich, Winterthurerstr. 190, 8057 Zürich, Switzerland, uthal@aim.unizh.ch (adresse for correspondence)

Rolf Kümmerli

Institute of Ecology-ZEA, University of Lausanne, Biology Building, 1015, Lausanne, Switzerland. rolf.kuemmerli@ie-zea.unil.ch

Alphonse Zaramody

Department of Earth Sciences, University of Mahajanga, P.O. Box 652, Mahajanga, 401 Madagascar. zaramody@gmx.net

Key words: Madagascar, Lemurs, *Propithecus verreauxi*, Species Concepts, Subspecies, Distribution, Chromatic Variation

Introduction

Subspecies are defined as "an aggregation of phenotypically similar populations of a species that inhabit a geographical

segment of the distribution range of a species and can be taxonomically distinguished from other populations of that species" (Mayr 1963: p. 348; Mayr and Ashlock 1991: p. 43). As a rule of thumb, Mayr (1963; Mayr and Ashlock 1991) recommended that 75 % of all individuals of a population should be different from all other individuals within the species, which corresponds to a Non-Overlap of 90 %. Although the subspecies concept has been criticized because of some inherent problems, it is commonly used and accepted to describe population entities that correspond to the above definition (for more details see Groves 2001a: p. 35-37).



Fig. 1: Classic *Propithecus verreauxi deckeni* from Bemaraha (above) and *P. v. coronatus* from Anjamena (below).

The case of two populations of western sifaka, Decken's sifaka and the crowned sifaka (Fig. 1), commonly included as *Propithecus verreauxi deckeni* and *P. v. coronatus* within the species *Propithecus verreauxi*, has attracted some attention because chromatic variation has been documented within them (Petter and Peyrieras 1972; Petter *et al.* 1977; Tattersall 1982, 1986, 1988; Thalmann and Rakotoarison

1994a,b; Curtis *et al.* 1998; Manganirina *et al.* 2001). It has been suggested that the two forms are not valid subspecies, this is based on evidence of sympatry (Tattersall 1988) and mtDNA (Pastorini *et al.* 2001). If a valid subspecies, *P. v. coronatus* has to be considered one of the most endangered lemurs of Madagascar. If the critically endangered *P. v. coronatus* is synonymized for priority reasons with *P. v. deckeni*, to form a chromatically variable subspecies of *P. verreauxi deckeni*, its conservation status would, at best, be vulnerable, i.e. two categories lower. We are, hence, confronted with a question that could severely influence conservation measures for a taxon. In the most recent and comprehensive revision of primate taxonomy, Groves (2001a) still recognizes the two subspecies *deckeni* and *coronatus* as valid taxa but includes them within the full species *Propithecus deckeni*. This species along with the monotypic full species *Propithecus verreauxi* and *Propithecus coquereli* form the informal *Propithecus verreauxi* group.

To answer the question as to whether Decken's sifaka and the crowned sifaka constitute valid subspecies, we compiled published and new survey data that have mostly accumulated in recent years and analyzed the data quantitatively by means of different indices. We can safely infer that the two populations are different subspecies if a consistent pattern can be recognized and the 90 % Non-Overlap rule of thumb is fulfilled. If this is not the case, it does not, however, necessarily follow that we are dealing with only one taxon. In addition, we propose a hypothesis based on a very local event that might explain the puzzling variation in the lower reaches of the Mahavavy du Sud River.

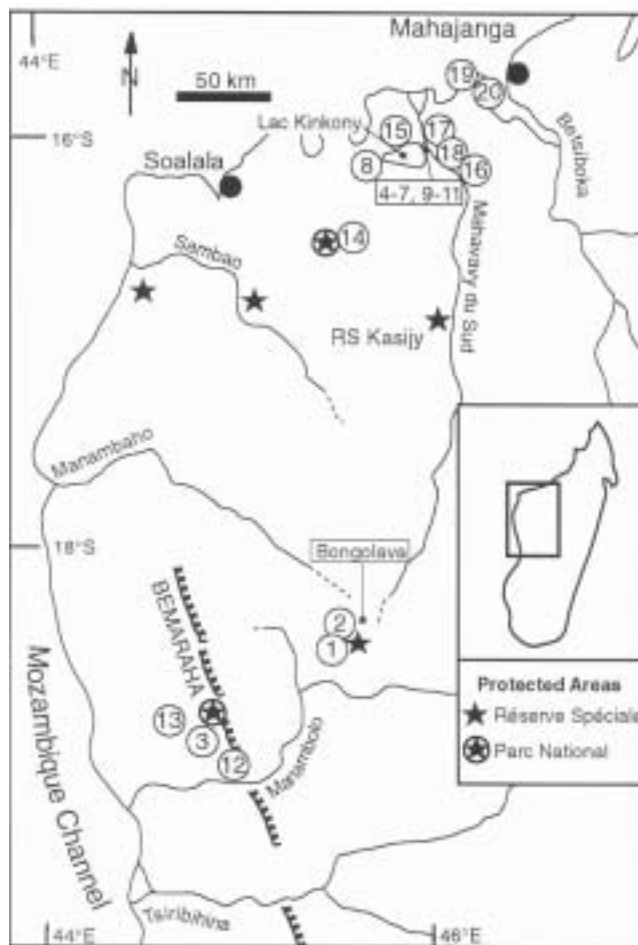


Fig. 2: Map of the study region with localities mentioned in text or referring to Table 1. The Ambinany River is the short connection between the Mahavavy River and Lac Kinkony. For more details in this region see FTM (1956: Flle K40 Bekipy) or Curtis *et al.* (1998: p. 158, Fig. 1).

Material and Methods

Survey localities (Fig. 2) were partially chosen to study variation in the two populations and concentrated on (i) regions of known morphological variation (n=5) and (ii) localities where the populations are almost adjacent and only separated by a river (within 10 km, at most, of a riverbank; n=8). Seven localities are in places that could be considered as part of the core area of the distributions. Overall, we deal with a biased sample that overemphasizes variation. Core or center areas of distributions are underrepresented. With regard to rivers potentially separating the two populations, two localities are in the Bongolava region, between the upper reaches of the Mahavavy du Sud and Manambolo Rivers, 13 localities are southwest (SW) of the Mahavavy River (left riverside) and 5 localities are on the northeast (NE, right riverside) of the Mahavavy River. Data used for quantitative analyses are shown in Table 1.

For analyses we divided individuals into two easily recognizable categories: (i) Individuals that resemble the classic *P. v. deckeni* "with uniformly white pelage often washed with yellowish or (less frequently) pale silver tints on the neck, shoulders and back" (Tattersall 1986: p. 56); (ii) Individuals that are unlike classic *P. v. deckeni*, i.e. exhibiting distinct and obvious melanistic influence and/or individuals representing classic *P. v. coronatus*: "predominantly white, have dark brown or black forehead, crown and cheeks and throat, sometimes with golden or silver-brown tints on the back and/or externally on the forelimbs" (Tattersall 1986: p. 56). In reality, melanistic variation in pelage coloration is rather complex (Petter *et al.* 1977; Curtis *et al.* 1998). In the Bongolava, individuals may even exhibit pelage coloration more reminiscent of Verreaux's sifaka and Coquerel's sifaka (S. Goodman, pers. comm.; U. Thalmann unpubl. photographs). This variation has not been considered in detail here, and such individuals were treated as non-*deckeni*, and subsumed under *coronatus*.

As subspecies by definition cannot occur sympatrically, allocation to one or the other form in Table 1 should not be read in a strict taxonomic sense. In total, 696 individuals, of which 422 represent the pattern of *P. v. deckeni* and 274 represent the non-*deckeni* pattern (close or identical to *P. v. coronatus*), are included in the quantitative analyses.

We analyzed two data sets separately, the full data set with 20 localities and a subset with 17 localities, the latter excluding the three localities with the highest variation in the lower reaches of the Mahavavy River to assess the influence of this comparatively over-represented population. Further published information, though qualitative in nature, is considered in the discussion.

We calculated the Percentage Non-Overlap as 100 % minus Percentage Overlap following Krebs (1989: p. 383), the Dominance Index I and Evenness E following Brower *et al.* (1990), and the asymmetrical MacArthur and Lewis Overlap Measure M (Krebs 1989) as well as the symmetrical Morisita Index I_M (Brower *et al.* 1990). The Dominance Index I is the probability that two individuals taken at random from a community belong to the same species (i.e. show the same coloration pattern). The Evenness is an expression for the distribution of individuals among species (here differently colored individuals) in relation to a dispersion having the maximum possible diversity. MacArthur and Lewis' M expresses the overlap of sample 1 by sample 2 (here SW by NE riverside), and, *vice versa*, of sample 2 by sample 1. It allows in the present case to infer a direction of influence from one sample on the other. Morisita's Index of overlap (also called Morisita's Index of community similarity) refers to the probability that individuals randomly drawn from each of the two samples (here communities on each riverside) will belong to the same species (here color morphs), relative to the probability of randomly selecting a pair of specimens of

the same species (here color morph) from one of the communities. It ranges from 0 to around 1. A value close to 1 indicates high similarity between the samples, a value close to 0 low similarity.

Table 1: Survey data used for analysis. Subspecies names should not be taken in a strict taxonomic manner. They more exactly represent coloration patterns (see text).

Nr	Locality	South	East	Pvd	Pvc	Date	Reg	Ref
1	Forêt d'Ambohijanahary	18°32'	45°26'	20	2	2.-13.5.94	ce	1
2	RS Ambohijana hary	18°22'	45°23'	36	5	before 1977	ce	2
3	Ambalarano	18°59'	44°45'	25	0	18.-23.9.91	SW	3
4	Ambinany-Analabe	16°07'	45°57'	18	2	25.-29.7.95	SW	4
5	Anadabomandry	16°03'	45°54'	19	0	10.9.95	SW	4
6	Analabe	16°06'	45°56'	104	34	26.7.95	SW	4
7	Ankotrakotraka	16°09'	46°00'	52	17	26.-28.7.01	SW	5
8	Antseza	16°13'	45°53'	15	0	23.-24.7.95	SW	4
9	Bemahazaka	16°05'	45°54'	22	0	9.12.94	SW	3
10	Ihopy E	16°15'	45°58'	30	0	16.8.95	SW	4
11	Ihopy W	16°15'	45°58'	20	0	15.-16.8.95	SW	4
12	Manambolo N	19°08'	44°49'	13	0	3.-17.11.94	SW	6
13	Tsimembo	18°58'	44°28'	32	0	1990	SW	7
14	Namoroka	16°28'	45°21'	13	0	8.8.01	SW	3
15	Tsiombikibo S	16°00'	45°50'	2	0	22.5.95	SW	4
16	Anaborengy	16°05'	45°56'	0	96	10.8.95	NE	4
17	Anjamena	16°03'	45°55'	0	33	3.12.94	NE	3
18	Antsoherikely	16°09'	46°01'	1	66	29.7.01	NE	5
19	Katsepy (light house)	15°46'	46°15'	0	15	25.8.95	NE	4
20	Katsepy (white house)	15°45'	46°15'	0	4	30.7.01	NE	5
	20 Localities			422	274			

Abbreviations: Pvd=*Propithecus verreauxi deckeni*. Pvc=*Propithecus verreauxi coronatus*. Reg=Region (ce=centre, Bongolava. NE=northeastern (right) and SW=southwestern (left) riverside of Mahavavy du Sud. Ref=References: 1 Thalmann and Rakotoarison (1994 unpubl.); 2 Petter *et al.* (1977); 3 Thalmann unpubl. data; 4 Curtis *et al.* (1998); 5 this work; 6 Thalmann and Rakotoarison (1994); 7 Bousquet and Rabetaliana (1992).

Results

The values for the different indices and the two different samples analyzed are summarized in Table 2. In the complete sample (20 localities), individuals in the 15 localities on the SW (left) riverside of the Mahavavy River and in the Bongolava region exhibited in 87.5 % of all cases a typical *deckeni* coloration, in 12.5 % of cases a coloration closer to or identical with *coronatus*. In the 5 localities on the NE (right) riverside of the Mahavavy, 99.5 % of animals showed classic *coronatus* coloration and only one individual had *deckeni* coloration. This corresponds to a Non-Overlap of 87.1 %. The Dominance Index I for the SW (left) riverside is $I=0.78$, hence, smaller than for the NE (right) riverside ($I=0.99$). The MacArthur and Lewis overlap M is asymmetrical (Tab. 2). The coloration overlap of the SW population by the NE population is higher than *vice versa*. More *coronatus*-like animals are present on the left riverside than *deckeni*-like animals on the right riverside. Overall, the overlap is rather low with Morisita's $I_M=0.14$.

In the reduced sample (17 localities) the differences are even clearer. In the 12 localities on the SW (left) riverside of the Mahavavy or in the Bongolava region, animals exhibited in 97.2 % of all cases a typical *deckeni* coloration, only 2.8 % had a coloration close or identical with *coronatus*. For the 5 localities on the NE (right) riverside of the Mahavavy values remain obviously unchanged. This corresponds to a Non-Overlap of 96.8 % between individuals of the two opposite riversides. The Dominance Index on the SW (left) riverside rises considerably to $I=0.95$. MacArthur and Lewis' M over-

laps for the coloration of individuals from the SW (left) riverside by NE individuals and *vice versa* are now equal. The Morisita-Index drops to a very low $I_M=0.04$.

Table 2: Calculated indices. Subspecies names in this table should not be taken in a strict taxonomic manner. They more exactly represent coloration patterns (see text).

Localities 1 through 20 in Table 1				
Index	SW riverside and coloration		NE riverside and coloration	
	P. v. deckeni	P. v. coronatus	P. v. deckeni	P. v. coronatus
n	421	60	1	214
% of animals	87.5	12.5	0.5	99.5
Percentage Non-Overlap ¹	87.1			
Dominance-Index I ²	0.78		0.99	
Evenness ²	0.44		0.02	
MacArthur and Lewis' M ³	0.16		0.13	
Morisita's I _M ⁴	0.14			
without localities 4, 6, 7 in Table 1				
n	247	7	1	214
% of animals	97.2	2.8	0.5	99.5
Percentage Non-Overlap ¹	96.8			
Dominance-Index I ²	0.95		0.99	
Evenness ²	0.11		0.02	
MacArthur and Lewis' M ³	0.03		0.03	
Morisita's I _M ⁴	0.03			

¹ Percentage Non-Overlap calculated as 100% minus Percentage Overlap (Krebs 1989: p. 383).
² Brower *et al.* (1990: p. 159-161).
³ MacArthur and Lewis' Measure M of overlap is asymmetrical. The first value gives the value to which the coloration pattern of the SW (left) riverside animals is overlapped by the NE (right) riverside, the second value *vice versa* (Krebs 1989: 382).
⁴ Morisita's I_M can have values between 0 and around 1. A value close to 1 indicates high similarity, a value close to 0 little similarity.

Discussion

Morphology

According to the rule of thumb to recognize subspecies as valid taxa, a Non-Overlap of 90 % between the populations in question should be present. In the analysis based on the full sample, which is clearly biased, this is almost the case (Non-Overlap=87.1 %). It is however very clear if the reduced sample is analyzed (Non-Overlap=96.8 %). Obviously, the three localities in the region that harbor an "isolated melanistic population of Decken's sifaka" (Curtis *et al.* 1998: 157) strongly influence the Percentage Non-Overlap. More quantitative data for the central areas of the distribution of the two populations are not readily available; there are however qualitative data that help to clarify the issue further. Surveys conducted south of the Mahavavy and farther away in the region of Soalala and down to the Manambolo River revealed no variation. Hawkins *et al.* (1998) reported *P. v. deckeni* for 9 localities (Hawkins *et al.* 1998, Fig. 1); the same applies to a variety of other localities between the Mahavavy and Manambolo Rivers (Ausilio and Raveloanrinoro 1998; Sterling 1998; Thalmann *et al.* 1999; Manganirina *et al.* 2000). Only one other survey revealed variation. Manganirina *et al.* (2001) reported four animals with *coronatus* coloration from the Réserve Spéciale de Kasijy. These animals were very rare and the vast majority of sifaka in this reserve showed the *deckeni* pattern (Manganirina *et al.* 2001). Kasijy is, again, located directly on the SW (left) riverbank of the Mahavavy River, approximately 100 km upstream of the localities with the highest variation (Ambinany-Analabe (Fig. 2 locality #4), Analabe (#6), Ankotrakotraka (#7)).

Fewer survey data are available for the NE (right) riverside of the Mahavavy. However, neither D.Curtis (pers. comm.) nor P.Müller (pers. comm.), both working at Anjamena on the NE (right) riverside for a prolonged period, ever observed any notable variation in crowned sifaka. Also, Rabemazava (1990; pers. comm.) working on status and distribu-

tion of crowned sifaka between the Betsiboka River (Baie de Bombetoka) and the Mahavavy River never observed any variation. All of the sighted animals (n=327) exhibited a typical *coronatus* coloration. Gauthier *et al.* (2000; C.-A. Gauthier pers. comm.) working in the surrounding of the lighthouse at Katsepy (#19) also reported exclusively *P. verreauxi coronatus*. Only Tattersall (1982, 1986, 1988) reported *deckeni*-like animals from near the lighthouse at Katsepy (#19). Taken together, unification of Decken's sifaka and the crowned sifaka is based on two main lines of evidence: (i) presumed sympatric occurrence based on pelage coloration, and (1) mtDNA analysis.

Sympatry

Melanistic variants have been reported in several localities: (i) the Bongolava region, (ii) the region between the Mahavavy River and Lac Kinkony south of the Ambinany River, (iii) the Réserve Spéciale Kasijy, and (iv) most interestingly, Katsepy (#19) which is relatively far north of the Mahavavy River. The latter case finally led Tattersall (1988) to conclude that *deckeni* and *coronatus* should be subsumed under *deckeni* for reasons of taxonomic priority.

In the first case, partial melanization may easily be explained through occasional gene exchange between the populations. It cannot be expected, in the Bongolava region, that the upper reaches of the originating Mahavavy River is an efficient genetic barrier. However, occasional gene exchange between subpopulations is apparently not 'forbidden' by the subspecies definition cited above.

The second case is more difficult to understand. Curtis *et al.* (1998) provided no explanation as to how the presumably isolated melanistic variant of Decken's sifaka might have occurred. We believe that the high degree of pelage variation in the "isolated" region should not be addressed as a melanistic variant. This seemingly implies a kind of discrete unit. In addition, we do not believe that the population is isolated from the surrounding population on the left riverside of the Mahavavy, namely Decken's sifaka. We hypothesize that a local change in the river system is responsible for the variation observed. Lac Kinkony is connected with the Mahavavy River through a natural river channel, the Ambinany River. The current of this river changes according to the water level of the Mahavavy River and Lac Kinkony. If the water level of the Mahavavy River is higher than the level of Lac Kinkony, due to, for example, high precipitation in the highlands, the Ambinany River flows into Lac Kinkony and contributes to filling the lake. During the dry season, the current of the Ambinany River changes and water from the now higher Lac Kinkony flows back into the Mahavavy River. During the rainy season, many smaller rivers occur in the very flat and inundated region. One of these smaller side arms may once have been the main bed of the Mahavavy, separating the two subspecies. With a change in water flow pattern and the establishment of a new main riverbed of the Mahavavy, a whole small 'island' with crowned sifaka may have changed riversides and be cut off from the parent population of crowned sifaka. Consequently, this limited population came into contact with the surrounding Decken's sifaka, and is now interbreeding with the Decken's sifaka. Decken's sifaka may flow in via the southern part of this small region and along the Mahavavy River (Curtis *et al.* 1998, Fig. 1). The topography of the region is suggestive of such an explanation (FTM 1956: Flle K40 Bekipay). There are possible and likely connections between the Mahavavy and Lac Kinkony that need a raise of only very few meters in water level to become established. Aerial views from low altitude also suggest that this explanation is highly probable (Thalmann and Müller 1997).

The case of Kasijy cannot be explained in exactly the same manner. The topography is different, however a comparable

explanation is probable, although it, perhaps, differs in detail.

For Katsepy (#19), located on the left riverside of the Betsiboka estuary, Tattersall (1988) reports that he and R.W. Sussman saw *deckeni* colored individuals in 1973 (Tattersall 1982, 1986, 1988). All subsequent reports document *coronatus* colored individuals (D. Reid in 1987 cited in Tattersall (1988); Curtis *et al.* 1998; Müller *et al.* 1999; Gauthier *et al.* 2000; U. Thalmann on several occasions between 1994 and 2000, this work). It is difficult to place Tattersall and Sussman's observation. However, this is the only report for *deckeni* colored individuals at Katsepy, whereas reports for *coronatus* colored animals are many. We cannot provide a good explanation for the possible presence of *deckeni* colored individuals at Katsepy.

At least two cases of melanization or sympatry can be easily explained by natural causes (probably Kasijy too) and one case is somewhat erratic (Katsepy). Based on three out of these four cases, Tattersall (1988) proposed synonymy of Decken's sifaka and crowned sifaka, implicitly questioning the genetic coherence and cohesiveness of the two populations. With the data now available it is possible to make a comprehensive investigation of the latter aspect.

The highly variable population of the small region represented here by the three localities Ambinany-Analabe (#4), Analabe (#6) and Ankotrakotraka (#7) contributes substantially to the present sample, which is also biased toward demonstrating variability. If the three localities are excluded from analyses, a consistent pattern is clearly evidenced by the high Non-Overlap Percentage, the high Dominance Index (one of the two color morphs is highly dominant on the respective riverside), the low Evenness and Overlap-indices (Tab. 2). The Evenness Index E is in one case approximately 5 times smaller, in the other case 25 times smaller, than the maximal possible evenness. Furthermore, it is notable that MacArthur and Lewis' Index of Overlap is asymmetrical for the full sample but symmetrical in the reduced sample. This can be interpreted as a consequence of an unidirectional gene flow from the NE (right) riverside to the SW (left) riverside as suggested above through passive translocation of a small *coronatus* population to the opposite riverbank. These data leave very little doubt that we are dealing with two highly coherent and cohesive morphological forms and that they do, in fact, constitute valid subspecies.

Molecular data

Based on mtDNA data, Pastorini *et al.* (2001) concluded that the Mahavavy River does not work as an efficient barrier for gene flow between Decken's sifaka and the crowned sifaka and that no further significant genetic differentiation has occurred within the clade *verreauxi-deckeni-coronatus*. This contrasts with morphological evidence as presented above for *deckeni* and *coronatus*, and additionally with evidence from skull morphology. Both Decken's sifaka and the crowned sifaka possess an inflated muzzle that distinguishes them from Verreaux' sifaka with an uninflated muzzle (Tattersall 1982). It is very unlikely that mtDNA drives such morphological differentiation, which is undeniably real, but instead follows passively processes of differentiation. Whereas mtDNA data can be helpful to distinguish taxa, it is not *a priori* possible to prove the contrary. Such judgments should, hence, not rely on this line of evidence alone. The genus *Propithecus* provides an especially instructive example in this regard. Pastorini *et al.* (2001) found no evidence in mtDNA to distinguish Coquerel's and Tattersall's sifaka at the species level despite obvious morphological differences and, certainly more importantly, differences in karyotype. Coquerel's sifaka has a diploid number of $2n=48$ chromosomes (Rumpler 1975; Poorman 1983) and Tatter-

sall's sifaka $2n=42$ (Simons 1988). Such differences are very prone to influence, reduce or even prohibit reproduction of interbreeding animals. Based on mtDNA it might be possible to unite Coquerel's and Tattersall's sifaka in a single species, based on morphology it is certainly not recommended, and based on karyotypes it is clearly to be rejected. Both morphological and, especially, karyogenetic characters can be very efficient reproductive isolating mechanisms.

Taxonomy and Systematics

We are convinced that we have provided enough evidence that Decken's sifaka and the crowned sifaka constitute well characterized, geographically separated populations with few, locally limited but explainable exceptions and little unexplained 'noise'. The core populations can safely be addressed as subspecies. Evidence from mtDNA is not very helpful in proving anything different. Whether the two populations should be subsumed under a polytypic *Propithecus deckeni* (Groves 2001a) or kept, as subspecies within a polytypic *Propithecus verreauxi* is a different question. Now that we have presented evidence that, under the Biological Species Concept, Decken's sifaka and the crowned sifaka are 'good' subspecies, the question automatically rises as to whether the two populations would, in fact, pass as species under another concept, namely the Phylogenetic Species Concept. The Phylogenetic Species Concept has recently been promoted and applied by Groves in his new comprehensive *Primate Taxonomy* (Groves 2001a). Following this concept, a species is "the smallest diagnosable cluster of individual organisms within which there is a parental pattern of ancestry and descent" (Cracraft 1983 cited in Groves 2001b: p.195). Essentially, this applies to the populations of Decken's sifaka and the crowned sifaka, and they could consequently be addressed as the two full species *Propithecus deckeni* and *Propithecus coronatus*.

In cases where the evidence is not sufficient to decide the status of a taxon that would be extremely endangered if accepted but much less so if not accepted, we recommend, in line with Groves (2001a), another rule of thumb: *in dubio pro reo*. However, this now seems unnecessary in the case of Decken's sifaka and the crowned sifaka.

Acknowledgements

The excursion was conducted under an 'Accord de Coopération' between the Universities of Zürich (Switzerland) and Mahajanga. We thank the "Commission Tripartite" for research permission, and gratefully acknowledge helpful comments on the manuscript by A. Müller and C.P. Groves, and corrections by C. Harcourt. We are grateful for financial support provided by the A.H. Schultz-Foundation, the G. and A. Claraz-Donation, the Margot Marsh Biodiversity Foundation, Primate Conservation, Inc., and P.E. and W. Wirth.

References

- Ausilio, E.; Raveloanrinoro, G. 1998. Les lémuriens de la région de Bemaraha: Forêts de Tsimembo, de l'Antsingy et de la région de Tsiandro. *Lemur News* 3: 4-7.
- Bousquet, B.; Rabetaliana, H. 1992. Site du Patrimoine Mondiale des Tsingy de Bemaraha et autres Sites d'Intérêt Biologique et Ecologique du Fivondronona d'Antsalova. UNESCO, Paris.
- Brower, J.E.; Zar, J.H.; von Ende, C.N. 1990. *Field and Laboratory Methods for General Ecology* (3 ed.). Wm. C. Brown Publ., Dubuque (USA).
- Cracraft, J. 1983. Species concepts and speciation analysis. Pp. 159-187. In: *Current Ornithology* Vol.1. R.F. Johnston (ed.). New York, Plenum Press.
- Curtis, D.J.; Velo, A.; Raheliasoa, E.-O.; Zaramody, A.; Müller, P. 1998. Surveys on *Propithecus verreauxi decke-*

- ni*, a melanistic variant, and *P.v.coronatus* in north-west Madagascar. *Oryx* 32: 157-164.
- FTM (Foiben-Taosarintanin'i Madagasikara/Institut National de Géodésie et Cartographie). 1956. Carte de Madagascar au 1/100.000: Feuille K40 Bekipay. Service Géographique de Madagascar, Antananarivo.
- Gauthier, C.-A.; Deniaud, J.-L.; Leclerc-Cassan, M.; Rakotomalala, M.; Razafindramanana, S.; Renson, G. 2000. Biologie des propitèques couronnés (*Propithecus verreauxi coronatus*) in situ: Résultats préliminaires. Pp. 177-180. In: Diversity and Endemism in Madagascar. W.R. Lourenço, S.M. Goodman (eds.). Société de Biogéographie (Paris), Paris.
- Groves, C.P. 2001a. Primate Taxonomy. Smithsonian Institution Press, Washington D.C.
- Groves, C.P. 2001b. Why taxonomic stability is a bad idea, or why are there so few species of primates (or are there?). *Evol. Anthropol.* 10: 192-198.
- Hawkins, A.F.A.; Durbin, J.C.; Reid, D.B. 1998. The primates of the Baly Bay area, north-western Madagascar. *Folia Primatol.* 69: 337-345.
- Krebs, C.J. 1989. Ecological methodology. Harper and Row, New York.
- Manganirina, P.; Ramsamison, A.; Rakotozafy, L.; Totovolahy, A. 2001. Inventaire des lémuriens dans la Réserve Spéciale de Kasijyi. *Lemur News* 6: 7-8.
- Manganirina, P.; Randrianarisoa, A.R.; Rakotozafy, L. 2000. Inventaire biologique dans la Réserve Spéciale de Bemarivo: volet Primatologie. *Lemur News* 5: 16-19.
- Mayr, E. 1963. Animal Species and Evolution. Belknap Press, Harvard University Press, Cambridge (Mass.).
- Mayr, E.; Ashlock, P.D. 1991. Principles of Systematic Zoology (2nd ed.). McGraw-Hill, New York.
- Müller, P.; Velo, A.; Rahelarisoa, E.-O.; Zaramody, A.; Curtis, D.J. 2000. Surveys of five sympatric lemurs at Anjanaharibe-Sud Special Reserve and Marojejy National Park (Nicoll and Langrand 1989; Sterling and McFadden 2000). The combined protected area available for this taxon totals to over 90,000 ha (Mittermeier *et al.* 1992; Goodman 2000). However, this number is a gross overrepresentation of the subspecies' protected home range, as prior census studies at Marojejy National Park reveal that the silky sifaka has never been observed below 700 meters in altitude (Mayor and Wright pers obs.; Duckworth *et al.* 1996; Sterling and McFadden 2000). It is unclear whether this is a result of historic habitat preference or hunting pressures (Duckworth *et al.* 1996). The silky sifaka has been accorded the highest priority of conservation action (Mittermeier *et al.* 1992). In response to this priority, a genetic, behavior and ecology study was conducted on this taxon during the austral winter seasons of 2000 and 2001.
- Petter, J.-J.; Albignac, R.; Rumpler, Y. 1977. Mammifères Lémuriens (Primates Prosimiens). ORSTOM/CNRS, Paris.
- Petter, J.-J.; Peyrieras, A. 1972. Melanization in the genus *Propithecus* Malagasy lemur. *J. Hum. Evol.* 1: 379-388.
- Poorman, P.A. 1983. The banded chromosomes of Coquerel's sifaka, *Propithecus verreauxi coquereli* (Primates, Indrididae). *Int. J. Primatol.* 4: 419-425.
- Rabemazava. 1990. Statut et distribution du propitèque couronné (*Propithecus verreauxi coronatus*) et proposition de mesures de protection. Rapport de stage, Ecole pour la formation de spécialiste de la faune Garoua.
- Rumpler, Y. 1975. The significance of chromosomal studies in the systematics of the Malagasy lemurs. Pp. 25-40. In: Lemur Biology. I. Tattersall; R.W. Sussman (eds.). New York, London, Academic Press.
- Simons, E.L. 1988. A new species of *Propithecus* (Primates) from Northeast Madagascar. *Folia Primatol.* 50: 143-151.
- Sterling, E.J. 1998. Preliminary report on a survey for *Daubentonia madagascariensis* and other primate species in the west of Madagascar, June-August 1994. *Lemur News*, 3: 7-8.
- Tattersall, I. 1982. The Primates of Madagascar. Columbia University Press, New York.
- Tattersall, I. 1986. Notes on the distribution and the taxonomic status of some subspecies of *Propithecus* in Madagascar. *Folia Primatol.* 46: 51-63.
- Tattersall, I. 1988. Distribution survey of the Malagasy lemurs: Request for information and initial report. *Prim. Cons.* 9: 116-117.
- Thalmann, U.; Kerloc'h, P.; Müller, A.E.; Zaramody, A. 1999. A visit to the Strict Nature Reserve Tsingy de Namoroka (NW Madagascar). *Lemur News* 4: 16-19.
- Thalmann, U.; Rakotoarison, N. 1994a. Distribution of lemurs in central western Madagascar, with a distribution hypothesis. *Folia Primatol.* 63: 156-161.
- Thalmann, U.; Rakotoarison, N. 1994b. Reconnaissance dans la forêt d'Ambohijanahary (Bongolava) - une forêt perdue?! Unpublished report to the University of Zurich and Parc Botanique et Zoologique de Tsimbazaza.

Preliminary study of the Silky Sifaka (*Propithecus diadema candidus*) in north-east Madagascar

Elizabeth Kelley

Oxford Brookes University, Oxford, UK and 736 33rd Street, West Des Moines, IA 50265, USA. kelle_lisa@yahoo.com

Mireya I. Mayor

(Corresponding author) Department of Anthropology, SUNY at Stony Brook, Stony Brook, NY 11794-4364, USA. mireyamayor@yahoo.com

Key words: *Propithecus diadema candidus*, Marojejy National Park, behavioral ecology, conservation, endangered primate

The silky sifaka (*Propithecus diadema candidus*) inhabits a restricted range of primary mid-altitude and montane rainforest within Madagascar's northeast sector (Duckworth *et al.* 1996). This taxon is found in two protected areas, Anjanaharibe-Sud Special Reserve and Marojejy National Park (Nicoll and Langrand 1989; Sterling and McFadden 2000). The combined protected area available for this taxon totals to over 90,000 ha (Mittermeier *et al.* 1992; Goodman 2000). However, this number is a gross overrepresentation of the subspecies' protected home range, as prior census studies at Marojejy National Park reveal that the silky sifaka has never been observed below 700 meters in altitude (Mayor and Wright pers obs.; Duckworth *et al.* 1996; Sterling and McFadden 2000). It is unclear whether this is a result of historic habitat preference or hunting pressures (Duckworth *et al.* 1996). The silky sifaka has been accorded the highest priority of conservation action (Mittermeier *et al.* 1992). In response to this priority, a genetic, behavior and ecology study was conducted on this taxon during the austral winter seasons of 2000 and 2001.

Methods

Research was conducted at Marojejy National Park, located at 14°18'-39'S, 49°33'-52'E, within the Province d'Antsiranana, between the towns of Andapa and Sambava, north-east Madagascar (Duckworth *et al.* 1996; Goodman 2000). The study site was located above Goodman's "Camp 2", which is situated 10 km northwest of the village Manantenina at 14°26'0"S, 49°45.7'E, >775 m above sea level (Goodman 2000). The habitat above Camp 2 is moist evergreen forest with a transition to lichen forest at the higher elevations (Messmer *et al.* 2000). The canopy is discontinuous over 25 m in height, with a moderate tree density and an open understory (Duckworth *et al.* 1996; Messmer *et al.* 2000). Although the forest at this site appears to be relatively pristine, old unmarked trails exist throughout the area.

On June of 2000 and 2001, a group of 3 male and 3 female silky sifakas were captured to obtain genetic materials and for the identification of individuals in preparation of the be-

havioral study (see Mayor and Lehman 1999 for capturing methods). In addition to the collection of blood and tissue samples, weights and measurements were also taken from all members in the group. Estimates of age were based on weight and canine emersion/canine wear. The oldest male and female were estimated to be 10 to 12 years of age, about middle age when compared with longevity estimates of *Propithecus diadema edwardsi* (Wright 1995). Three of the individuals were classified as young adults and one female was classified as a juvenile (approximately one year of age as of July 2001). The consistent nighttime sleeping association (100 %) between the young adult female and the juvenile suggests that the young adult female was the mother of the juvenile (Wright 1995). With the exception of the addition of the juvenile, group composition did not change between the years 2000 and 2001. In order to facilitate locating the group on a regular basis, the middle-aged female was radio collared. In addition, one other female was collared to accurately distinguish group members. We did not feel it was necessary to collar any of the other individuals, as variations in facial pigmentations and other markings (fur colorations, ear notches) made recognizing and distinguishing individuals possible.

Data collection for the behavior and ecology study took place from July 29, 2001 to October 1, 2001. Excluding the pilot study, a total of 173 hours of data were collected using focal animal instantaneous sampling and all-occurrences of some behaviors sampling (Altmann 1974). In accordance with other Indridae studies (Powzyk 1997; Mayor and Lehman 1999), all day focal animal follows were attempted. Focal animals were first chosen through random selection (Lehner 1996). If the individual was out of view for over 20 minutes, the next individual on a predetermined list was followed and the prior individual's name was placed at the end of the list. However, largely due to the topography of the site, routine checks on this method soon revealed an overrepresentation of slow moving and less active individuals. Thus, modifications were made, and an individual's name was only placed at the end of the list if the individual was followed for an hour or more. Approximately every two weeks, data collection samples were tallied to ensure that each individual was being represented equally in the study. With the exception of eight randomly dispersed days, data were collected every day of the week. With rare exceptions, all day follows began approximately 15 minutes after dawn and continued until dusk. Descriptive statistics and non-parametric statistics were used to analyze the data. Excel was the primary program used for analysis, although some non-parametric tests were conducted using SPSS 10.1.

Results

Activity budget data and dietary intake data were collected using the five-minute instantaneous focal sampling method. Resting predominated the total group activity budget at 47 %, while feeding and traveling percentages were approximately equal at 25 % and 23 % respectively. The remaining 5 % of daily activity was spent in intragroup social behavior. The group's diet was highly folivorous during this season as the sifakas were observed feeding on mature leaves 61.3% and young leaves 16.2 % of the time. The group was observed feeding on fruit and seeds 15.2 %, flowers 6.7 %, with bark and soil eaten on rare occasions.

When the silky sifaka group's dietary consumption of food types was separated by gender, differences between the sexes were detected (Fig. 1). While males consumed mature leaves, fruit/seeds, soil and bark more often than female group members (Fig. 1a), females consumed young leaves and flowers more often than did male group members (Fig. 1b). However, when the counts of recorded feeding bouts on specific foods items were analyzed using Pearson's chi-

squared tests ($n=516$), the only significant variances between the sexes were females' consumption of flowers ($\chi^2=25.49$, $df=1$, $p<0.01$) and consumption of young leaves ($\chi^2=5.0$, $df=1$, $p<0.05$).

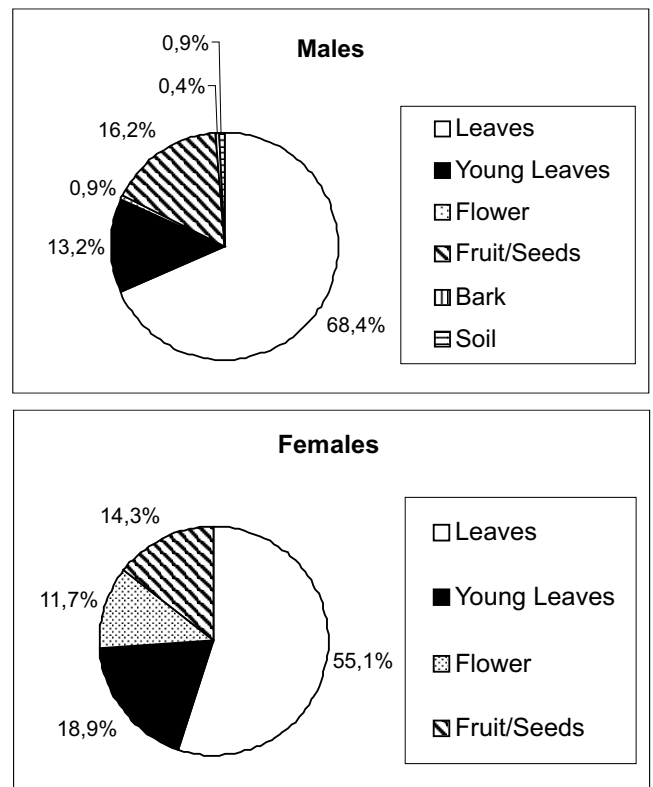


Fig. 1.: Mean dietary consumption of food kinds of a) 3 male silky sifakas b) 3 female silky sifakas ($n=516$ five minute instantaneous samples).

All-occurrence sampling was used to record social interactions. Examples of social behaviors that were recorded included agonistic and submissive behaviors (cuffs, pushes, hard bites, displacements, chases, flees, avoids and chattersqueals), and affiliative behaviors (direction and duration of grooming bouts, huddles, play).

Agonistic behaviors were only observed 29 times out of an all-occurrence sample count of 1,858. Bisexual agonistic interactions composed 65 % of the total agonistic interaction sample and 55.1 % of bisexual agonistic interactions depicted clear "winners" and "losers". With the exception of two occurrences, every agonistic interaction was dyadic. Fights, defined as agonistic behaviors over a measurable length of time, never occurred throughout the course of this study. A G test found that aggressive encounters occurred significantly more often between male and female dyads than between members of the same sex ($\chi^2=10.41$, $df=2$, $p<0.05$). Counts of aggressive acts found that males displaced females as often as females displaced males ($r=1:1$). However, there were some notable trends at the individual level. For example, while the oldest male followed closely by the two oldest females were the primary aggressors, the juvenile female and one of the youngest males submitted to a majority of the aggression. Agonistic interactions between the sexes most often occurred because a resource was being contested ($n=22$). Within the contested resource sample, 17 of the conflicts involved food items.

Social grooming observations were analyzed and presented in a spatial proximity pattern to emphasize and compare dyadic cohesion within the group (Fig. 2.). Although male and female group members did not typically seek one another as primary grooming partners ($n=89$, total duration in minutes=118), observed bouts of allogrooming reflected

93.8 % of the affiliative interactions between male and female group members. Males initiated grooming bouts with female group members significantly more often than the reverse ($c^2 = 9.45$, $df=1$, $p<0.01$).

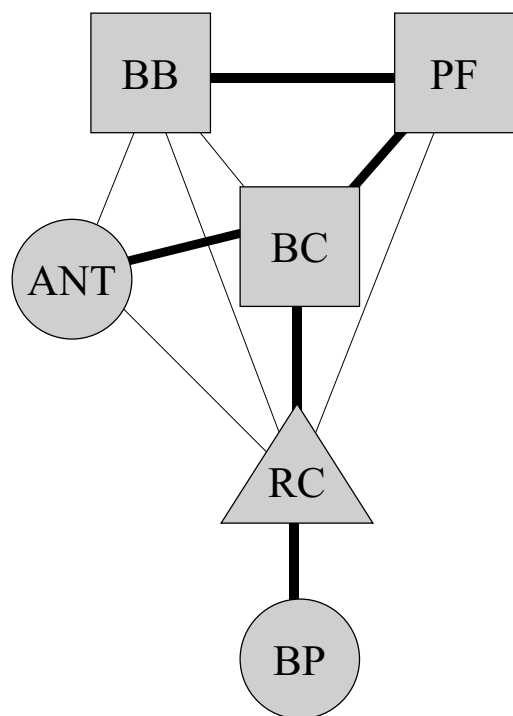


Fig. 2: Spatial group cohesion pattern based upon duration of grooming bouts using all-occurrence data. A half weight association index (Lehner 1996) was first used to normalize data before the figure was drawn. Thick lines depict the top 33% of associations. Thin lines depict the next highest 33 % of associations. Associations that fell below 34 % have not been included in the drawing. Squares represent males, circles represent females and the triangle represents a juvenile female.

Discussion

During the three-month behavior and ecology study, only one additional pair of silky sifakas was sighted. The same pair was seen twice within the first week of August. Distinctive pelage patterns as well as the absence of ear biopsy punches distinguished this pair from the study group individuals. The pair was observed twice, once around 725 meters and once around 775 meters from base camp. The second sighting suggests a slight overlap in home range with the study group. Another infant was seen at Anjanaharibe-Sud Special Reserve in the fourth week of July 2002, during the genetic component of the study. The infant was born to a pair group of silky sifakas. The infant was clinging ventrally and was estimated to be approximately two weeks of age. In conclusion, the silky sifaka is a charismatic primate that inhabits the remaining fragments of Madagascar’s pristine rainforest. Efforts to conserve this taxon will not only conserve the primate, but will also conserve the silky sifakas’ environment well beyond the forest boundaries. Long-term behavioral ecology studies in conjunction with the data found through census work may be the only hope for understanding how to develop a management plan for the survival of this rare taxon of sifaka.

Acknowledgements

We thank the Government of the Democratic Republic of Madagascar, especially Association Nationale pour la Gestion des Aires Protégées (ANGAP), for permission to con-

duct our research. We also thank the staff, and guides of the World Wide Fund for Nature (WWF) in Andapa for their assistance and support. We are very grateful to Dr. Patricia Wright, Benjamin Andriamahaja, and the staff of the Institute for the Conservation of Tropical Environments (Stony Brook and Antananarivo) for their support. We gratefully acknowledge Nestor Jean Randrianasy, Desiré Rabary, Wil Frank, Richard Randriamampiono and team, for their expertise and assistance in the field. Lastly, we would like to thank Dr. Edward Louis for his invaluable support, Dr. Patricia Wright for her comments and suggestions on earlier drafts, and Dr. Caroline Harcourt for her extensive review of the master’s dissertation that provided much of the material for this article. This research was supported in part by grants from Primate Conservation, Inc., Margot Marsh Biodiversity Foundation, Omaha’s Henry Doorly Zoo, and the St. Louis Zoological Society.

References

Altmann, J. 1974. Observational study of behavior: Sampling methods. *Behav.* 49: 227-267.
 Duckworth, J.W.; Evans, M.I.; Hawkins, A.F.A.; Safford, R.J.; Wilkinson, R.J. 1994. The lemurs of Marojejy Strict Nature Reserve Madagascar: a status overview with notes on ecology and threats. *Int. J. Primatol.* 16: 545-559.
 Goodman, S.M. 2000. Description of the Parc National de Marojejy, Madagascar, and the 1996 biological inventory of the reserve. Pp. 1-18. In: *A Floral and Faunal Inventory of the Parc National de Marojejy, Madagascar: With Reference to Elevational Variation.* S.M. Goodman (ed.). Fieldiana: Zoology, New Series 97.
 Lehner, P. 1996. *Handbook of Ethological Methods*, 2 edn. Cambridge Univ. Press, Cambridge.
 Mayor, M.; Lehman, S. M. 1999. Conservation of Perrier’s Sifaka (*Propithecus diadema perrieri*) in Analamera Special Reserve, Madagascar. *Lemur News* 4: 21-23.
 Messmer, N.; Rakotomalaza, P.J.; Gautier, L. 2000. Structure and floristic composition of the vegetation of the Parc National de Marojejy. Pp. 41-104. In: *A Floral and Faunal Inventory of the Parc National de Marojejy, Madagascar: With Reference to Elevational Variation.* S.M. Goodman (ed.). Fieldiana: Zoology, New Series 97.
 Mittermeier, R.A.; Konstant, W.R.; Nicoll, M.E; Langrand, O. 1992. *Lemurs of Madagascar: An Action Plan for their Conservation 1993-1999.* IUCN, Gland.
 Nicoll, M.E.; Langrand, O. 1989. *Madagascar: Revue de la Conservation et des Aires Protégées.* World Wildlife Fund, Gland.
 Powzyk, J. 1997. The socio-ecology of two sympatric indrids, *Propithecus diadema diadema* and *Indri indri*: A comparison of feeding strategies and their possible repercussions on species-specific behaviors. Unpublished Ph.D. Thesis, Duke University.
 Sterling, E.; McFadden, K. 2000. Rapid census of lemur populations in the Parc National de Marojejy, Madagascar. Pp. 265-274. In: *A Floral and Faunal Inventory of the Parc National de Marojejy, Madagascar: With Reference to Elevational Variation.* S.M. Goodman (ed.). Fieldiana: Zoology, New Series 97.
 Wright, P.C. 1995. Demography and life history of free-ranging *Propithecus diadema edwardsi* in Ranomafana National Park, Madagascar. *Int. J. Primatol.* 16: 835-854.

The current status of lemurs in the Sahivo and Antanamalaza classified forests, and the forest of Ambakaka, Toamasina province, Madagascar

Adam Britt

Madagascar Fauna Group, Project Betampona, BP 442, Toamasina 501, Madagascar.

Key words: Lemurs, Survey, Sahivo, Antanamalaza, Ambakaka, Betampona

As previously reported (Britt *et al.* 1999) Sahivo and Antanamalaza classified forests were the subject of one-day lemur surveys in January 1998 and January 1999. Despite dramatic loss of forest cover and continued human encroachment four lemur species were observed at Sahivo (*Indri indri*, *Eulemur fulvus albifrons*, *Hapalemur griseus* and *Avahi laniger*) and four at Antanamalaza (*Varecia v. variegata*, *I. indri*, *E. f. albifrons* and *A. laniger*). Information presented here is the result of repeat surveys of Sahivo in June and September 2001 and Antanamalaza in September 2001. In addition during the visit to Antanamalaza, the sacred forest of Ambakaka was also surveyed.

Sahivo classified forest

The Sahivo forest (17°53' S, 49°10' E) on paper covers 225 ha. In the 1950's this forest was continuous with the Betampona reserve. While it is difficult to provide an accurate estimate of remaining forest cover it was obviously much reduced since 1999, when it was estimated at less than 100 ha (Britt *et al.* 1999). What little remains is highly fragmented into blocks of around 1 ha in area. The largest block is around 5 ha, and a reasonable estimate of remaining forest would be in the region of 20 ha. Furthermore, the forest is extremely disturbed, with a marked absence of small and medium trees. This is likely a precursor to clear-felling for tavy this summer.

Antanamalaza classified forest

On paper the Antanamalaza forest (17° 50' S, 49°11' E) covers an area of 231 ha and lies approximately 10 km directly north-west of Betampona. Within the past 20 years the forest was continuous with the Sahivo forest to the south, and thus also with Betampona. The remaining forest is severely fragmented. The two largest patches may be up to 20ha - one at the far north of Antanamalaza, the other near the village of Longoza. Other patches range from 1 to 5 ha. Fragments are separated by savoka and tavy plots with occasional large forest trees standing alone. Savoka ranges from spiny shrub growth, through monospecific stands of *Afromomum augustifolium* to grassland. Some fragments are linked by narrow corridors of highly degraded forest. All the forest is severely disturbed. Most remaining patches are on ridge tops, while valley bottoms are devoid of forest. The forest continues to be clear-felled for tavy. A large palissandre tree was found being cut and prepared for transport, and many *Ravinala madagascariensis* had been cut to obtain the heart. There was also much evidence of the removal of timber for house construction. Despite all this, many large forest trees still remain, including impressive specimens of *Terminalia ombrophila*, *Rheedia* spp., *Uapaca* spp., *Canarium madagascariensis* and *Haematodendron glabrum*. Several small snares (presumably for tenrecs) were discovered.

Ambakaka forest

The Ambakaka forest (17° 52' S, 49°10' E) is sacred to local people and is thus somewhat protected. A number of tombs

are reportedly located within the forest. The forest lies directly between Sahivo to the south and Antanamalaza to the north, and consists of a single, approximately 30 ha narrow block of continuous forest. In addition there are a number of small (approx. 1 ha or less) patches close to the periphery. This was the least disturbed forest in the area, despite being the closest to human settlements. However there was still evidence of selective logging and other human disturbance. Three lemur snares were discovered during 2 hours in the forest on 23 September.

The status of lemurs in the three forests

In January 1998 1 *Indri*, 7 *Eulemur fulvus albifrons* (including 1 infant), 3 *Hapalemur griseus* and 2 *Avahi laniger* were sighted during two hours in the Sahivo classified forest. Villagers reported that two groups of 3 *Indri* were present. In June 2001 no lemurs were sighted, the *Indri* are no longer present and it seems unlikely that the remaining fragmented forest could support even *E. f. albifrons*. In September the continued presence of *H. g. griseus* was confirmed from evidence of feeding on bamboo. This is probably the last remaining diurnal lemur species at Sahivo. No lemurs were sighted in the forest during 2 hour visits on 23 June and 21 September 2001. Villagers at Lohanifontsy I (the closest village to the remaining forest) reported that they had not heard *Indri* for more than a year and that they no longer saw *E. f. albifrons*. However, villagers in Marofatana (approx. 3 km to the south-east) were adamant that *E. f. albifrons* were still present. In September evidence of *H. g. griseus* feeding on bamboo was apparent along the northern edge of Sahivo. Twenty-eight bird species were recorded.

At Antanamalaza, in January 1998 4 *Indri*, 6 *Varecia* and 3 *E. f. albifrons* were sighted; in January 1999 4 *Indri*, 4 *Varecia*, 4 *E. f. albifrons* and 2 *Avahi laniger* were sighted (Table 1). No lemurs were sighted in September 2001, although a group of *Varecia* were heard calling (possibly 3 individuals) was heard calling on 22 September at 0827 from a 5ha block of forest at the southern end of Antanamalaza. The group were not located, but faeces was found containing seeds of *Eugenia* sp. This was the only evidence of the presence of lemurs during 10 hours in the forest. Tracks of a Fossa (*Cryptoprocta ferox*) were seen on a trail in open grassland. Villagers in Lohanifontsy IV report that *E. f. albifrons* and *H. g. griseus* are still present. They also reported the continued presence of *Indri*. However, this was forcefully denied by an old woman in Lohanifontsy II. No calls were heard throughout the 3 days spent in the area. Of the nocturnal species villagers reported *Microcebus rufus*, *Cheirogaleus major*, *Phaner furcifer*, *Avahi laniger* and *Daubentonia madagascariensis*. Thirty-seven bird species were recorded.

It should be noted that the follow-up visits in 2001 were at a different time of year to previous visits. During January lemur species at Betampona are more active and sightings are more frequent than in June or September (pers. obs.). It is thus possible that the time of year was also a factor accounting for the paucity of lemur sightings.

At least three *E. f. albifrons* were heard calling at 0740 in the south of the the Ambakaka forest. Despite hearing them again further north at 0812 the group was not visually located. No evidence of the presence of other diurnal lemur species was apparent. Some villagers did report *Varecia* and *Indri* from this forest. This would seem to be the likeliest forest in the area where both species could persist. It is possible that these lemur species may move into this forest from other blocks as a patchy corridor exists along ridge tops to the north. However, the proximity of this forest to several villages may deter them from using the area. It seems likely that *H. g. griseus* would be present, but no evidence was found. At the northern end of the forest the complete skeletal remains and some fur of an adult male Aye-aye (*Dau-*

bentonia madagascariensis) were found at the base of a lemur snare (estimated to be less than 6 months old). It is presumed that the Aye-aye was found caught in the snare and left by the trapper due to the local belief that the killing of this species brings bad luck. In the region around Betampona it is fady to kill the Aye-aye. The Betsimisaraka people in this region believe that the Aye-aye belongs to an evil-spirit, the "Tsiny". If an Aye-aye is killed by a man the Tsiny will in turn kill the culprit, unless certain measures are taken. In this instance the trapper, on discovering the snared Aye-aye should have covered the body in the white cloth used for wrapping human cadavers, and placed it on a raised wooden platform to appease the Tsiny (for a review see Simons and Meyers 2001). The skeleton was given to the Environmental Education Centre at Parc Ivoloïna for display. Despite the local fady against killing this species the finding of an individual killed by a snare indicates that hunting can still have, an albeit, indirect effect on populations of this species. Fifteen bird species were recorded - considerably lower diversity than at the other two sites.

Sahivo provides the most dramatic documentation of lemur species loss. In the 1980's *Varecia* are reported to have still been present, and certainly until 1998 so were *Indri*. While it is likely that all the species recorded at Antanamalaza in 1998 and 1999 are still present, their numbers may be much reduced - certainly their available habitat is dramatically reduced.

If one considers the diurnal lemur fauna (5 species) of the nearby Betampona reserve (Britt *et al.* 1999) as representative of the full complement of species naturally occurring in low altitude rain forest in modern times, a clear pattern of species loss is apparent from Sahivo and Antanamalaza (Table 1). The first species to go is *Propithecus d. diadema*, absent from both forests and rare at Betampona. *Varecia* are next, followed by *Indri* and finally *E. f. albifrons*. *H. g. griseus* seems able to persist even in the absence of any forest.

Table 1. Presence/absence of the 5 diurnal lemur taxa at Betampona and in two classified forests, 2001.

Species	RNI Betampona	Sahivo CF	Antanamalaza CF
<i>H. g. griseus</i>	yes	yes	probably
<i>E. f. albifrons</i>	yes	possibly	probably
<i>V. v. variegata</i>	yes	no	yes
<i>I. indri</i>	yes	no	yes
<i>P. d. diadema</i>	yes	no	no

Whilst habitat destruction is undoubtedly the major factor behind species loss and reduction in population sizes, it is certain that hunting helps to hasten the process. It seems likely that without rapid and effective intervention, the forests of Sahivo and Antanamalaza will cease to exist within the next few years. Given the sacred status of the Ambakaka forest this will likely persist and may provide refuge for a few individuals of the local lemur fauna which was still relatively abundant until the mid-1980's.

There is a suggestion of attempting to create a forest corridor between the Betampona and Zahamena reserves (C. Welch pers. comm.). The preservation of forest remnants such as Sahivo and Antanamalaza should be viewed as an urgent priority by anyone considering such action. This could allow the gradual linking of small patches over relatively short distances. Indeed further forest patches are visible from Antanamalaza in the direction of Zahamena. However, if these forest remnants continue to be cleared at the current rate any attempts to create a corridor between the two reserves will become increasingly difficult.

Acknowledgements

Razandahy Arsene (MFG Betampona) assisted with surveys in all 3 forests. Jean-Noël (MFG Betampona) assisted with the surveys of Antanamalaza and Ambakaka. Razafy Celestin (MFG Betampona) kindly explained the local beliefs concerning the Aye-aye. Grateful thanks to the villagers of Lohanifontsy IV and Marofatana for their hospitality, and to all the people in the region who provided information on the status of lemurs in these forests both past and present.

References

- Britt, A.; Axel, A.; Young, R. 1999. Brief surveys of two classified forests in Toamasina Province, eastern Madagascar. *Lemur News* 4: 25-27.
- Simons, E.L.; Meyers, D. 2001. Folklore and beliefs about the aye aye (*Daubentonia madagascariensis*). *Lemur News* 6: 11-16.

Inventaire écologique dans l'île aux Prunes

Aimé Rasamison, Barson Rakotomanga et Pierre Manganirina Randrianarisoa

BIODEV Madagascar Consulting, B.P 6212, Antananarivo (101) Madagascar, Biodevmad@simicro.mg

Key words: Survey, Ile aux Prunes, Toamasina

Une équipe pluridisciplinaire du Cabinet d'étude BIODEV Madagascar s'est rendue dans l'île aux Prunes ou Nosy Alalana du 12 au 19 Janvier 2001, afin d'y réaliser un diagnostic physico-bio-écologique. Cette mission entre dans le cadre de l'étude d'impact environnemental relative au projet d'aménagement et d'exploitation de cette île, pour le compte du Grand Cercle Neptune sur financement du Fonds d'Appui au Secteur Privé ou FASP. L'île aux Prunes est un îlot ravissant situé à environ 10 km au large de Toamasina, soit une demi-heure de traversée en vedette rapide au départ du Grand Port. Elle est localisée dans les coordonnées géographiques suivantes: 18°03'19" S et 49°27'68" E.

L'île aux Prunes d'une superficie totale d'environ 30 ha est recouverte de forêts. Elle est entourée d'une jolie frange corallienne formant ce qu'on appelle un "récif frangeant". De belles plongées en apnée peuvent se faire depuis la plage jusqu'au front récifal. C'est un endroit idéal pour s'initier à la plongée en raison de la clarté de l'eau et de sa faible profondeur. En outre, elle est délimitée par une large plage corallienne.

L'écosystème forestier de l'île aux Prunes se présente sous forme de ceinture végétale concentrique constituée de trois séries de végétation qui se répartissent du centre de l'île vers la mer en forêt dense humide sempervirente à *Guettarda speciosa* et *Hibiscus tiliaceus*, forêt dense humide à *Baringtonia butonica* et le peuplement à *Casuarina equisetifolia* (sur la périphérie de l'île). En effet, la végétation de cette île est constituée d'une forêt très ancienne qui maintient les principaux caractéristiques d'une forêt dense humide sempervirente de l'Est. Elle s'installe sur un substrat calcaire formé par des débris coralliens. L'aspect physiognomique de cette forêt présente une canopée fermée à 25 m de hauteur. C'est une forêt à cinq strates avec la présence des émergents dominés par le *Terminalia catappa* (Atafana).

Sur les 42 espèces floristiques inventoriées, 32 seulement (soit 76,2 %) figurent dans l'ouvrage "Flore et Végétation de Madagascar et des Comores" (Perrier de la Bathie, 1921; Index Kewensis et Ethnobotany of Madagascar). Parmi elles, 11 espèces (soit 34,4 %) sont classées endémiques de Madagascar et 21 non endémiques. Ce chiffre montre un taux

d'endémicité faible dans l'écosystème forestier de l'île aux Prunes.

Concernant la faune, cette étude a permis de répertorier:

- une espèce de Lémuriens (*Varecia v. variegata*),
- quatre espèces de micromammifères dont deux endémiques (*Setifer setosus*, *Tenrec ecaudatus*) et deux introduites (*Rattus rattus*, *Suncus murinus*),
- une espèce de mégachiroptères (*Pteropus rufus*),
- 10 espèces d'Oiseaux dont six forestières et endémiques de Madagascar ou de la région et quatre espèces introduites et marines,
- cinq espèces de reptiles (*Zonosaurus madagascariensis*, *Mabuza gravenhorsti*, *Hemidactylus mercatorius*, *Phelsuma lineata bifasciata* et *Phelsuma pisulla pisulla*),
- 49 espèces de poissons,
- 27 espèces d'invertébrés macrofaunes (mollusques, échinidés, holothuries, etc...),
- 29 espèces de corail.

Des enquêtes auprès des pêcheurs et des gardiens du phare érigé sur cette île ont permis de connaître qu'un opérateur économique de Toamasina y a fait introduire quatre individus de *Varecia v. variegata* (Varika) et deux individus de *Hapalemur griseus* (Bokombolo) en 1989. Les Varika ont pu se reproduire et le nombre d'individus vivant en 1994 atteignait treize. Ces animaux ont été nourris avec des bananes en plus de leur alimentation naturelle dans le milieu. Toutefois, après la mort de cet opérateur (1994), ces animaux ont été laissés à l'état sauvage dans cette île.

Au cours de cet inventaire, un individu de *V. variegata* seulement a pu être répertorié. Aucun *H. griseus* n'a été ni observé ni signalé par les gardiens et pêcheurs. Ces derniers ont par ailleurs affirmé la présence actuelle de ce seul individu de Varika qui venait près du campement avec ses cris forts et aigus vers la fin de l'après-midi et au crépuscule. Les observations ainsi que les enquêtes auprès des gardiens et pêcheurs effectuées au cours de cette étude ont montré que cet individu de *Varecia variegata variegata* mange surtout des graines de *Terminalia catappa* qui abondent sur l'île. Néanmoins, plusieurs autres espèces de plantes telles que *Mimusops commersonii* (Voaranto) et *Morinda citrifolia* (Kafeala) sont aussi utilisées comme alimentation par cet animal.

Les informations données par les pêcheurs ont révélé la présence de certains chasseurs qui étaient surtout venus dans cette île pour chercher les mégachiroptères mais qui en même temps ont profité l'occasion pour chasser ces lémuriens. Durant notre passage dans l'île aux Prunes, un total de sept personnes y était présent dont deux gardiens du phare, la femme d'un gardien avec son enfant et trois pêcheurs. Selon un gardien, ce nombre varie entre quatre à dix personnes par semaine. Un pêcheur reste en moyenne quatre jours dans cette île avant de retourner à Toamasina. Néanmoins, d'autres pêcheurs n'y passent que quelques heures seulement.

La disparition de ces Lémuriens pourrait aussi être due à la "non-adaptation" avec le milieu notamment pour *Hapalemur griseus* qui est une espèce diurne vivant surtout dans des milieux forestiers où les bambous sont abondants (Petter and Peyrieras, 1970a; Pollock, 1986; Wright, 1986; Mittermeier *et al.*, 1994). En effet, cette espèce se nourrit surtout de jeunes pousses et feuilles de bambous. Toutefois, cette plante est presque inexistante dans l'île aux Prunes. Quelques types de pressions menacent la biodiversité de cette île aux Prunes malgré son insularité et son éloignement par rapport à la ville de Toamasina. En effet, la pression anthropique y intervient toujours car c'est un lieu de passage ou d'escale des pêcheurs et éventuellement un lieu de chasse aux mégachiroptères. L'existence de quelques étuis de bal de fusil de chasse dans la forêt indique que des chasseurs y parviennent. Cette présence humaine a surtout

permis l'envahissement des espèces nuisibles telles que *Rattus rattus* pour la faune et *Lantana camara* pour la flore sur l'ensemble de l'île. En outre, l'inventaire des bois coupés montre une valeur de 90 coupes/ha appartenant surtout à l'espèce *Casuarina equisetifolia* ou Filao.

Bibliographie

- Mittermeier, R.A.; Tattersall, I.; Konstant, W.R.; Meyers, D.M.; Mast, R.B. 1994. Lemurs of Madagascar. Conservation International, Washington D.C.
- Petter, J.J.; Peyrieras, A. 1970. Observations éco-éthologiques sur les lémuriens malgaches du genre *Hapalemur*. La Terre et la Vie 24: 356-382.
- Pollock, J.I. 1986. A note on the ecology and behavior of *Hapalemur griseus*. Primate Conservation 7: 97-100.
- Wright, P.C. 1986. Diet, ranging behaviour and activity pattern of the gentle lemur (*Hapalemur griseus*) in Madagascar. Amer. J. Phys. Anthropol. 69: 283.

The occurrence of *Allocebus trichotis* in the Parc National de Marojejy

Steven M. Goodman

Field Museum of Natural History, 1300 Roosevelt Road, Chicago, Illinois 60605, USA and WWF, B.P. 738, Antananarivo (101), Madagascar

Achille P. Raselimanana

WWF, B.P. 738, Antananarivo (101), Madagascar

Key words: Lemurs, *Allocebus trichotis*, survey, Marojejy

Over the course of the past 15 years or so there has been a considerable change in the status of the Hairy-eared Dwarf Lemur *Allocebus trichotis*. Before this period it was known from five specimens and was considered endangered (Harcourt and Thornback 1990; Meier and Albignac 1991). Since that time there have been numerous observations of this species from a variety of localities (from north to south): Réserve Spéciale (RS) d'Anjanaharibe-Sud (Schütz and Goodman 1998; Schmid and Smolker 1998), Parc National (PN) de Masoala (Sterling and Rakotoarison 1998), near Mananara (Meier and Albignac 1991), Réserve Naturelle Intégrale de Zahamena (Rakotoarison 1995), RS d'Analama-zaoatra (Garbutt 2001), and Forêt de Vohidrazana, near Andasibe (Rakotoarison *et al.* 1997). On the basis of this new information it has become clear that this species is widely distributed at least in the northern portion of the eastern humid forest across a range of elevations from lowland forest to montane forest up to about 1250 m.

In October and November 2001 we were members of a inventory team that conducted a survey of the northwestern slopes of the PN de Marojejy. At our first camp, located at Province d'Antsiranana, 11.5 km SE Doany, next to Bemanavy River, 14°25.6'S, 49°36.5'E, 810 m, we noted *Allocebus trichotis* on two occasions. The first observation of this species was on 16 October in a dense tangle within 15 m of the Bemanavy River. The individual was noted about 5 m off the ground and quickly moved off upon being approached. The distinct ear tufts were noticeable. The second record of this species in the same transect zone was on 19 October in an area with relatively dense vegetation, mostly medium-size lianas passing over a zone of low-growing trees. The single animal was noted at 2 m off the ground. When approached to within 3 m it froze for about 10 seconds and then quickly moved off. Once again the clear ear tufts were readily visible. In both cases the vegetation was sufficiently dense that it was difficult to observe in detail the animals' behavior.

The second site along the elevational transect was in montane forest and was located at Province d'Antsiranana, 13.0 km SE Doany, on ridge between the Antsahaberaoka and Andranomazava rivers, 14°26.2'S, 49°37.2'E, 1175 m. Individuals identified as *Allocebus* were observed on several occasions during nocturnal surveys. On 25 October, in a zone of forest with a dense understory at about 1100 m, a single individual was noted. During that same night an *Allocebus* was captured at 11:55 hr in a mist-net placed in the forest to capture birds and bats (Figure 1). The net was placed in a zone of relatively dense medium-sized trees that were closely packed and were connected by understory lianas. The captured animal was an adult male with scrotal testicles. The following measurements were made from the individual: Total length: 313 mm, head-body length: 143 mm, tail length: 155 mm, hind foot length (not including claw): 38 mm, ear length: 17 mm, and body mass 87 g. These measurements fall within the range of those presented by Meier and Albignac (1991) for museum specimens and individuals they captured in the Mananara region.



Allocebus trichotis captured by use of a mist net along the northwestern slopes of the Parc National de Marojejy at 1100 m (Photograph by Achille P. Raselimanana).

On 28 October at the second site an *Allocebus* was observed at close range and was followed for about 3 minutes. Here we paraphrase from SMC's notes. "The animal was first noted about 5 m off the ground coming down a looping 2-3 cm diameter liana headfirst. It descended to about 2 m off the ground and then leaped to a bush approximately 2.5 m off the ground, subdued an insect (probably a large beetle), and then consumed it. The insect was held in the lemur's forelimbs and the head was torn off with a bite and then a twisting action. The *Allocebus* spit out the head and let it drop to the ground. Thereafter it placed most of the insect's body in its mouth, bit off more-or-less half, and retained the other half in its forelimbs. Finally, the balance of the insect was consumed and the lemur continued on its way – it jumped from the bush to a lianescent bamboo and then vanished." Soon after the disappearance of this animal a second *Allocebus* was noted about 15 m away and approaching in the opposite direction from that the first individual disappeared. It too quickly moved off. Whether the two individuals were a pair or moving together as family members is impossible to discern. At the very least, at least two individuals occurred in the same patch of lianas.

Further notes made on the first individual include "It [the *Allocebus*] was distinctly larger than a typical *Microcebus rufus* and moved in an even more sporadic fashion. By that I mean when moving along the liana and then jumping to the small bush, it stopped, restarted, stopped, restarted, etc.... The gray back of the beast was very distinctive. At first

glance, based on the dorsal view of the animal, one could mistake it for a small *Cheirogaleus*, but its locomotion was not at all like this animal. The ear tufts were not always clear as the ears are relatively short and lying close to the head. Further, it appeared that the *Allocebus* physically moved its ears, perhaps when searching for prey, and in doing so the air tufts were variously visible."

During the primate survey conducted by Sterling and McFadden (2000) along the southeastern slopes of the PN de Marojejy they recorded 10 species of primates. Our documentation of *Allocebus* in another portion of the massif increases the known number of primates from the park to 11 species. Further, they reported the occurrence of *Phaner furcifer* at a lowland site based on vocalization. We can now confirm the presence of this species in the reserve along the northwestern slopes of the massive. We heard and saw this species on several occasions at the 810 m site.

The occurrence of *Allocebus* in the PN de Marojejy is not unexpected. The site it was recorded at in the RS d'Anjanaharibe-Sud is approximately xx km away direct line distance. The density of this species in the park is notable and our two transect sites, particularly the second one, might be excellent places to conduct a detailed study of the ecology and natural history of this species.

Acknowledgements

We are grateful to WWF staff in Andapa for their help in organizing logistical aspects of our mission to the northwestern slopes of Marojejy, in particular Anjara Manantsara and Njaka Evariste. The study was financed by a grant from Kreditanstalt für Wiederaufbau (KfW) to WWF.

References

- Garbutt, N. 2001. Brief observations of Hairy-eared Dwarf Lemur (*Allocebus trichotis*) in Analamazaotra Special Reserve, eastern Madagascar. *Lemur News* 6: 37.
- Harcourt, C.; Thornback, J. 1990. Lemurs of Madagascar and the Comoros. The IUCN Red Data book. IUCN, Gland and Cambridge.
- Meier, B.; Albignac, R. 1991. Rediscovery of *Allocebus trichotis* Günther 1875 (Primates) in northeast Madagascar. *Folia Primatol.* 56: 57-63.
- Rakotoarison, N. 1995. First sighting and capture of the hairy-eared dwarf lemur (*Allocebus trichotis*) in the Strict Nature Reserve of Zahamena. Unpublished report to Conservation International.
- Rakotoarison, N.; Zimmerman, H.; Zimmerman, E. 1996. Hairy-eared dwarf lemur (*Allocebus trichotis*) discovered in a highland rain forest of eastern Madagascar. Pp. 275-282. In: Biogéographie de Madagascar, W. R. Lourenço (ed.). Editions de l'ORSTOM, Paris.
- Schmid, J.; Smolker, R. 1998. Lemurs of the Réserve Spéciale d'Anjanaharibe-Sud, Madagascar. Pp. 227-238. In: A floral and faunal inventory of the Réserve Spéciale d'Anjanaharibe-Sud, Madagascar: With reference to elevational variation. S.M. Goodman (ed.). Fieldiana: Zoology, new series, 90.
- Schütz, H.; Goodman, S. 1998. Photographic evidence of *Allocebus trichotis* in the Réserve Spéciale d'Anjanaharibe-Sud. *Lemur News* 3: 21-22.
- Sterling, E.; McFadden, K. 2000. Rapid census of lemur populations in the Parc National de Marojejy, Madagascar. Pp. 265-274 in: A floral and faunal inventory of the Parc National de Marojejy, Madagascar: With reference to elevational variation. S.M. Goodman (ed.). Fieldiana: Zoology, new series, 97.
- Sterling, E.; Rakotoarison, N. 1998. Rapid assessment of richness and density of primate species on the Masoala Peninsula, eastern Madagascar. *Folia Primatol.* 69 (supplement 1): 109-116.

Medical evaluation of free-ranging primates in Betampona Reserve, Madagascar

Randall E. Junge

MS, DVM, Dipl ACZM, Staff veterinarian, St. Louis Zoo, St. Louis, MO, USA

Edward E. Louis

DVM, PhD, Geneticist, Henry Doorly Zoo, Omaha, NE, USA

Key words: Lemurs, blood count, serology, parasites

The issue of disease impact on freeranging populations has been of increasing interest in recent years (Spalding and Forrester 1993). For large stable populations, disease outbreaks are natural occurrences and usually have minimal impact on the species as a whole. However, as an animal species population declines, random stochastic events such as epidemics may have catastrophic effects. When small populations are fragmented into remnant islands, the effect may be even more pronounced. Evaluation of the incidence and prevalence of disease in wild populations is essential to be able to assess effects on population. Such evaluations have been done in few species, including preliminary evaluations of sifaka (Garell and Meyers 1995).

Knowledge of the disease status of a resident population is also critical in restocking programs, to allow risk assessment for both the released animals and those already present (Griffiths *et al.* 1993; Ballou 1993; Woodford 1993). Such a restocking program is occurring in Betampona Reserve with black and white ruffed lemurs (*Varecia v. variegata*; Welsh and Katz 1992, Britt *et al.* 1998, 2000) and medical evaluation of captive release candidates has been described (Junge and Garell 1995). This project involved medical evaluations of several species of prosimians in the reserve, allowing assessment of health status of sympatric species and free-ranging ruffed lemurs as well.

Materials and Methods

All animal immobilizations were performed in December 2000 Betampona Strict Nature Reserve, near Tamatave, on Madagascar's east coast. All animals were immobilized with tiletamine/zolazepam (10 mg/kg), administered by remote injection. Once anesthetized, each animal was given a complete physical examination, weighed, and had blood, fecal and ectoparasite samples collected. Each animal was monitored by assessing heart rate, respiratory rate, and body temperature. Each animal was given subcutaneous balanced electrolyte solution (LRS) equivalent to the amount of blood collected. Animals were held in cloth bags until fully recovered from anesthesia, then released at the site of capture.

Blood samples were collected not exceeding 1% of body weight (1ml/100g body weight). Whole blood (1/2 ml) was put into EDTA anticoagulant, the remaining volume into non-anticoagulant tubes and allowed to clot. Serum tubes were centrifuged within 8 hours of collection. Serum was pipetted into plastic tubes and frozen in liquid nitrogen for transport. Once transported to the St. Louis Zoo, the samples were stored at -70° C until analysis.

Fecal samples were collected either from freshly voided feces, or collected on a sterile cotton swab introduced into the rectum. Samples could not be obtained from all animals. Approximately 1 ml of feces was placed into 10% formalin for examination for parasite ova. If sufficient feces was obtained, a second 1 ml sample was frozen in liquid nitrogen for culture.

If external parasites were discovered on physical examination, they were removed with a cotton swab or forceps and placed into 70 % isopropyl alcohol.

Laboratory procedures

Within 8 hours of collection, two blood smear slides were made from each anticoagulant sample; these smears were fixed, stained, and preserved with cover slip and mounting medium for later evaluation. A total white blood cell count was done within 8 hours of collection, using the Unipette system (Becton Dickenson Co, Franklin Lake NJ 07417). Stained smears were examined microscopically for differential blood cell count and hemoparasite examination. Serum was submitted to a veterinary clinical service laboratory (Antech Diagnostics, Alsip, IL 60803) for serum biochemical profile by standard methods. Serum was submitted to a commercial laboratory (Exotex, San Antonio TX 78229) for viral serology for the following agents; adenovirus group-specific antibody, influenza A antibody, influenza B antibody, parainfluenza 1 antibody, rotavirus group-specific antibody, hepatitis A antibody, hepatitis B surface antigen.

Fecal samples in formalin and ectoparasites were submitted for identification (Clinical Parasitology Service, Veterinary Teaching Hospital, Knoxville, TN 37996). Frozen feces was submitted for aerobic culture (Antech).

Results and Discussion

Table 1 indicates the number of samples from each species that are reported for each test. Tables 2 -4 provide details of the analyses for each individual.

Table 1: Number of samples analyzed for different lemur species.

Species	CBC	Chem profile	Serology	Endo-parasites	Ecto-parasites	Fecal culture
Indri	7	7	7	1	7	4
<i>Eulemur</i>	2	4	3	3	4	1
<i>Varecia</i>	3	3	3	0	3	2
<i>Lepilemur</i>	1	1	0	1	1	1
<i>Avahi</i>	1	1	0	1	1	1

CBC = Complete blood cell counts

Complete blood cell counts (CBC):

No reference values for complete blood counts are available for *Indri*, *Avahi*, or *Lepilemur*. These species are not currently held in captivity. For these species, parameters show consistency and are comparable to other prosimian species (*Varecia*, *Eulemur*, *Lemur*) that have reference ranges published. Values for *Varecia* and *Eulemur* are within reference ranges (ISIS 1996). In most cases, the distribution is predominantly neutrophils. Two individuals (indri BET8 and ruffed lemur BET18) showed an inversion of the lymphocyte:neutrophil ratio. This may indicate infection or a stress response.

Serum biochemical profiles

As with CBCs, no reference values are available for *Indri*, *Avahi*, or *Lepilemur*. Serum chemistry values show consistency and are similar to other lemur species with published values. The exception is CPK, which is consistently high in these animals, most likely due to muscle trauma secondary to darting for capture. For *Varecia*, values are similar to reference ranges for captive animals with the exception of BUN (5-6 mg/dl), considerably lower than the published mean (21-10 mg/dl; ISIS 1996). This has been reported for ruffed lemurs previously (Junge and Garell 1995) and is postulated to reflect a higher protein level in the diet fed in captivity.

Two animals (indri BET9 and white-fronted lemur BET32) had very high serum alkaline phosphatase values. This may reflect young age in these two individuals. Although unable to determine conclusively, both were thought to be young adults based on general condition and dental condition. White-fronted lemur BET33 had very high AST and ALT compared to the others sampled, possibly indicating hepatic disease. All 4 white-fronted lemurs had high amylase values but lipase values in normal ranges for other mammals. This suggests that the high amylase values reflect a species peculiarity rather than an indication of pancreatic disease.

Serology

Serum antibody titers were determined for Adenovirus group specific IgG, Influenza A, Influenza B, Parainfluenza type 1, Rotavirus (SA11), Hepatitis A total antibody, and Hepatitis B antibody to surface antigen. These titers were tested for 7 *Indri*, 3 *Varecia* and 3 *Eulemur*. No antibody titers to the viral diseases tested were present. It is not possible at this time to determine if this reflects an actual lack of exposure to the viral disease, or simply an inability for the test to detect a response. The viral diseases that were selected are diseases present in other primate groups (including humans) that may be present in lemurs. Few viral diseases have been found to naturally occur in lemurs (Junge 1998).

Parasite examinations

Four *Indri*, 1 *Avahi*, 1 *Lepilemur*, 2 *Eulemur*, and 3 *Varecia* were examined for ecto-, endo-, and hemoparasites. External parasites (*Haemaphysalis lemuris*) were present on two *Varecia* examined. None of the other lemurs had ticks. The tick *Haemaphysalis lemuris* has been described from *Lemur catta*, *Varecia variegata*, *Propithecus v. verreauxi*, and *Lepilemur leucopus* (Hoogstraal 1953). Presumed ear mites were found in all white fronted lemurs examined, but this was de-

termined to be a mesostigmatid mite, which is not a parasite.

Moderate infections with pinworms and a few strongylates were found in the *Lepilemur* examined. Endoparasites were not found in any of the other individuals. There were microfilariae in the blood smear from the *Avahi* BET16, but identification has not yet been accomplished (may not be possible).

Fecal culture

Fecal cultures were established for the same individuals as listed in the "parasite examinations". Five species of enteric bacteria were cultured from fecal samples. They included Group D *Enterococcus* for *Indri*, *Avahi*, and *Lepilemur*; *Bacillus* sp. for *Indri* and *Varecia*; *Escherichia coli* for *Indri*; coagulase negative *Staphylococcus* sp. for *Indri*, *Avahi*, *Lepilemur*, and *Varecia*; *Enterococcus* sp. for *Lepilemur*; *Lactobacillus* sp. for *Eulemur*.

These bacteria are considered nonpathogenic and normal enteric flora. The species reported here have also been reported in black lemurs (*Eulemur macaco*) in captivity (Junge 1998).

Conclusions

These preliminary results are a valuable contribution to the reference database for lemurs. For 3 species, no reference values exist (*Indri*, *Avahi*, *Lepilemur*). For other species, few samples in the reference database are from wild animals. Differences such as those noted for *Varecia* (BUN levels) may be important for guiding husbandry changes. Documentation of parasites and fecal bacteria is useful for veterinarians in assessing health of captive animals. This project demonstrates that significant amounts of useful data can be collected by maximizing field procedures and forming cooperative projects.

Table 2: Serum biochemical profile and complete blood cell counts for Indri (*Indri indri*) from Betampona (Dec. 2000).

Test*	Units	BET1	BET2	BET3	BET8	BET9	BET10	BET42	Average	SD
AST	iu/l	83	48	46	32	63	32	78	54.6	20.7
ALT	iu/l	45	38	36	46	45	25	45	40.0	7.7
T Bili	mg/dl	0.2	0.3	0.5	0.4	0.1	0.1	0.3	0.3	0.2
Alk Phos	iu/l	88	55	71	189	442	104	109	151.1	135.2
GGT	iu/l	10	6	13	1	9	17	10	9.4	5.1
TP	g/dl	7.3	6.5	7.1	6.6	6	7.9	5.8	6.7	0.7
Albumin	g/dl	5.9	5.6	5.7	5.5	3.2	6.7	4.8	5.3	1.1
Globulin	g/dl	1.4	0.9	1.4	1.1	2.8	1.2	1	1.4	0.6
Cholest	mg/dl	159	163	146	106	134	118	116	134.6	22.6
BUN	mg/dl	13	17	14	15	17	13	15	14.9	1.7
Creat	mg/dl	1.4	1.4	1.3	0.9	1.2	1.1	1.5	1.3	0.2
Ph	mg/dl	3.6	2.9	4.5	6.3	4.6	5.3	3.9	4.4	1.1
Ca	mg/dl	10.5	9.4	10.3	10.1	10.4	10.2	9.2	10.0	0.5
Glucose	mg/dl	70	114	90	92	103	96	116	97.3	15.8
Amylase	iu/l	118	127	84	51	64	62	128	90.6	33.2
Lipase	iu/l	25	25	25	25	25	25	25	25.0	0.0
Na	mEq/l	153	149	154	147	150	156	141	150.0	5.0
K	mEq/l	4.4	3	4.3	5	4.4	5.6	4	4.4	0.8
Cl	mEq/l	115	107	110	111	110	121	103	111.0	5.7
CPK	iu/l	2120	1529	2228	1129	3709	848	3848	2201.6	1185.0
Triglycer	mg/dl	68	87	32	88	60	34	80	64.1	23.5
Mg	mEq/l	3	2.6	2.3	2	2.2	2.3	2.6	2.4	0.3
WBC	cells/ μ l	8.8	4.4	5.05	3.55	2.75	6.05	6.05	5.2	2.0
PCV	%	24	37.5	43.5	42.5	40.4	54.1	37.9	40	9.0
Seg	%	85	59	77	45	65	62	68	65.9	12.9
Band	%	0	0	0	0	0	0	0	0	0
Lymph	%	15	41	22	54	34	37	27	32.9	12.9
Eosin	%	0	0	1	1	1	1	5	1.8	1.8
Mono	%	0	0	0	0	0	0	0	0	0
Baso	%	0	0	0	0	0	0	0	0	0

* Abbreviations: AST = aspartate aminotransferase; ALT = alanine aminotransferase; T Bili = total bilirubin; Alk Phos = alkaline phosphatase; Cholest = cholesterol; BUN = blood urea nitrogen; Creat = creatinine; Ph = phosphorus; Ca = calcium; Na = sodium; K = potassium; Cl = chloride; CPK = creatine phosphokinase; Triglycer = triglycerides; Mg = magnesium; WBC = white blood cell count; PCV = packed cell volume; seg = segmented neutrophils; Band = band neutrophils; Lymph = lymphocytes; Eosin = eosinophils; Mono = monocytes; Baso = basophils.

Table 3: Serum biochemical profile and complete blood cell counts for white-fronted lemurs (*Eulemur fulvus albifrons*) from Betampona (Dec. 2000).

Test*	Units	BET31	BET32	BET33	BET34	Average	SD
AST	iu/l	182	29	646	34	222.8	291.0
ALT	iu/l	28	53	330	51	115.5	143.4
T Bili	mg/dl	0.5	0.3	0.3	0.2	0.3	0.1
Alk Phos	iu/l	170	417	253	298	284.5	103.0
GGT	iu/l	1	6	19	4	7.5	7.9
TP	g/dl	6.7	5.8	6.7	6.7	6.5	0.5
Albumin	g/dl	5.4	4.2	3	5.1	4.4	1.1
Globulin	g/dl	1.3	1.6	3.7	1.6	2.1	1.1
Cholest	mg/dl	22	12	20	19	18.3	4.3
BUN	mg/dl	5	5	7	5	5.5	1.0
Creat	mg/dl	0.7	0.5	0.5	0.5	0.6	0.1
Ph	mg/dl	6.1	8.6	7.1	5.3	6.8	1.4
Ca	mg/dl	10	10	9.5	8.8	9.6	0.6
Glucose	mg/dl	80	59	67	91	74.3	14.1
Amylase	iu/l	2094	2024	3005	2536	2414.8	454.1
Lipase	iu/l	79	116	92	181	117.0	45.3
Na	mEq/l	138	136	140	142	139.0	2.6
K	mEq/l	5.7	4.6	5	5.1	5.1	0.5
Cl	mEq/l	104	98	102	110	103.5	5.0
CPK	iu/l	9770	2327	4506	925	4382.0	3882.4
Triglycer	mg/dl	31	21	26	49	31.8	12.2
Mg	mEq/l	2.3	1.9	1.7	2.1	2.0	0.3
WBC	cells/ μ l		7.15	9.02		8.1	1.3
PCV	%		40	40.7		40.4	0.5
Seg	%		49	56		52.5	
Band	%		3	0		3.0	
Lymph	%		44	44		44.0	
Eosin	%		0	0		0	
Mono	%		4	0		4.0	
Baso	%		0	0		0	

* For abbreviations, see Table 2.

Table 4. Serum biochemical profile and complete blood cell counts for *Varecia vareigata*, *Avahi laniger*, and *Lepilemur mustelinus* from Betampona (Dec. 2000).

		Varecia	Varecia	Varecia	Lepilemur	Avahi
		BET18	BET51	BET52	BET21	BET16
AST	Units	94	63	83	76	29
ALT	iu/l	68	42	63	70	39
T Bili	iu/l	0.1	0.2	0.5	0.3	0.3
Alk Phos	mg/dl	627	170	735	85	59
GGT	iu/l	11	7	4	2	12
TP	iu/l	5.5	6.5	5.6	6.7	6.1
Albumin	g/dl	3.7	4.9	4.2	4.1	4.4
Globulin	g/dl	1.8	1.6	1.4	2.6	1.7
Cholest	g/dl	50	44	60	107	106
BUN	mg/dl	5	5	6	5	8
Creat	mg/dl	0.5	0.5	0.5	0.5	0.5
Ph	mg/dl	7.6	5.4	8.9	4.2	3.5
Ca	mg/dl	9.3	9.5	9	8.9	9.6
Glucose	mg/dl	133	125	123	143	120
Amylase	mg/dl	1526	1214	1112	97	286
Lipase	iu/l	25	25	25	1423	25
Na	iu/l	144	136	138	139	148
K	mEq/l	5.2	5	5.2	6.9	3.9
Cl	mEq/l	106	96	103	111	115
CPK	mEq/l	901	375	1193	4670	366
Triglycer	iu/l	47	50	71	145	78
Mg	mg/dl	2.1	1.8	2.2	3.3	2.3
WBC	cells/ μ l	10.29	11.67	8.965	5.28	4.84
PCV	%	43.9	51.8	41.1	34.5	42.5
Seg	%	31	74	39	69	46
Band	%	1	0	0	0	0
Lymph	%	62	24	59	31	53
Eosin	%	0	0	0	0	1
Mono	%	6	2	2	0	0
Baso	%	0	0	0	0	0

Acknowledgements

The study was sponsored by the St. Louis Zoo Field Research for Conservation Fund.

References

- Ballou, J.D. 1993. Assessing the risks of infectious diseases in captive breeding and reintroduction programs. *J. Zoo Wildl. Med.* 24: 327-335.
- Britt, A.; Welsh, C.R.; Katz, A.S. 1998. First release of captive-bred lemurs into their natural habitat. *Lemur News* 3: 9-11.
- Britt, A.; Welsh, C.R.; Katz, A.S. 2000. Ruffed lemur restocking and conservation program update. *Lemur News* 5: 36-38.
- Garell, D.M.; Meyers, D.M. 1995. Hematology and serum chemistry for free-ranging golden crowned sifaka (*Propithecus tattersalli*). *J. Zoo. Wildl. Med.* 26: 382-386.
- Griffiths, B.; Scott, M.; Carpenter, J.W.; Reed, C. 1993. Animal translocations and potential disease transmission. *J. Zoo Wildl. Med.* 24: 231-236.
- Hoogstraal, H. 1953. Ticks (Ixodoidea) of the Malagasy faunal region (excepting the Seychelles). *Bull. Mus. Comp. Zool., Harvard College* 3: 37-113.
- ISIS 1996. Normal Physiological Values. International Species Inventory System.
- Junge, R.E. 1998. Diseases of Prosimians. Pp 365-369. In: *Zoo and Wild Animal Medicine*. 4 Ed. M.E. Fowler, R.E. Miller (eds.), Saunders Co, Philadelphia.
- Junge, R.E.; Garell, D. 1995. Veterinary evaluation of ruffed lemurs (*Varecia variegata*) in Madagascar. *Primate Cons.* 16: 44-46.
- Spalding, M.G.; Forrester, D.J. 1993. Disease monitoring of free-ranging and released wildlife. *J. Zoo Wildl. Med.* 24: 271-280.
- Welsh, C.R.; Katz, A.S. 1992. A survey and census work on lemurs in the Natural Reserve of Betampona in eastern Madagascar with a view to restocking. *DODO*, 28: 45-58.
- Woodford, M.H. 1993. International disease implications for wildlife translocation. *J. Zoo Wildl. Med.* 24: 265-270.

Relationships inside the genus *Hapalemur* based on mitochondrial DNA sequences

Jean-Luc Fausser, Prosper Prosper and Yves Rumpler

ULP-Institut d'Embryologie, EA3428, Faculté de Médecine, 11 rue Human, 67085 Strasbourg cedex, France

Prosper Prosper

Parc Botanique et Zoologique de Tsimbazaza, Antananarivo, Madagascar

Key words: Lemurs, taxonomy, biogeography

The classification and the phylogenetic relationships of the different subspecies of *Hapalemur griseus*, as well as their distribution remain uncertain (Petter *et al.* 1977). In the *H. griseus* species, cytogenetic studies led to the description of four subspecies: *H. g. griseus*, *H. g. occidentalis*, *H. g. alao-trensis* and *H. g. meridionalis*. In order to clarify the relationships between the subspecies of the genus *Hapalemur*, cytogenetic and molecular studies based on cytochrome b and 12S mitochondrial DNA were performed on samples extending from the north to the south of the east of Madagascar (Fausser *et al.* 2002; Rumpler *et al.* in press). The data demonstrated:

Extensions of the *H. g. occidentalis* distribution area to the south at least till Maroantsetra.

The existence of a new variant of *H. griseus*, *H. griseus* ssp., characterized by its karyotype and living in the area

of Ranomafana-Kianjavato, so that the distribution area of *H. g. griseus* appears now more restricted than the widespread one previously described.

The genetic distances as well as the phylogenetic relationships among the *H. griseus* subspecies (Fig.1) confirm the subspecies status of *H. g. occidentalis* (all individuals from Ambato to Maroantsetra cluster together and small genetic distances are found between *H. g. griseus* and *H. g. occidentalis*).

The very short genetic distances found between *H. g. alaotrensis* and *H. g. griseus* would support a combination of these two groups into a single subspecies. However, due to the significant differences in body size and the differences in the content of heterochromatin found in both karyotypes, we propose to maintain both of them in separate subspecies.

All *H. g. meridionalis* cluster together and are separated from the other *H. g.* subspecies by distances in the range of those observed between species. Therefore we propose to raise this group to the specific rank *H. meridionalis*.

Finally, the phylogenetic relationships inside the *H. griseus* subspecies show that the *H. griseus* ssp. from Ranomafana contain two groups. The first one clusters with the *H. g. meridionalis*, while the second one clusters with the *H. g. griseus*/*H. g. alaotrensis* (Fig.1). This may be related to a recent mitochondrial DNA introgression or to the divergence of an ancestral polymorphic population containing both haplotypes. In the population of Ranomafana both haplotypes (*H. g. meridionalis* and *H. griseus* ssp.) were maintained. In the second population only the *H. g. meridionalis* haplotype remained present and the gain of a block of heterochromatin gave rise to the *H. g. meridionalis* karyotype.

Attempts are now made to study new molecular markers including nuclear sequences. We also wish to include animals originating from regions around Ranomafana. This will help us to precise the repartition areas and the boundaries between the *H. g. meridionalis*, *H. griseus* ssp and *H. g. griseus*.

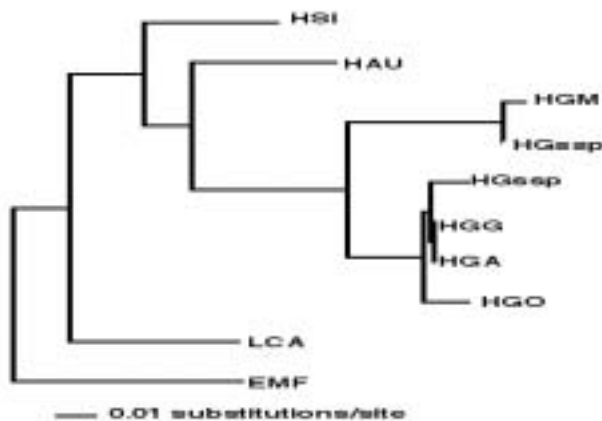


Fig. 1: Phylogenetic tree based on a 357 bp sequence of the cytochrome b gene. Neighbor-joining search with Kimura two parameters distance correction were used. The tree is rooted using a *Eulemur macaco flavifrons* (EMF) sequence. Comparisons are made between consensus sequences. HSI: *Hapalemur simus*, HAU: *Hapalemur aureus*, HGM: *Hapalemur griseus meridionalis*, HGssp: *Hapalemur griseus* ssp, HGG: *Hapalemur griseus griseus*, HGA: *Hapalemur griseus alaotrensis*, HGO: *Hapalemur griseus occidentalis*, LCA: *Lemur catta*.

Acknowledgements

This work was partly supported by the Association Européenne pour l'Étude et la Conservation des Lémuriens (A.E.E.C.L.), the DREIF-MENESR (EA3428), and the Institut de Génétique et de Biologie Moléculaire et Cellulaire (Pr.

P. Chambon). The authors thank the Commission Tripartite of the Malagasy Government and the Ministère pour la Production Animale et des Eaux et Forêts for their permission to capture the animals, to take samples and for delivery CITES. Thanks are also due to Mrs M. Lavaux for her secretarial assistance, to Dr B. Ravaoarimanana and M. Hauwy for their helpful comments, and to S. Vicaire (IGBMC, Strasbourg) for sequencing the cytochrome b and 12S fragments. Special thanks for insight comments on the cladograms are due to Dr. D. Montagnon.

References

- Fausser, J.L.; Prosper, P.; Rumpler, Y. 2002. Phylogenetic relationships between *Hapalemur* species and subspecies based on mitochondrial DNA sequences. BMC Evol. Biol. 2: 4. (www.biomedcentral.com/1471-2148/2/4).
- Petter, J.J.; Albignac, R.; Rumpler, Y. 1977. Mammifères lémuriens (Primates prosimiens). Faune de Madagascar, n° 44. ORSTOM-CNRS, Paris.
- Rumpler, Y.; Prosper, P.; Hauwy, M.; Rabarivola, C.; Rakotoarisoa, G.; Dutrillaux, B. (in press). Chromosomal evolution of the *Hapalemur griseus* subspecies (Malagasy Prosimian), including a new chromosomal polymorphic variant. Chromosome Research.

Ecologie des Lémuriens dans la forêt Littorale de Tampolo

Joelisoa Ratsirarson et Jeannin Ranaivonasy

Département des Eaux et Forêts, BP 175 ESSA, Université d'Antananarivo, Madagascar. j.ratsirarson@simicro.mg

Key words: Lemurs, Littoral forest, Madagascar

Madagascar est considéré comme parmi les régions rouges et prioritaires en matière de conservation de la biodiversité dans le monde (Mittermeier *et al.* 1998; Myers *et al.* 2000). Cette considération est liée non seulement à son degré de diversité et d'endémisme très élevé, mais aussi à la destruction continue et répandue de ses communautés naturelles (Green et Sussman 1990; Ganzhorn et Sorg 1996; Goodman et Patterson 1997; Lourenço et Goodman 2000). Les forêts littorales de la côte Est de Madagascar sont classées parmi les écosystèmes les plus menacés à Madagascar (Ganzhorn *et al.* 1997; Hannah *et al.* 1998; de Gouvenain et Silander 2000; Ganzhorn *et al.* 2000). Elles sont situées sur une bande de plaine côtière sableuse et rocailleuse à une altitude inférieure à 200 m et d'une distance à moins de 10 km de la côte (Koechlin *et al.* 1974). De ces forêts littorales ne restent que des fragments de forêts de petites tailles ayant une superficie totale de 500 km² (Du Puy et Moat 1996; Agarwal *et al.* sous presse). Elles ont été identifiées par le Plan National d'Action Environnemental comme prioritaires pour des actions de conservation à Madagascar (Ganzhorn *et al.* 1997; Hannah *et al.* 1998).

Les forêts littorales de Madagascar sont considérées comme des écosystèmes abritant des communautés de vertébrés de faible diversité spécifique, dont aucun n'est endémique dans ces forêts (Lourenço et Goodman 2000). Ce faible diversité de vertébrés a été suggéré être liée non seulement à une conséquence de la fragmentation de la forêt à cause des activités humaines et aux catastrophes naturelles, mais probablement aussi à la faible productivité de cette forêt sise sur sols sableux (Ganzhorn *et al.* 2000). Toutefois, ces forêts littorales contiennent quand même une diversité remarquable de plantes, d'invertébrés et d'écosystèmes, et fournit des habitats critiques de diverses espèces rares (Ratsirarson et Goodman 1998; Ganzhorn *et al.* 2000).

Les lémuriens de Madagascar, avec les trentaines d'espèces sont considérés comme un symbole unique de la faune de Madagascar (Mittermeier *et al.* 1994; Garbutt 1999). Peu de données sont disponibles sur l'écologie de ces lémuriens dans les forêts littorales de Madagascar sur sols sableux. Cependant, des études récentes indiquent en général que les forêts littorales contiennent une richesse spécifique faible par rapport à celles des forêts humides avoisinantes sur sol latéritiques (Ganzhorn *et al.* 2000). Une meilleure connaissance de l'écologie de ces lémuriens est indispensable, pour la mise en place des stratégies de conservation à long terme, en particulier pour les espèces qui habitent ces forêts littorales menacées.

Site d'étude et méthodologie

La forêt de Tampolo est l'un des derniers vestiges de forêts littorales le long de la côte Est de Madagascar, sise sur sols sableux (Ratsirarson et Goodman 1998). Elle est située à 10 km au Nord Ouest de Fenoarivo Atsinanana (ex Fénérive Est), entre la côte et la route nationale n°5 reliant Toamasina et Soanierana Ivongo (Fig. 1). Le climat est de type per-humide chaud, avec une précipitation moyenne annuelle de 2700 mm, répartie sur 8 mois, et une température moyenne annuelle de 24°C (Rajoelison 1997; Ratsirarson et Goodman 1998). Cette forêt de Tampolo est un des quatre sites de formation et de recherche géré par le Département des Eaux et Forêts de l'ESSA (Ecole Supérieure des Sciences Agronomiques) de l'Université d'Antananarivo. Les pressions qui s'exercent sur la forêt de Tampolo sont surtout les prélèvements illégitimes des produits forestiers y compris la collecte des bois de chauffe, de bois de charpente et d'ébénisterie, de produits forestiers non ligneux, la chasse (oiseaux aquatiques, lémuriens, tenrec) et la pêche (lac Tampolo) (voir Ratsirarson et Goodman 1998; Ratsirarson *et al.* 2001). En plus des activités de formation et de recherche à Tampolo, d'autres activités en partenariat avec les acteurs locaux pour alléger ces pressions et menaces continuent, notamment des activités en matière de conservation, d'éducation, de sensibilisation et de développement (Ratsirarson *et al.* 2001).

La forêt littorale de Tampolo comprend 4 types de forêts (Rajoelison 1997; Ratsirarson et Goodman 1998) (Fig. 2 et 3): la forêt d'enrichissement où la formation a fait l'objet de plantation d'espèces exotiques (*Eucalyptus robusta*, *Aucoumea klaineana*) ou autochtones (*Canarium madagascariensis*, *Intsia bijuga*) dans d'anciennes zones d'exploitation; la forêt sur sol marécageux qui est localisée sur les étangs plus ou moins temporaires et qui est dominée par des peuplements de *Typhonodorum lindleyanum* et de *Pandanus*, quelquefois des peuplements d'*Ilex mitis* et d'*Anthostema madagascariensis*;

la forêt temporairement inondée qui s'étend le long de la côte avec une flore appauvrie formant un peuplement serré d'arbres de petites dimensions;

la forêt littorale proprement dite qui constitue la majeure partie de la station de Tampolo avec la présence de traces de coupes sélectives des arbres de la canopée

Six espèces de lémuriens ont été inventoriées dans la forêt de Tampolo, dont quatre espèces nocturnes: *Microcebus rufus*, *Cheirogaleus major*, *Lepilemur mustelinus*, *Avahi laniger* et deux espèces diurnes: *Haplemur griseus griseus*, *Eulemur fulvus fulvus* (Ratsirarson et Goodman 1998). Goodman et Rakotondravony (1998) ont noté des indices de la présence de l'aye-aye (*Daubentonia madagascariensis*) dans cette forêt, mais nous n'avons pas pu en rencontrer lors de notre étude.

L'objectif de la présente étude consiste à mieux comprendre l'écologie de ces espèces de lémuriens dans la forêt littorale de Tampolo. La distribution spatiale et le comportement social et alimentaire de ces lémuriens sont examinées dans cette étude.

L'étude sur terrain a été entreprise en mars et avril 2001, mais l'équipe locale de l'ESSA-Forêts continue les observations des groupes de lémuriens dans la forêt de Tampolo. Nous avons suivi les layons et avons pénétré à l'intérieur des unités de parcelles par des virées successives (va et vient) pour le recensement des animaux. Pour le domaine vital, nous les avons suivis dans tous leurs déplacements et synthétisé les résultats de toutes les observations. Pour l'étude du comportement, nous avons adopté la méthode focal sampling qui consiste à enregistrer toutes les activités d'un individu focal ainsi que les renseignements complémentaires observés pendant une durée déterminée de 60 minutes (Sussman 1999).

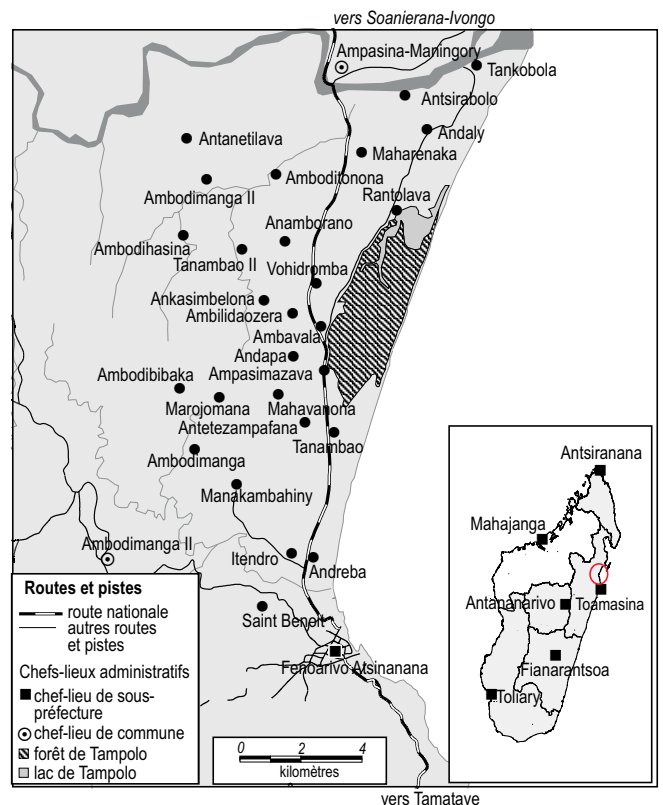


Fig. 1: Localisation de la forêt de Tampolo.

Résultats

Microcebus rufus:

C'est une espèce nocturne et solitaire. *M. rufus* est actif dans tous les niveaux de la forêt et fréquente surtout les lisières. C'est une espèce quadrupède et sauteuse. L'espèce ingère des quantités considérables d'insectes en particulier des Coléoptères. Elle consomme aussi une quantité importante de fruits de diverses espèces pendant la saison de pluies juste avant la période d'hibernation. La circonférence de sa queue augmente avant cette période d'hibernation (Randrianasolo, obs. pers.). De plus, elle mange des faibles quantités de feuilles, fleurs et bourgeons. L'espèce construit des nids à partir de touffes de feuilles pour dormir, et se rencontre surtout dans la forêt littorale proprement dite (Fig. 2).

Lepilemur mustelinus:

L'espèce est nocturne, solitaire et fortement territoriale. *L. mustelinus* s'accroche et saute verticalement aux branches. Elle utilise des substrats verticaux de faible diamètre pendant le déplacement, d'une hauteur variant de 5 à 8 m. Il y a une discussion considérable concernant le statut taxinomique du *Lepilemur* de la côte Est de l'île, mais la couleur

rousse du dos et de la queue des individus de Tampolo nous confirme leur appartenance à l'espèce *L. mustelinus* (Goodman et Rakotonondravy 1998). La plupart des activités de *L. mustelinus* sont dévouées aux activités de repos suivi des activités de nourriture. L'espèce se repose plus et se déplace moins pendant son activité. L'importance de l'activité repos est typique des espèces folivores qui ont besoin de prendre beaucoup de nourritures de faibles qualités et utilisent plus de temps pour la digestion (Garbutt 1999). L'espèce ingère une quantité appréciable de feuilles, en particulier les feuilles de *Xylophia* spp. (Annonaceae). Le comportement de caecotrophie a été observé à Tampolo. *L. mustelinus* dort dans des trous d'arbres. L'espèce est très rare dans la forêt de Tampolo, en particulier dans la forêt littorale proprement dite et la forêt de sol marécageux (Fig. 2).

Cheirogaleus major:

L'espèce est nocturne et solitaire. *C. major* est une espèce quadrupède. L'espèce ingère différentes parties de plantes (jeunes feuilles, feuilles, fruits, fleurs) suivant leur disponibilité. En plus des insectes, on a noté que l'espèce apprécie une quantité considérable de fruits en particulier ceux de *Mimusops lastellei*. On a observé la réduction des activités de l'animal et le gonflement de la queue de l'espèce pendant les mois de juin et de juillet (Randrianasolo obs. pers.). *C. major* dort dans des trous d'arbres pendant la journée. Cette espèce se rencontre partout dans les types de forêts de Tampolo sauf la forêt d'enrichissement (Fig. 2).

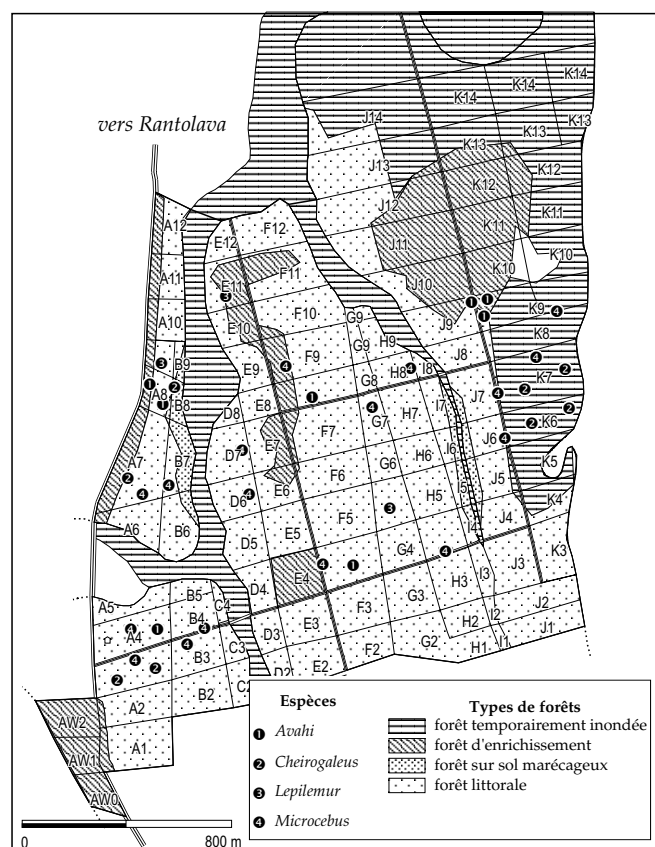


Fig. 2: Distribution des espèces nocturnes et les types de forêts à Tampolo.

Avahi laniger:

L'espèce est nocturne et vit en groupe de 2 à 5 individus à Tampolo. Comme *L. mustelinus*, *A. laniger* s'accroche et saute verticalement aux branches. Elle utilise un niveau plus haut (7 à 11 m de hauteur) que *Lepilemur*. *A. laniger* ingère aussi des feuilles en particulier des feuilles de *Harungana madagascariensis* et *Ocotea* sp. Elle peut être ren-

contrée dans les parcelles de plantation d'Okoume (*Aucoumea klaineana*). Elle utilise cet endroit comme dortoir pendant la journée (Fig. 2).

Eulemur fulvus fulvus:

L'espèce est active pendant le jour et la nuit (espèce cathémère) tout au long de l'année à Tampolo. L'effet de la disponibilité des ressources sur ces activités cathémérales n'est pas du tout claire. Nous avons observé à plusieurs reprises les animaux qui se nourrissent de même type d'aliments pendant les activités diurnes que nocturnes. Elle vit en groupe variant de 15 à 23 individus, avec un sex-ratio biaisé en faveur des mâles. Quelquefois, les groupes tendent à se diviser pendant la journée puis se remettent ensemble. *E. f. fulvus* est quadrupède et arboricole. Elle se déplace rarement au sol et fréquente surtout la strate forestière supérieure à 7 m de haut. La distance parcourue par jour varie de 500 à 1500 m avec une distance parcourue pendant la journée beaucoup plus longue que pendant la nuit. Les activités nocturnes tendent à être plus importantes pendant la période de pleine lune. Elle peut se rencontrer dans les différents types de forêt à Tampolo y compris la forêt temporairement inondée, la forêt de plantation mais en particulier la forêt littorale proprement dite (Fig. 3). Les individus sont extrêmement méfiants, indiquant probablement un stress dû à une pression à la chasse locale. *E. f. fulvus* mange des feuilles, des fleurs mais surtout des fruits (60 % de son régime alimentaire) tout au long de l'année. Elle apprécie les fruits du letchi (*Litchi sinensis*) aux alentours de la forêt pendant la saison des letchis. Les fruits de *Prothorus ditimena*, *Filicium decipiens*, *Mammea bongo*, *Astrotrichilia* sp. et *Oryza sativa* sont très appréciés, en plus des fleurs de *Aucoumea klaineana* et des feuilles de *Cynometra commersonii*. *E. f. fulvus* est l'espèce la plus abondante à Tampolo. *Haplemur griseus griseus*: Même si *H. g. griseus* est souvent considéré principalement comme diurne (Mittermeir et al. 1994; Garbutt 1999; Sussman 1999), l'espèce est cathémère à Tampolo. Il n'existe pas de différence significative d'activité entre les mâles et les femelles. L'espèce est très calme par rapport à *E. f. fulvus*. Son territoire se chevauche quelquefois avec celui de ce dernier. Elle est présente surtout dans la forêt littorale proprement dite (Fig. 3). Elle vit en groupe de 5 à 7 individus et fréquente surtout le niveau < à 5 m. Pour la nourriture, cette espèce se contente des jeunes feuilles d'*Ocotea cymosa* en plus des feuilles et fruits de *Oryza sativa* (riz). Les individus ont aussi un comportement très craintif en présence de l'homme. L'espèce a une tendance à se rapprocher des milieux marécageux pour profiter d'*O. sativa*. La forêt de Tampolo ne contient pas de forêt de bambous, qui est la nourriture habituelle de *H. g. griseus* (voir Mittermeir et al. 1994; Garbutt 1999), mais ici elle se contente des brins de graminées comprenant surtout des pousses d'*O. sativa*.

Prédation des lémuriens à Tampolo

Les prédateurs potentiels des lémuriens à Tampolo comprennent les espèces de Viverridae (*Galidia elegans*), les chats sauvages (*Felis* sp. Felidae), les chiens domestiques (*Canis domesticus* Canidae), les serpents et les oiseaux de proie. Quelques auteurs ont avancé l'importance de la prédation comme une force majeure sélectionnant le comportement et la morphologie des primates et d'autres mammifères (Goodman et al. 1993; Sussman 1999). Quelques observations ponctuelles sur la prédation des lémuriens ont été notées à Tampolo. Il existe aussi des comportements anti-prédateurs adoptés par ces lémuriens pour réduire leur vulnérabilité face aux prédateurs.

Un cri d'alarme très spécifique a été noté pour *Lepilemur mustelinus* en présence de *Boa manditra* (Boidae). Nous avons eu l'occasion d'observer un chien domestique (*Canis*

domesticus) en train de manger un microcèbe (*Microcebus rufus*) adulte, dans la périphérie de la forêt. Randrianasolo a noté l'occasion d'observer un *Asio madagascariensis* en train de dévorer un *M. rufus* (Randrianasolo, obs. pers.). Un Boidae (*Boa manditra* ou *Sanzinia madagascariensis*) a été observé capturer et ingérer entièrement un *H. g. griseus* adulte (Rakotondravony *et al.* 1998). Le caractère très craintif et méfiant des *E. f. fulvus* et *H. g. griseus* en présence de l'homme peut être lié à la chasse intensive de ces espèces. Les enquêtes auprès des villageois ont montré l'importance de la chasse de ces lémuriens diurnes dans la forêt de Tampolo et ses alentours.

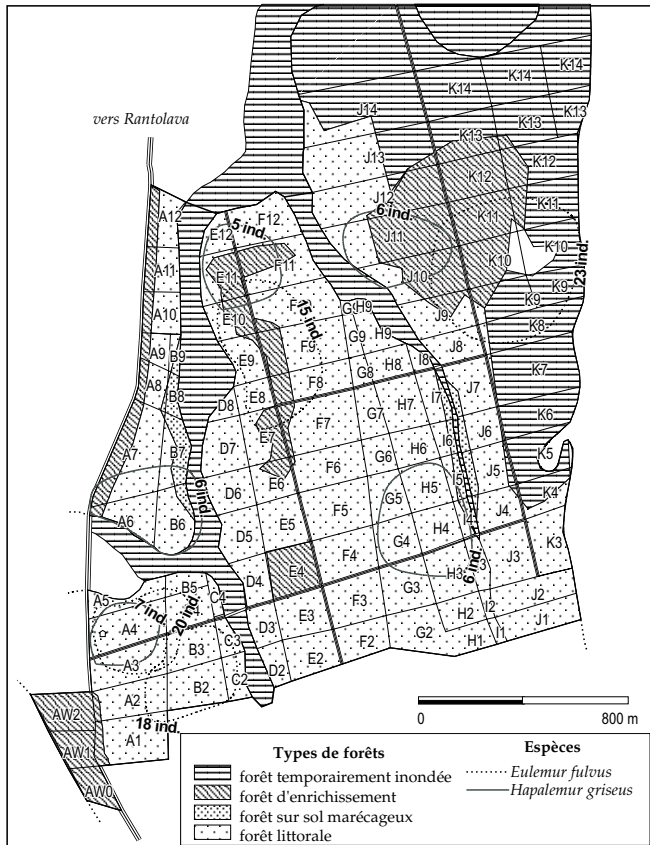


Fig. 3: Distribution de *H. g. griseus* et *E. f. fulvus* et les types de forêts à Tampolo

Les espèces nocturnes peuvent servir facilement de proies aux prédateurs. Elles sont relativement de petites tailles et solitaires. Elles ne peuvent alors se protéger ni par des moyens de défenses directes ni par l'intermédiaire d'un comportement social. Elles semblent utiliser comme stratégies de comportement anti-prédateur le choix de sites dortoirs bien cachés et des activités situées dans une dense végétation. D'autres auteurs ont avancé que le taux de reproduction élevé est aussi une des stratégies anti-prédatrices (Godman *et al.* 1993; Sussman 1999).

Conclusion

Les lémuriens nocturnes à Tampolo présentent un régime alimentaire et un choix d'habitat spécifique, qui dans la plupart des cas, semblent réduire la possibilité d'une compétition entre les espèces. Le régime alimentaire de chaque espèce peut être lié aux caractéristiques morphologiques et physiologiques spécifiques. Si *Microcebus rufus* et *Cheirogaleus major* se spécialisent pour les fruits et insectes, *Lepilemur mustelinus* et *Avahi laniger* s'intéressent surtout aux feuilles. Cependant, si *M. rufus* se trouve souvent sur les lières, *C. major* est rencontrée surtout dans la forêt. Les

deux espèces *L. mustelinus* et *A. laniger*, strictement folivores se différencient par l'utilisation des strates dans leur habitat, et puisque *A. laniger* utilise des strates beaucoup plus hautes que *L. mustelinus*. La disponibilité des ressources dans la forêt de Tampolo amène aussi les lémuriens à y adapter leurs habitudes alimentaires.

L'activité cathémérale des lémuriens diurnes semble être liée au niveau de la luminosité ambiante dans la forêt, l'activité nocturne est beaucoup plus poussée pendant la période de pleine lune. Les espèces diurnes sont extrêmement craintives et méfiantes vis à vis de la présence humaine. Ce comportement est lié aux activités de chasse locale des lémuriens.

La protection de la forêt de Tampolo constitue la première priorité pour la conservation de ses lémuriens. Le renforcement des contrôles des coupes illicites et la chasse ainsi que la destruction de l'habitat est fortement recommandée. Une stratégie de contrôle et de surveillance en collaboration avec les acteurs locaux (villageois, Service des Eaux et Forêts, Gendarmerie Nationale) est déjà en cours. Des études démographiques plus approfondies et à long terme sur ces espèces de lémuriens peuvent encore apporter une meilleure connaissance pour améliorer la stratégie de conservation qui est déjà en place.

Remerciements

Nous voulons remercier l'équipe de l'ESSA/Forêts Tampolo sur terrain pour l'appui logistique pendant cette étude. N. Ralison, V. Rakotozafy, J.A. Randrianarisoa et J. Alijimy nous ont assistés lors des différentes étapes de cette étude. Nous remercions vivement M. Randrianasolo, non seulement pour son assistance sur le terrain, mais aussi ses observations personnelles et données non publiées qu'il a mises à notre disposition. Nous sommes reconnaissants aux conseils et appuis de R.A. Mittermeier et W.R. Constant. La Fondation Margot Marsh à travers le Conservation International à Washington D.C. et la Fondation John D. et Catherine T. MacArthur ont appuyé financièrement cette étude.

Bibliographie

- Agarwal, D.K.; Gelfand, A.E.; Silander, J.A.Jr. sous presse. Investigating tropical deforestation using two stage spatially misaligned regression models. *J. Agri. Biol. Environ. Stat.*
- de Gouvenain, R.C.; Silander, J.A.Jr. 2000. Structure and composition of a forest fragment in eastern Madagascar in relation to human disturbance. Pp. 45-62. In: *Diversité et Endémisme à Madagascar*. W.R. Lourenço, S.M. Goodman (eds.). Mémoires de la Société de Biogéographie. Paris.
- Du Puy, D.J.; Moat, J. 1996. A refined classification of the primary vegetation of Madagascar based on the underlying geology: using GIS to map its distribution and to assess its conservation status. Pp. 205-218. In: *Biogeography of Madagascar*. W.R. Lourenço (ed.) ORSTOM. Paris.
- Ganzhorn, J.U.; Sorg, J.P. 1996. (eds.) *Ecology and Economy of a Tropical Dry Forest in Madagascar*. Primate Report 46-1. Deutsches Primatenzentrum. Göttingen.
- Ganzhorn, J.U.; Rakotosamimanana, B.; Hannah, L.; Hough, J.; Olivieri, S.; Rajaobelina, S.; Rodstrom, C.; Tilkin, G. 1997. Priorities for biodiversity conservation in Madagascar. Primate Report 48-1: 1-81.
- Ganzhorn, J.U.; Goodman, S.M.; Ramananjato, J.-B.; Rakotondravony, D.; Rakotosamimanana, B.; Vallan, D. 2000. Vertebrate species in fragmented littoral forests of Madagascar. Pp. 155-164. In: *Diversité et Endémisme à Madagascar*. W.R. Lourenço, S.M. Goodman (eds.) Mémoires de la Société de Biogéographie. Paris.
- Garbutt, N. 1999. *Mammals of Madagascar*. Yale University Press.

- Goodman, S.M.; O'Connor, S.; Langrand, O. 1993. A review of predation on lemurs: implications for the evolution of social behavior in small, nocturnal primates. Pp. 51-66. In: Lemur Social Systems and their Ecological Basis. P.M. Kappeler, J.U. Ganzhorn (eds.) Plenum Press. New York, USA.
- Goodman, S.M.; Patterson, B.D. 1997. (eds.) Natural Change and Human Impact in Madagascar. Smithsonian Institution. Washington D.C.
- Goodman, S.M.; Rakotonirainy, D. 1998. Les lémuriens. Pp. 213-222. In: Inventaire Biologique de la forêt littorale de Tampolo (Fenoarivo Atsinanana). J. Ratsirarson, S.M. Goodman (eds.). Série Sciences Biologiques n°14. CIDST. Antananarivo.
- Green, G.; Sussman, R.W. 1990. Deforestation history of the eastern rain forests of Madagascar from satellite images. Science 248: 212-215.
- Hannah, L.; Rakotosamimanana, B.; Ganzhorn, J.U.; Mittermeier, R.A.; Olivieri, S.; Rajaobelina, S.; Hough, J.; Andriamialisoa, F.; Bowles, I.; Tilkin, G. 1998. Participatory planning, scientific priorities and landscape conservation in Madagascar. Envir. Cons. 25: 30-36
- Koechlin, J.; Guillaumet, J.L.; Morat, P. 1974. Flore et Végétation de Madagascar. Vaduz: Cramer.
- Lourenço, W.R.; Goodman, S.M. 2000. (eds.) Diversité et Endémisme à Madagascar. Mémoires de la Société de Biogéographie. Paris.
- Mittermeier, R.A.; Tattersall, I.; Constant, W.R.; Meyers, D.M.; Mast, R.B. 1994. Lemurs of Madagascar. Conservation International. Washington D.C.
- Mittermeier, R.A.; Myers, N.; Thomsen, J.B.; da FONSECA, G.A.B.; Olivieri, S. 1998. Biodiversity hotspots and major tropical wilderness areas: approaches to setting conservation priorities. Cons. Biol. 12: 516-520.
- Myers, N.; Mittermeier, R.A.; Mittermeier, C.G.; da FONSECA, G.A.B.; Kent, J. 2000. Biodiversity hotspots for conservation priorities. Nature 403: 853-858.
- Rajoelison, L.G. 1997. Etude de la Forêt Tropicale Humide Malagasy: Exemple de la forêt littorale exploitée de Tampolo (Fenoarivo Atsinanana). Université d'Antananarivo, E.S.S.A-Forêts. Publication Série n4.
- Rakotonirainy, D.; Goodman, S.M.; Soarimalala, V. 1998. Predation on *Haplemur griseus* by *Boa manditra* (Boidae) in the littoral forest of eastern Madagascar. Folia Primatol. 69: 405-408.
- Ratsirarson, J.; Goodman, S.M. 1998. (eds.) Inventaire Biologique de la forêt littorale de Tampolo (Fenoarivo Atsinanana). Série Sciences Biologiques n°14. CIDST. Antananarivo.
- Ratsirarson, J.; Andrianarijaona, J.; Ranaivonasy, J.; Alijimy, L. 2001. Plan d'Aménagement et de Gestion de la forêt littorale de Tampolo. Division Ecologie & Biodiversité. ESSA-Forêts. Université d'Antananarivo, Madagascar.
- Sussman, R.W. 1999. Primate Ecology and Social Structure. Vol 1: Lorises, Lemurs and Tarsiers. Pearson Custom Publishing. MA.

Un Programme International de Recherche et de Conservation pour le Lémur aux yeux turquoise (*Eulemur macaco flavifrons*)

Jean-Marc Lernoald

Parc Zoologique et Botanique de Mulhouse, 51, rue du Jardin Zoologique, 68100 MULHOUSE, France
zoomulhouse@hrnet.fr et jean-marc.lernoald@hrnet.fr

Key words: Lemurs, Sahamalaza, *Eulemur macaco flavifrons*

Le travail des jardins zoologiques s'est considérablement modifié au cours des dernières décennies. Tout en continuant de remplir leurs fonctions récréative et éducative, ils se sont impliqués toujours davantage dans la conservation des espèces.

Cette conservation fut d'abord comprise comme un élevage d'espèces rares, menacées de disparition, pour lesquelles furent établis des studbooks internationaux, première étape d'une coordination de l'élevage qui s'est développée en Amérique du Nord puis en Europe (EEP). Cette coordination a permis la constitution, dans les parcs zoologiques, de populations animales bien gérées, composées d'un nombre d'individus suffisant et présentant une bonne variabilité génétique, ce qui permet d'assurer la survie à long terme de quelques espèces en élevage et, dans certains cas, des réintroductions dans la nature.

Certains jardins zoologiques ont entrepris des actions plus fondamentales et plus globales pour la conservation des espèces. Ils considèrent que, dans certains cas, l'élevage est un chaînon indispensable dans l'ensemble des activités visant à la conservation des espèces et de leurs milieux et que les zoos doivent s'impliquer de façons diverses dans ces activités.

En effet si les premières mesures qui s'imposent pour la conservation des espèces animales sont les actions visant à protéger les milieux naturels, il peut arriver parfois que ces mesures soient insuffisantes ou peu efficaces. La chasse et le braconnage viennent souvent aggraver les problèmes. Les zoos et leur public doivent soutenir les efforts des organisations de protection de la nature locales, nationales ou internationales mais, parfois, en attendant que ces efforts portent leurs fruits, il est nécessaire de prendre des mesures d'urgence pour que certaines espèces ne disparaissent pas. Ces mesures incluent, entre autres :

- un réseau de stations d'élevage in situ et ex situ, assuré de la collaboration internationale de spécialistes de la zootechnie, de la nutrition, de la pathologie, de l'éthologie, de la biologie de la reproduction, afin de constituer une réserve d'animaux pouvant être utilisée pour d'éventuelles réintroductions ;
- un programme de recherches scientifiques variées sur le terrain et en laboratoire auquel participent des chercheurs nationaux et étrangers ;
- l'étude au laboratoire de la biologie de la reproduction afin d'améliorer les résultats d'élevage y compris, si besoin, par la maîtrise des techniques de conservation du sperme et de l'insémination artificielle.

Le Parc Zoologique et Botanique de la Ville de Mulhouse est ainsi actif aux Philippines pour empêcher la disparition du Cerf du Prince Alfred (*Cervus alfredi*) et des forêts où il survit. Au Brésil, il est partenaire du Centre de Primatologie de Rio de Janeiro pour développer en Europe le programme d'élevage et de conservation du Capucin à poitrine jaune (*Cebus apella xanthosternos*). Au Vietnam, il participe aux activités du Centre de sauvetage des primates du Parc National de Cuc Phuong. Dans ces exemples les espèces concernées ont des effectifs dans la nature de l'ordre de quelques centaines d'individus seulement, ce qui indique clairement l'urgence qu'il y avait à mettre en place des élevages. A Madagascar, le Zoo de Mulhouse s'est impliqué, entre autres, dans la sauvegarde du Lémur aux yeux turquoise (*Eulemur macaco flavifrons*).

Dès 1980, le Zoo de Mulhouse, qui vient de construire un bâtiment destiné à l'élevage des lémuriens, avec le soutien financier du Ministère de l'Environnement, collabore avec l'Institut d'Embryologie de la Faculté de Médecine de l'Université de Strasbourg où le Pr. Yves Rimpler étudie l'évolution des lémuriens. Cette collaboration se développe et en 1984 le Zoo de Mulhouse soutient financièrement la deuxième mission d'étude de *E. m. flavifrons*, redécouvert l'an-

née précédente, à 10 km de Maromandia, par une mission franco-malgache organisée par l'Université de Strasbourg (Koenders *et al.* 1985).

E. m. flavifrons, dont chaque sexe découvert séparément au siècle dernier avait reçu un nom d'espèce différent (*Lemur flavifrons* (Gray 1867) pour la femelle beige, *Lemur nigerrimus* (Sclater 1880) pour le mâle noir), fut longtemps considéré comme un animal mythique. Certains considéraient même qu'il n'avait pas d'existence réelle (Tattersall 1982) et que seul l'état de dégradation de certaines peaux de *E. m. macaco* des collections des musées était responsable des variations qui avaient permis de caractériser cette sous-espèce.

La première étude de terrain avait permis de préciser la description morphologique de *E. m. flavifrons*, les limites nord et sud de l'aire de répartition avaient été déterminées (Koenders *et al.* 1985a; Koenders *et al.* 1985b). Les deux partenaires décident alors de développer l'élevage des lémuriens rares et, en particulier, de mettre en oeuvre un projet d'élevage, d'étude scientifique et de conservation pour *E. m. flavifrons* dont on pouvait déjà penser qu'il était en danger.

En 1984 et 1986, quelques lémurs furent capturés dans une forêt en cours de destruction complète et envoyés au Parc Ivoloina ainsi qu'à Strasbourg et Mulhouse afin de commencer un élevage de recherche et de conservation (Brun *et al.* 1989).

En 1986 les deux partenaires officialisent leur projet en signant un protocole d'accord avec la Direction des Eaux et Forêts. Afin de développer leur capacité d'élevage et leurs moyens d'action, ils invitent les zoos de Cologne et Saarbrücken, en Allemagne, connus pour leur expérience de l'élevage des lémuriens, à les rejoindre au sein d'un Consortium. Le Consortium, représenté à la réunion de Ste Catherine aux Etats-Unis en 1987, adhère à la "Convention de collaboration pour la faune malgache menacée" qui est rédigée par les participants malgaches et internationaux. Conformément à cette convention, en 1988, il signe un protocole d'accord avec le Service des Eaux et Forêts de Madagascar qui définit précisément un projet de conservation de *E. m. flavifrons* (élevage, recherche fondamentale, création d'une réserve) qui inclut un soutien à la transformation de la Station forestière de l'Ivoloina en centre d'élevage ouvert au public ainsi qu'un programme de formation d'étudiants, de chercheurs et de techniciens malgaches. La même année, le consortium se structure en devenant "Association Européenne pour l'Etude et la Conservation des Lémuriens", AEECL.

Il fut alors possible de prendre en charge le travail sur le terrain d'un chercheur malgache qui précisa les limites est et ouest de l'aire de répartition de *E. m. flavifrons* (Fig. 1) et qui détermina, à l'est, une zone d'hybridation caractérisée par le passage progressif de *E. m. macaco* à *E. m. flavifrons* (Rabarivola *et al.* 1991; Meyers *et al.* 1989). Les résultats obtenus par ce chercheur dans l'étude de la génétique de diverses populations sauvages de *E. m. macaco* et *E. m. flavifrons* (Rabarivola *et al.* 1996, Rabarivola *et al.* 1998) lui permirent de soutenir une thèse de 3e cycle (Rabarivola 1993) puis une thèse de doctorat (Rabarivola 1998) et d'occuper un poste de professeur à l'Université de Madagascar où il enseigne la primatologie et la conservation des espèces, tout en continuant à participer à la recherche et à former de nouveaux scientifiques malgaches.

Forte de ces résultats, l'AEECL put aborder l'étape suivante: la délimitation précise d'une zone à mettre en réserve. Cette partie du programme fut coordonnée par un ingénieur des Eaux et Forêts malgache. Un 1er survol de l'aire de répartition de *E. m. flavifrons* a été effectué pour repérer les zones les plus boisées avec une densité d'occupation humaine faible. Au cours d'un 2e survol à une altitude de 2000 m, la zone retenue après le survol précédent fut quadrillée par une série de prises de vues effectuées avec une fréquence de 1 tous les 600 m et avec un chevauchement des photos de 60%. Les photos aériennes furent étudiées à l'aide d'un sté-

réoscope, ce qui permit de dresser une carte de la répartition des différents types de forêts (forêts subhumides de Sambirano, forêts sèches de l'ouest, zones de mangroves) et d'apprécier l'extension des zones dégradées. Les résultats, comparés à ceux obtenus à partir de photos aériennes effectuées en 1949, ont montré que, dans la zone choisie, le couvert forestier n'avait pas régressé mais que les forêts sèches avaient progressé au détriment des forêts humides. Les inventaires effectués sur le terrain ont permis d'estimer entre 700 et 3500 le nombre des *E. m. flavifrons* compris dans la zone à protéger. Ils ont montré que cette région comprenait également d'autres lémuriens (*Daubentonia*, *Lepilemur*, *Microcebus*, *Hapalemur*) ainsi que des espèces rares d'oiseaux, telles que l'aigle pêcheur (*Haaliaetus vociferoides*).

L'inventaire complet des oiseaux, des petits mammifères, des amphibiens et des reptiles est en cours de réalisation par des équipes de l'Université de Tananarive, soutenues financièrement par l'AEECL.

Une étude socio-économique est également en cours et les premiers résultats indiquent que les villages inclus dans la zone à protéger ont été en partie désertés et que la population restante accepterait volontiers de les quitter pour des conditions économiques meilleures. La confirmation de ces résultats préliminaires assurerait une situation particulièrement favorable pour la création d'une zone protégée.

La fin des études sur le terrain devra aboutir à la dernière étape du projet, la constitution du dossier permettant à la Direction des Eaux et Forêts d'entamer la procédure de mise en réserve de la zone ainsi délimitée (Fig. 1) qui comprendra, outre la région forestière de près de 300 Km² abritant les *E. m. flavifrons*, une zone importante de mangrove de près de 80 km² et une surface maritime de près de 200 km² riche en récifs coraliens, le tout devant former un ensemble protégé de 580 km² environ.

Le soutien des zoos de Mulhouse, Cologne et Saarbrücken a également été déterminant dans l'utilisation des techniques de biologie moléculaire pour apprécier la variabilité génétique de populations de lémuriens des parcs zoologiques et des instituts de recherche, afin de la comparer à celle existant dans les populations sauvages et de gérer rationnellement l'élevage (Neveu *et al.* 1996).

Avec l'aide financière des trois zoos, des chercheurs de l'Université de Strasbourg et de Göttingen ont ainsi pu com-

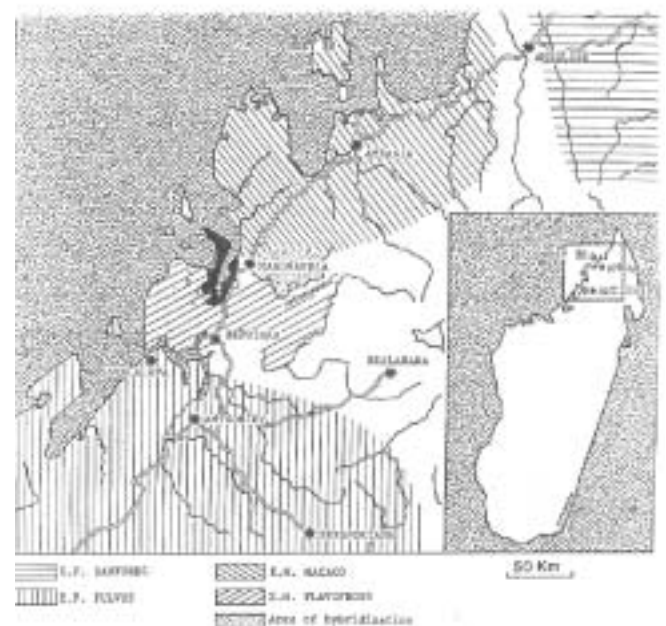


Fig. 1: Distribution of *Eulemur macaco* subspecies and bordering *Eulemur fulvus* subspecies. Area in black: zone of the future reserve.

parer la variabilité génétique des populations de *Microcebus murinus* de différents élevages et montrer que l'effectif de la population ne suffisait pas à définir la qualité de celle-ci et masquait parfois la pauvreté de la diversité génétique. La même équipe a montré que, par un choix judicieux des reproducteurs (Neveu *et al.* 1998) provenant des différents élevages, il était possible d'améliorer considérablement la variabilité génétique et de se rapprocher de celle des populations naturelles (Neveu *et al.* 1996).

L'Association Européenne pour l'Etude et la Conservation des Lémuriens s'est maintenant engagée à soutenir deux nouveaux chercheurs malgaches. L'un fait un inventaire systématique du genre *Hapalemur* dans toute l'île, utilisant simultanément des techniques cytogénétiques classiques et des techniques de biologie moléculaire. L'autre fait une recherche originale sur le rôle des remaniements chromosomiques dans la spéciation de *Lepilemur septentrionalis* au nord de Madagascar. Cette étude qui allie à la fois travail sur le terrain et technique de biologie moléculaire a débuté par un inventaire des différentes sous-espèces de *Lepilemur septentrionalis* et la détermination de leurs aires de répartition.

Le programme pour la conservation du lémur aux yeux turquoise est l'élément majeur de la contribution de l'AEELCL à la protection de la nature à Madagascar. Cependant des recherches scientifiques sur d'autres lémuriens ont pu aussi être réalisées grâce au soutien financier de l'Association.

A ce jour une vingtaine de publications ont présenté les travaux réalisés par l'AEELCL ou avec son soutien. Une thèse de 3e cycle et 3 thèses de doctorat ont été soutenues grâce à l'AEELCL.

Ceci démontre parfaitement que les zoos peuvent jouer un rôle important dans la conservation in situ des espèces et dans la recherche scientifique, un rôle qui va bien au delà des activités d'élevage, de présentation au public et d'éducation qui sont bien connues.

Dans le cas particulier des espèces animales dont les effectifs sont très réduits dans la nature (quelques centaines à quelques milliers), leur élevage peut jouer un rôle déterminant s'il est intégré dans l'ensemble des mesures de conservation telles que: protection du milieu, création de réserves, interdiction de la chasse, recherche scientifique, éducation des populations locales, formation de techniciens et chercheurs nationaux, etc. Les compétences des zoos dans ce domaine sont irremplaçables et, si des réintroductions deviennent nécessaires et possibles, seul l'élevage permet de les réaliser.

Par ailleurs, au delà de la contribution financière indirecte qu'ils apportent à la conservation par l'élevage d'espèces menacées plutôt que d'espèces communes (nourriture, main d'oeuvre, coûts divers...), les zoos peuvent drainer des fonds nouveaux pour la conservation en particulier par l'information et la sensibilisation d'un public très nombreux.

Afin de développer la population en élevage du lémur aux yeux turquoise, de nouveaux parcs zoologiques européens sont invités à devenir membres de l'AEELCL. Ils contribuent aussi de cette façon à développer les moyens financiers que l'Association peut consacrer à ses activités de conservation, de recherche et de formation à Madagascar.

Il y a actuellement plus de 30 *E.m. flavifrons* dans les 7 institutions membres de l'AEELCL. Cette population est gérée globalement au sein d'un programme européen (EEP) coordonné à Mulhouse. Des échanges sont prévus avec la population captive d'Amérique du Nord et il est souhaitable que les deux parcs malgaches participent à la mise en place d'une coordination internationale de l'élevage afin d'assurer la meilleure variabilité génétique de cette population qui pourra, en cas de besoin, servir à des opérations de réintroduction ou de renforcement de populations sauvages.

Addendum

Cet exposé ayant été présenté en 1998 au congrès de l'International Primatological Society à Antananarivo, il convient aujourd'hui, en mai 2002 de l'actualiser.

Neuf établissements ont rejoint l'Université de Strasbourg et les zoos de Mulhouse, Cologne et Saarbrücken: en France, le Parc Zoologique de Paris, aux Pays-Bas, le Parc de primates d'Apenheul, en Pologne, le Zoo de Poznan, au Royaume-Uni, les zoos de Banham, Colchester, Edinburgh, Londres, Twycross et la collection privée du défunt Martin Bourne. Au 1^{er} janvier 2002, on dénombre 35 *E.m. flavifrons*, (17 mâles et 18 femelles) en Europe.

Depuis 1998, les travaux de recherche scientifique soutenus par l'AEELCL, ont porté sur:

- la variabilité génétique de *E.m. flavifrons* dans la région de Sahamalaza en rapport avec le projet de création d'aire protégée,
- la phylogénie des *Lepilemuridae* (Montagnon *et al.* 2001 ; Ravaoarimanana *et al.* 2001),
- la spéciation de *Lepilemur septentrionalis* (Ravaoarimanana 2001; Rumpler *et al.* in press),
- la taxonomie et la distribution de *Hapalemur griseus* par l'étude comparée des caryotypes et de l'ADN mitochondrial (Rumpler *et al.* 2002 ; Fausser *et al.* 2002),
- la comparaison de deux populations de *Hapalemur simus* (morphologie des dermatoglyphes, analyse génétique, adaptation à l'environnement) (Andriaholinirina 2001).

Afin de faire progresser le projet de création d'une aire protégée à Sahamalaza proposé par l'AEELCL, un partenariat a été conclu avec la Wildlife Conservation Society (WCS) en 1999. Des études écologiques générales, botaniques et primatologiques ont permis de compléter et de mettre à jour les données biologiques obtenues antérieurement à Sahamalaza. Une étude préliminaire de la situation hydrologique a été menée. Deux personnes de la région ont été identifiées et formées pour collecter des données socio-économiques dans tous les villages de la zone concernée.

Bien que les forêts de la presqu'île soient assez dégradées, elles supportent une population viable de *E.m. flavifrons* et d'autres espèces rares. L'enquête menée auprès des habitants a démontré qu'ils sont bien conscients que leurs mauvaises conditions de vie sont liées à la dégradation de l'environnement.

Un atelier organisé en décembre 2000 à Antananarivo avec des représentants de la région de Sahamalaza, l'ANGAP et diverses ONG a abouti à la décision de mettre en œuvre un processus de Gestion Communautaire des Ressources Naturelles (GCRN) dans la région de Sahamalaza. Cette gestion a pour but de faire participer les populations aux décisions et aux réalisations destinées à améliorer leurs conditions de vie tout en assurant la conservation à long terme des environnements terrestre, marin et des processus naturels des écosystèmes à Sahamalaza, par la création d'une aire protégée.

Suite à la proposition soumise par le comité scientifique de l'UNESCO Madagascar, en septembre 2001, le Bureau du Conseil International de Coordination du Programme MAB sur l'Homme et la Biosphère de l'UNESCO a approuvé la désignation de la Réserve de Biosphère de Sahamalaza / Iles Radama, reconnaissant ainsi la haute importance biologique de cette région. Le Bureau souhaite que cette réserve de biosphère serve d'exemple pour promouvoir une gestion durable des ressources naturelles dans le nord-ouest de Madagascar.

En septembre 2001, une association locale, dénommée "Volamaitso" a été créée. Par cette association, les villageois ont clairement exprimé leur adhésion au processus GCRN que le partenariat AEELCL-WCS essaie de mettre en place dans

la région. Une convention entre Volamaitso, WCS et AEECL sera bientôt signée.

Tous les éléments sont maintenant réunis pour la création d'une aire protégée à Sahamalaza avec l'accord et la participation de la population.

L'atelier de décembre 2000 à Antananarivo a défini un plan d'action assez détaillé pour la mise en œuvre du processus de GCRN à Sahamalaza. L'année 2001 a vu se réaliser les premières actions de ce plan. Une partie des actions futures dépendra de partenaires et de financements qui restent à identifier et/ou à confirmer.

Les activités de recherches scientifiques à Sahamalaza vont se développer parallèlement au processus de GCRN. Une étude de l'impact de la fragmentation des forêts sur la population de *E. m. flavifrons* dans le cadre d'un DEA ainsi qu'une thèse de doctorat sur l'écologie de *E.m.flavifrons* vont bientôt débiter.

Enfin, un groupe d'habitants de la région de Mulhouse, séduit par le projet Sahamalaza, a décidé de créer une association destinée à collecter des fonds pour soutenir les populations locales dans le domaine scolaire en particulier.

De l'idée initiale, et apparemment simple, de créer une aire protégée pour un lémurien rare, on est arrivé maintenant à la mise en place d'une GCRN nécessitant le développement de partenariats très divers et la recherche de financements importants. Ceci est très éloigné de ce qu'on peut imaginer du travail des parcs zoologiques mais les membres de l'AEECL sont convaincus qu'il faut persévérer dans cette voie.

Bibliographe

- Andriaholinirina, N. 2001. Etude comparative de *Hapalemur simus* (Gray, 1870) de deux sites de la province autonome de Fianarantsoa, Madagascar: forêt dégradée d'Ambolomavo et forêt secondaire du Parc National de Ranomafana au niveau de la morphologie, des dermatoglyphes, de l'analyse génétique et du mode d'adaptation à son environnement. DEA, Antananarivo.
- Brun, B ; Lernould, J.-M.; Rumpler, Y. 1989. Rare lemurs born in captivity. *Primate Conservation* 10: 33.
- Fausser, J.L.; Prosper; Donati, G.; Ramanamanjato, J.B.; Rumpler, Y. 2002. Phylogenetic relationships between *Hapalemur* species and subspecies based on mitochondrial DNA sequences. *BMC Evolutionary Biology* 2: 4.
- Koenders, L.; Rumpler, Y.; Ratsirarson, J. 1985a. *Lemur macaco flavifrons* (Gray, 1867): a rediscovered subspecies of primates. *Folia Primatol.* 44: 210-215.
- Koenders, L.; Rumpler, Y.; Ropartz, P. 1985b. Differences in male-female interaction between *Lemur fulvus* and *L. macaco*. *Primates* 26: 195-201.
- Montagnon, D.; Ravoarimanana, B.; Rumpler, Y. 2001. Taxonomic relationships and sampling effects among Lepilemuridae and Lemuridae using a partial cytochrome b gene. *CR Acad Sci III.* Jul ; 324: 647-656.
- Meyers, D.; Rabarivola, C.; Rumpler, Y. 1989. Distribution and conservation of Sclater's lemur. Implications of a morphological cline. *Primate Conservation* 10: 77-81.
- Neveu, H.; Montagnon, D.; Rumpler, Y. 1996. Paternity discrimination in four Prosimian species by the RAPD method. *Folia Primatol.* 67: 175-285.
- Neveu, H.; Hafen, T.; Zimmermann, E.; Rumpler, Y. 1998. Comparison of the genetic diversity of wild and captive groups of *Microcebus murinus* by the RAPD method: Implications for the management of captive breedings. *Folia Primatol.* 69 (Suppl.): 124-135.
- Rabarivola, C. 1993. Etude génétique comparative de populations naturelles de *Eulemur macaco* des îles de Nosy-Be et de Nosy-Komba, et de la presqu'île d'Ambato. Thèse de Doctorat de 3e cycle en Anthropologie Biologique, Antananarivo le 10 juillet 1993.

Rabarivola, C. 1998. Etude génétique comparative de populations insulaires et "continentales" de *Eulemur macaco*. Utilisation simultanée des dermatoglyphes de marqueurs sanguins et de l'ADN (RAPD) pour étudier la différenciation de *E. macaco* en deux sous-espèces: *E. m. macaco* et *E. m. flavifrons*. Thèse de doctorat d'Etat. Antananarivo, avril 1998.

Rabarivola, C.; Rumpler, Y.; Meyers, D. 1991. Distribution and morphological characters of intermediate forms between the black lemur (*Eulemur macaco macaco*) and the Sclater's lemur (*Eulemur macaco flavifrons*). *Primates* 32: 269-273.

Rabarivola, C.; Scheffrahn, W.; Rumpler, Y. 1996. Population genetics of *Eulemur macaco macaco* (Primates: Lemuridae) on the Islands of Nosy-Be and Nosy-Komba and the Peninsula of Ambato (Madagascar). *Primates* 37: 215-225.

Rabarivola, C.; Meier, B.; Langer, C.; Bayart, F.; Ludes, B.; Rumpler, Y. 1998. Comparison of genetic variability in wild insular and mainland populations of *Eulemur macaco*: Implications for Conservation Strategy. *Folia Primatol.* 69 (Suppl.): 136-151.

Ravoarimanana, B. 2001. Apport de la biologie moléculaire à la taxonomie et à l'étude de la spéciation de *Lepilemur septentrionalis*. Complémentarité des techniques morphologiques cytogénétiques et moléculaires. Thèse de Doctorat de l'Université Louis Pasteur de Strasbourg I, n° 3846, 28 août 2001.

Ravoarimanana, B.; Fausser, J.L.; Rumpler, Y. 2001. Genetic comparison of wild populations of *Lepilemur septentrionalis* and *Lepilemur dorsalis* using RAPD markers. *Primates* 42: 221-231.

Rumpler, Y.; Prosper; Hauwy, M.; Rabarivola, C.; Rakotarisoa, G.; Dutrillaux, B. 2002. Chromosomal evolution of the *Hapalemur griseus* subspecies (Malagasy Prosimian), including a new subspecies (*H. g. ranomafanensis*). *Chromosome Research* 10: 145-153.

Rumpler, Y.; Ravoarimanana, B.; Hauwy, M.; Warter, S. In press. Cytogenetic arguments in favour of taxonomic revision of *Lepilemur septentrionalis* species. *Folia Primatol.*

Tattersall, I.: 1982. The primates of Madagascar. Columbia University Press, New York.

FUNDING AND TRAINING

Sophie Banforth Conservations Biology Fund

The Sophie Danforth Conservation Biology Fund (SDCBF), established by the Roger Williams Park Zoo and the Rhode Island Zoological Society in 1989, supports conservation programs which protect threatened wildlife and habitats worldwide. Field studies and other projects that demonstrate a multi-disciplinary approach to biodiversity and ecosystem conservation and projects that involve in-country collaborators receive the highest funding priority. Environmental education programs, development of techniques that can be used in a natural environment, and captive propagation programs that stress an integrative approach to conservation are also appropriate. The maximum annual request is US\$1,000. The maximum total proposal length is one title page, a three-page proposal narrative (10 point type minimum), two-page CV and two letters of recommendation. Applications and letters of recommendation must be

received by 1 June, 2001. Grants are awarded 1 September, 2001. Further information and applications by e-mail, postal mail or fax to: Sophie Danforth Conservation Biology Fund, Roger Williams Park Zoo, 1000 Elmwood Avenue, Providence, Rhode Island 02907, USA, Fax: (401) 941-3988, Ldabek@rwpzoo.org.

Wildlife Conservation Society- Research Fellowship Program

Mailing Address and Contact Information for the Wildlife Conservation Society - Research Fellowship Program are: Program Coordinator, Research Fellowship Program, Wildlife Conservation Society - International, 2300 Southern Blvd., Bronx, NY 10460, USA, Tel: +1 (718) 220-6828, Fax: +1 (718) 364-4275, fellowship@wcs.org.

wcs.org/home/wild/researchfellowship/4596.

Bi-annual deadlines: Must be post-marked by 1 January and 1 July of every year. Geographic preferences: Africa, Asia, Latin America and their regional marine areas. Please note that the RFP does not support research in North America (excluding Mexico), Australia, or Europe and their territories. The RFP will not limit any individual from applying, however, most of the grantees are: professional conservationists from the country of research, and/or post-graduates pursuing a higher degree. There are the following restrictions: Organizations are not eligible for funding; previous research fellows are not eligible for funding for the same project; faculty and/or research advisors should not be listed as principal investigators unless they plan to carry out the majority of the field work; the principal researcher must write the proposal (those written on behalf of another individual will be disallowed). Application information: Interested applicants may download the application from the website or e-mail the Program Coordinator and request an electronic RFP Application. Any queries or further information, please contact: Christina Ojar, Research Fellowship Program (address above).

Lincoln Park Zoo Funds

The Lincoln Park Zoo, Chicago, Illinois, has a Neotropic and Africa/Asia Fund to support field research in conservation biology around the world. The Neotropic Fund focuses on projects undertaken in Latin America and the Caribbean and emphasizes the support of graduate students and other young researchers from those countries. The fund, created in 1986, has awarded over 146 grants in 19 countries. Usually between five and ten projects are supported annually, including project renewals for a second year. The typical award given falls into the range of \$3,000-6,000. Initial support is for up to one year from the date of the award and the maximum duration of support is for two years. For additional information and application procedures please see: www.lpzoo.com/conservation, conservation@lpzoo.org or write to: Lincoln Park Zoo NF/AA Funds, Department of Conservation and Science, Lincoln Park Zoo, 2001 N. Clark St. Chicago, IL 60614, USA.

Masters Course in Primate Conservation

The Oxford Brookes University in Oxford, United Kingdom is offering a masters course in primate conservation aimed at providing a high quality research qualification relevant

to the careers of anthropologists, conservation biologists and educators. The course term is from October 2002-September 2003. Each student will be encouraged to build on their own strengths and interests through a choice of a practical assignment and co-authorship of a relevant chapter of the house journal. Eight major themes are covered in the course: primate diversity and biogeography, socio-political aspects of conservation, environmental education, molecular and population genetics, fieldwork training and methods, captive management, museum studies, habitat protection and the future of rainforests. Qualifications include: Honors degree in anthropology, biology or acceptable related discipline. Undergraduate students will be considered if they can demonstrate ability to work at an advanced level. Costs for the course: £7350 for full time overseas students, £2988 for full time EU students and £1494 for part time EU students. The application deadline is May 31, 2002. Applications are available at:

www.brookes.ac.uk/courses/pgcourses/application/down.html.

For further information contact: Simon Bearder, School of Social Sciences and Law, Gypsy Lane Campus, Oxford, United Kingdom OX3 0BP, Tel: 01865 483 760, Fax: 01865 483 937, skbearder@brookes.ac.uk.

MEETINGS

Abstracts of talks presented at the "Journées de la Recherche, Mahajanga 30-31 Octobre 2001"

Ramanivosoa, B. 2001. Découverte d'un nouveau site à lémurien subfossiles dans les Karts malgaches.

L'île de Madagascar située dans l'Océan Indien, est une partie du continent africain dont elle s'est éloignée vers 165 million d'années. Sa flore et sa faune sont entièrement endémiques avec des teintes africaines et asiatiques. C'est un endémisme particulier, sur une grande échelle et une géographie très variée. Madagascar présente une faune subfossile de l'holocène (ère quaternaire) fort intéressante, en particulier les lémurien, cousins éloignés de l'homme, appartenant tous à l'Ordre des Primates. La plupart des gisements subfossiles de lémurien sont situés dans le Sud-Ouest et le centre de Madagascar, ceux du Nord-Ouest étant rares. Le nouveau site à Archaeolemur, lémurien subfossile prospecté à la presqu'île de Narinda Bungo-Tsimanindroa, au Nord-Ouest de Madagascar est resté inconnu jusqu'à la mission de reconnaissance en 1997. L'un des grands intérêts de ce nouveau site réside dans le fait que la totalité de la macrofaune est constituée par des restes crâniens et post-crâniens d'Archaeolemur trouvés dans les karsts calcaires non encore perturbés. La base des karsts est formée par des calcaires marneux des marnes crayeuses du Maestrichtien-Danien, et par des calcaires crayeux paléocènes. Certaines parties des individus d'Archaeolemur trouvées dans des différentes localités sont encore en connexion anatomique. Les spécimens de Bungo Tsimanindroa présentent deux morphologies crâniennes différentes. Donc, deux espèces peuvent être suggérées, car le dimorphisme sexuel n'existe pas chez les lémurien. Les nouvelles découvertes montrent que la diversité des Archaeolemurs a été au moins aussi importante que celle des lémurien actuels. Les découvertes du site Bungo Tsimanindroa de la presqu'île de Narinda vont donc compléter les données sur les Archaeolemurs de cette région. Les Archaeolemurs posent encore de nombreuses questions en ce qui concerne la variation écogéographique

de la taille, et le paléoenvironnement. Un dossier est en cours actuellement pour classer le site de Bungo Tsimanin-droa comme patrimoine national et mondial.

Farasolo Ralison, P.-A.; Fabre, M.; Rumpler, Y. 2001. Deux lémuriens pas comme les autres: Etudes morphologiques et physiologiques des glandes de marquage brachiales et ante-brachiales chez Lemur catta et Hapalemur griseus.

Ces deux espèces sont seules à posséder ces glandes, qu'elles utilisent pour marquer leur territoire, surtout en période de reproduction. Comme il existe chez les lémuriens un cycle reproducteur, il semble intéressant de préciser chez ces deux espèces l'évolution morphologique et physiologique de ces glandes au cours du cycle et de les corrélérer avec le taux circulant des stéroïdes gonadiques. Une meilleure connaissance fonctionnelle de ces glandes permettra de mieux comprendre la biologie de ces espèces protégées et peut-être leur maintien dans leur biotope dans des conditions optimales. Sur des mâles et femelles de ces deux espèces en périodes d'activité sexuelle (hiver) et de repos (été), des microbiopsies des deux glandes sont préparées en vue d'observations histologiques et des prélèvements de sérum permettront de suivre l'évolution des taux d'hormones stéroïdes entre les deux périodes. Les coupes semi-fines et ultra-fines des glandes antebrachiales montrent chez les deux sexes la présence de plusieurs tubes glandulaires, séparés par des cellules interstitielles polyédriques, peu nombreuses chez le mâle, riches en vacuoles lipidiques. Elles montrent au grossissement x 50000 des granulations foncées enfermées chacune dans une membrane et collées entre elles ; une ou deux cristalloïdes apparaissent chez le mâle et surtout la femelle. Les glandes brachiales, souvent absentes chez la femelle, sont formées de grosses cellules plus ou moins arrondies, contenant parfois deux noyaux en position centrale avec nucléole bien visible, des vacuoles lipidiques avec parfois des granulations plus ou moins foncées. Elles se réunissent en lobules séparés par des travées conjonctives minces. On note une corrélation positive entre le taux de testostérone, qui augmente en période d'activité sexuelle et le diamètre de la lumière des tubes glandulaires, de même que la présence de cristalloïdes. Ces glandes de marquage, que ces lémuriens utilisent activement en période d'activité sexuelle subissent une influence hormonale et leur morphologie est très proche de celle de glandes endocrines.

Gauthier, C.A.; Razafindramanana, S.; Rakotondravony, D.; Roger, E. 2001. Projet pilote bioculturel d'Antrema. (Domaine: Conservation de la Biodiversité et développement culturel à Madagascar).

Le Projet Pilote Bioculturel d'Antrema est né en 1998 d'une rencontre avec une communauté Sakalava isolée sur une péninsule et désireuse de poursuivre leur existence en harmonie avec le milieu naturel. De plus, cette péninsule de la commune de Katsepy est soumise à très peu de pressions et peut être considérée comme un vestige fragile de l'écosystème typique de la région Nord Ouest de la Grande Ile (forêt sèche caducifoliée, mangrove et littoral) (Roger Edmond, 1999). Elle abrite entre autres espèces endémiques, une forte proportion de lémuriens dont les Propithecus couronnés ou *Propithecus verreauxi coronatus* qui se trouvent maintenant dans une zone protégée (le site est devenu Station forestière en 2000) ainsi que les espèces d'oiseaux en danger tel l'Ankoay ou *Haliastur vociferoides*. Le projet s'est construit sur la nécessité de faire avancer parallèlement les travaux de développement en partenariat avec d'autres organismes de recherches scientifiques. La préservation actuelle du milieu est due à une exploitation rationnelle du milieu liée à la coutume de la population locale. Les objectifs du projet, les différents partenaires ainsi que les principaux résultats effectués seront présentés.

Andrianasolomahefa, A.; Tovonary, E.J.; Ralambozafy, A. P.; Rakotondrazafy, F.N.; Razafy, A.; Lehimena, E.; Razanamparany, L.; Rakotovao, M.; Randriantsoa, A. 2001. Interactions Plantes-Lémuriens dans le Parc National de Ranomafana: Etude biochimique et chimique des plantes utilisées par les lémuriens.

L'étude des plantes utilisées par les lémuriens pour leur nutrition et leur santé s'inscrit dans le programme de recherche visant à établir la carte nutritionnelle de ces lémuriens, à découvrir de nouvelles molécules pharmacologiquement actives et établir de nouvelles bases de chimiotaxonomie. Cette étude contribue à la mise en évidence des valeurs nutritionnelles des plantes consommées par les lémuriens et à la détermination de nouveaux constituants chimiques à partir des plantes utilisées pour leur santé.

Méthodes: Suivi écologique de lémuriens dans le Parc National de Ranomafana pendant 3 mois afin de déterminer: les plantes consommées, les habitudes alimentaires et les plantes utilisées pour leur soin de la santé; Détermination botanique des plantes inventoriées suivie de récolte et étude en laboratoire des plantes sélectionnées; Analyse biochimique (8 plantes) et chimique (2 plantes) des extraits de feuilles.

Résultats: 107 plantes appartenant à 41 familles botaniques ont été inventoriées dans le cadre de cette étude. Ces plantes sont utilisées par 6 espèces de lémuriens (*Propithecus diademata edwardsi*, *Eulemur fulvus*, *Eulemur rubriventer*, *Hapalemur aureus*, *Hapalemur griseus*, *Hapalemur simus*). Huit plantes ont été étudiées sur le plan biochimique: leur analyse a montré un fort pourcentage en eau (75 %), glucide (70 %) et protéine (30 %) mais peu de lipides (2 %) et éléments minéraux (0,80 %). L'étude chimique de 2 plantes appartenant à la famille des Clusiaceae et des Pittosporaceae a permis de déterminer de nouvelles molécules chimiques. Selon les résultats de l'analyse biochimique des plantes étudiées, les feuilles consommées par les lémuriens sont riches en matières organiques mais pauvres en éléments minéraux. De ces résultats, on peut se demander si les bases nutritionnelles de ces lémuriens sont constituées essentiellement d'eau et de substances glucidiques et protéiniques. De même, est-ce normal que ces lémuriens utilisent peu de lipides et d'éléments minéraux? La mise en évidence de nouvelles molécules chimiques dans les plantes étudiées servira de bases à une classification chimiotaxonomique des substances naturelles d'origine végétale.

RECENT PUBLICATIONS

Books

Given the renewed interest in lemur taxonomy and phylogeny, the two recent issues of journals listed below provide excellent background information and should be of special interest for "lemurologists".

The Future of Evolution

Volume 98 of 8 May 2001 of the *Proceedings of the National Academy of Sciences* includes a series of papers presented at a National Academy of Sciences Colloquium - "The Future of Evolution" held 16-20 March, 2000 at the Arnold and Mabel Beckman Center in Irvine California. It was organized by Norman Myers, of Green College, Oxford University, who with Andrew Knoll (Harvard University) wrote the first, overview paper on the effect of the extinction crisis on the future of the evolution of the planet's biota. Myers and Knoll give an eloquent and dramatic summary of the biotic crisis

that they, and the other authors, argue cogently will disrupt and deplete certain basic processes of evolution, with consequences likely to persist for millions of years. The "first order effects" include 1) a major extinction of species estimated to remove one-third to two-thirds of all species; 2) a mega-mass extinction of populations; 3) alien invasions and mixings of biota; 4) progressive depletion and homogenization with potential threshold effects on ecosystems; 5) general biotic impoverishment and a decline in global biomass; and 6) gross reduction and virtual elimination of entire sectors of some biomes, notably tropical forests, coral reefs and wetlands which have served as centers for diversification in the past. Further evolutionary effects they discuss include: 1) fragmentation of species ranges with disruption of gene flow; 2) decline in effective population sizes with depletion in gene reservoirs; and 3) biotic interchanges introducing species and even entire biotas into new areas, with multiple founder effects and novel competitive and other ecological interactions. The consequences they consider include an outburst of speciation, proliferation of opportunistic species ("pest and weed" ecology), depletion of evolutionary powerhouses; decline in biodiversity (the biota's manifest morphological and physiological variety), an end to speciation in large vertebrates, and emergent, difficult to predict novelties.

Papers: The biotic crisis and the future of evolution – N. Myers & A. H. Knoll, pp. 5389-5392; Lessons from the past: Evolutionary impacts of mass extinction – D. Jablonski, pp. 5393-5398; Lessons from the past: Biotic recoveries from mass extinctions – D. H. Erwin, pp. 5399-5403; Loss of speciation rate will impoverish future diversity – M. L. Rosenzweig, pp. 5404-5410; What was natural in the coastal oceans? – J. B. C. Jackson, pp. 5411-5418; The future of coral reefs – N. Knowlton, pp. 5419-5425; Disrupting evolutionary processes: The effect of habitat fragmentation on colored lizards in the Missouri Ozarks – A. R. Templeton, R. J. Robertson, J. Brisson, & J. Strasburg, pp. 5426-5432; Human-caused environmental change: Impacts on plant diversity and evolution – D. Tilman & C. Lehman, pp. 5433-5440; Plant biology in the future - F. A. Bazzaz, pp. 5441-5445; The evolutionary impact of invasive species - H. A. Mooney & E. E. Cleland, pp. 5446-5451; Rapid plant diversification: Planning for an evolutionary future - R. M. Cowling & R. L. Pressey, pp. 5452-5457; Human-modified ecosystems and future evolution – D. Western, pp. 5458-5465; The current biodiversity extinction event: Scenarios for mitigation and recovery – M. J. Novacek & E. E. Cleland, pp. 5466-5470; Decline of biomes and biotas and the future of evolution – D/S. Woodruff, pp. 5471-5476; Intervening in evolution: Ethics and actions – P. R. Ehrlich, pp. 5477-5480.

Special Issue of *TREE* - Speciation

A special issue of *Trends in Ecology and Evolution*, Vol. 16(7), July 2001, Editor Catriona J. MacCallum, is dedicated to "Speciation". The Guest Editor was Nicholas J., Barton, Institute of Cell, Animal and Population Biology of the University of Edinburgh, UK. The special issue aims to review recent developments and to bring together all aspects of speciation, from genetics through ecology to palaeontology. Of particular interest for conservation is the first article by Jody Hey, Rutgers University, NJ, who discusses the confusion about exactly what a species is, arising from conflict between intuitive classification and the complex and continuous process of evolution. In his Introduction (p.325), Barton rationalizes some of the subsequent series of articles in the form of questions: "Why should there be distinct 'species' at all rather than a continuous intergradation of interbreeding organisms that reflects the continuity of evolution (Turelli *et al.*)? Is the distribution of species' abundance determined primarily by the distribution of ecological

niches, or does it also depend on how species form (Godfray & Lawton)? To what extent does genetic exchange impede divergence? In the extreme, can a single population split into two species without any spatial separation at all (Turelli *et al.*, Via, and Riesenberger)? What processes drive divergence - random drift, natural selection, or sexual selection (Panhuis *et al.* and Schluter)? What kinds of genetic differences distinguish species, and what do these tell us about the process of divergence (Turelli *et al.* and Orr)." Further aspects treated include the role of selection as a cause of divergence (Panhuis *et al.* and Schluter), the use of molecular markers (Orr), the use of phylogenies for rigorous comparative tests and inferences about the evolutionary process (Barraclough and Nee), the use of "gene trees" to measure evolutionary processes of selection, migration and drift that are involved in speciation (Nichols), and how palaeontology has allowed clear hypotheses about the relation between speciation and morphological evolution (Benton and Pearson).

Journals and Book chapters (without abstracts)

Given the excellent possibility to access and search the Library and Information Service of the Wisconsin Primate Research Center (see "NEWS and ANNOUNCEMENTS") and assuming that most readers of *Lemur News* have access to the internet we no longer intend to list single recent lemur publications here. Please let us know if readers wish that we should resume this service.

Developments in Primatology: Progress and Prospects

Kluwer Academic/Plenum Publishers is pleased to introduce *Developments in Primatology: Progress and Prospects* (formerly *Advances in Primatology*), a new series under the direction of the Editor-in-Chief of the *International Journal of Primatology*: Dr. Russell H. Tuttle, University of Chicago, Chicago, Illinois.

This peer-reviewed book series will meld the facts of organic diversity with the continuity of the evolutionary process. The volumes in this series will exemplify the diversity of theoretical perspectives and methodological approaches currently employed by primatologists and physical anthropologists. Specific coverage includes: primate behavior in natural habitats and captive settings; primate ecology and conservation; functional morphology and developmental biology of primates; primate systematics; genetic and phenotypic differences among living primates; and paleoprimateology. Volume authors will be invited to participate based on their expertise in a given area and overall approval by the series editor. Volume Authors and Editors will receive generous royalties, complimentary copies and full marketing and editorial support. Contributors will receive complimentary copies as opposed to royalties. All manuscripts will be "typeset from disk" for the convenience of the author/editor. Volumes will be approximately 300 printed pages (all page lengths are negotiable) in a 6 1/2 x 9 7/8 format. For further information on how to contribute an authored or edited volume to this series please contact Andrea Macaluso at (212) 620-8007 or via amacaluso@wkap.com.

Russell H. Tuttle, Department of Anthropology, The University of Chicago, 1126 East 59th Street, Chicago, Illinois 60637, USA.

New series for the publication of monographs in tropical ecology

The German Society of Tropical Ecology (GTÖ) is now publishing "*Ecotropical Monographs*" under the direction of Dr.

Karl-L. Schuchmann, Zoological Research Institute and Museum of Zoology, Bonn. This peer-reviewed book series will provide opportunities to publish papers too long for inclusion in the society's journal "Ecotropica". It is open for all aspects of tropical ecology.

The first volume in the new series summarizes a study by Angela Peetz on the "Ecology and social organization of the Bearded Saki *Chiropotes satanas chiropotes* (Primates: Pitheciinae) in Venezuela". Angela Peetz studied the influence of ecological parameters on the feeding, activity budget, and ranging behavior. In addition she described the social behavior and organization of this species on an island of about 180 ha located in Lake Guri, at the northern limit of the species' range. The publication is very well done. It contains informative tables, plenty of figures and a very useful index. The first volume contains 170 pp and costs 55 Euro plus 5 Euro for handling and shipping.

Orders and requests on whether or not a study might be suitable for publication in this new series should be sent to **Karl-L. Schuchmann**, Zoological Research Institute and Museum of Zoology, Adenauerallee 160, 53113 Bonn, Germany. kl.schuchmann.zmfk@uni-bonn.de

Ongoing lemur studies

Braune, P. Acoustic variability and its biological significance in mouse lemurs (*Microcebus* spp.) PhD thesis, University of Hannover.

Marquardt, K. Comparative ecological study on the distribution of lemurs in two dry deciduous forests within the Ankarafantsika Natural Reserve, Diploma thesis, University of Stuttgart.

Radespiel, U.; Randranambinina, B.; Rasoloharijaona, S.; Zimmermann, E. Influence of forest fragmentation on the distribution, genetics and biology of *Microcebus* spp. and *Lepilemur* spp. in the Natural Reserve Ankarafantsika.

Randrianambinina, B.; Radespiel, U.; Rasoloharijaona, S.; Zimmermann, E. Geographic variation in morphology, ecology and genetics of *Microcebus* spp. in northwest Madagascar.

Rasoloharijaona, S.; Randrianambinina, B.; Radespiel, U.; Zimmermann, E. Geographic variation of the morphology, the vocal communication and the genetics of *Lepilemur* spp.

Zimmermann, E.; Radespiel, U.; Randranambinina, B.; Rasoloharijaona, S. Distribution, ecology, social ecology and vocal communication of nocturnal lemurs in the region of Ampijoroa.

Theses completed

Andriaholinirina, V.N. 2001. Etude comparative de *Haplorhina simus* (Gray, 1870) de deux sites de la province autonome de Fianarantsoa, Madagascar: forêt dégradée d'Ambolomavo et forêt secondaire du Parc National de Ranomafana-Ifanadiana au niveau de la morphologie, des dermatoglyphes, de l'analyse génétique et du mode d'adaptation à son environnement. Mémoire de D.E.A., Département de Paléontologie et d'Anthropologie Biologique. Faculté des Sciences, Université d'Antananarivo. Résumé: Une étude morphologique et génétique de *H. simus* a été effectuée à Ambolomavo et à Ranomafana. Des captures à l'aide d'un fusil à air comprimé ont été réalisées lors des observations journalières. Les individus capturés qu'on a relâchés ont été suivis chaque jour. Des prélèvements de sang, des différentes mensurations, des prises et des lectures de dermatoglyphes ont été faits lors de chaque capture. Les résultats obtenus ont montré que du point de vue des dermatoglyphes et des mensurations, les groupes de *H. simus* des deux sites étudiés ne présen-

tent pas de différence statistiquement significative. Le type de la structure sociale de *H. simus* d'Ambolomavo serait "multimâles-multifemelles" et celle de Ranomafana serait "unimâle-multifemelles". En effet, une étude plus approfondie semble être importante pour confirmer nos hypothèses. Les résultats de l'étude de paternité ont montré un père potentiel pour la forme de Ranomafana. De plus, une étude de tous les descendants du groupe s'avérerait également très intéressante pour la suite.

Andriamalala, S. 2001. Contribution à l'étude du rôle du *Lemur catta* dans la dissémination des graines forestières dans la Réserve Spéciale de Beza Mahafaly. Mémoire de fin d'études. ESSA/Forêts. Université d'Antananarivo.

Andriamanaitra, S. 2001. Contribution à l'étude du comportement alimentaire du *Propithecus tattersalli* (Simons 1988), dans la forêt de Bekaraoka (Daraina, Vohepar). Mémoire de Fin d'étude. ESSA - Département des Eaux et Forêts. Université d'Antananarivo.

Harisoa, V.V. 2001. Structure et dynamique de populations de *Microcebus murinus* (J.F. Miller, 1777) et de *Microcebus ravelobensis* (Zimmermann *et al.*, 1998) dans le Jardin Botanique "A" de la station forestière d'Ampijoroa/Ankarafantsika durant la saison des pluies. Mémoire de D.E.A. Département de Paléontologie et d'Anthropologie Biologique. Faculté des Sciences, Université d'Antananarivo. Des études de la structure et la dynamique de populations de *M. murinus* et de *M. ravelobensis* ont été faites dans le jardin Botanique A (JBA) de la station forestière d'Ampijoroa / Ankarafantsika durant la saison de pluie. En utilisant deux méthodes: méthode par capture / recapture et méthode du transect, ces études nous ont fourni quelques renseignements sur les différents facteurs entre autre: nourriture, cycle de reproduction, climat qui pourraient régler la densité de populations. Il est dit au préalable que l'activité des Microcèbes et la disponibilité alimentaire ont une influence sur la densité de populations. La méthode capture / recapture permet d'étudier non seulement la fluctuation des activités des individus, mais aussi elle permet de faire la comparaison de la morphologie de ces deux espèces (23 *M. murinus*, 14 mâles et 9 femelles; 9 *M. ravelobensis*, 7 mâles et 2 femelles) et d'étudier leur reproduction. Avec la méthode du transect, nous pouvons conclure que d'abord la préférence alimentaire joue un rôle très important sur le rendement du piégeage. Ensuite, le nombre des animaux capturés dépend du cycle de reproduction: les mâles sont faciles à capturer durant la phase d'accouplement tandis que les femelles le sont lorsqu'elles sont en œstrus et lactante; enfin, la fraîcheur apportée par la grande pluie pourrait diminuer l'activité des Microcèbes.

Lutermann, H. 2001. Female associations and reproductive strategies of grey mouse lemurs (*Microcebus murinus*) in Northwest Madagascar. PhD thesis, University of Hannover. Information from the field about reproductive strategies of female grey mouse lemurs are limited and data from the laboratory is contradictory. Data has been collected from a population in their natural habitat a dry deciduous forest in Northwest Madagascar on population ecology, home range and sleeping site usage, respectively, with special reference to brood care. This study was carried out in a 30 ha plot covering two complete breeding seasons (July 1998 - April 1999, August 1999 - April 2000). Mark-recapture data shows seasonal variation in the number of animals captured and a sex ratio bias towards males in the captured population. Seasonal variation of testes volume as well as the occurrence of

oestrus in captured females suggest two distinct mating and birth peaks. Ectoparasite load varied seasonally and was more prominent in males than females. Home range size decreased throughout the season and home range overlap was more pronounced within than between sleeping groups, indicating intrasexual competition. Using an overall of 26 radio-collared females 332 different sleeping sites have been located. They could be assigned to three different categories: tree holes, leaf nests and open sites. Choice of sleeping site type, usage duration and changing behaviour showed seasonal variation that was affected by climatic parameters as well as group size and the presence of offspring. Sleeping sites are crucial as predator defence, for thermoregulation as well as rearing young. Preferred sleeping site parameters and plant families were rare at the study site, resulting in limited availability of suitable sites and intrasexual competition between females for this resource. Females formed long-term sleeping groups of two to four individuals lasting for up to two seasons. Apart from one exception sleeping groups consisted exclusively of females, usually from different age classes. Sleeping sites used solely by groups showed higher quality in respect to predator defence and thermoregulatory needs suggesting competitive advantages of groups. Sleeping groups used their sites exclusively and as a consequence of intrasexual competition distribution of sleeping sites showed a clear distinction in space between different groups. The activity budget of focal animals remained constant while diet showed seasonal variation with fruits and insects being eaten mainly during the rainy season. Social interactions could rarely be observed and occurred predominantly in the reproductive context. In particular when leaving sleeping sites and at feeding sites urine washing was shown (62 % and 38 % respectively) suggesting its important role in territorial defence of female groups. Females regularly had two litters per season consisting of 1-3 offspring and showed high birth synchrony within as well as between different groups. Females decreased the time spent with their offspring with increasing age of young. They gained benefits from communal care by decreasing the time progeny remained unattended. Female members of sleeping groups frequently were close kin often consisting of mother-daughter dyads. Within the population females commonly had more close kin than males and distances between related female-female dyads tended to be shorter than between male-male dyads, indicating that females were the philopatric sex while males disperse. This leads to the establishment of matrilineal groups of which nine could be identified throughout the whole study. The results of this study show that food and sleeping sites are crucial resources for female reproduction in grey mouse lemurs. Their limited availability leads to intense intrasexual competition for these resources but patterns of competition found are neither covered by the definition for 'scramble competition' nor 'contest competition'. Therefore I suggest cryptic competition as a new label for this type of competition.

Raharimanantsoa, V. 2001. Etude comparative de la communication olfactive entre les sexes et entre les groupes chez *Eulemur fulvus rufus* (Audebert, 1800) dans la station forestière du C.F.P.F./Kirindy, Morondava. Mémoire de D.E.A, Département de Paléontologie et d'Anthropologie Biologique. Faculté des Sciences, Université d'Antananarivo. Résumé: La communication olfactive a été étudiée chez deux groupes d'*E. f. rufus* pendant deux périodes distinctes (la période de reproduction et la période qui la précède) durant 334 heures d'observations, dans la forêt dense sèche de Kirindy/Morondava. L'étude concerne uniquement les animaux adultes mâles et femelles. Pen-

dant la période qui précède la reproduction, chaque sexe a effectué la même fréquence des séquences. Deux ou plusieurs événements olfactifs de même ou de différents types sont généralement combinés en séquences. Le matin est le moment le plus favorable aux événements olfactifs par rapport à l'après-midi. Les petits supports inclinés ou obliques ont été utilisés fréquemment par cette espèce lors des marquages anogénitaux et aussi lors de l'olfaction. L'étude du territoire a montré que la majorité des marquages anogénitaux se situent dans les lieux périphériques du territoire pour chaque groupe et ceci est corrélé avec la distribution temporelle. Finalement, les deux sexes ont la même fréquence des séquences olfactives pendant la période de reproduction.

Rakotonirainy, E.O. 2001. Contribution à l'étude bio-écologique de la communauté de vertébrés frugivores de la forêt littorale du Sud-Est de Madagascar (Tolagnaro): observation sur *Ficus* spp., en vue de la conservation et de la réhabilitation de cet écosystème. Mémoire de DEA, Département de Biologie Animale. Faculté des Sciences, Université d'Antananarivo. Résumé: La recherche sur les relations *Ficus* - Vertébrés frugivores de la forêt littorale de Tolagnaro (Mandena et Sainte Luce) a permis de tirer des données relatives à la bio-écologie de ces Vertébrés et d'envisager leurs rôles dans la dispersion et la régénération naturelle de cet écosystème. Les échantillonnages ont révélé l'existence de quatre espèces de *Ficus* (MORACEAE) dont les fruits servent de ressource clé de nourriture pour la communauté frugivore, sur huit mois de l'année avec un pic de fructification dans la petite période sèche (Septembre-Octobre). La densité est de 8 pieds/ha. Les pieds de *Ficus* poussent dans les lisières, les anciens "tavy", et les clairières avec une productivité de 0,548 kg/m/j pour *Ficus soroceoides* et de 0,050 kg/m/j pour *Ficus guatteriaefolia*. Onze espèces de vertébrés frugivores mangent les fruits de ces figuiers. Elles cohabitent sur la canopée de ces derniers sans entrer en compétition. Le groupe de Primates (*Eulemur fulvus collaris*, *Cheirogaleus major*) et les PTEROPODIDAE ont une affinité pour les fruits de grande taille ($\varnothing > 15$ mm; poids > 15 g) de couleur verte tandis que les Oiseaux (*Treron australis*, *Alectroenas madagascariensis*, *Hypsipetes madagascariensis*) et les petits mammifères (*Microcebus rufus*, *M. murinus*) préfèrent les petites figues ($\varnothing < 15$ mm; poids < 15 g) de couleur rouge. *T. australis*, *A. madagascariensis* et *H. madagascariensis* sont très actifs de 7h-8h et de 16h-18h. *C. major* et les PTEROPODIDAE augmentent leurs activités dans la première moitié de la nuit surtout entre 21h-22h. La zoochorie au niveau du *Ficus* est observée chez *H. madagascariensis* et les PTEROPODIDAE. La zoochorie est également observée chez *T. australis*, *A. madagascariensis*: les graines ayant traversé leur tube digestif germent à un taux de 2,3 % et à une vitesse moyenne de germination de 16 jours. L'abondance spécifique de *Ficus* et des vertébrés frugivores de cet écosystème sont étroitement corrélées à la taille de la forêt.

Rakotoson, S. 2001. Contribution à l'étude du rôle du *Eulemur fulvus fulvus* (Lemuridae) dans la dissémination des graines forestières dans la Réserve Spéciale d'Ambohintantely. Mémoire de fin d'études. ESSA/Forêts. Université d'Antananarivo.

Ralison, J.M. 2001. Influence de la qualité de la forêt sur la population de *Eulemur fulvus collaris* (Geoffroy, 1817) dans la formation littorale de Mandena et Sainte Luce à Tolagnaro en 1998-1999, Madagascar. Mémoire de DEA, Département de Biologie Animale. Faculté des Sciences, Université d'Antananarivo. Résumé: La formation litto-

rale du Sud-Est de Madagascar, où les populations de *E. f. collaris* évoluent, a connu une forte dégradation dans les vingt dernières années, compte tenu de la croissance incessante de la population humaine. Cette dégradation intensive du milieu forestier nous a amené à faire une prospection sur la correspondance entre la présence de *E. f. collaris* dans un fragment littoral et l'état de ce dernier. Cette prospection effectuée en 1998-1999 et menée dans deux sous régions de Tolagnaro (Mandena et Sainte Luce) s'est déroulée dans dix fragments littoraux. Le but de celle-ci était de chercher les éléments intervenant pour la survie de *E. f. collaris* au sein de son habitat naturel. En utilisant les méthodes de transect diurne pour les observations de l'animal, la technique de quadrat pour l'étude de la forêt et les différents types d'analyses statistiques (Test de corrélation de Spearman et Analyse Factorielle des Correspondances Multiples ou AFCM), nous avons établi que l'existence de *E. f. collaris* dans une forêt, que ce soit à Mandena ou à Sainte Luce, repose sur la taille et la qualité de la forêt. La connaissance des exigences et préférences de l'espèce permet, d'une part, d'évaluer la surface optimale favorable au maintien de la population viable de *E. f. collaris*, et d'autre part, d'établir des zones de conservation nécessaires à la préservation de cette espèce à l'intérieur de la zone d'intervention de QIT Madagascar Minerals.

Ralison, N. Z. 2001. Etude du comportement de *Avahi laniger laniger* (Gmelin 1788), lémurien nocturne malgache, dans la forêt de plantation de Mandraka. Mémoire de Fin d'étude. ESSA - Département des Eaux et Forêts. Université d'Antananarivo.

Randrianambinina, B. 2001. Contribution à l'étude comparative de l'écoéthologie de deux microcèbes rouges de Madagascar: *Microcebus ravelobensis* (Zimmermann *et al.*, 1998) et *Microcebus rufus* (Lesson, 1840). Thèse de doctorat de 3^e cycle, Dépt. de Biologie Animale. Faculté des Sciences, Université d'Antananarivo. Résumé: Les Microcèbes genre *Microcebus*, sont des petits lémuriens exclusivement nocturnes. Ils vivent dans la forêt primaire et secondaire de Madagascar. Actuellement, il existe huit espèces de Microcèbes dont la distribution est encore mal connue. A part le Microcèbe gris, l'information concernant l'écologie et la vie sociale est assez faible ou même totalement insuffisante. Un essai de comparaison de l'étude de l'écoéthologie de deux populations de Microcèbes rouges qui diffèrent par l'ADN mitochondrial, localité géographique et condition climatique: *M. ravelobensis* de la forêt sèche de l'Ouest d'Ampijoroa, Nord-Ouest de Madagascar et *M. rufus* de la forêt humide de Mantadia, à l'Est de Madagascar a été effectué. Des méthodes de capture-recapture, et de radiotélémétrie ont été utilisées. Au total, 17 individus *M. ravelobensis* et 9 *M. rufus* ont été munis des colliers. Il ressort de nos résultats qu'au point de vue morphométrique, *M. ravelobensis* a une grande taille que *M. rufus*. Ensuite, la densité est estimée de 6 à 8 individus/ha chez *M. ravelobensis* tandis que 3 à 4 individus/ha chez *M. rufus*. En outre, ce travail nous a permis de mettre en évidence plusieurs phénomènes biologiques: la différence de rythme d'activité, du cycle reproductif, de la socialité de deux populations. Enfin, on a observé l'existence de la superposition intrasexuelle et intersexuelle des domaines vitaux.

Randriatahina, G.H. 2001. Etude des interactions sociales des femelles de *Varecia variegata variegata* (Kerr, 1792), dans la forêt perturbée de Manombo, Farafangana, Madagascar. Mémoire de D.E.A, Département de Paléontologie et d'Anthropologie Biologique. Faculté des Sciences,

Université d'Antananarivo. Résumé: La population des *V. v. variegata* a été étudiée depuis Février 1999 jusqu'en Février 2000. Cette étude a été menée dans la forêt de Manombo, Farafangana dans la région Sud-Est de Madagascar. Cette étude met en évidence l'impact de la perturbation sur les activités et les interactions sociales de cette espèce. Les résultats ont montré que peu de temps sont consacrés aux interactions sociales, seulement 8 % du comportement en général. Les individus dépensent beaucoup de temps au repos avec 70,05 % contre 20,45 % pour l'alimentation, tandis que peu de temps sont consacrés au déplacement avec 5,65 % et à la recherche de nourriture avec 3,85 % seulement du mode d'activité. Le temps mis par les femelles et les mâles pour les différentes activités ne sont pas statistiquement différentes. Mais lorsque l'écart de rang entre deux individus est grand, la différence pour la prise de nourriture entre eux est devenue statistiquement différente. Les toilettages représentent 82% des interactions contre 15 % pour l'approche et 3 % pour les agressions. Les subordonnés toilettent généralement les dominants même si l'inverse est rare. Bien qu'il y ait peu d'agression, elle se passe surtout lorsque les individus mangent ensemble. C'est pour cette raison que la distance interindividuelle au cours de l'alimentation est grande lorsque deux individus de rangs différents mangent ensemble, par contre elle est classée courte lorsqu'il s'agit de couple. La disponibilité de la nourriture est insuffisante pour satisfaire le besoin de l'organisme pour la reproduction. Ceci pourrait être considéré comme l'une des raisons que les *Varecia* de Manombo ne donnent pas de bébé.

Rasoazanabary, E. 2001. Stratégie adaptative chez les mâles de *Microcebus murinus* (J.F Miller, 1777) pendant la saison sèche, dans la forêt de Kirindy, Morondava. Mémoire de D.E.A, Département de Paléontologie et d'Anthropologie Biologique. Faculté des Sciences, Université d'Antananarivo. Résumé: Les mâles de *M. murinus* sont toujours actifs pendant la saison sèche et les femelles hibernent. Les informations sur cette activité des mâles sont acquises au cours de notre travail dans la forêt de Kirindy entre le mois d'Avril et le mois de Septembre 1999. Grâce à la méthode de capture-recapture combinée avec la méthode d'observation de type Animal Focus sur 12 animaux munis de colliers émetteurs dont 6 mâles et 6 femelles, nous avons su que les mâles ne présentent pas de variations saisonnières d'activités. Bien qu'il y ait diminution des nombres des individus capturés, bien que certains mâles présentent une nuit à une semaine d'inactivité; période intercalée de quelques nuits d'activité, leur activité ne change pas pendant la saison sèche. Ensuite le temps consacré à l'alimentation, au déplacement et au repos ne change pas. Ainsi, leur poids est maintenu constant. Tous ces comportements adaptatifs jouent un rôle important dans la reproduction qui se fait vers la fin de la saison sèche. Malgré les risques face aux aléas de la saison sèche et les dépenses énergétiques, *M. murinus* mâle devient de plus en plus apte à la reproduction. Ces bénéfices stratégiques ne dépendent pas de la température, donc les facteurs écologiques et sociaux restent à déterminer pour une meilleure connaissance de l'activité qui différencie les deux sexes chez *M. murinus*.

Rasolofonirina, 2001. Contribution à l'étude comparative du comportement chez *Eulemur rubriventer* (I. Geoffroy, 1850) et *Eulemur fulvus rufus* (Audebert, 1800) femelles pendant la lactation dans la forêt dense humide de Ranomafana. Mémoire de DEA, Département de Paléontologie et d'Anthropologie Biologique. Faculté des Sciences, Université d'Antananarivo. Résumé: Pendant trois mois

d'observation, du Septembre en Novembre où la femelle allaite, deux groupes de Lemur à ventre rouge, *E. rubriventer* et un groupe de Lemur à front roux, *E. f. rufus* ont été observés pendant 491 heures et 10 minutes dans le Parc National de Ranomafana (lieu d'étude Talatakely). Ces observations ont permis d'obtenir des renseignements plus détaillés sur le comportement de la femelle allaitante, essentiellement sur le comportement alimentaire. Toutes les données ont été collectées d'une façon continue sur une femelle allaitante par jour. Cinq principales conclusions ont été tirées. Primo, les femelles allaitantes d'*E. f. rufus* et d'*E. rubriventer* utilisent les mêmes types d'activités, de catégories alimentaires, de locomotion, de postures, de dimensions et orientations du support utilisé dans le site d'étude mais avec des fréquences différentes. Secundo, ces femelles sont frugivores et mangent au total 34 espèces végétales. Tertio, elles restent accompagnées par le mâle adulte ainsi que par les autres membres du groupe durant le repos et l'allaitement. Quarto, la femelle allaitante d'*E. f. rufus* est plutôt agressive avec les membres du groupe, alors que celle d'*E. rubriventer* fait beaucoup de toilettage réciproque avec les individus du groupe. Enfin, chez les deux espèces, les femelles allaitantes préfèrent mieux la hauteur comprise entre 7m et 15m pour toutes les activités.

Rasoloharijaona, S. 2001. Contribution à l'étude comparative de la communication vocale et de la vie sociale de deux formes de *Lepilemur* (Geoffroy, 1858) (Lepilemuridae, Petter et al., 1977) provenant de la forêt sèche de l'Ouest et de la forêt humide de l'Est de Madagascar. Thèse de doctorat de 3è cycle, Dépt. de Paléontologie et d'Anthropologie Biologique. Faculté des Sciences, Université d'Antananarivo. Résumé: Les lépilemurs, genre *Lepilemur*, sont des lémuriens exclusivement nocturnes, dont la taxonomie présente encore des imprécisions. Trois hypothèses ont été émises à ce sujet à savoir que le genre *Lepilemur* est formé, soit d'une seule espèce, soit de six espèces, soit de sept espèces selon les auteurs, et la principale question est de savoir si le genre *Lepilemur* forme une mégapopulation ou s'il renferme différentes espèces. Un essai de comparaison de deux formes de lépilemur, l'une provenant de la forêt sèche de l'Ouest, l'autre de la forêt humide de l'Est de Madagascar a été effectué. Trois méthodes d'approche telles que la morphologie, la bioacoustique et l'écologie ont mis en évidence que le genre *Lepilemur* ne forme pas une mégapopulation mais il renferme différentes espèces. D'autre part, de nouvelles informations qui ont manqué auparavant sur le mode de vie de ce lémurien, ont été mises en exergue dans ce travail.

Ravaoarimanana, I.B. 2001. Apport de la biologie moléculaire à la taxonomie et à l'étude de la spéciation des *Lepilemur septentrionalis*. Complémentarité des techniques morphologiques, cytogénétiques et moléculaires. Thèse de Doctorat. U.F.R des Sciences de la vie et de la terre. Université Louis Pasteur Strasbourg. Résumé: La classification des êtres vivants était jusqu'à une époque récente fondée presque exclusivement sur des caractères morphologiques. Cet abord de la systématique a été complété par d'autres approches telles que la cytogénétique et plus récemment la biologie moléculaire. L'étude taxonomique étant un préalable indispensable à toute action de conservation, une telle étude s'est avérée urgente pour les populations de lépilemur du nord de Madagascar dont la taxonomie était controversée et la survie menacée par la déforestation et la chasse. Ainsi, les quatre formes caryotypiques de ces populations: *L. s. ankaranensis* 2N=36, *L. s. andrafiamenensis* 2N=38, *L. s. sahafarensis*

2N= 36 et *L. s. septentrionalis* 2N=34 sont analysées par les approches morphométrique, cytogénétique et moléculaire (D-loop et Cyt b) afin de préciser leur place systématique et de rechercher leur mode de spéciation. La concordance des résultats morphométriques, cytogénétiques et moléculaires fournit des arguments en faveur de l'existence de deux espèces distinctes présentant chacune un polymorphisme chromosomique intraspécifique: *L. septentrionalis* renfermant les individus *L. s. septentrionalis* et *L. s. sahafarensis* (2N=36, 35 et 34) et *L. andrafiamenensis* englobant les individus *L. s. ankaranensis* et *L. s. andrafiamenensis* (2N=38, 37 et 36). En outre, nous avons comparé les séquences de cyt b de *L. septentrionalis* et *L. andrafiamenensis* avec celle d'une autre espèce de lépilemur, *L. dorsalis*. Malgré la séparation de *L. andrafiamenensis* et *L. dorsalis* par huit remaniements chromosomiques, la divergence génétique entre elles est faible suggérant leur séparation récente, probablement sous l'effet d'une accumulation rapide de mutations chromosomiques provoquant une barrière reproductive. Par contre, les divergences génétiques sont élevées entre *L. septentrionalis* et *L. dorsalis* et aussi entre *L. septentrionalis* et *L. andrafiamenensis* bien que *L. septentrionalis* se soit séparée plus récemment de *L. andrafiamenensis* suggérant que la population *L. septentrionalis* a subi une dérive génétique importante probablement à l'origine de sa spéciation.

Razafimahazo, J.C. 2001. Contribution à l'étude saisonnière dans l'utilisation verticale de l'habitat par deux lémuriens: *Hapalemur aureus* (Meier, B.; Rumpler, Y; Peyrieras, A.; Albignac, R.; et Wright, P.C., 1987) et *Hapalemur simus* (Gray, 1870) dans la forêt dense humide de Ranomafana-Ifanadiana. Mémoire de D.E.A, Département de Paléontologie et d'Anthropologie Biologique. Faculté des Sciences, Université d'Antananarivo. Résumé: La cohabitation entre les deux lémuriens: *H. aureus* et *H. simus* dans la forêt dense humide de Ranomafana constitue un exemple intéressant d'étude écologique. L'objectif, c'est d'étudier la variation saisonnière dans l'utilisation verticale de l'habitat par ces deux espèces. Comme méthode, nous avons eu recours généralement à l'analyse de fréquence avant de passer au test de X auquel nous utilisons le tableau de contingence. Le suivi en alternance d'un groupe pour chaque espèce montre les faits suivants: il y a une différence saisonnière: sur l'ensemble des activités globales respectives des deux groupes, sur la fréquentation de niveau de la végétation, sur le type de supports utilisés et sur leurs catégories alimentaires respectives. Ces deux lémuriens diffèrent dans la fréquentation des niveaux forestiers et dans la composition du régime alimentaire: *H. aureus* préfère relativement le plus haut niveau d'arbre tel que 8 à 12m et 4 à 8m au cours de ses activités tandis que *H. simus* préfère le niveau plus bas sur les arbustes, en ne dépassant pas généralement la hauteur de 8 mètres. Ce dernier fréquente le sol à la saison chaude. Ces deux espèces exploitent différemment leurs ressources. Il s'avère important de protéger tous les niveaux forestiers pour la survie de ces lémuriens mangeurs de bambous.

Reimann, W. 2002. Coexistence and feeding ecology in female grey and golden-brown mouse lemurs (*Microcebus murinus* and *M. ravelobensis*) in north-western Madagascar. Dissertation. School of Veterinary Medicine Hannover. In this study data about feeding ecology of female grey and golden-brown mouse lemurs were collected and analysed with regard to an ecological differentiation between these two species. Besides of the diet, three-dimensional and temporal parameters were taken into consid-

ration, to get further insight into possible mechanisms to avoid competition. The study included two research periods of three months in two successive years. Data were collected during the dry season in a dry deciduous forest in north-western Madagascar. In order to investigate the population ecology of the two mouse lemur populations mark-recapture data were obtained. Direct focal observations were conducted using the method of radiotracking, and thereby collecting data about behaviour, localisation and heights used by the animals. In addition feeding experiments and analyses of fecal samples were carried out. The availability of food was estimated by phenological controls. While there were significantly more *M. murinus* captured in the first year, there was no difference between the numbers of captured animals of both species in 2001. The sex-ratio in both years was male biased. The population density (MNA method) did not vary much for *M. murinus* with 0,5 - 1,1 individuals/ha in the first and 0,8 - 1,1 animals/ha in the second year. In *M. ravelobensis* I found an increase from 0,4 - 1,1 animals/ha to 0,8 - 1,2 individuals/ha. Based on mark-recapture data there was an spatial extension of the *M. ravelobensis* population associated with an increase of the proportion of first captured animals of this species in 2001. The weight of both species remained relatively constant during the two research years. In consideration of focal observations, feeding experiments and analysed fecal samples the diet of *M. murinus* and *M. ravelobensis* is considered to be omnivorous with very similar food items. There was an interspecific difference with respect to the range of plant species consumed by the two lemurs. The hypothesis of a specialist *M. murinus* and a generalist *M. ravelobensis* was formulated. Concerning the three-dimensional use of space there was no difference in the two sympatric lemur species with respect to a different use of vertical forest strata. Hypotheses about different microhabitat use were suggested since *M. murinus* prefer the stable trunk of trees in 2-5 m height for feeding and fine branches in the canopy where they build continuous horizontal strata. *M. ravelobensis* with its more flexible locomotion pattern can also move in discontinuous strata and showed the opposite trend. Judging from the results of the horizontal examinations an exclusive distribution of the two lemur species in the study area could not be observed. There were traps used by both species as well as interspecific home range overlaps, though the latter were limited. With respect to a different temporal pattern of *M. murinus* and *M. ravelobensis* there was no ecological differentiation of the two species. The results about population ecology could not confirm the previous statement of *M. murinus* and *M. ravelobensis* living in a stable state of coexistence in the study site. However, based on results of feeding ecology an ecological differentiation between *M. murinus* and *M. ravelobensis* with respect to diet and three-dimensional parameters was suggested, but should be further investigated. Future studies should illuminate the bases of the changes in population ecology and their longterm manifestation in the population development.

Schmelting, B. 2001. Reproductive tactics in male grey mouse lemurs (*Microcebus murinus*, J.F. Miller 1777) in Northwestern Madagascar. PhD thesis, School of Veterinary Medicine Hannover. The purpose of this study is to investigate socio-biological aspects of male reproductive tactics and strategies of the promiscuous *M. murinus*, by combining long-term behavioural and demographic data with molecular genetic data for paternity analysis using the microsatellite technique. The results should reveal for the first time for a free-living nocturnal primate how behaviour and reproductive activity are related to male

reproductive success by using the grey mouse lemur as a model. From 1995 to 2000, a total of 320 (210 males, 110 females) different individuals were captured in a study site of approx. 30 ha in the dry deciduous forest of Ampijoroa, north-western Madagascar, using the mark-recapture method. The calculated population density ranged between 75 animals/km² in the rainy season and 148 animals/km² in the dry season. No significant deviation from an even sex ratio (1:1) was observed during any month of the year. The survival curve decreased particularly significantly in both sexes, between the first and the second breeding season. The median survival time for both sexes was ten months only. Overall, the long-term survival rate in the study site was slightly higher for males than for females, while it was nearly equal in the first two years of life. Males were recaptured until an age of at least six years whereas females were lastly recaptured with an assumed age of about four years. For ten radiocollared males long-term data on home ranges and sleeping sites of more than four months could be gathered from July 1998 to April 1999. Male home ranges reached their largest extent during the two mating seasons starting in September and November within the breeding season. The sizes of long-term home ranges ranged between 2.48 ha and 7.73 ha per male (median 5.22 ha). The largest monthly home range was on average only 67 % of the size of the long-term home range of a male. The male home range size within each mating season seemed to be related to the spatial experience of a male. Resident males had significantly larger long term home ranges with an average size of more than the double of the home ranges of non-residents. Home range sizes and access to females, as measured by mean female capture sites within a male's home range, showed a significant positive correlation. The larger a male's home range was, the more receptive females could be found in it. A total of 1244 (427 different) sleeping sites were determined. No spatial exclusion occurred within sleeping site areas. At the end of the dry season male sleeping groups (without any female participation) were observed 33 times. A total number of 16 males was found that shared simultaneously a sleeping site with one or two other males. Only resident males slept together more than once. For none of the males any kin-relatedness could be determined. Of a total number of 255 grey mouse lemurs tissue samples were available. These individuals were genotyped and further analyses concerning reproductive success and relatedness were performed based on seven polymorphic microsatellite markers. By the use of the CERVUS 2.0 programme (Marshall *et al.* 1998), 38 individuals were identified as offspring of 29 candidate fathers. Therefore, observed success rate of identified paternities was 19 %. With the Popassign 3.9f programme (Funk, Institute of Zoology, London), 34 fathers were assumed to have sired 50 offspring. Hence, candidate fathers were found for 24.6 % of the potential offspring. For 8.2 % only of the 203 potential offspring the same candidate father was found by both programmes. The median distance between the mean capture site of a putative father and its offspring revealed by either of the programmes was 200 m. Popassign 3.9f detected nine father-mother-offspring triads. The distances between the mean capture sites of the putative parents ranged between 17 m and 524 m with a median distance of 140 m. The median distance between the mean capture sites of a putative mother and her offspring was 121 m. When using both programmes, none of the successful breeders had more than one offspring per year. Both, non-resident and resident males reproduced. No correlation between body weight and reproductive success could be determined. The longer a male survived the

higher the chance was to reproduce successfully. Thus, it is assumed that males who survived the longest, had the best chance to gain the greatest life time reproductive success. The results of this study indicated for the first time, that male *M. murinus* develop an experienced-dependent reproductive strategy. Following this 'safer sex strategy', two alternative reproductive tactics exist: A 'greenhorn tactic' or an 'old hand tactic', depending on a male's experience.

Weidt, A. 2001. Ecology and Sociality of female golden brown mouse lemurs (*Microcebus ravelobensis*) in North-west Madagascar. Diploma thesis. University of Goettingen. Up to date hardly anything was known about the golden brown mouse lemur (*M. ravelobensis*), a nocturnal strepsirrhine discovered in the dry deciduous forest in Northwest Madagascar in 1994 (Zimmermann *et al.* 1998). In this study, the ecology and sociality of females was investigated for the first time. To obtain population data, capture-recapture studies were carried out during a 6-months field study from May till October 2000. Radio-telemetry data revealed information on the spatial distribution and nocturnal activity of individuals. Focal observations were used to achieve data on food ecology and social behaviour and determinations of sleeping sites and sleeping group compositions took place to obtain further information on their sociality. Female golden brown mouse lemurs can be classified as omnivorous – they were observed feeding on leaves, fruits, flowers, gum, insects and secretions of homoptera larvae. Intra- and intersexual home range overlaps occurred before as well as in the mating season. The locations of individual home ranges thereby showed a temporal stability. Animals predominantly used tree nests as sleeping sites. One female sleeping group and four sleeping groups with members of both sexes could be determined within the study period. Even if animals frequently changed sleeping sites, the sleeping group compositions showed a temporal stability over time. Individual knowledge and individual relationships of sleeping group partners can be concluded from these results as well as from a typical social behaviour when entering the sleeping sites and affiliative social encounters during the night. In general, regular social encounters during their nightly activity period occurred with both sexes - with sleeping group partners as well as with other conspecifics. The results suggest a multi-male/multi-female system with – predominantly bisexual-sleeping groups as a basic social unit.