



# ***LEMUR***

## ***NEWS***

*The Newsletter of the Madagascar Section  
of the I.U.C.N./S.S.C. Primate Specialist Group*

*NUMBER 11, June 2006*



**Cover photo:** This volume of Lemur News is dedicated to Madame Berthe Rakotosamimanana (1938-2005).

## ***LEMUR NEWS***

The Newsletter of the Madagascar Section of the IUCN/SSC Primate Specialist Group

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## EDITORIAL

The preparation of Lemur News Vol. 11 has been shadowed by the untimely death of our colleague, Madame Berthe Rakotosamimanana in November 2005. Since then there was not a single primatological conference without an obituary for Madame Berthe and speakers expressing their gratitude for all her help, personal and academic integrity. She was more than an appreciated colleague and a leading figure in primatology and conservation. She cared about people and left lasting traces not by using her political power but by living her life. A friend is gone: for us, for the international community, and for Madagascar as expressed by Ralaiarison Raharizelina Raobivelonoro and Yves Rumpler in their obituaries. But Madame Berthe has prepared her field well. The smooth transition from her being the "Secrétaire Général du GERP" to the election of Dr. Jonah Ratsimbazafy illustrates the spirit she has left with her colleagues. We would like to thank the GERP for its efficiency and congratulate Jonah Ratsimbazafy to this honour. Also, we welcome Jonah Ratsimbazafy and Rodin Rasoloarison as new editors of *Lemur News*. Together with Randrianarison, Rose Marie they are a strong team which will help managing and improving the newsletter. We also welcome Anne Yoder among the editors. Anne has become the director of the Duke University Primate Center and will continue the good tradition and dedication of Elwyn Simons and Ken Glander to lemurs and Madagascar.

**Jörg U. Ganzhorn**

### Professeur Berthe RAKOTOSAMIMANANA

Professeur Berthe RAKOTOSAMIMANANA fut née à Andasibe (ex-Perinet) le 18 Janvier 1938. Elle a obtenu son Doctorat de 3<sup>ème</sup> cycle de Biologie Animale, option Anthropologie à l'Université de Paris VII, Faculté des sciences. A peine revenue au pays en 1967, elle a enseigné au Service de Géologie, Faculté des sciences de l'Université de Madagascar où elle était chargée des travaux pratiques et dirigés de Géologie. En 1974, elle a créé le Service de Paléontologie à la Faculté des Sciences (avec le Professeur Jean Henri Rakotoarivelo), en le détachant du service de Géologie, et elle fut la coordonnatrice des enseignements pratiques et dirigés dans ce service. Elle obtint son Doctorat d'Etat et Sciences Naturelles en 1977 suite à des recherches effectuées sur les hautes terres de Madagascar. L'intitulé de sa thèse est: "Diversité anthropologique des isolats des Hautes Terres de l'Imerina (Madagascar). Confrontations du biologique et du socia". Dès lors, elle a été le responsable des enseignements théoriques, pratiques et dirigés en paléontologie et anthropologie du 1<sup>er</sup> cycle au 3<sup>ème</sup> cycle. La transformation du Service de Paléontologie en Département de Paléontologie et d'Anthropologie Biologique en 1993, fut en grande partie due à son initiative. Elle y a alors créé 3 laboratoires (Anthropologie Physique, Anthropologie Nutritionnelle, Primatologie et Biologie évolutive). Elle fut le chef de ce département de 1995 à 1998 dates de son admission à la retraite. Mais elle a été maintenue en activité au département jusqu'en 2003.

Les fruits de ses 36 années d'enseignement et de recherche au sein de ce département sont nombreux, et pour ne citer que les étudiants qu'elle a encadrés en 3<sup>ème</sup> cycle, 65 ont soutenu leur mémoire de DEA dont 34 en Anthropologie Biologique, 7 en Paléontologie des Vertébrés et 24 en Biologie évolutive. Par ailleurs, 14 titulaires de DEA ont obtenu leur Doctorat de 3<sup>ème</sup> cycle en Anthropologie Biologique et 2 d'entre eux ont soutenu leur Thèse de Doctorat d'Etat, tous sous sa direction. La veille de sa mort survenue le 29 Novembre 2005, elle discutait encore avec une candidate qui devrait soutenir sa thèse d'état ce mois de décembre.

De 1994 jusqu'à sa mort, Professeur Berthe Rakotosamimanana a occupé le poste de Secrétaire Général de l'association "Groupe d'Etude et de Recherche sur les Primate de Madagascar" (GERP), association dont elle fut l'initiatrice et l'un des membres fondateurs. Elle a été le secrétaire générale du 17<sup>ème</sup> Congrès de la Société Internationale de Primatologie (IPS) qui se tenait à Antananarivo en 1998, congrès dont elle a dirigé l'organisation de main de maître.

Par ailleurs, elle a aussi occupé des fonctions "hauts emplois de l'Etat". Ainsi de 1977 à 1983 elle été Directeur de la recherche scientifique au Ministère de l'Enseignement Supérieur et de la Recherche Scientifique et de 1986 à 1992 elle occupait le poste de Conseiller Technique non Permanent en matière de recherche auprès du Ministère de l'Enseignement Supérieur

Professeur Berthe Rakotosamimanana a été aussi membre de plusieurs sociétés savantes nationales et internationales: Académie malgache, projet "Parc national de Ranomafana", Commission de Survie des Primates de l'IUCN/SSC, Editorial Board des périodiques "International Journal of Primatology" et "Lemur News", Société de Biométrie Humaine, Société d'Anthropologie de Paris, Association Internationale des Anthropologistes, Groupement des Anthropologistes de Langue Française (GALF) dont elle a été membre du Conseil. A cet effet, le professeur Charles Susanne, au nom du conseil du staff, a proposé le message suivant à insérer dans cette nécrologie: Le professeur Berthe Rakotosamimanana était de longue date membre du conseil du GALF où elle a joué un rôle initiateur non négligeable, elle était le lien entre les autres nationalités francophones et Madagascar.

Nous pouvons témoigner de ses qualités humaines et naturellement aussi de ses qualités scientifiques et nous regrettons tous son décès. Pour Madagascar, pour le GALF et pour l'anthropologie francophone, nous perdons un des collègues les plus éminents et les plus attachants.

Les qualités de son enseignement ont été largement reconnues par tous ceux qui en ont profité, aussi bien dans son contenu que dans sa façon d'enseigner. Et toutes les personnes qui l'ont connue et ont travaillé avec elle reconnaissent en elle une personne généreuse, dynamique, enthousiaste et aimant le travail bien fait. Elle a consacré sa vie, non seulement à sa famille, mais aussi aux nombreuses personnes qu'elle a formées et éduquées, aux travaux de recherche en Anthropologie et nous pouvons dire que nous avons perdu une grande personnalité de la nation malgache toute entière.

**Docteur Ralaiarison Raharizelina Raobivelonoro**

Membre scientifique et membre de Bureau Exécutif du GERP; [ralaiari@yahoo.fr](mailto:ralaiari@yahoo.fr)

Berthe RAKOTOSAMIMANANA est née à Andasibé le 18 janvier 1938. Elle a obtenu son Doctorat de 3<sup>e</sup> cycle de Biologie Animale, option Anthropologie à l'Université de Paris VII. Dès son retour à Madagascar en 1967 elle a enseigné au service de Géologie, Faculté des sciences de l'Université de Madagascar. En 1974, avec le Pf J.H. Rakotoanravelo elle a créé le Service de Paléontologie à la Faculté des Sciences où elle enseigna. Après la soutenance de son Doctorat d'Etat en Sciences Naturelles en 1977 avec une thèse intitulée "Diversité anthropologique des isolats des Hautes Terres de l'Imerina (Madagascar). Confrontation du biologique et du social", Elle devient la responsable des enseignements en paléontologie et en anthropologie. L'intérêt primatologique du Pf Rakotosamimanana est apparu très tôt puisque dès son arrivée à Madagascar en 1967 bien qu'elle enseigna en géologie, elle s'est passionnée pour l'évolution des lémuriens. Elle a appliqué ses connaissances des dermatoglyphes humaines le sujet de sa thèse d'état à l'étude de l'évolution des soles palmaires et plantaires des lémuriens. Ses résultats ont amené à l'isolement des lépilemurs dans une famille à part, les Lepilemuridae. Son investissement dans la Primatologies, en l'occurrence la lémurologie, a été sans cesse croissant. Son ouverture d'esprit lui a fait très tôt prendre consciences de l'intérêt d'associer des étudiants malgaches aux équipes de chercheurs étrangers qui faisaient du terrain. C'est ainsi que lorsqu'elle occupa des fonctions de responsabilité au ministère de la recherche, elle assortit toutes les autorisations de recherche à une obligation d'emmener des étudiants dans les différentes missions. Ses étudiants ont ainsi été au contact avec de nombreux chercheurs et impliqués dans des missions de toutes nationalités.

Elle signa très tôt des accords de coopération interuniversitaires portant sur la recherche en Primatologie et c'est ainsi que ses étudiants purent bénéficier de bourses d'études, de soutien financier pour la recherche sur le terrain et de séjours à l'étranger jusqu'à la conclusion de leur recherche et à la soutenance de leurs thèses de 3<sup>e</sup> cycle et thèse d'Etat.

Son ouverture d'esprit l'a poussée à faire acquérir à ses étudiants des connaissances dans des domaines qui n'étaient pas de sa spécialité; consciente que les élèves devaient en savoir plus que leur maître pour accroître la connaissance globale de l'équipe.

C'est ainsi que nombre de ses élèves se formaient en génétique, cytogénétique, biologie moléculaire, écologie des lémuriens, sans oublier bien sur la morphologie qui était sa discipline et qu'elle dominait parfaitement.

La liste des accords interuniversitaires et accords de recherche est longue et impliquera la France, Les USA, l'Allemagne...

La communauté scientifique internationale est unanime pour reconnaître son mérite et sa passion de la recherche et le nom de *Microcebus bertae* en est l'illustration.

Son besoin scientifique de s'impliquer dans la recherche ne s'est pas tari à sa retraite puisqu'elle poursuivit dans le cadre du GERP ses études sur les lémuriens. D'une certaine façon, déchargée de ses obligations administratives, elle a pu participer plus directement à la recherche de son équipe dans les différentes études de terrain en cours consciente de l'importance de la taxonomie pour la protection des lémuriens.

Sa cordialité était reconnue de tous et sa maison ouverte. Tous ceux qui ont collaboré avec elle pendant de longues années ont connu le plaisir de son hospitalité

très familiale et la qualité de sa table. Les repas étaient cordiaux et on continuait à table de parler Primatologie, et ceci d'autant plus que son mari Philibert Rakotosamimanana était également un expert en Primatologie.

Nous regrettons tous le départ de Berthe Rakotosamimanana et nous n'avons pas seulement perdu une grande scientifique, mais une figure attachante sur le plan humain. Faire une mission scientifique à Madagascar comprenait toujours un rendez-vous chez Mme Berthe. Pour tous ceux qui l'ont connue, cette étape manquera.

**Yves Rumpler**

Université de Strasbourg

## NEWS and ANNOUNCEMENTS

### Procès verbal de la Réunion de l'Assemblée Générale du GERP

**Date:** Samedi 21 Janvier 2006

**Lieu:** Siège du GERP, 34 Cité des Professeurs, Fort Duchesne, Antananarivo (101)

**Horaire de la réunion:** de 9 heures 50 minutes à 12 heures 07 minutes

**Président de la séance:** Dr Rakotozafy Lucien M.A., Comité d'Orientation et de Suivi du GERP

**Secrétaire de la séance:** Randrianarison Rose Marie, Secrétaire Exécutive du GERP

#### Ordre du Jour:

- Rapport de l'élection du SG / GERP
- Nomination officielle du SG

#### Rapport de l'élection du SG /GERP:

L'élection a eu lieu le Vendredi 20 Janvier 2006 de 9 heures A.M. à 16 heures 15 minutes PM au siège GERP, 34 Cité des Professeurs, Fort Duchesne, Antananarivo (101).

Les membres inscrits dans la liste électorale sont au nombre de quatre vingt deux (82).

Le dépouillement a débuté à 16 heures 15 minutes PM et a été assisté par un membre de COS, deux membres de Bureau, un membre scientifique.

Le Comité électoral a reçu deux e-mails qui leur ont demandé d'attendre les votes venant des USA à cause du décalage horaire entre USA et Madagascar. Alors, le Comité électoral fallait attendre jusqu'à 8 heures 55 minutes de la matinée du 21 janvier 2006.

L'effectif des votants a été trente deux (32).

Le suffrage exprimé a été donc de l'ordre de 39,0 %.

Parmi les 32 votants, une personne a donné une procuration et dix (10) ont voté par e-mail.

Les résultats obtenus ont été les suivants:

- Sept (7) votes, soit 21,9 %, pour Dr Ralaiarison Raharizelina.
- Vingt cinq (25) votes, soit 78,1 %, pour Dr Jonah Ratsimbazafy.

Ainsi, l'Assemblée Générale a accepté que Dr Jonah Ratsimbazafy soit élu au poste du Secrétaire Général du GERP, pour un mandat de 3 ans.

### Nomination officielle du SG de GERP:

Le COS déclare que Dr Jonah Ratsimbazafy est officiellement le Secrétaire Général du GERP à partir de la date du 21 Janvier 2006.

Le nouveau SG du GERP, Dr Jonah Ratsimbazafy, a prononcé son discours. Il a rappelé que le GERP est une Association malgache reconnue, tant au niveau national qu'international grâce aux efforts déployés par la regrettée Secrétaire Générale Pr. Berthe Rakotosamimanana.

Il veut prendre des dispositions à longue durée pour que chacun des membres exercera ses potentialités. Il a souhaité que le GERP accomplisse ses activités de recherches multidisciplinaires avec succès et réussite.

L'assemblée Générale, ainsi que la candidate Dr. Ralaiarison Raharizelina, ont félicité le Secrétaire Général. Le COS a demandé au Secrétaire Général, Dr Jonah Ratsimbazafy, et à la candidate Dr. Ralaiarison Raharizelina de se placer devant le Gâteau, et en le découplant ensemble de prononcer un vœux au GERP. Ils disent que "Hiroborobo hatrany anie ny GERP" ou "Nos meilleurs vœux pour la prospérité du GERP". Et avant de prendre le cocktail, l'Assemblée Générale a décidé d'effectuer les échanges de cadeaux, à l'occasion de nouvel an.

Avant de prendre le cocktail, vers 10 heures 18 minutes AM, le SG a demandé à Andrianasolondraibe Ony de prononcer une prière pour le GERP.

A la fin de la séance, le Secrétaire Général du GERP, Dr Jonah Ratsimbazafy, a invité les Membres du COS, les membres du Bureau et le Responsable financier des projets, en exercice, d'assister à la réunion qui se tiendra le Mercredi 25 Janvier 2006, à 17 heures 30 minutes PM, au siège du GERP.

La séance est levée vers 12 heures 07 minutes AM.

Nous tenons à vous informer que Docteur Philbert Rakotosamimanana accepte aimablement que le siège du G.E.R.P. se situe encore à son domicile au 34, Cité des Professeurs, Fort Duchesne, Antananarivo (101).

### Randrianarison Rose Marie

Secrétaire Exécutive du GERP, 34, Cité des Professeurs, Fort Duchesne, Antananarivo (101),  
gerp@wanadoo.mg



GERP et le Reboisement à Bongatsara, 2001. A l'extrême gauche, la Regrettée Pr. Berthe Rakotosamimanana et son époux.

### Possibilities for publication

Two new journals might be of interest for general natural history and conservation oriented papers concerning Madagascar:

**1. *Phelsuma*** is a journal published by the Nature Protection Trust of the Seychelles, PO Box 207, Victoria, Mahé, Seychelles. Contact address: [jstger-lach@aol.com](mailto:jstger-lach@aol.com).

### 2. *Madagascar Conservation and Development*

Madagascar Wildlife Conservation and the Jane Goodall Institute Switzerland have founded the new journal *Madagascar Conservation and Development*. The aims of the journal are to provide a forum for exchange of information about all aspects of conservation and development work in Madagascar and to alert people to particular threats to nature and culture as they arise. The focus of the journal is on scientific articles such as results of original research, field surveys and advances in field and laboratory techniques. In addition the journal publishes informal status reports from research, conservation, development and management programs and in-field projects in Madagascar along with interviews and statements from local people and organisations. The first issue of *Madagascar Conservation and Development* will be published in summer 2006. It will be freely available on the internet via the websites of *Madagascar Wildlife Conservation* [www.mwc-info.net](http://www.mwc-info.net) and the *Jane Goodall Institute Switzerland* [www.janegoodall.ch](http://www.janegoodall.ch). Copies will be printed for free distribution in Madagascar and will be available on demand. Further details on the new journal are available on the same websites or can be obtained by contacting [info@journalmcd.net](mailto:info@journalmcd.net).

### Madagascar Wildlife Conservation Switzerland

c/o Anthropological Institute University Zürich-Irchel, Winterthurerstrasse 190, 8057 Zürich, Switzerland, Fax: +41 (0)44 635 68 04, [contact@mwc-info.net](mailto:contact@mwc-info.net)

### Jane Goodall Institute Switzerland

Germaniastrasse 51, 8006 Zürich, Switzerland, Fax: +41 (0)44 364 27 21, [info@janegoodall.ch](mailto:info@janegoodall.ch)

### Act for Nature

En 2004 l'Organisation Non Gouvernementale Act for Nature a été créé sous l'égide du Prince Albert II de Monaco. Chaque jour, un grand nombre d'espèces animales et végétales disparaissent de la planète. Pourtant les causes de ces extinctions sont souvent identifiées et les solutions à mettre en œuvre pour leur sauvegarde ont déjà fait leurs preuves. Dans ce contexte, Act for Nature élabore des programmes de conservation comprenant plusieurs volets: l'éducation à la biodiversité, des actions de terrain pour la conservation des milieux naturels et des espèces menacées ainsi qu'une valorisation de ces actions par l'organisation de différents événements et opérations médiatiques.

### Mission et vision

**Mission:** La mission d'Act for Nature est d'agir en faveur de la conservation des espèces animales et végétales en voie de disparition et qui figurent sur la "liste rouge" des espèces menacées de l'Union Internationale pour la Conservation de la Nature (UICN).

**Slogan:** "Protéger la Nature c'est respecter la Vie"

### Principes d'action

**Une mission de conservation:** Grâce à une équipe professionnelle et pluridisciplinaire, Act for Nature s'implique dans des missions de conservation et des créations de

projets, inscrivant l'ONG ainsi que la Principauté de Monaco dans un processus de développement durable en terme de conservation de la biodiversité.

*Un moyen essentiel: la sensibilisation des populations:* La participation et la sensibilisation des populations locales aux enjeux écologiques sont des éléments essentiels de la conservation des écosystèmes. Par des missions sur le terrain, Act for Nature contribue, en finançant des actions, à l'implication des populations locales dans la protection et le respect du patrimoine de leurs régions.



*Une action scientifique concrète sur le terrain:* Act for Nature soutient et donne les moyens nécessaires à des spécialistes qui s'investissent dans des programmes de conservation à long terme d'espèces animales et végétales menacées d'extinction. En accord avec des instituts de recherche, des études in situ ou ex situ sont financées et coordonnées par l'association. Le choix des programmes est défini par le comité scientifique d'Act for Nature qui se compose d'experts internationaux.

*Une communication médiatique et institutionnelle:* La conservation des espèces menacées passe par l'information: quel est l'état général de la diversité biologique, à quel rythme s'appauvrit-elle, où constate-t-on les pertes et quelles en sont les causes?

Act for Nature s'attache à développer sa communication, dans le domaine médiatique et institutionnel, à l'échelle locale, nationale et internationale. Elle implique aussi les jeunes générations dans des projets à visée pédagogique. Pour atteindre les buts que s'est fixée Act for Nature, il est essentiel d'obtenir le soutien de partenaires, des médias et de la société civile afin de poursuivre et développer ses actions.

*Act for Nature:* Président: Jean Pierre Pastor;  
Directeur: Olivier Arnoult  
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## New Studbooks for Lemurs

New studbooks have been compiled for *Eulemur coronatus*, *Eulemur macaco flavifrons*, and *Eulemur rubriventer*. For information please contact:

Pierre Moisson  
Parc Zoologique et Botanique, 51 rue du jardin zoologique, 68100 Mulhouse, France,  
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## Revision of the IUCN Red List Petition Process

The IUCN Red List petitions process has now been revised. A document outlining the full procedure for handling petitions against current listings on the IUCN Red List of Threatened Species is available on the Red List pages on the SSC website:

[www.iucn.org/themes/ssc/redlistindex.htm](http://www.iucn.org/themes/ssc/redlistindex.htm).

You will find it in the section "IUCN Red List Process" within the "Technical Documents":

[www.iucn.org/themes/ssc/redlists/petitions.html](http://www.iucn.org/themes/ssc/redlists/petitions.html).

**Caroline Pollock**, IUCN Red List Programme, 219c Huntingdon Road, Cambridge CB3 0DL, United Kingdom, [caroline.pollock@ssc-uk.org](mailto:caroline.pollock@ssc-uk.org); [www.iucnredlist.org](http://www.iucnredlist.org)

## Protected area for the Menabe

In March 2006 the minister of environment signed an arrete creating a protected area for the whole of the Menabe forests, including Kirindy and Ambadira. The first phase of protection (meaning no logging, deforestation or mining) just signed will be formalised once the management plan is completed later this year.

**Frank Hawkins**

## IPS 2005 Galante Award and Conservation Grants

IPS is pleased to announce the winners of the 2005 Galante Award and Conservation Grants. Information on the scope of these awards and application procedures can be found on our website:

[pin.primate.wisc.edu/ips/ipsfunding.html](http://pin.primate.wisc.edu/ips/ipsfunding.html)

The winner of the 2005 Galante Award is: Inza Kone - Laboratory of Zoology, University of Cocody, Abidjan, Côte-d'Ivoire Centre Suisse de Recherches Scientifiques en Côte-d'Ivoire (CSRS).

The winners of 2005 IPS Conservation Grants are:  
Pamela Cunneyworth - Conducting a census of the rare Angolan Black and white colobus Monkey (*Colobus angolensis palliatus*): comparing populations over time in an hyper-hot biodiversity area.

Ilaria Agostini - A population assessment and comparative study of two howler monkeys (*Alouatta guariba* and *Alouatta caraya*) living in sympatry.

Tharcisse Ukizintambara - Status of l'hoest's monkey (*Cercopithecus lhoesti*) in Bwindi Impenetrable National Park, Uganda: Habitat characteristics, edge effects, intra-specific behavioral ecology and conservation.

Kimberley Williams-Guillen - Survey and Assessment of Primate Populations in Chococente Wildlife Refuge, Nicaragua.

Melissa Remis - Assessing Human Impact on Forest Mammals in the Dzanga-Sangha Reserve, Central African Republic.

## ARTICLES

## Surveys for lemurs and biodiversity in the Beakora Forest southeast of Kalambatritra Reserve, Madagascar

Pascal Rabeson<sup>1</sup>, Désiré Randrianarisata<sup>1</sup>, Paul Rasabo<sup>1</sup>, Dina Andrianoely<sup>1</sup>, Georges Razafindrakoto<sup>1</sup>, Dominique Razafindraibe<sup>1</sup>, Loret Rasabo<sup>1</sup>, Patricia C. Wright<sup>1,2</sup>

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**Key words:** *Lepilemur* nov. sp., *Eulemur collaris*, *Hapalemur griseus*, *Cheirogaleus*, *Avahi laniger*, south-east, Madagascar

Madagascar's eastern rainforests have been subject to extensive destruction (Green and Sussman, 1990). Expanding human populations continue to exert pressure on the remaining forest for agriculture and settlement (Jernvall and Wright, 1998; Myers *et al.*, 2000; Sussman *et al.*, 2003). Since 1991 the number of national parks has expanded from 2 to 18 (Plangap, 2002) and extensive plans for a combination of community management and protected area management are in process (Durban Vision, 2003). Although many of Madagascar's protected areas have been the focus of long-term intensive studies and are therefore well-known biologically [e.g., Ranomafana National Park (Wright, 1999; Wright and Andriamihaja, 2002; 2003), Berenty Private Reserve (Jolly *et al.*, 2002), Beza-Mahafaly Special Reserve (Sauther *et al.*, 2002; Richard *et al.*, 2002), and Kirindy Forest (Ganzhorn and Sorg, 1996)] others remain largely unstudied. It is of immediate importance that efforts be made to directly survey the remaining unprotected and unknown forests, in order to confirm the existence and abundance of currently endangered rainforest species. And it is urgent to use these surveys to influence policy makers to focus on making these forests with endangered and new primate species into protected areas.

Kalambatritra Massif (23°22'S, 46°20'E, summit at 1824 m) is located 110 km south of Ihosy, in both Toliara and Fianarantsoa Provinces, in the region occupied by the Bara people. Kalambatritra massif forest is unique in that it lies significantly further west than any comparable rainforest in Madagascar, and straddles the continental divide between eastern (Ianaivo River) and western (Ihosy) drainages. The Massif is important to conservationists on account of the large forest, classified as mid-elevation evergreen humid forest, ranging in elevation from around 1000 m to 1750 m. It is remarkable because it is almost pristine (human population density is extremely low in this area) and contains some of the biggest trees in Madagascar (Irwin *et al.*, 2001). It is also the most westerly outpost of the Madagascar's eastern escarpment forest. Kalambatritra Special Nature Reserve (23°15' - 23°29'S, 46°23' - 46°36'E) contains about half the forests on the Kalambatritra massif, leaving the remaining forests unprotected.

Five brief expeditions to Kalambatritra Special Nature Reserve to survey fauna were conducted between 1987 and 1995 (summarized in Irwin *et al.*, 2001). An expedition organized by P. C. Wright in 2000 and led by Mitch Irwin and Karen Samonds (Irwin and Samonds, 2002; Irwin *et al.*, 2001; 2004) surveyed the larger forest block in the northern half of the reserve (23°21' S, 46°28' E), which had been neglected by previous surveys. The team observed no members of the family Indridae in northern Kalambatritra Special Nature Reserve, and identified the controversial *Eulemur fulvus rufus* (Nicoll and Langrand, 1989) as *Eulemur collaris*. In addition the *Hapalemur griseus* appeared much larger than *Hapalemur griseus* at other sites, and the *Lepilemur* was quite large-bodied with large ears and peculiar toilet habits (Irwin *et al.*, 2000, 2004). Subsequent expeditions included a UNESCO World Heritage Nomination by V. Razafindratsia who surveyed the northern edge of Kalambatritra Special Reserve for 12 days and obtained sightings of the *Hapalemur griseus* and *Eulemur collaris* (Razafindratsita, 2003). In June, 2004 Ed Louis and his capture team took a six day expedition to forest fragments at the edge of western Kalambatritra Special Reserve in collaboration with P.C. Wright and captured *Lepilemur* sp. for species determination by genetic analysis at the Henry Doorly Zoo Center for Conservation Genetics.

Following-up on the previous work we surveyed a more remote area. In this paper we report findings of lemurs from the southeastern forest, outside Kalambatritra Special Reserve in Beakora Forest. Special attention was spent on the species of *Lepilemur* which may be a new species (Irwin *et al.*, 2004).

### Field site

In January and February, 2005 an ICTE/Central ValBio team from Ranomafana National Park made an expedition to the Beakora Forest (Fig. 1). The team traveled to Fianarantsoa by car 150 km to Ihosy, then by car 118 km to Betroka where gendarmes joined the team. At the end of the road (25 km) at Ivahona porters joined, and the group went from Ambatomaity to Ambatobe to Amdroizaha to Sahalava (CAMP). Beakora Forest is overlooking the Ianaivo River, the river which divides Kalambatritra Special Reserve from Midongy du Sud National Park. Beakora Forest, approximately 9000 ha, is located just south of the Tropic of Capricorn and is classified as a primary mid elevation humid forest. Camp was set up within the Beakora Forest (23°32.23'S, 46°32.04'E, altitude: 1180 m) below the Ampandility Mountain, which is 1546 m at its summit (Fig. 2). From the summit of Ampandility, a canopy dominated by rosewood trees (Maka) can be seen in all directions (P. Rasabo, pers. comm.) as well as Midongy du Sud National Park to the east. There were 5 clear streams of 4-5 m in width in the forest study site. Some of the boulders in the streams are covered with green moss. The depth of the stream is about 20-50 cm, with a cobble bottom (not sand) and the riparian vegetation is pristine. No amethyst, mica or quartz crystal was observed in the streams. Very little bamboo was seen overhanging the streams.

### Methods

Because no trails existed in the study area, it was necessary to cut trails. A 2-km transect was established. Standard line-transect census methodology (Struhsaker, 1981; Whitesides *et al.*, 1988; Johnson and Over-

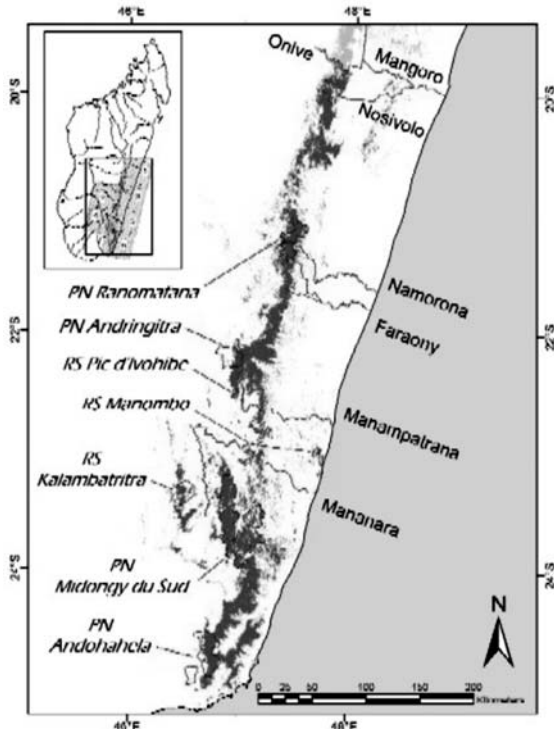


Fig. 1: Map from satellite photos 2000. with Kalambatrira Special Reserve, Beakora Forest and Midongy National Park (adapted from Irwin *et al.*, 2005).

dorff, 1999) was employed. A total of 18 diurnal censuses were conducted, both in the morning (approximately 6:00 to 8:00). In addition, 18 nocturnal censuses (approximately 18:00 to 20:00) were conducted. For each census, the following information was recorded: date, time, trail, census team and weather. For each lemur sighting, the following information was recorded: Time, position on trail, species/subspecies, age and sex of each individual seen, sighting distance, sighting angle (relative to trail), perpendicular distance (distance from trail), height, group spread, activity, who detected the animals, method of detection, and miscellaneous observations.

Each morning a bird census was conducted by bird expert Loret Rasabo (total = 18 censuses) along the 2-km census trail (concurrent with censusing for primates by other researchers). For each bird detected, the following information was recorded: Genus, species, method of detection (heard/seen), distance from observer, number of individuals, and trail location. Additional observations of birds outside the censuses were recorded and used in compilations of species lists.

In addition we assessed forest disturbance and hunting pressure by informal discussions with local villagers, employed as porters, cooks and guides. All researchers also reported any signs of disturbance such as tree cut marks, mammal traps, cattle dung, harvesting of *Pandanus* and *Cyperus*, cutting of trees for honey, cultivation of plants and trails for humans (Wright *et al.*, 2005).

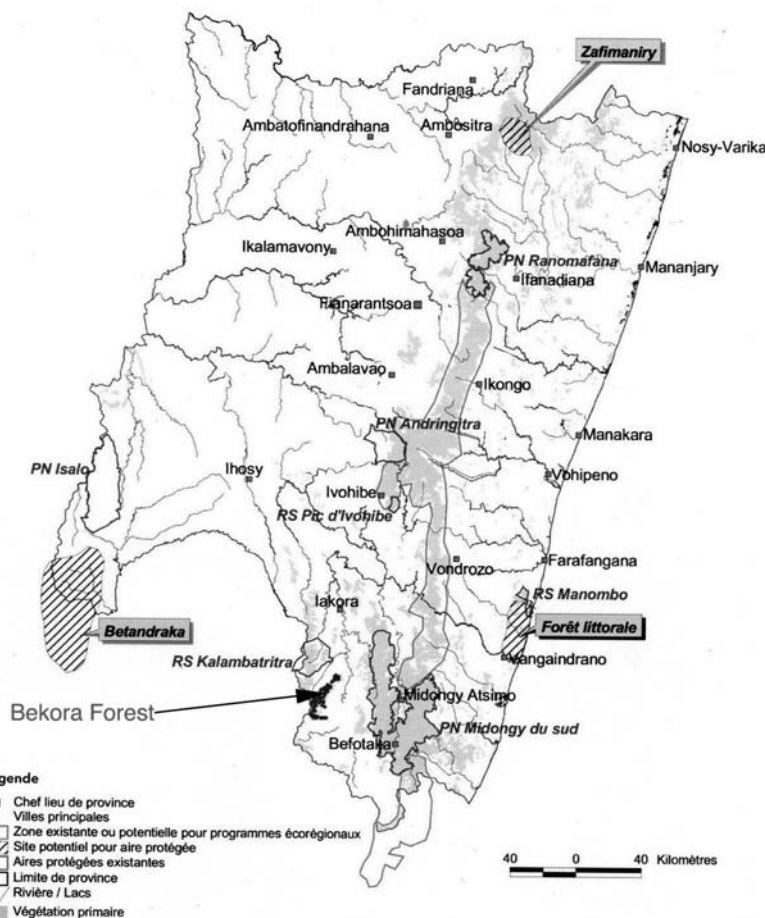


Fig. 2: Location of Kalambatrira Special Reserve, Beakora Forest and Midongy du Sud National Park, south-eastern, Madagascar.

## Results

### Lemurs

The species richness of the lemur community at Beakora Forest was 8, including 2 species of diurnal and 5 species of nocturnal lemurs observed. The traces of aye-aye tooth gnaws on numerous dead tree trunks suggested the occurrence of *Daubentonia madagascariensis*. Population densities, extrapolated from the census trails suggest that primate densities are lower than at Ranomafana National Park (Table 1) where the species number is also higher (8 vs. 12) and includes *Propithecus edwardsi*, *Varecia variegata*, *Haplolemur simus* and *H. aureus*, all species not seen at Beakora Forest. Most densities were similar to northern Kalambatrira Special Reserve, except for the high densities of *Lepilemur* sp. and absence of *Avahi laniger* in northern Kalambatrira.

This study verified that *Eulemur collaris* exists in Beakora Forest. *Lepilemur* sp. was also sighted, but was not in high population density as seen in northern Kalambatrira Reserve (Irwin *et al.*, 2001). One possible reason for the reduced density of *Lepilemur* sp. in Beakora is the presence of another nocturnal folivore, *Avahi laniger* (Ganzhorn, 1989). It is possible that there are 2 species of *Cheirogaleus* here, one half the size of the other.



Irwin and his colleagues (2001) mentioned that the *Hapalemur griseus* is larger in northern Kalambatritra Reserve, and this observation also held for Beakora Forest.

*Avahi*: This expedition found a population of *Avahi laniger* at Beakora Forest verifying that the family Indridae is not absent from the Kalambatritra Massif, as was hypothesized (Irwin *et al.*, 2001). *Avahi laniger* was sighted in groups of 2-3. An infant about 3-4 months old was seen riding on its parent's back. There was no visual indication that this woolly lemur was a different species, and the body mass was similar to the animals found in Ranomafana National Park (900 g).

*Cheirogaleus* had the highest density of any lemur sighted (Table 1). Group size ranged from 1-3 with pairs or groups of three sighted 30 % of the sightings. Identifications are difficult in the dark, but there may be two species, one brown (*Cheirogaleus major*), and one gray and half the body mass (*Cheirogaleus* sp.).

*Daubentonia*: Definitive aye-aye marks on dead logs suggested that aye-ayes existed, even if not observed.

*Eulemur*: *Eulemur rubriventer* was never sighted at Beakora Forest, and this is further evidence that its geographic range stops at the Mananpatrana River (Irwin *et al.*, 2005; Mittermeier *et al.*, 2006). Neither *Eulemur albocollaris* nor *E. fulvus rufus* were sighted in Beakora Forest. *Eulemur collaris* is found at about the same population densities (12/km<sup>2</sup>) at Beakora Forest and in northern Kalambatritra Special Reserve (14/km<sup>2</sup>) (Table 1). All males observed had bright chestnut orange beards, and all females had gray heads. Several groups had a 4-5 month old offspring. Group size ranged from 1-5 individuals.

Table 1: Lemur population densities (ind./km<sup>2</sup>) at Beakora Forest compared to similar genera at Kalambatritra Reserve, northern region (Irwin *et al.*, 2004, 2005), and Ranomafana National Park RNP (Irwin *et al.*, 2000). It should be noted that the RNP list is a subset of the 12 species present.

	Beakora	Kalambatritra	RNP
<i>Eulemur collaris</i>	12	14	
<i>E. fulvus rufus</i>			33
<i>Hapalemur griseus</i>	11	2	20
<i>Avahi laniger</i>	2		18
<i>Cheirogaleus</i> sp.1	32		
<i>Cheirogaleus</i> sp. 2	6		
<i>Cheirogaleus major</i>			
<i>Lepilemur</i> sp.	6	72	
<i>Lepilemur seali</i>			1
<i>Microcebus rufus</i>			100
<i>Microcebus</i> sp.	6	6	
<i>Daubentonia madagascariensis</i>	+	+	+

*Hapalemur griseus*: The taxonomic status of the *H. griseus* encountered at Beakora Forest remains uncertain. The body size of these bamboo lemurs is larger, estimated at over 1.5 kg, and some of the stalks of bamboo were consumed in a way that suggests *Hapalemur simus*. But no *H. simus* were ever seen, and *H. griseus* was sighted near these bamboo stalk traces. It is strongly suggested that this population of *H. griseus* be cap-

tured and measured with analysis of DNA for taxonomic assessment. Group size ranged from 2-4 individuals.

*Lepilemur* sp. was sighted 8 times during nocturnal surveys and never during the day. Single animals were seen in 6 sightings and twice 2 animals were sighted within 5 m of one another. *Lepilemur* heights ranged from 4-20 m with most being at 12 m. *Lepilemur* sp. was observed in its sleeping hole which was 4 m high, with a hole diameter of 4 cm in a large *Tambourissia* sp. tree (Monimaceae). Along the stream where the *Lepilemur* sleeping site was observed, there were big trees including *Rahiaka* (*Chrysophyllum boivianum*), *Halampona* (*Malvaceae*), *Dombeya*, *Rotra* (*Eugenia* sp.) *Harongana* (*Harungana* sp.) *Ramiandriana* (*Dilobia* sp.). A *Lepilemur* sp. infant of about 3-4 months of age was also seen alone on a branch, not vocalizing. During the census walks, three times there were 2 *Lepilemur* individuals together. However, densities of *Lepilemur* were not as high as observed in northern Kalambatritra Reserve (72/km<sup>2</sup>). The *Lepilemur* seen in Beakora appeared as large as that described from northern Kalambatritra (Irwin *et al.*, 2004). The body mass of this species of *Lepilemur* captured by Ed Louis was 1.8 and 1.9 kg, which is more than twice the body mass of *Lepilemur seali* from Ranomafana and four times larger than the species directly west *Lepilemur leucopus*.

*Microcebus*: All *Microcebus* encountered appeared to be *Microcebus rufus* and were found at low population densities (6 ind/km<sup>2</sup>). This is not unexpected, as mouse lemurs usually are at low densities in large climax, pristine forest areas (Atsalis, 1998).

## Birds

Loret Rasabo identified 52 species of birds (Table 2). The Madagascar Red Owl (*Tyto soumagnei*) was not observed. Almost all of the species are endemic and some of the species are restricted. The Madagascar Flufftail (*Sarothrura insularis*), generally considered a savannah-dwelling bird, was encountered deep within the forest on several occasions during the bird censuses

Table 2: Beakora Forest bird list (52 species).

Scientific name	Common English name
<i>Accipiter hensti</i>	Henst's Goshawk
<i>Alectroenas madagascariensis</i>	Madagascar Blue Pigeon
<i>Asio madagascariensis</i>	Madagascar Long-eared Owl
<i>Atelornis crossleyi</i>	Rufous-headed Ground Roller
<i>Atelornis pittoides</i>	Pitta-like Ground Roller
<i>Bernieria</i> (=Phyllastrephus) <i>cinereiceps</i>	Grey-Crowned Greenbul
<i>Bernieria</i> (=Phyllastrephus) <i>madagascariensis</i>	Long-Billed Greenbul
<i>Bernieria</i> (=Phyllastrephus) <i>zosterops</i>	Spectacled Greenbul
<i>Buteo brachypterus</i>	Madagascar Buzzard
<i>Calicalicus madagascariensis</i>	Red-tailed Vanga
<i>Cisticola cherina</i>	Madagascar Cisticola
<i>Copsychus albospectularis</i>	Madagascar Magpie Robin
<i>Coracina cinerea</i>	Madagascar Cuckoo Strike
<i>Coracopsis nigra</i>	Lesser Vasa Parrot
<i>Coracopsis vasa</i>	Greater Vasa Parrot
<i>Coua caerulea</i>	Blue Coua
<i>Coua reynaudi</i>	Red-Fronted Coua
<i>Crossleyia xanthophrys</i>	Yellow-Browed Oxyllabes
<i>Cyanolanius madagascarinus</i>	Madagascar Blue Vanga
<i>Dicrurus forficatus</i>	Crested Drongo
<i>Dromaeocercus brunneus</i>	Brown Emutail

Scientific name	Common English name
<i>Eurystomus glaucurus</i>	Broad-billed Roller
<i>Foudia omissa</i>	Forest Fody
<i>Hartertula flavoviridis</i>	Wedge-Tailed Jery
<i>Hypsipetes madagascariensis</i>	Madagascar Bulbul
<i>Ispidina madagascariensis</i>	Madagascar Pygmy Kingfisher
<i>Leptosomus discolor</i>	Madagascar Cuckoo-Roller
<i>Lophotibis cristata</i>	Crested Ibis
<i>Mystacornis crossleyi</i>	Crossley's Babbler
<i>Motacilla flaviventris</i>	Madagascar Wagtail
<i>Nectarinia souimanga</i>	Souimanga Sunbird
<i>Neodrepanis coruscans</i>	Common Sunbird-Asity
<i>Neomixis striatigula</i>	Stripe-Throated Jery
<i>Neomixis tenella</i>	Common Jery
<i>Neomixis viridis</i>	Green Jery
<i>Nesillas typica</i>	Madagascar Brush Warbler
<i>Newtonia brunneicauda</i>	Common Newtonia
<i>Numida melleagr</i>	Helmeted Guinea Fowl
<i>Otus rutilus</i>	Madagascar Scops Owl
<i>Oxylabes madagascariensis</i>	White-throated Oxylabes
<i>Philepitta castanea</i>	Velvet Asity
<i>Ploceus nelicourvi</i>	Nelicourvi Weaver
<i>Polyboroides radiatus</i>	Madagascar Harrier Hawk
<i>Pseudobias wardi</i>	Ward's Flycatcher
<i>Pseudocossyphus sharpei</i>	Forest Rock-Thrush
<i>Randia pseudozosterops</i>	Rand's Warbler
<i>Sarothrura insularis</i>	Madagascar Flufftail
<i>Streptopelia picturata</i>	Madagascar Turtle dove
<i>Tersiphone mutata</i>	Madagascar Paradise Flycatcher
<i>Tylas eduardi</i>	Tylas Vanga
<i>Vanga curvirostris</i>	Hooked-billed Vanga
<i>Zosterops maderaspatana</i>	Madagascar White-eye

### Human Disturbance

Beakora Forest is remote and distant from any human encroachment. Signs of forest disturbance were non-existent except for ancient sacred tombs near the forest edge found near the campsite. The local people from the nearest village could not answer any questions about the forest or access to the forest, indicating that they didn't know the forest. Elders in informal interviews said the people do not hunt in this forest. There was only one narrow trail found and a local guide said it was used by cattle rustlers in the past. No cut marks, signs of extraction of forest products, snares or any other indication of human disturbance was found. The abundance of large rosewood trees (Maka: *Weinmania*) and many species of more than 80 cm diameter at breast height including Rahiaka (*Chrysophyllum boivianum*), *Halampona* (Malvaceae), *Dombeya*, *rotra* (*Eugenia* sp.), and *ramiandriona* (*Dilobia* sp.) suggested no timber exploitation (Paul Rasabo, pers. comm.). Even the *harongana* trees were large with more than 30 cm dbh. The abundance of trees with honey bee hives was another strong indicator that humans were not exploiting this forest in any way.

### Discussion

This report presents results from the first expedition to Beakora Forest south east of Kalambatritra Special Reserve and west of Midongy du Sud National Park. In this 9000 ha of pristine rain forest we found over 400 species of plants (many new to science), 8 species of lemur, at least 52 species of birds and a high diversity of insects, reptiles and amphibians. There are possibly a new species of *Cheirogaleus* and *Hapalemur*, as well as *Lepilemur* and these species should be captured for morphometric and genetic analysis for confirmation. It

is interesting that *Avahi laniger* is found in this forest, but not in northern Kalambatritra Reserve, and that the *Lepilemur* populations in Beakora Forest are much lower. This gives further evidence to Ganzhorn's hypothesis that there is competition between these two species (Ganzhorn, 1989). This species of *Lepilemur* is the largest of any species yet described, and there should be follow-up research on behavioral ecology. Our observations of an independent young *Lepilemur* suggests that infants are born in September-October. The results of this inventory of Beakora Forest provide justification that this unprotected forest should become a protected area in the future, as it is one of the last remaining undisturbed rain forests of Madagascar and is protecting many possibly new species of primate (Jernvall and Wright, 1998). One suggestion is to double the size of Kalambatritra Special Reserve to include these southern and eastern forests. The second possibility is to gazette Beakora Forest separately as a new National Park or separate protected area. We suggest that Beakora Forest become a part of the Durban Vision of expanding the protected areas of Madagascar by three times proposed by President Ravalomanana (Economist, 2005).

### Acknowledgements

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### References

- Atsalis, S. 1999. Diet of the brown mouse lemur (*Microcebus rufus*) in Ranomafana National Park, Madagascar. *Int. J. Primatol.* 20: 193-229.
- Ganzhorn, J.U. 1989. Niche separation of the lemur species in the eastern rainforest of Madagascar. *Oecologia* 79: 279-286.
- Ganzhorn, J.U.; Sorg, J.P. 1996. Ecology and Economy of a Tropical Dry Forest in Madagascar. *Primate Report* 46-1. Göttingen, Erich Goltze GmbH.
- Green G.M.; Sussman R.W. 1990. Deforestation history of the eastern rain forests of Madagascar from satellite images. *Science* 248: 212-215.
- Irwin, M.T.; Samonds, K.E. 2002. Range extension of the Madagascar Red Owl *Tyto soumagnei* in Madagascar: the case of a rare, widespread species? *Ibis* 144: 680-683.
- Irwin, M.T.; Smith, T.M.; Wright, P.C. 2000. Census of three eastern rainforest sites north of Ranomafana National Park: Preliminary results and implications for lemur conservation. *Lemur News* 5: 20-23.
- Irwin, M.T.; Samonds, K.E.; Raharison, J.L. 2001. A biological inventory of the lemur community of the Réserve Spéciale de Kalambatritra, south-central Madagascar. *Lemur News* 6: 24-28.
- Irwin, M.T.; Samonds, K.E.; Raharison, J.L.; Wright, P.C. 2004. Lemur latrines: observations of latrine behavior in wild primates and possible ecological significance. *J. Mamm.* 85: 420-427.

- Irwin, M.T.; Johnson, S.E.; Wright, P.C. 2005. The state of lemur conservation in south-eastern Madagascar: population and habitat assessments for diurnal and cathemeral lemurs using surveys, satellite imagery and GIS *Oryx* 39: 204-218.
- Jernvall, J.; Wright, P.C. 1998. Diversity components of impending primate extinctions. *Proceedings of the National Academy of Sciences, USA* 95: 11279-11283.
- Johnson S.E; Overdorff D.J. 1999. Census of brown lemurs (*Eulemur fulvus* spp.) in southeastern Madagascar: Methods-testing and conservation implications. *Am. J Primatol.* 47: 51-60.
- Jolly, A.B.; Dobson, A.; Rasamimanana, H.M.; Walker, J.; O'Connor, S.; Solberg, M.; Perel, V. 2002. Demography of *Lemur catta* at Berenty Reserve, Madagascar: Effects of troop size, habitat, and rainfall. *Int. J. Primatol.* 23: 327-353.
- Mittermeier, R.A.; Konstant, W.R.; Hawkins A.F.A.; Louis, E.E.; Langrand, O.; Ratsimbazafy, H.J.; Rasoloarison, M.R.; Ganzhorn, J.U.; Rajaobelina, S.; Tattersall, I.; Meyers, D.M. 2006. *Lemurs of Madagascar*. 2<sup>nd</sup> ed. Conservation International, Washington D.C.
- Myers, N.; Mittermeier, R.A.; Mittermeier, C.G.; de Fonseca, G.A.B.; Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403: 852-858.
- Nicoll, M.E.; Langrand O. 1989. *Madagascar: Revue de la conservation et des Aires Protégées*. Gland, Switzerland: World Wide Fund for Nature.
- Razafindratsita, V. 2003. The biodiversity of Kalambatritra Reserve. UNESCO World Heritage Natural Site Report.
- Richard A.F.; Dewar, R.E.; Schwartz, M.; Ratsirarison, J. 2002. Life in the slow lane? Demography and life history of male and female sifaka, *Propithecus verreauxi verreauxi*. *J. Zool., London* 256: 421-436.
- Sauther, M.L.; Sussman, R.W.; Gould, L. 1999. The socioecology of the ring-tailed lemur: Thirty five years of research. *Evol. Anthropol.* 8: 120-132.
- Struhsaker T.T. 1981. Census methods for estimating densities. In: *Techniques for the Study of Primate Population Ecology*. Subcommittee on Conservation of Natural Populations (eds.) Washington, DC: National Academy Press.
- Sussman, R.W.; Green, G.M.; Porton, I.; Andrianasolondraibe, O.L.; Ratsirarison, J. 2003. A survey of the habitat of *Lemur catta* in southwestern and southern Madagascar. *Primate Cons.* 19: 32-57
- Whitesides G.H.; Oates J.F.; Green S.M.; Kluberanz R.P. 1988. Estimating primate densities from transects in a West African rain forest: A comparison of techniques. *J. Anim. Ecol.* 57: 345-367.
- Wright, P.C. 1999. Lemur traits and Madagascar ecology: Coping with an island environment. *Yb. Phys. Anthropol.* 42: 31-72.
- Wright, P.C.; Andriamihaja, B.A. 2002. Making a rain forest national park work in Madagascar: Ranomafana National Park and its long-term research commitment. Pp. 112-136. In: *Making Parks Work: Strategies for Preserving Tropical Nature*. J. Terborgh, C. van Schaik, M. Rao, L. Davenport (eds.) Covelo, California: Island Press.
- Wright, P.C.; Andriamihaja, B.A. 2003. The conservation value of long-term research: A case study from Parc National de Ranomafana. In: *Natural History of Madagascar*. S.M. Goodman, S. and J. Benstead, (eds.). University of Chicago Press, Chicago.
- Wright, P.C., Andriamihaja, B.R.; Raharimiandra, S. 2005. Tanala Synecological Relations with Lemurs in Southeast Madagascar. Pp. 118-145. In: *Communi-*

alism and Conflict: the primate – human interface. J.D. Paterson, J. Wallis (eds.). New York: Kluwer Press.

## Inventaires des Lémuriens nocturnes dans la forêt pluviale de Maromizaha (Est de Madagascar)

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**Mots-clés:** Inventaire, Forêt pluviale de Maromiza, lémuriens, nocturnes, distribution

La forêt pluviale de Maromiza occupe une position primordiale au sein du corridor Andasibe-Mantadia-Zahamena due au fait à sa position géographique entouré par les autres forêts à savoir la forêt d'Analamazaotra à l'ouest, la forêt de Vohidrazana au Sud-Est, et les forêts d'Ambato et Mantadia au Nord (Fig. 1 et 2). De ce fait, les forêts d'Analamazaotra-Maromiza-Vohidrazana sont facilement reliées, ce qui rendra aisément les échanges des faunes entre les différentes forêts assurant ainsi la viabilité et la conservation des différentes espèces. L'objectif de cette étude était de répertorier les différentes espèces de lémuriens nocturnes dans la forêt pluviale de Maromiza.

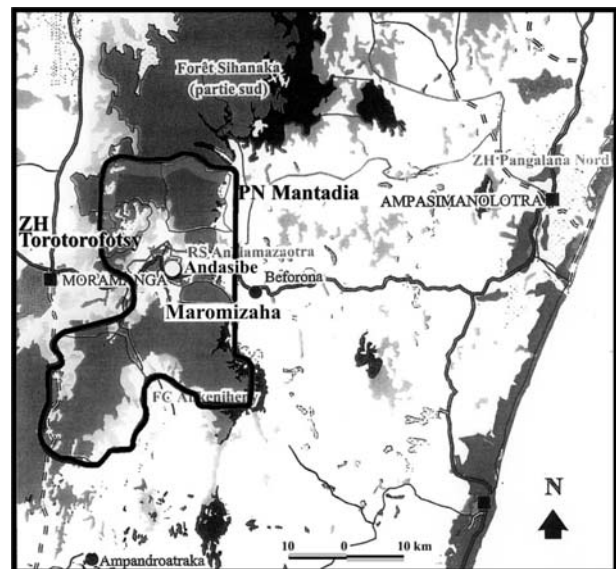


Fig. 1: Localisation de site d'étude (source NAT).

### Site d'étude

La forêt pluviale de Maromiza (altitude 1020 m; 18°57'59,1"S, 48°27'50,8"E) se trouve dans la commune rurale d'Andasibe, sous-préfecture de Moramanga, région d'Alaotra Mangoro, à environ 130 km au Nord-Est de la capitale de Madagascar. Plus précisément, elle se situe à 3 km du croisement de la route vers Andasibe en suivant la route nationale No. 2.

La forêt de Maromiza a une superficie de 1600 ha dont 820 ha sont encore intactes, alors que les 360 ha sont plus ou moins perturbées et les 420 ha qui restent sont des "savoka". Le statut de Maromiza reste encore dom-

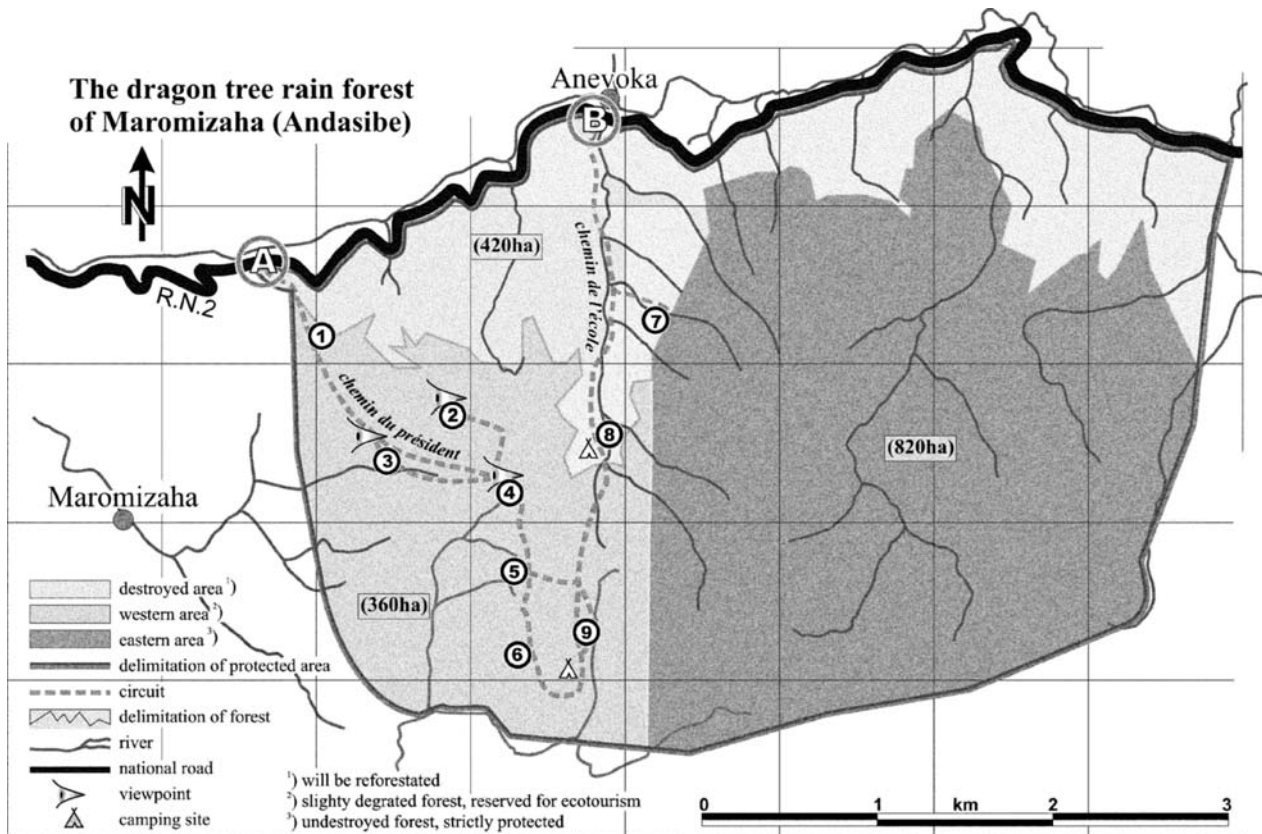


Fig. 2: Carte de localisation (source NAT).

aniale mais cette forêt est sous la gérance de l'ONG NAT (Stiftung Natur-und Artenschutz in den Tropen: Fondation pour la protection de la nature et des espèces tropicales; Zimmermann et Randrianambinina, 2005). Des inventaires de lémuriens nocturnes ont été effectués pour la première fois pendant la saison d'hiver (durée de l'étude: 03.05.-04.06.05; 13.06.-07.07.05; 17.07.-03.08.05).

## Méthodologie

### 1. Recensement par observation directe

Le recensement des espèces de lémuriens nocturnes a été fait soit par observation directe, soit par vocalisation. L'observateur emprunte une piste de 1 km (à une vitesse moyenne de 0,7 km/h) préalablement élaborée et mesurée par la Fondation NAT. Nous avons travaillé sur deux pistes (piste arbre dragon et piste quatre chemins-Ambodipaiso) et tout au long de cette observation, deux personnes ont pris part dans chaque piste dont l'une assurait l'observation du côté gauche, alors que l'autre personne faisait attention ceux qui sont à droite de la piste. L'observation nocturne se faisait entre 18h30 à 20h. Avec une lampe frontale de faible intensité, on repère facilement les lémuriens nocturnes et ceci due au fait au reflet lumineux de leurs yeux. Une fois repéré, une autre lampe beaucoup plus puissante (maglite) a été utilisée pour l'identification de l'espèce. A chaque parcours d'observation, nous avons focalisé sur les informations suivantes: l'heure, position de l'observateur par rapport à l'individu, nombre d'individu observé, distance entre l'observateur et l'animal, hauteur, angle, le comportement de l'animal au moment de l'observation et l'espèce. Chacune des pistes a été parcourue 6 fois en tenant compte de changer le sens

pendant les six passages pour bien détecter la présence ou non des espèces de lémuriens.

Le nombre moyen calculé pour chaque espèce sera donné par la formule:  $N_m = [(N_a/6) + (N_b/6)] / 2$ ;  $N_m$ : moyenne du nombre d'individus recensés par km;  $N_a$ : nombre total d'individus recensés pour une espèce durant 6 recensements sur la piste A;  $N_b$ : nombre total d'individus recensés pour une espèce durant 6 recensements sur la piste B.

### 2. Enquête effectués auprès des villageois et des guides touristiques locaux

Afin de compléter les informations sur la présence éventuelle des espèces de lémuriens nocturnes à Maromiza, nous avons questionné les villageois et les guides. Pour cela, nous avons leurs montré des photos d'espèces de lémuriens nocturnes qui pourraient être probablement présentes dans cette zone.

## Résultats et Discussions

La forêt pluviale de Maromizaha abrite 6 espèces nocturnes de lémuriens. *Microcebus rufus* (Cheirogaleidae) décrit maintenant sous le nom de *Microcebus lehilahytsara* (Kappeler et al., 2005) a été recensée malgré le fait que nous avons effectué cette étude pendant l'hiver. Une étude sur cette espèce a été faite par Randrianambinina en 1999 dans le Parc de Mantadia et d'après cette étude, les adultes chez *Microcebus lehilahytsara* diminuent considérablement leurs activités durant quelques temps pendant la période d'hiver (Randrianambinina et al., 2003).

*Avahi laniger* (Indridae) a été observée deux fois seulement dans le site. Il est facilement remarquable avec la ligne blanchâtre qui existe sur la cuisse ainsi que ses oreilles un peu-courtes par rapport au *Lepilemur*. *Lepi-*

*lemur microdon* ou *mustelinus* (Lepilemuridae) a été recensée et capturée dans cette zone. Contrairement aux autres espèces de *Lepilemur* de la région Ouest et Nord-Ouest de Madagascar, aucune localisation de cette espèce n'a été entendue durant cette étude. Cela peut être due à l'abondance très faible du *Lepilemur* à Maromiza entraînant ainsi la rareté des contacts entre les individus. L'espèce *Daubentonia madagascariensis* (Daubentoniidae) pourrait être présente dans la forêt de Maromiza. Des marquages laissés par cette espèce ainsi que l'enquête effectuée auprès des guides nous a permis d'avancer cette hypothèse. Théoriquement si on regarde l'aire de distribution de cette espèce, elle pourrait observer dans cette zone (Mittermeier *et al.*, 2006). *Cheirogaleus major* (Cheirogaleidae) n'a pas été observée ni recensée même si sa présence est fortement confirmée dans le site par les guides et les villageois. Cela est sûrement dû à la période d'inventaire car les Cheirogales hibernent pendant la saison d'hiver et restent ainsi difficiles à observer pendant cette période. La présence d'*Allocebus trichotis* (Cheirogaleidae) dans la forêt de Maromiza a été confirmée par les guides. Cette espèce nocturne fait partie des espèces de lémuriens très rares dont nombreux chercheurs ont pensé qu'elle a été totalement disparue de la forêt de l'est avant sa redécouverte dans la forêt de Vohidrazana (Rakotoarison *et al.*, 1996).

Tableau 1: Moyenne du nombre d'individus recensés par km dans la forêt pluviale de Maromizaha.

Espèces	Forêt de Maromizaha
<i>Microcebus lehilahytsara</i>	3,41
<i>Lepilemur</i> spp.	0,74
<i>Avahi laniger</i>	0,33
<i>Allocebus trichotis</i>	(+)
<i>Cheirogaleus major</i>	(+)
<i>Daubentonia madagascariensis</i>	(+)

(+): présence effective d'après les guides et les villageois

Tableau 2: Moyenne du nombre d'individus recensés par km dans la forêt d'Ankarafantsika et d'Andranovelona/Madirovalo (Rasoloharijaona *et al.* 2005)

Espèces	Ankara-fantsika	Andranovelona/Madirovalo
<i>Microcebus</i> spp.	4,00	7,33
<i>Lepilemur</i> spp.	0,97	2,00
<i>Avahi occidentalis</i>	1,93	

## Conclusions

Selon notre étude la forêt pluviale de Maromiza abrite 6 espèces nocturnes de lémuriens. On note aussi la présence des 4 espèces strictement diurnes, à savoir *Indri indri*, *Propithecus d. diadema*, *Eulemur rubriventer* et *Varecia v. variegata* et 2 espèces cathémérales, à savoir *Eulemur f. fulvus* et *Hapalemur g. griseus*. Une autre forme de *Hapalemur* qualifiée de nouvelle aurait été observée dans l'Est de Maromizaha (Rakotosamimanana *et al.*, 2004). La présence de la Fondation NAT qui gère la forêt de Maromizaha aurait apporté sans doute des retombées bénéfiques non seulement sur les lémuriens nocturnes mais aussi les diurnes. Cette diversité de lémuriens dans la forêt de Maromizaha constituera

ainsi un potentiel écotouristique très élevé de ce site. De ce fait, il est primordial de mettre en place un programme de conservation qui assurera un avenir prometteur non seulement aux espèces faunistiques et floristiques dans ce merveilleux écosystème forestier mais aussi aux villageois environnants.

## Remerciements

Ce travail n'a pas pu être réalisé sans l'appui et l'intervention des différentes institutions et des personnes mentionnées ci-après: Pour commencer nos vifs remerciements s'adressent à la Direction des Eaux et Forêts de nous avoir donné la permission de mener la recherche dans la forêt de Maromiza. Notre reconnaissance s'adresse aussi à la Fondation NAT représentés par son Président Mr. Helmut Zimmermann et le chef de Station Harisoa Vololonarivo Voahangihinirina de nous avoir donné l'opportunité de camper à Maromiza ainsi que pour leur assistance technique. Nous adressons un grand merci au Pr. Elke Zimmermann Directrice de l'Institut de Zoologie de Hanovre ainsi qu'au Pr. Jörg U. Ganzhorn pour leurs commentaires constructifs. Nous tenons à remercier également le Doyen de la Faculté des Sciences (Université d'Antananarivo), Pr. Olga Ramilijaona chef de département de Biologie Animale pour leur assistance et appui à l'octroi de l'autorisation de recherche. Nos plus sincères gratitude s'adressent également à tous les villageois d'Anevoka. Nos éternelles reconnaissances s'adressent également à Mr. Dominique Sum Chuk Lan et Mr. Julien Sum Chuk Lan de l'Hôtel Feon'ny Ala Andasibe pour leur assistance. Nous remercions vivement VW (I /76828) d'avoir supporté financièrement ce travail.

## Références

- Kappeler, P.M.; Rasoloarison, R.M.; Razafimanantsoa, L.; Walter, L.; Roos, C. 2005. Morphology and molecular evolution of giant mouse lemurs (*Mirza* spp.) Gray, 1870, with description of a new species. Primate Report 71: 3-26.
- Mittermeier, R.A.; Konstant, W.R.; Hawkins A.F.A.; Louis, E.E.; Langrand, O.; Ratsimbazafy, H.J.; Rasoloarison, M.R.; Ganzhorn, J.U.; Rajaobelina, S.; Tattersall, I.; Meyers, D.M. 2006. Lemurs of Madagascar. 2<sup>nd</sup> ed. Conservation International, Washington D.C.
- Rakotoarison, N.; Zimmermann, H.; Zimmermann, E. 1996. First discovery of the hairy-eared dwarf lemur (*Allocebus trichotis*) in a highland rain forest of eastern Madagascar. Folia Primatol. 68: 86-94.
- Randrianambinina, B.; Rakotondravony, D.; Radespiel, U.; Zimmermann, E. 2003. Seasonality in general activity, body mass and reproduction of the Golden Brown Mouse Lemur (*Microcebus ravelobensis*) in northwestern Madagascar and the Brown Mouse Lemur (*Microcebus rufus*) in eastern Madagascar. Primates, 44: 321-331.
- Rakotosamimanana, B.; Raharizelina, R.R.; Ralisoamalala, R.C.; Rasolofoharivelo, T.M.; Raharimanantsoa, V.; Randrianarison, R.M.; Rakotondratsimba, J.G.; Rasolofoson, D.R.; Rakotonirainy, E.O.; Randriamboavonjy, T.M. 2005. Comment et pourquoi les lémuriens diurnes disparaissent peu à peu dans les forêts d'Ambato et de Maromizaha (région de Moramanga) Madagascar? Lemur News 9: 19-24.
- Rasoloharijaona, S.; Randrianambinina, B.; Rakotosamimanana, B.; Zimmermann, E. 2005. Inventaires des lémuriens dans la Forêt d'Andranovelona/Madirovalo (nord ouest de Madagascar), les Savoka de

manehoko, la Réserve de Lokobe, la Réserve Spéciale de l'Ankarana, et la Réserve Spéciale d'Analamerana, au nord de Madagascar. Lemur News 10: 8-11.  
 Zimmermann, H.; Randrianambinina, B. 2005. La Fondation NAT dans la région d'Andasibe (Est de Madagascar). Lemur News 10: 1-2.

## An international conservation and research programme for Perrier's sifaka (*Propithecus perrieri* Lavauden, 1931) in northern Madagascar

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† In memoriam

Perrier's sifaka (*Propithecus perrieri*; Fig. 1), one of the most endangered and least-studied lemur species, only remains in a small and already highly fragmented area of dry forest in northern Madagascar. Formerly regarded as a subspecies of *Propithecus diadema*, the taxon was recently elevated to full species status (Mayor *et al.*, 2004). It inhabits the Analamerana Special Reserve and the Andrafiama hills (Petter *et al.*, 1977; Tattersall, 1982; Hawkins *et al.*, 1990). Whereas the species has once been reported to occur in the Anka-



Fig. 1: Perrier's sifaka (*Propithecus perrieri*).  
 Photo: Russell Mittermeier

rana Special Reserve, Banks *et al.* (in press) as well as Rasoloharijaona *et al.* (2005) did not find it there in 2003/2004. Overall population size is estimated to be between 100 and 1,000 individuals (Mittermeier *et al.*, 2005, 2006; Banks *et al.*, in press). The most recent estimate is provided by Banks *et al.* (in press), who predict that there are 915 black sifakas remaining with an effective population unlikely to exceed 230 individuals. Perrier's sifaka is threatened by hunting, selective logging, habitat destruction to make way for agriculture and pasture for livestock, as well as mining for gemstones. It was assessed Critically Endangered (CR C2aII) at the most recent IUCN Red List assessment in April 2005 on the basis of its very small population size and the continuing decline in numbers. The species was recently found to also occur in a corridor of forest between Analamerana and Ankarana as well as in the Andavakoera Classified Forest. For the latter two areas, protection measures are urgently needed.

In 2005, a group of interested parties headed by the Monaco-based NGO *Act for Nature* and the *Groupe d'Etude et de Recherche sur les Primates de Madagascar* (Université d'Antananarivo) decided to implement a conservation and research programme for Perrier's sifaka in northern Madagascar. The goals of this programme are on the one hand to achieve a sustainable conservation of *P. perrieri* in at least one of the major areas of repartition of the species which are currently without any degree of protection, on the other hand to gain scientific knowledge of *P. perrieri* directly relevant to effectively planning and carrying out such conservation measures. Here, in the first phase of the programme precedence is given to questions relating to the effect of habitat destruction and fragmentation on the species as well as to its feeding ecology.

### Programme objectives

Perrier's sifaka is, alongside the silky sifaka (*Propithecus candidus*), considered to be the rarest sifaka species, and the precise limits of its very small distribution area are not known (Tattersall, 1982; Mayor and Lehman, 1999; Mittermeier *et al.*, 2006), nor its biogeography and chorology which could explain its present limited range. Most of the remaining population is thought to occur in the 34,700 ha Analamerana Special Reserve, situated at 12°44'S and 49°44'E, 36 km south-east of Anivorano-Nord in the autonomous province of Antsiranana (Nicoll and Langrand, 1989; Ganzhorn *et al.*, 1996/1997). However, Banks *et al.* (in press) calculated that 26 % of the total remaining population of *P. perrieri* is found in areas without any protection, particularly in the forest corridor between the special reserves of Analamerana and Ankarana. According to the same authors, one third of these approximately 240 animals are living in forest fragments of less than 1 km<sup>2</sup>. Given the low densities of Perrier's sifakas of 3-4 individuals/km<sup>2</sup> reported by Petter *et al.* (1977) and Banks *et al.* (in press), it is obvious that none of these small fragments can harbour a self-sustaining population of the species. Mayor and Lehman (1999) report that, unlike other sifakas, Perrier's sifakas regularly come to the ground to cross large stretches of savannah between forest patches. It would therefore be of value to the conservation of *P. perrieri* to investigate how well the lemurs are able to utilise the matrix surrounding the forest fragments (matrix-tolerant species; Laurance and Bierregaard, 1997) and to disperse between these fragments.

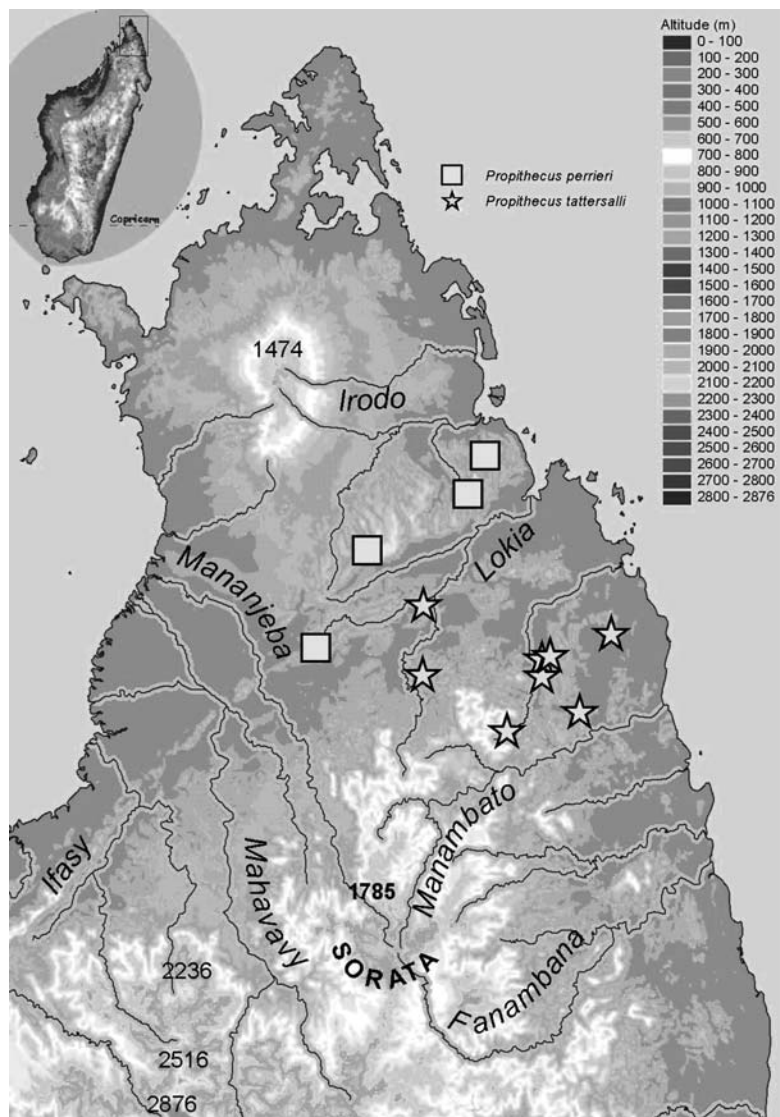


Fig. 2: Distribution area of *Propithecus perrieri* and *Propithecus tattersalli* in northern Madagascar. Map: Lucienne Wilmé

Although Banks *et al.* (in press) provide a reasonable estimate of the remaining *P. perrieri* population, there is, to date, no information on the number of groups and the size of the forest fragments these groups inhabit. Knowledge of these aspects will provide a basis for conservation measures to be carried out on. It will furthermore constitute a first step of a larger study on the effects of habitat fragmentation on Perrier's sifaka.

Perrier's sifaka lives in groups of 2-6 individuals which occupy home ranges of up to 30 ha (Meyers and Ratsirarson, 1989; Mayor and Lehman, 1999; Mittermeier *et al.*, 2006). In their two-month study of 2 *P. perrieri* groups in Analamerana, Lehman and Mayor (2004) found that the sifakas mainly fed on leaves (45-55 %), flowers (26-29 %) and fruits (15-20 %). The two studied groups exploited a total of 28 and 35 different plant species, respectively. Of all recorded activities of the studied animals, 28 % were devoted to feeding. So far, no systematic long-term study of the feeding ecology of *P. perrieri* has been carried out. From the conservation perspective it is necessary to study how the animals cope with the destruction of their original food resources and how well they are able to exploit new resources such as second growth plant species generated through edge

effects. The results of such studies can be used to guide reforestation measures and the possible planting of corridors between forest fragments too far apart to allow for dispersal of sifakas.

Regarding direct conservation measures, the main goal of the programme is to prepare everything necessary for the conservation of the yet unprotected parts of the *P. perrieri* distribution area in order to ensure a long-term survival of the species. On the one hand this means the sensitisation of the local communities for ecosystem conservation, on the other hand the planning and coordination of direct development aid measures. In this respect it will be crucial for the programme to directly link as many incomes of the locals as possible to the conservation of the sifakas and their habitat. This can be achieved by employing people as guides or park rangers, but also by enhancing ecotourism or having people plant and manage fruit tree corridors between forest fragments.

**Implementation**

The studies on the effects of habitat fragmentation on *P. perrieri* as well as on the feeding ecology of the species, briefly outlined above, should be part of a long-term action plan for the conservation of Perrier's sifaka in its original habitat in northern Madagascar. Part of this plan is to establish a field research station in one of the major repartition areas of the species that do not yet receive any protection (i.e. the corridor between Ankarana and Analamerana special reserves). The station will be used by both researchers and conservationists concerned with Perrier's sifaka or other projects relevant to species or habitat conservation to be carried out in the area.

Considering the biodiversity and the high degree of endemism within northern Malagasy habitats, the programme described above should be able to promote research and conservation in the entire northern region, including a botanical inventory as well as studies on sociocultural aspects. Special attention will be given to a public awareness component to be emphasized as part of the programme.

The conservation and research programme for Perrier's sifaka was officially launched on March 21, 2006 with a gala ceremony under the patronage of HSH Prince Albert II of Monaco. The establishment of a research station and the onset of the research work are scheduled for mid 2006. Initial funding will be provided by the government of Monaco, Act for Nature, Conservation International, Westfälische Gesellschaft für Artenschutz, Zoologische Gesellschaft für Arten- und Populationsschutz and Jardin Zoologique et Botanique Mulhouse-Sud Alsace.

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## References

- Banks, M.A.; Ellis, E.R.; Antonio, M.; Wright, P.C. (in press). Census results for lemurs of northern Madagascar, including low population numbers for the critically endangered *Propithecus perrieri*. *Animal Cons.*
- Ganzhorn, J.U.; Langrand, O.; Wright, P.C.; O'Connor, S.; Rakotosamimanana, B.; Feistner, A.T.C.; Rumpler, Y. 1996/1997. The status of lemur conservation in Madagascar. *Primate Conservation* 17: 70-86.
- Hawkins, A.F.A.; Chapman, P.; Ganzhorn, J.U.; Bloxam, Q.M.C.; Barlow, S.C.; Tonge, S.J. 1990. Vertebrate conservation in Ankarana Special Reserve, northern Madagascar. *Biol. Cons.* 54: 83-110.
- Laurance, W.F.; Bierregaard, R.O. 1997. *Tropical Forest Remnants: Ecology, Management, and Conservation of Fragmented Communities*. University of Chicago Press, Chicago. 616 p.
- Lavauden, L. 1931. Un nouveau propithecus de Madagascar (*Propithecus perrieri*, sp. nov.). *Comptes rendus des Séances de l'Académie des Sciences, Paris* 193: 77-79.
- Lehman, S.M., Mayor, M. 2004. Dietary patterns in Perrier's sifakas (*Propithecus diadema perrieri*): a preliminary study. *Am. J. Primatol.* 62: 115-122.
- Mayor, M.; Lehman, S.M. 1999. Conservation of Perrier's sifaka (*Propithecus diadema perrieri*) in Analamera Special Reserve, Madagascar. *Lemur News* 4: 21-23.
- Mayor, M.I.; Sommer, J.A.; Houck, M.L.; Zaonarivelo, J.R.; Wright, P.C.; Ingram, C.; Engel, S.R.; Louis, E.E. Jr. 2004. Specific status of *Propithecus* spp. *Int. J. Primatol.* 25: 875-900.
- Meyers, D.; Ratsirarson, J. 1989. Distribution and conservation of two endangered sifakas in northern Madagascar. *Primate Conservation* 10: 82-87.
- Mittermeier, R.A.; Valladares-Pádua, C.; Rylands, A.B.; Eudey, A.A.; Butynski, T.M.; Ganzhorn, J.U.; Kormos, R.; Aguiar, J.M.; Walker, S. 2005. *Primates in Peril. The World's 25 Most Endangered Primates 2004-2006*. IUCN/SSC Primate Specialist Group, International Primatological Society, Conservation International.
- Mittermeier, R. A.; Konstant, W.R.; Hawkins A.F.A.; Louis, E.E.; Langrand, O.; Ratsimbazafy, H.J.; Rasoloarison, M.R.; Ganzhorn, J.U.; Rajaobelina, S.; Tattersall, I.; Meyers, D.M. 2006. *Lemurs of Madagascar*. 2<sup>nd</sup> ed. Conservation International, Washington D.C.
- Nicoll, M.E.; Langrand, O. 1989. Madagascar: Revue de la Conservation et des Aires Protégées. World Wildlife Fund, Gland.
- Petter, J.-J.; Albignac, R.; Rumpler, Y. 1977. *Mammifères: Lémuriens (Primates, Prosimiens)*. Faune de Madagascar 44. ORSTOM/CNRS, Paris.
- Rasoloharijaona, S.; Randrianambinina, B.; Rakotosamimanana, B.; Zimmermann, E. 2005. Inventaires des lémuriens dans la forêt d'Andranovelona/ Madirovalo (nord ouest de Madagascar), les "savoka" de Manehoko, la Réserve de Lokobe, la Réserve Spéciale de l'Ankarana, et le Réserve Spéciale d'Analamerana, au nord de Madagascar. *Lemur News* 10: 8-11.
- Tattersall, I. 1982. *The Primates of Madagascar*. Columbia University Press, New York.

## Preliminary survey of lemur density in the semimontane rainforest of Anka, Fort-Dauphin region

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**Key words:** Anka, lemur density, deforestation, *Eulemur*, *Avahi*, *Cheirogaleus*, *Microcebus*.

Here we present the first lemur survey conducted in the forest of Anka, a semimontane rainforest area located in the southern sea-side part of the Vohimena Mountains and included in the classified area Tsitongambarika I. The estimated densities of the lemur species encountered during the survey (*Eulemur collaris*, *Avahi laniger*, *Cheirogaleus* spp., *Microcebus rufus*) appear to be at the upper end of the values for the southeastern rainforest and, in some case, similar to the high densities recorded in the littoral forests close to Fort-Dauphin. Knowing the relative density of lemurs in different forest sites of the Fort-Dauphin region can help to understand the complex migration dynamics of predators (fossa) in the area. In fact, from a fossa's perspective, the forests of Andohahela, Anka and Mandena may be part of "meta-forest" since they are able to move from one site to another within their home-range: the fossa may follow a "density gradient" of the favourite preys when prey population falls under a sustainable threshold.

The parcel 1 of Andohahela National Park represents the largest rainforest area in South-East Madagascar and it should be protected from increasing hunting and logging pressure (Fenn, 2003). However, in Andohahela hunting and logging pressures are far from being eliminated, even in the sites controlled by ANGAP (Rasoarimanana, 2005). In this situation, it is of crucial importance to assess the biodiversity value and the human impact on the buffer areas around the national park. While the mountain rainforests are still relatively undisturbed due to their inaccessibility, the semimontane and low-altitude habitats are exposed to higher rates of deforestation and deserve urgent investigation and conservation efforts. Indeed, Cornac *et al.* (2003) detected both recent and older disturbance in the low-elevation part of the Andohahela protected area.

The forest of Anka (Fig. 1) is located in the southern sea-side part of the Vohimena mountains. This semimontane rainforest is included in the classified forest area called Tsitongambarika I. It is connected with the parcel 1 of Andohahela via the Manangotry corridor. Being not officially protected, hunting and logging levels are supposed to be higher compared to the protected areas. However, the two villages of the *fokotany* of Anka established an agreement to manage the forest, thus a partial protection against illegal activities is in progress. No survey had been conducted in the forest of Anka yet. Surveys seemed necessary as people of Anka re-



ported the sighting of black lemurs similar to *Eulemur collaris*.

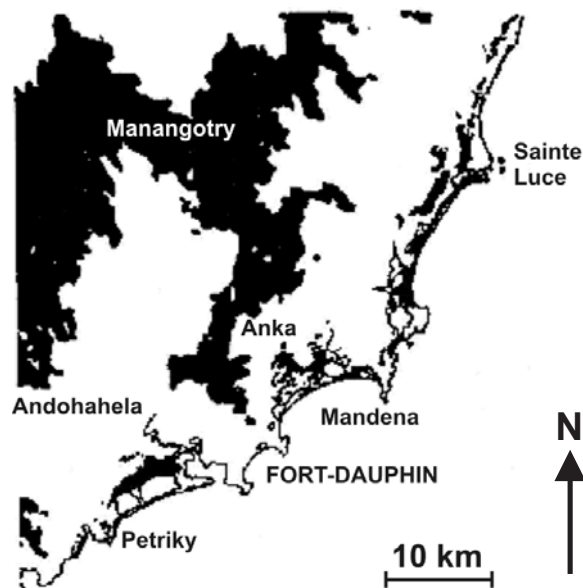


Fig. 1: Location of the forest of Anka (survey site) and of other forest sites in the Fort-Dauphin region.

Together with the adjacent Andohahela rainforests, the littoral forests of Mandena and Sainte Luce are also close to the Anka forest (Mandena and Anka are less than 4 km apart). In 2000, 28 individuals of *Eulemur collaris* were translocated to the Mandena fragments M15/M16 (protected by QMM conservation programs) from the nearby forest fragments M3/M4 before their disappearance (Bollen and Donati, 2006). Over the last two years, at least 7 fossas (*Cryptoprocta ferox*), the largest lemur predator, entered the Mandena area, where it had not been reported before (Donati *et al.*, submitted). It has been suggested that the fossas came from the Anka region, the closest large forest block to Mandena. In general, predator density is related to preys (Ricklefs, 1990). Consequently, the evaluation of the density of lemurs in the Anka forests can help to understand the possible migration dynamic of predators (such as fossas) within forest sites that are as close to one another as the Mandena fragments and the Anka forests. Lemur censuses were conducted in the forests of Mandena, Sainte Luce, and Andohahela (Feistner and Schmid, 1999; Andrianjalahatra, 2000; Donati, 2002; Andrianasolo, 2004; Rakotondranary, 2004; Rasoarimanana, 2005; Norscia, 2006).

Here we present the results of a preliminary survey in Anka, comparing the estimated density of different lemur species with those reported for other sites of the Antanosy region (Andohahela, Mandena, and Sainte Luce) and evaluating the possible consequences on forest ecology.

### Methods

The survey presented here was conducted in the forest of Anka (24°57'S, 46°56'E) during 4 days in November, 2004. The habitat is semimontane rainforest and the survey altitude varied from 50 to 200 meters. Major tree taxa included *Uapaca*, *Canarium*, *Syzygium*, *Dyopsis*, *Tambourissa*. The forest was expected to host at least the following lemur species: *Microcebus rufus*, *Cheirogaleus* spp., *Avahi laniger*, *Hapalemur meridionalis* and *Eulemur collaris*.

During daytime, one transect of 2.0 km and 2 transects of 4.5 km were performed in the southern side of the Anka forest (the best preserved part), while one walk of about 6.5 km was taken in the northern part of the forest. During the night, three 500 m transects were walked in the southern part of the forest to obtain a first estimate of the density of nocturnal lemurs. Steep topography and time constraints precluded the possibility of using straight line transects. When possible, we used existing trail systems crossing various microhabitats and altitudes. All transects were walked with an average speed of 700-800 m per hour.

Lemur density per species was estimated as the average of the densities calculated for each walk. The density/transect was calculated as the number of individuals encountered during each walk/the total surface covered. The total surface was obtained as follows:  $2 \times (\text{average distance of animals from the trails}) \times (\text{trail length})$ .

### Results

The low-altitude portions of the Anka forest are "corroded" by logging and slash and burn (Fig. 2) even though the remaining area is occasionally patrolled by agents coordinated by the two villages of the *fokotany* of Anka. The *tavy* are mainly used to grow manioc, while the selective logging seems to be focused on *Dyopsis* spp. It was beyond the goal of our survey to provide an accurate estimate of forest cover. However, we observed that the remaining patches appear to be clearly limited on the hilltops, while the bottom of the valley was completely deforested by cutting. Indeed, local people reported that only few years ago the forest was much closer to the villages. Instead, at higher altitudes the forest cover appears to be continuous and connected to the block of Ivorona and Manantately, to the western and southern directions, respectively.

No melanistic individual of *Eulemur collaris* was seen during the census and interviews with local people revealed that last sightings dated back to the 80s. Moreover, even if suspected to occur in the area, the presence of *Hapalemur meridionalis* was not noticed during this survey. Individuals of *Eulemur collaris*, *Cheirogaleus* spp, *Avahi laniger*, and *Microcebus rufus* encountered during the walks could be counted and their estimated density in the forest was evaluated (Table 1).

When encountered, some groups of *E. collaris* fled immediately while others reacted with alarm calls. It is difficult to estimate the level of hunting pressure in the



Fig. 2: Deforestation in the forest of Anka (photo by Ivan Norscia).

Table 1: Mean number of sightings per trail and mean detection distances (m) ( $\pm$  standard deviation). Mean detection distances are given perpendicular to the trail.

	Number of census	Trail length (km)	Mean # of sightings	Mean detection distance (m) $\pm$ SD
<i>Cheirogaleus</i> spp.	3	0.5	4.0	14.2 $\pm$ 10.4
<i>Microcebus rufus</i>	3	0.5	2.0	6.3 $\pm$ 7.1
<i>Avahi laniger</i>	3	0.5	2.3	24.3 $\pm$ 11.0
<i>Eulemur collaris</i>	4	2.0-6.5	4.25	26.2 $\pm$ 9.9

area. During our visit, we did not notice the presence of *tandroho*, the typical *Eulemur* traps used by the Antanosy people for this species. However, based on the information provided by the local guides hunting is ongoing in this forest.

The estimated density of *E. collaris* in Anka is higher than the densities reported in the parcel 1 of the Andohahela National Park (Table 2) and in other rainforests of southeastern Madagascar (0.11/ha; Johnson and Overdorff, 1999). Conversely, *E. collaris* density in Anka seems lower than in Sainte Luce and comparable to the one reported in the fragments M15-M16 of Mandena (Table 2).

Table 2: Lemur densities (mean individuals/ha) in Anka, Andohahela, Mandena and Ste Luce.

	Anka <sup>1</sup>	Andohahela <sup>2</sup>	Mandena <sup>3</sup>	Ste. Luce <sup>4</sup>
<i>Cheirogaleus</i> spp.	2.82	1.17	0.80	12.00
<i>Microcebus rufus</i>	3.16	1.41	6.80	3.00
<i>Avahi laniger</i>	0.95	0.66	1.02	3.00
<i>Eulemur collaris</i>	0.15	0.08	0.19	0.38

<sup>1</sup>Present data; <sup>2</sup>Rasoarimanana (2005), Feistner and Schmidt (1999); <sup>3</sup>Norscia (unpublished data), Donati *et al.* (submitted); <sup>4</sup>Donati (2002), Norscia (2006, unpubl. data).

The estimated densities for the nocturnal lemurs *Avahi laniger*, *Microcebus* spp. and *Cheirogaleus* spp. seem to be higher in Anka than in Andohahela (Table 2). The estimated density of *A. laniger* in Anka is quite similar to the density found in Mandena (M15-M16), while it is three times lower than the density found in Ste Luce. Instead, the estimated density of *Cheirogaleus* spp. seems to be much higher in Anka than in Mandena, while, again, Ste Luce show the highest value. Finally, the density of *Microcebus* spp. is similar in Anka and Ste Luce, while it is twice as high as in Mandena (Table 2).

## Discussion

Overall, the density values presented here (Table 2) suggest that Anka forest is still holding a community of lemurs in good conditions. The estimated densities of each species encountered during the survey appear to be at the upper end of the values for the southeastern rainforest and, in some case, similar to the high densities recorded in the littoral forest (Table 2). Instead, the absence of *Haplemur meridionalis* may be a consequence of the anthropic encroachment, the short period of the survey or, simply, the absence of suitable habitats for this species in the area.

The high densities recorded in Anka could be due to unprotected forests at the periphery of Anka. Although subject to logging, they may still contain a large lemur population due to their contiguity with larger forest blocks. Second, the involvement of local people in forest

management may have produced immediate benefits for lemur populations (better protected), regardless of the official conservation status of the area. As for the latter aspect, the high lemur densities and the alarm calls of the Eulemurs encountered during the day may suggest that the hunting pressure is reduced if compared to other Antanosy forests. The reduced hunting pressure may also be due to the participation of villagers in the conservation

program conducted by QIT Madagascar Minerals (QMM) in the nearest area of Mandena. This program may have produced an increased awareness of conservation problems in the local population.

As concerns the fossas found in Mandena in 2004, it seems reasonable to assume that they have moved from the near site of Anka (Fig. 1). In fact, the two sites are about 4 km apart and according to Hawkins (2003) fossas can have home ranges up to 13 km<sup>2</sup> (females) and 26 km<sup>2</sup> (males). The sudden increase of density of *E. collaris* in the fragments M15/M16 after the translocation of lemurs into M15/M16 in 2000 might represent one of the main reasons why some fossas have moved to Mandena, especially considering that the estimated density of nocturnal lemurs (Table 2) is lower in Mandena than in Anka (with the exception of the small *Microcebus*). From a fossa perspective, the forests of Andohahela, Anka and Mandena may be part of "meta-forest" since they are able to move from one site to another within their home-range, possibly following a "density gradient" of the favourite preys. Finally, if we consider that the forest of Sainte Luce is only some kilometers from the Ivoloibe forest (on the eastern slopes of Tsitongambarika II classified area) and that fragment S9 shows the highest densities of *E. collaris*, *A. laniger* and *Cheirogaleus* spp., it cannot be excluded that fossas may arrive in Sainte Luce in search of food, as soon as lemur densities in the nearest mountain forests decrease below the sustainable threshold.

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## References

- Andrianasolo, H.T. 2004. Effets de la dégradation de la forêt sur la population de *Cheirogaleus* spp. (E. Geoffroy, 1812) dans la forêt littorale de Sainte-Luce (Sud-Est de Madagascar). Unpubl. DEA theses, Université d'Antananarivo.
- Andrianjalahatra, L.T. 2000. Contribution à l'étude de la séparation écologique de trios lemuriens sympatriques de Mandena, Fort-Dauphin: *Microcebus murinus* (J. Miller, 1777), *Cheirogaleus* spp. (E.

- Geoffroy, 1812), *Avahi laniger* (Gmelin, 1788). Unpubl. DEA Thesis, Université d'Antananarivo.
- Bollen, A.; Donati, G. 2006. Conservation status of the littoral forest of south-eastern Madagascar: a review. *Oryx*, 40: 1-10.
- Cornac, L.; Dubois, M.A.; Riera B. 2003. Rapid methods for characterizing forest structure in Madagascar. Pp. 96-103. In: The Natural History of Madagascar. S.M. Goodman, J.P. Benstead (eds.). University Chicago Press, Chicago.
- Donati, G. 2002. L'attività e le sue correlate ecologiche nel lemure bruno dal collare, *Eulemur fulvus collaris* (Lemuridae), nella foresta litorale di Ste Luce (Fort-Dauphin, Madagascar). Unpubl. PhD theses, Università di Pisa.
- Fenn, M.D. 2003. Learning conservation strategies: a case study of the Parc National d'Andohahela. Pp. 1494-1501. In: The Natural History of Madagascar. S.M. Goodman, J.P. Benstead (eds.). University Chicago Press, Chicago.
- Feistner, A.T.C.; Schmid, J. 1999. Lemurs of the Réserve Naturelle Intégrale d'Andohahela, Madagascar. Pp 269-283. In: A floral and faunal inventory of the Réserve Naturelle Intégrale d'Andohahela, Madagascar: with reference to elevational variation. S.M. Goodman (ed.). Fieldiana, Zoology (new series, n.94), Chicago.
- Hawkins, C.E. 2003. *Cryptoprocta ferox*, Fossa, Fosa. Pp.1360-1361. In: The Natural History of Madagascar S.M. Goodman, J.P. Benstead (eds.). University Chicago Press, Chicago.
- Johnson, S.; Overdorff, D.J. 1999. Census of brown lemurs (*Eulemur fulvus* spp.) in Southeastern Madagascar: Methods-testing and conservation implications. *Am. J. Primatol.* 47: 51-60.
- Norscia, I. 2006. Adaptation strategies of a nocturnal lemur (*Avahi laniger*) in a pluvial littoral forest of southeastern Madagascar: implications for conservation. Unpubl. PhD theses, Università di Pisa.
- Rakotodranary, S.J. 2004. Effets de la dégradation de la forêt sur la population d'*Avahi laniger* (Gmelin, 1788) dans la forêt littorale de Sainte-Luce (Sud-Est de Madagascar). Unpubl. DEA theses, Université d'Antananarivo.
- Rasoarimanana, J. 2005. Suivie de lémuriers diurnes dans le Parc National de Andohahela. *Lemur News* 10: 27-29.
- Ricklefs, R.E. 1990. *Ecology*, 3rd ed., Freeman, New York.

## Range extension of Perrier's Sifaka, *Propithecus perrieri*, in the Andrafiarana Classified Forest

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**Key words:** Andrafiarana, Analamerana, *Propithecus perrieri*, classified forest

An inventory of the lemur fauna in Andrafiarana Classified Forest located in northern Madagascar southwest of Analamerana Special Reserve was conducted in September 2005, confirming the presence of Perrier's Sifaka, *Propithecus perrieri*. Perrier's Sifaka is considered one of the most endangered lemurs of Madagascar and was considered to be restricted to fragments of forest in the protected area of Analamerana Special Reserve. We are reporting this sighting, along with morphometric data on this species and two other lemur species found within Andrafiarana Classified Forest. Due to the highly endangered nature of the lemur fauna found within this unprotected forest, we are proposing that protective status be extended immediately for Andrafiarana Classified Forest.

Madagascar is regarded as one of the most unique biodiversity rich regions in the world (Mittermeier *et al.*, 2004). Being the fourth largest island in the world and isolated by 400 km from Africa by the Mozambique Channel to the west and the Indian Ocean to the east, Madagascar is prioritized as a global biodiversity "hot-spot" (Myers *et al.*, 2000). Madagascar's diverse habitats include an expansive radiation of endemic fauna and flora including the lemurs. By having unprotected areas achieve national park status, the wildlife agencies and conservation organizations in Madagascar can enhance conservation efforts to preserve the rare and endemic species on the island. In Madagascar, habitat disturbance is not only restricted to the anthropogenic pressures, but also to stochastic or natural disturbances such as cyclones which can complicate management decisions (Richard and O'Connor, 1997; Wright, 1997). Hundreds of species, lemurs included, are under the threat of extinction due to the loss and fragmentation of natural habitat, a consequence of deforestation. Even though over 80 % of the original forest cover of Madagascar has been lost during the last centuries, large fragments of the forest still need to be inventoried. During an expedition in late 2005 to Andrafiarana Classified Forest, the presence of Perrier's Sifaka (*Propithecus perrieri* Lavauden, 1931) in this unprotected forest was confirmed.

Punctuating Conservation International's ranking of global biodiversity hotspots (Mittermeier *et al.*, 2004), Perrier's Sifaka, recently elevated to species level (Mayor *et al.*, 2004), is one of the most critically endangered of Madagascar's lemurs. Perrier's Sifaka, also known as the black sifaka, Perrier's simpona, and ankomba joby, has been listed since 2002 and ranks third on The World's 25 Most Endangered Primates 2004-2006 list compiled jointly by the IUCN/SSC (World Conservation Union/ Species Survival Commission) Primate Specialist Group, International Primatological Society and Conservation International (Razakamana, 2003; Mittermeier *et al.*, 2004). The species succumbed to hunting pressure and habitat loss in Ankarana in the mid 1990's leaving the Analamerana Special Reserve as the only forest fragments known to harbor the last subpopulations (Fig. 1). Perrier's Sifaka have been documented at the Analabe, Antobiratsy, Ankavanana, and Ampasimaty sites within the Analamerana Special Reserve. A recent survey in the unprotected Andrafiarana classified forest fragment located a significant population in September 2005, extending the range to the south by approximately 20 km (Fig. 2; Fig. 3). The last reported sighting of this species in the eastern part of the Ankarana was by David Meyer's ex-

pedition in 1996, but this species had been considered absent from this area since this expedition (Meyers, 1996).

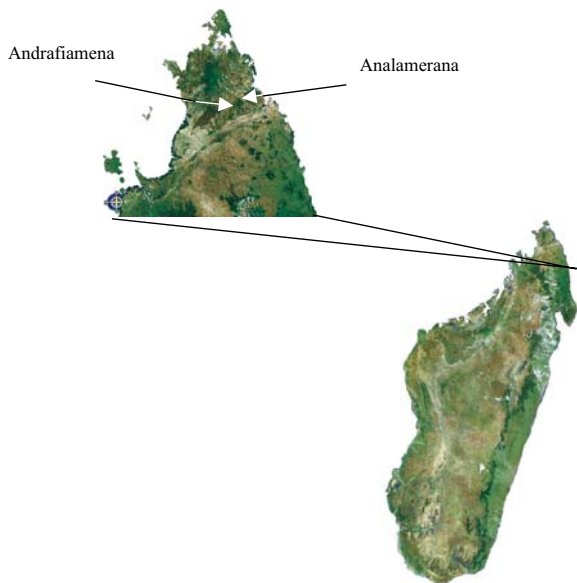


Fig. 1: Location of Analamerana Special Reserve and the Andrafiamera forest fragment.

**Study Site**

Research was conducted in the Andrafiamera classified forest located at 12°55'S / 49°19'E, at an elevation approximately 80 m above sea level, within the Province d'Antsiranana, Diego II district, CR Anivorano-Nord, Fokontany d'Andrafiabe, adjacent to the Anjakely village which is situated 19 km southeast of Marotaolana. Andrafiamera is comprised of two primary fragments: the first fragment is to the northeast and is tenuously connected to the Analamerana Reserve by a chain of isolated fragments, and the second fragment is to the southwest and is also outside of the Analamerana Reserve and Andrafiamera Classified Forest. All immobilizations and sample collections were done within the classified forest fragment.

Field expeditions have been conducted in Analamerana Special Reserve between 2000 and 2005 at the following forest fragments: Ankavanana, Antobiratsy, Analabe, and Ampasimaty. Analamerana is the northern extreme range of Perrier's Sifaka in Madagascar (Fig. 2).

**Materials and Methods**

*Immobilization and Data Collection*

The lemurs were immobilized with Telazol® (Fort Dodge Animal Health, Fort Dodge, Iowa) injections (10mg of Telazol®/kg body weight) administered with PNEU (0.5 cc P type 3/8 inch) darts propelled by DAN-INJECT®

**ANALAMERANA SPECIAL RESERVE**

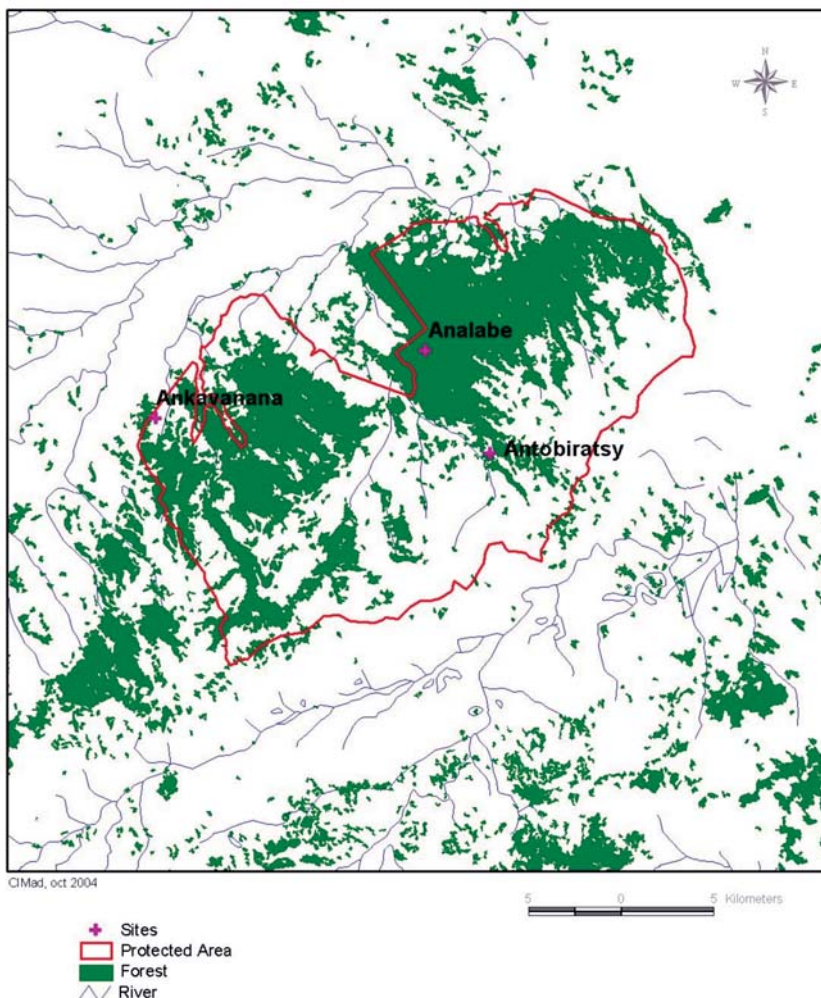


Fig. 2: Sample locations in and around the Analamerana Special Reserve including the Andrafiamera forest location.



Fig. 3: *Propithecus perrieri* from Andrafiarana (September, 2005).

CO<sub>2</sub> powered rifles. Global Positioning System (GPS) coordinates were taken to identify accurately the location that each lemur was captured. Blood and tissue samples were secured for genetic analysis. Each lemur was photographed, weighed (kg) using Pesola® scale, body and limb measurements (cm) and testes and canine measurements (mm) were recorded. A microchip was placed subcutaneously between the scapulas as a method of permanently identifying each individual, which will assist any re-capture or longevity studies. Each lemur was safely released upon complete recovery where it was initially immobilized and in contact with the family group.

#### Measurements

Standardized measurements were taken from all immobilized individuals (Table 1). The measurements are defined following the guidelines of Smith and Jungers (1997) as follows:

Head crown (HC): total length from the tip of the nose (not the soft tissue) to the basioccipital.

Body length (Body): total length of the body from basioccipital to the base of the tail.

Tail length (Tail): total length from the base of the tail to the end of the last caudal vertebra.

#### Fore limb:

Longest digit (FLD): total length of the D4 phalanges.  
Thumb (FTB): distal tip to proximal point of the last bone of the thumb.

Hand (FHD): phalanges and metacarpals to the carpal joint.

Radius/Ulna (FUR): carpal joint to the olecranon tip of the ulna.

Humerus (FH): greater tubercle to the end of the lateral condyle of humerus.

#### Hind limb:

Longest digit (HLD): total length of the D4 phalanges.  
Thumb (HTB): Distal tip to proximal point of the last bone of the thumb.

Foot (H-FT): Phalange metatarsal to the tarsal joint.  
Tibia (HTIB): Calcaneal tuberosity to the proximal tibial tuberosity.

Femur (H-F): Greater trochanter to the distal point of the lateral condyle of femur.

#### Others measurements:

Right testicle: (TRW): width; (TRL): length.

Left testicle: (TLW): width; (TLL): length.

Length of canine tooth: (C-U): upper gum line to tip; (C-L): lower gum line to tip.

#### Results

Data were collected on 3 lemur species (Ankarana sportive Lemur, *Lepilemur ankaranensis*; Aye-aye, *Daubentonia madagascariensis*; and Perrier's Sifaka, *Propithecus perrieri*) on this expedition into the Andrafiarana forest (Tables 1-4). A fourth species, Sanford's Brown Lemur, *Eulemur sanfordi*, was sampled (one individual; data not included), and a fifth species (Crowned Lemur, *Eulemur coronatus*) was observed, but was not immobilized. These data provide the initial values for establishing the baselines for species in this forest. From September 6<sup>th</sup> to 15<sup>th</sup>, 2005, 14 individuals of Perrier's Sifaka that have not been previously reported. They were observed in 4 family groups (2-5 individuals per group) from which 3 individuals were immobilized for study. All were found in the eastern part of the Andrafiarana forest fragment.

#### Discussion

President Marc Ravalomanana's announcement at the 5<sup>th</sup> World Park Congress in Durban, South Africa to triple the amount of protected areas should enhance Madagascar's ability to preserve biodiversity long-term. The Government of Madagascar has pledged that it will increase the areas under protection from 1.7 million hectares to 6 millions hectares over the next 5 years. Subsequently, the World Bank released money to expand protected areas, establish conservation sites in forests, and transfer forest management responsibilities to local communities. Currently, logging enterprises in the Andrafiarana forest are rapidly diminishing the size of suitable habitat for this rare species.

When the park boundaries for the Analamerana Special Reserve were initially defined, the established village territories were unavoidably close to the park or within forest limits. Buffer zones were designated within the park, where local people would still have the right to collect forest product for subsistence. In this case, the village of Anjakely is located quite close to the Andrafiarana forest. The Sakalava ethnic group historically settled in this area and was predominantly farmers and migrant people that utilized this ecosystem. Aside from the village residents, there are now many emigrants from neighboring provinces that also utilize the forest for generating their livelihood. The Andrafiarana forest is rich in natural resources, but is being destroyed by slash and burn agriculture, logging, and mining enterprises (sapphire). Thus, a principal strategy to protect the Andrafiarana forest is to develop economic incentives for the local people. Additionally, education programs, along with the creation of local infrastructure, should be established that would allow slash and burn

Table 1: Morphometric data of different lemur species sampled in the Andrafiarana Classified Forest.

Species	Sex	Wt (Kg)	HC	Body	Tail	F-TB	F-LD	F-HD	F-UR	F-H	H-TB	H-LD	H-FT	H-TIB	H-F
<i>Lepilemur ankaranensis</i>	F	1.0	6.4	24.8	31.9	2.4	3.0	5.4	7.1	5.1	4.7	3.2	8.1	9.4	10.8
	M	0.8	6.0	19.2	27.9	2.3	3.8	5.0	6.9	5.2	4.2	2.9	7.8	7.8	9.9
	F	0.8	6.2	21.5	26.6	2.4	2.5	5.1	6.3	4.8	4.2	2.8	7.0	7.0	9.2
	F	0.8	6.2	23.3	28.5	2.5	3.8	5.4	6.5	5.1	4.3	2.9	8.0	8.1	9.8
	F	0.9	6.0	21.9	27.8	2.4	3.1	5.3	7.0	5.3	4.4	3.0	7.4	7.6	8.7
	M	0.6	5.8	19.2	25.9	2.5	3.7	5.6	5.9	5.0	5.0	3.5	7.0	7.0	8.3
	F	0.6	5.6	20.2	25.8	2.4	2.8	4.8	5.6	4.2	4.4	3.0	7.1	7.2	8.3
	F	1.1	6.2	22.5	27.6	2.6	3.7	5.6	6.6	5.2	4.6	3.2	7.4	7.6	9.4
	F	0.8	6.3	22.4	30.6	2.6	3.5	5.4	6.4	5.4	4.6	3.3	7.6	7.8	9.2
	M	0.8	6.3	21.6	29.0	2.5	3.5	5.9	7.3	5.3	4.9	3.4	7.8	7.8	9.4
Mean		0.8	6.1	21.7	28.2	2.5	3.3	5.4	6.6	5.1	4.5	3.1	7.5	7.7	9.3
SD		0.2	0.3	1.8	2.0	0.1	0.5	0.3	0.5	0.4	0.3	0.2	0.4	0.7	0.8
Mean (females)		0.9	6.1	22.4	28.4	2.5	3.2	5.3	6.5	5.0	4.5	3.1	7.5	7.8	9.3
SD (females)		0.2	0.3	1.4	2.2	0.1	0.5	0.3	0.5	0.4	0.2	0.2	0.4	0.8	0.8
Mean (males)		0.7	6.0	20.0	27.6	2.4	3.7	5.5	6.7	5.2	4.7	3.3	7.5	7.5	9.2
SD (males)		0.1	0.3	1.4	1.6	0.1	0.2	0.5	0.7	0.2	0.4	0.3	0.5	0.5	0.8
<i>Daubentonia madagascariensis</i>	F	2.8	11.6	34.8	50.4	5.3	9.3	13.9	12.1	8.5	6.1	6.0	12.9	12.9	14.3
	F	1.8	8.8	25.2	48.1	5.0	7.9	12.0	10.5	8.7	6.6	5.8	12.5	12.4	13.8
Mean		2.3	10.2	30.0	49.3	5.2	8.6	13.0	11.3	8.6	6.4	5.9	12.7	12.7	14.1
SD		0.7	2.0	6.8	1.6	0.2	1.0	1.3	1.1	0.1	0.4	0.1	0.3	0.4	0.4
<i>Propithecus perrieri</i>	F	4.0	9.9	43.0	44.5	6.7	7.1	11.6	14.6	11.9	8.9	7.0	16.1	16.2	16.2
	M	4.8	9.9	44.8	45.2	6.1	7.2	12.2	14.7	12.5	10.3	8.8	16.6	16.8	20.6
	M	3.8	9.4	38.9	46.2	6.1	7.1	11.9	14.1	12.0	8.9	7.2	15.8	15.9	19.9
Mean		4.2	9.7	42.2	45.3	6.3	7.1	11.9	14.5	12.1	9.4	7.7	16.2	16.3	18.9
SD		0.5	0.3	3.0	0.9	0.4	0.1	0.3	0.3	0.3	0.8	1.0	0.4	0.5	2.4
Mean (males)		4.3	9.7	41.9	45.7	6.1	7.2	12.1	14.4	12.3	9.6	8.0	16.2	16.4	20.3
SD (males)		0.7	0.4	4.2	0.7	0.0	0.1	0.2	0.4	0.4	1.0	1.1	0.6	0.6	0.5

Table 2: Morphometric data of the Perrier's Sifaka from Antobiratsy (Analamerana).

Species	Sex	Wt (Kg)	HC	Body	Tail	F-TB	F-LD	F-HD	F-UR	F-H	H-TB	H-LD	H-FT	H-TIB	H-F
<i>Propithecus perrieri</i>	F	3.0	9.6	37.8	41.2	3.2	5.6	11.4	12.9	10.1	4.2	3.7	15.0	15.2	17.6
	F	4.6	9.9	38.0	43.3	3.2	6.3	11.6	14.2	11.7	4.8	6.6	15.7	15.9	17.7
	F	4.9	9.9	43.4	42.6	3.2	6.2	11.8	14.6	12.3	4.4	6.3	16.2	17.4	20.2
	F	4.3	10.0	41.1	43.5	5.3	6.1	12.2	15.3	10.7	8.5	5.6	17.3	17.1	21.2
	F	4.6	12.3	41.5	42.5	5.2	11.1	none	15.1	13.6	9.2	16.3	none	19.5	20.0
	M	4.7	10.9	45.5	42.3	5.9	12.7	none	14.8	10.2	10.4	16.0	none	18.7	20.1
	F	4.6	none	none	none	none	none	none	none	none	none	none	none	none	none
	F	4.6	11.2	34.7	35.0	5.8	9.9	none	12.7	11.3	7.8	13.8	none	16.2	18.6
	M	6.0	12.8	39.0	46.5	6.7	12.8	none	16.1	14.0	9.5	17.2	none	20.5	20.4
	F	5.1	10.7	42.6	41.5	5.9	11.7	none	15.7	11.0	10.9	16.6	none	19.9	21.1
	M	4.5	10.9	48.0	39.8	4.5	11.2	none	13.2	10.4	9.8	15.2	none	16.2	18.5
	Mean		4.6	10.8	41.2	41.8	4.9	9.4	11.8	14.5	11.5	8.0	11.7	16.1	17.7
SD		0.7	1.1	4.0	3.0	1.3	3.0	0.3	1.2	1.4	2.6	5.4	1.0	1.9	1.3
Mean (males)		5.1	11.5	44.2	42.9	5.7	12.2	??	14.7	11.5	9.9	16.1	??	18.5	19.7
SD (males)		0.8	1.1	4.6	3.4	1.1	0.9	??	1.5	2.1	0.5	1.0	??	2.2	1.0
Mean (females)		4.5	10.5	39.9	41.4	4.5	8.1	11.8	14.4	11.5	7.1	9.8	16.1	17.3	19.5
SD (females)		0.6	1.0	3.1	2.9	1.3	2.7	0.3	1.2	1.2	2.7	5.5	1.0	1.8	1.5

Table 3: Morphometric data of Perrier's Sifaka from Ankavanana (Analamerana).

Species	Sex	Wt (Kg)	HC	Body	Tail	F-TB	F-LD	F-HD	F-UR	F-H	H-TB	H-LD	H-FT	H-TIB	H-F
<i>Propithecus perrieri</i>	M	4.3	9.9	41.3	44.4	4.4	5.3	14.5	16.1	13.2	5.9	3.8	20.2	19.1	20.2
	M	4.6	11.6	43.2	44.1	3.6	5.1	12.1	16.9	13.9	6.2	4.4	20.6	18.6	20.6
	F	4.6	11.2	43.8	47.2	4.1	5.7	12.8	15.4	13.4	7.9	5.4	17.1	7.7	21.5
	F	5.0	11.4	44.1	41.4	4.6	5.3	14.1	14.3	12.9	6.1	5.4	16.0	17.8	19.3
	M	4.6	9.8	44.9	41.8	3.4	4.7	12.1	13.8	12.3	5.6	3.7	16.3	17.0	19.5
	M	5.1	10.9	41.8	47.6	3.3	5.4	12.6	14.1	11.2	5.3	3.9	17.3	17.6	20.9
	F	4.4	9.9	46.1	48.8	5.3	6.1	13.0	14.8	12.3	8.9	6.3	17.8	17.6	21.5
	F	4.0	9.6	42.9	44.5	5.6	6.9	10.2	14.1	10.8	9.3	6.2	16.5	16.6	20.9
Mean		4.6	10.5	43.5	45.0	4.3	5.6	12.7	14.9	12.5	6.9	4.9	17.7	16.5	20.6
SD		0.4	0.8	1.6	2.7	0.9	0.7	1.3	1.1	1.1	1.6	1.1	1.8	3.6	0.8
Mean (males)		4.7	10.6	42.8	44.5	3.7	5.1	12.8	15.2	12.7	5.8	4.0	18.6	18.1	20.3
SD (males)		0.3	0.9	1.6	2.4	0.5	0.3	1.1	1.5	1.2	0.4	0.3	2.1	0.9	0.6
Mean (females)		4.5	10.5	44.2	45.5	4.9	6.0	12.5	14.7	12.4	8.1	5.8	16.9	14.9	20.8
SD (females)		0.4	0.9	1.3	3.2	0.7	0.7	1.7	0.6	1.1	1.4	0.5	0.8	4.8	1.0

Table 4: Morphometric data of Perrier's Sifaka from Analabe (Analamerana) and for all individuals combined.

Species	Sex	Wt (Kg)	HC	Body	Tail	F-TB	F-LD	F-HD	F-UR	F-H	H-TB	H-LD	H-FT	H-TIB	H-F
<i>Propithecus perrieri</i>	F	4.0	9.4	44.0	42.4	5.5	5.5	11.5	16.0	13.2	8.3	5.0	16.0	19.1	21.0
	F	4.9	9.8	44.2	43.1	5.0	4.5	11.0	14.4	13.6	9.0	5.0	16.8	20.8	20.6
	M	4.6	7.7	46.1	41.5	4.5	4.5	11.7	13.3	10.2	8.6	5.0	15.8	19.3	16.7
	F	4.7	14.1	43.0	43.1	5.4	5.3	5.6	15.2	13.8	9.0	5.9	11.5	21.3	22.0
	M	4.2	14.3	40.4	44.6	6.0	6.1	6.8	16.2	14.5	7.3	5.9	11.2	21.8	21.0
Mean		4.5	11.1	43.5	42.9	5.3	5.2	9.3	15.0	13.1	8.4	5.4	14.3	20.5	20.3
SD		0.4	3.0	2.1	1.1	0.6	0.7	2.9	1.2	1.7	0.7	0.5	2.7	1.2	2.1
Mean (males)		4.4	11.0	43.3	43.1	5.3	5.3	9.3	14.8	12.4	8.0	5.5	13.5	20.6	18.9
SD (males)		0.3	4.7	4.0	2.2	1.1	1.1	3.5	2.1	3.0	0.9	0.6	3.3	1.8	3.0
Mean (females)		4.5	11.1	43.7	42.9	5.3	5.1	9.4	15.2	13.5	8.8	5.3	14.8	20.4	21.2
SD (females)		0.5	2.6	0.6	0.4	0.3	0.5	3.3	0.8	0.3	0.4	0.5	2.9	1.2	0.7
<b>All <i>P. perrieri</i> data</b>															
Mean		4.6	10.8	42.5	43.2	4.8	7.1	11.5	14.7	12.2	7.7	8.0	16.3	17.9	20.0
SD		0.5	1.5	3.1	2.9	1.1	2.8	2.3	1.1	1.4	2.0	4.9	2.4	2.9	1.4
Mean (males)		4.7	11.0	43.4	43.6	4.7	7.5	11.6	14.9	12.2	7.6	8.3	16.9	18.8	19.8
SD (males)		0.5	1.9	3.0	2.5	1.2	3.6	2.6	1.4	1.8	2.0	5.9	3.4	1.7	1.4
Mean (females)		4.5	10.6	41.9	42.9	4.8	6.9	11.4	14.6	12.2	7.7	7.7	16.0	17.3	20.2
SD (females)		0.5	1.3	3.1	3.1	1.0	2.3	2.2	1.0	1.3	2.1	4.4	1.7	3.3	1.4

and bush fire-grazing practices to be abandoned, in favor of more environmentally effective agricultural products that can be utilized in the disturbed areas.

The discovery of the Perrier's Sifaka in the Andrafiarana forest outside of the protected area is very important to the future of Madagascar's conservation of this species. The Andrafiarana Perrier's sifaka population represents a significant addition to the overall population totals. The population levels of Perrier's Sifaka at Andrafiarana also provides the necessary evidence that the Andrafiarana forest will be vital to the survival of this rare species and should be added to the list of protected sites to limit the current threats of deforestation. We strongly recommend that the Andrafiarana forest become a protected site to preserve this critical habitat from further reduction and to protect this critically endangered species from rapid extinction.

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#### References

Mayor, M., Sommer, J.A.; Houck, M.L.; Zaonarivelo, J.R.; Wright, P.C.; Ingram, C.; Engel, S.R.; Louis, E.E.J. 2004. Species status of *Propithecus* spp. Int. J. Primatol. 25:875-900.

Meyers, D.M. 1996. Update on the Endangered Sifaka of the North. Lemur News. 2: 13-14.

Mittermeier, R.A.; Langrand, O.; Lowry II, P.P.; Schatz, G.; Gerlasch, J.; Goodman, S.M.; Steininger, M.; Hawkins, F.; Raminosoa, N.; Ramilijaona, O.; A. L. Andriamaro, O.; Randrianasolo, H.; Rabarison, H.; Rakotobe Z.L. 2004. Madagascar and the Indian Ocean Islands. In Hotspots Revisited. Conservation International, New York. Pp. 138-144.

Mittermeier, R.A.; Konstant, W.R.; Hawkins, F.; Louis, E.E.; Lagrand, O.; Ratsimbazafy, J.; Rasoloarison, R.; Ganzhorn, J.U.; Rajaobelina, S.; Tattersall I.; Meyers, D.M. 2006. *Lemurs of Madagascar*, 2nd Ed. Conservation International, Washington, D.C. Pp. 388-390.

Razakamanana, L.H. 2003. Contribution à l'Etude du rythme d'activités et du régime alimentaire de trois groupes de *Propithecus diadema edwardsi* dans la forêt de Talatakely, du Parc de Ranomafana-Fianarantsoa. Memoire de CAPEN (Certificat d'Aptitude Pédagogique de l'Ecole Normale), Filière Sciences Naturelles, Ecole Normale Supérieure, Université d'Antananarivo.

Richard, A.F.; O'Connor, S. 1997. Degradation, transformation, and conservation, the past, present, and possible future of Madagascar's environment. In Natural Change and Human Impact in Madagascar. Steven M. Goodman and Bruce D. Patterson (eds.). Washington, D.C., Smithsonian Institution Press. Pp. 406-418.

Smith, R.J.; Jungers, W.L. 1997. Body mass in comparative primatology. J. Hum. Evol. 32: 523-559.

Wright, P.C. 1997. The Future of Biodiversity in Madagascar, a view from Ranomafana national park. In Natural Change and Human Impact in Madagascar. S. M. Goodman; B. D. Patterson (eds.). Washington, D.C., Smithsonian Institution Press. Pp. 381-405.

## A preliminary study on resident lemur populations in the Mariarano Classified Forest

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Madagascar is considered globally as a critically important biological hotspot (Mittermeier *et al.*, 2004) and is classified at the highest priority for primate conservation due to its high endemism and extreme diversity. The biodiversity is threatened by factors such as natural cataclysm, anthropogenic pressures (agricultural expansion, logging, mining, and forest sacrifice for fuel wood) which decrease the already diminished forest area. Continued deforestation of Madagascar poses an increasing threat to the diversity of the species therein and increases the urgency of developing comprehensive management plan for the remaining forest blocks (Sterling *et al.*, 1998). The lemurs of Madagascar are classified among the most threatened species in the world. The extent of the biodiversity harbored by most of the forest fragments is still unknown which presents challenging research opportunities in the areas of inventory and census of these forests in the immediate future.

In the western regions of the island the bushfire, or slash and burn practice, is used to increase available forage for cattle grazing or to reduce canopy coverage for cropping at the expense of the fragile deciduous forest which is the strict natural habitat of lemurs. Lemurs are particularly susceptible to extinction by such deforestation. Among the protected forest fragments and the subject of this study is the Mariarano classified forest in the Bora Special Reserve of the Ankarafantsika National Park. This historical agricultural practice is ingrained in the local culture and economy and therefore is a most difficult practice to change to protect the forest. In this case, the forest is managed by the local community or villagers association Vondron'Olona Ifotony (VOI). The advantage of local management is that the village leaders become aware of the plight of the conservation efforts, have a direct point of input into the preservation of the biomass, and can then act in a liaison capacity between citizens and the governmental (ANGAP and Eaux et Forêt) as well as the non-governmental organizations active in the Malagasy conservation efforts. The lemurs of the Mariarano forest are protected by "fady" (killing or eating of lemurs is culturally despised) by the local villagers; however, some migrant people venturing from neighboring villages do violate this custom and the poaching of the lemurs for food has been considered to be a threat to the populations. Before 2001, the forest was cut down and burned by the villagers for "tavy" (non-sustainable short-term seasonal cropping) so while the locals did not eat the lemurs, they did engage in agricultural practices responsible for a proportion of the decline of the habitat and thus negatively impacted the lemur populations. Since then, the local management has proven to be a successful method of implementing changes in some of the local practices as the village leaders become increasingly aware of the economical benefits enhanced by increased ecotourism which in less remote areas has boosted the local economy through the increased numbers of non-residents who visit the areas in hopes of viewing or studying the various aspects of biological diversity.

With increased local awareness in the Mariarano area, the stability of the forest should be maintained and the lemur populations better protected from habitat loss and meat-protein source hunting activities. The forest is near to Mahajanga town which provides reasonable access to the forest. We took advantage of this and the reputation that the forest is rich in lemur species with reasonable density to implement an initial sampling expedition for the development baseline data for our group and future researchers.

### Study Site

Our study was done the week of November 2 - November 7, 2004 in the Mariarano classified forest (S 15°28'50.0", E 046°41'31.5"). The forest is situated at the Sous-Préfecture Mahajanga II, Commune Rurale Mariarano, Fokontany Mariarano. This 1580 ha forest tract is a semi-deciduous forest (typical of western region) with some gallery forest. It is located 80km northeast of Mahajanga (Fig. 1). The forest is limited to the east by savannah, to the north by the Mariarano River, to the west by the Mozambique Channel and to the south by rice fields separating the forest from the Tanambao village. We worked at the west side of this forest.

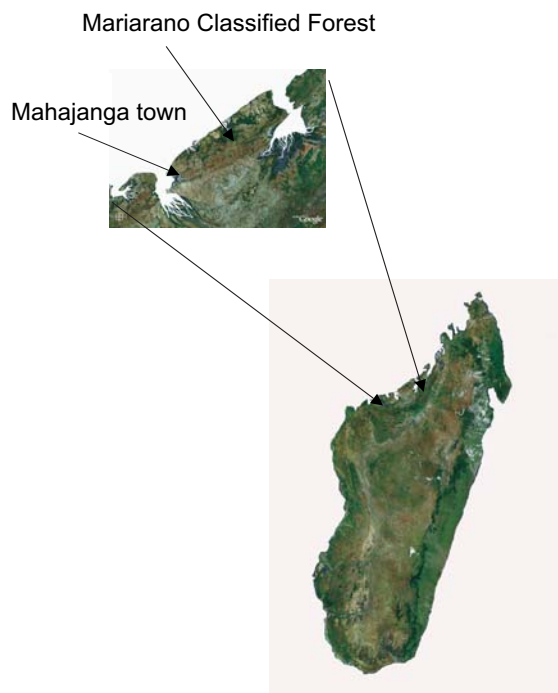


Fig. 1: Location of the Mariarano Classified Forest on the island of Madagascar.

### Methods

#### *Immobilization and collection*

The lemurs were tranquilized with Telazol® (Fort Dodge Animal Health, Fort Dodge, Iowa) injections (10 mg of Telazol®/kg body weight) administered from darts propelled by either DAN-INJECT® CO<sub>2</sub> powered rifles or blow-pipe. The exception to this capture method was the *Microcebus*, where the individuals were captured either by hand or in Sherman® live traps. Global Positioning



System (GPS) coordinates were taken to identify accurately the location that each lemur was captured. Each lemur was weighed (kg) using Pesola® scale, body and digit measurements (cm) were read from a tape ruler, testes and canine measurements were taken with caliper (mm) for precision data collection. Each individual was tagged by microchip subcutaneously between scapulas for permanent identification which can be useful if our team returns to the area or if other researchers might work in the forest and can benefit from our data collection and analyses. Each lemur was released at the same place that it was found based on GPS coordinates when completely conscious and in the portion of the day when that species is active (diurnal or nocturnal).

**Measurements**

Standardized measurements were taken of all collected individuals and averaged within species (Table 1). The measurements are defined as follows:

Head crown (HC): total length from the tip of the nose (not the soft tissue) to the basioccipital.

Body length (Body): total length of the body from basioccipital to the base of the tail.

Tail length (Tail): total length from the base of the tail to the end of the last caudal vertebra.

Fore limb:

Longest digit (FLD): total length of the D4 phalanges.

Thumb (FTB): distal tip to proximal point of the last bone of the thumb.

Hand (FHD): phalanges and metacarpals to the carpal joint.

Radius/Ulna (FUR): carpal joint to the oleocranon tip of the ulna.

Humerus (FH): greater tubercle to the end of the lateral condyle of humerus.

Hind limb:

Longest digit (HLD): total length of the D4 phalanges.

Thumb (HTB): Distal tip to proximal point of the last bone of the thumb.

Foot (H-FT): Phalange metatarsal to the tarsal joint.

Tibia (HTIB): Calcaneal tuber to the proximal tibial tuberosity.

Femur (H-F): Greater trochanter to the distal point of the lateral condyle of femur.

Right testicle (TRW): width; (T-RL): length.

Left testicle (TLW): width; (TLL): length.

Length of canine tooth (C-U): upper gum line to tip; (C-L): lower gum line to tip.

**Results**

Seven lemur species have been observed in the Maria-rano classified forest; however, only 6 of the species were collected in this study (Table 1). The seventh species, *Eulemur mongoz* (Dredrika) is found only in the eastern area of the forest, outside our sampling range. Representatives of two of the species, *Microcebus ravelobensis* and *Cheirogaleus medius* were collected but not in a sufficient number to be useful in developing reliable baseline values. These data are available from the corresponding author upon request.

The number of the animals per group of *Propithecus coquereli* varied from 2 to 7 animals. *Eulemur fulvus* was observed in larger family groups, ranging between 8 to 15 animals per group.

Table 1: Average of measurements and weight of *Eulemur fulvus*, *Avahi occidentalis*, *Lepilemur edwardsi*, *Propithecus coquereli* immobilized at Mariarano classified forest. Vernacular names are listed in brackets. Data was collected on the three *Microcebus ravelobensis* (Vokimbahy) and the one *Cheirogaleus medius* (Vokimbahibe; data available from the author upon request) but not reported for baseline data given the small sample size. Abbreviations are explained in the "Methods" section.

Species	Wt	HC	Body	Tail	FTB	FLD	FHD	FUR	FH	HTB	HLD	H-Ft	HTIB	H-F	TRL	TRW	TLL	TLW	C-U	C-L
<i>Eulemur fulvus</i> (Varika) n = 10	1.5 ±0.3	9.8 ±1.0	31.2 ±1.0	52.5 ±0.2	2.7 ±0.3	2.8 ±0.3	6.8 ±0.5	10.1 ±0.7	8.4 ±0.6	3.8 ±0.3	2.9 ±0.5	10.0 ±0.7	11.4 ±0.4	13.2 ±0.2					8.3 ±0.8	5.0 ±0.8
<i>Eulemur fulvus</i> females n = 7	1.5 ±0.2	9.7 ±0.2	31.0 ±0.8	52.7 ±1.6	2.6 ±0.3	2.7 ±0.3	6.8 ±0.3	10.2 ±0.5	8.5 ±0.7	3.7 ±0.6	2.9 ±0.3	9.9 ±0.4	11.5 ±0.3	13.1 ±0.2					7.5 ±1.0	5.0 ±0.9
<i>Eulemur fulvus</i> males n = 3	1.6 ±0.1	10.0 ±0.3	31.6 ±1.1	51.9 ±2.3	2.8 ±0.2	2.8 ±0.2	6.9 ±0.2	9.9 ±0.3	8.3 ±0.6	4.1 ±0.7	2.8 ±0.2	10.1 ±0.6	11.1 ±0.7	12.8 ±0.4	18.4 ±3.5	11.9 ±0.6	18.1 ±3.6	9.5 ±0.5	10.0 ±0.7	5.1 ±0.6
<i>Avahi occidentalis</i> (Tsarafangitra) n = 8	0.9 ±0.1	6.4 ±0.4	22.4 ±1.1	34.2 ±2.5	2.0 ±0.2	2.7 ±0.2	6.3 ±0.3	8.2 ±1.2	6.1 ±0.5	3.6 ±0.7	2.4 ±0.4	8.3 ±0.3	10.2 ±0.7	12.2 ±0.1					3.4 ±0.2	2.9 ±0.2
<i>Avahi occidentalis</i> females n = 4	1.0 ±0.1	6.5 ±0.5	23.5 ±0.5	35.7 ±1.6	2.0 ±0.2	2.8 ±0.1	6.3 ±0.2	8.9 ±0.3	6.3 ±0.6	3.8 ±0.8	2.7 ±0.5	8.3 ±0.2	10.8 ±0.8	12.3 ±0.2					3.4 ±0.3	2.8 ±0.1
<i>Avahi occidentalis</i> males n = 4	0.9 ±0.1	6.2 ±0.3	21.3 ±0.1	32.7 ±2.8	2.1 ±0.3	2.6 ±0.3	6.2 ±0.4	7.5 ±0.2	5.9 ±0.5	3.5 ±0.7	2.2 ±0.2	8.2 ±0.3	9.7 ±0.5	12.2 ±0.1	13.0 ±2.3	10.1 ±2.5	12.3 ±2.6	9.3 ±1.4	3.5 ±0.2	2.9 ±0.4
<i>Lepilemur edwardsi</i> (Fitsidika) n = 10	1.1 ±0.1	6.6 ±0.2	28.8 ±0.9	28.8 ±1.0	1.9 ±0.3	2.4 ±0.2	5.7 ±0.3	7.1 ±0.5	5.8 ±0.4	2.8 ±0.1	2.3 ±0.2	7.9 ±0.3	8.7 ±0.5	9.6 ±0.5					7.7 ±0.8	3.9 ±0.6
<i>Lepilemur edwardsi</i> females n = 5	1.1 ±0.2	6.6 ±0.9	28.5 ±0.8	29.0 ±1.0	2.0 ±0.4	2.5 ±0.4	5.7 ±0.8	7.0 ±0.9	5.6 ±0.8	2.7 ±0.4	2.3 ±0.3	8.0 ±0.2	8.8 ±0.5	9.7 ±0.4					6.5 ±0.3	3.7 ±0.9
<i>Lepilemur edwardsi</i> males n = 5	1.1 ±0.1	6.6 ±0.3	29.1 ±0.8	28.6 ±0.9	1.9 ±0.3	2.4 ±0.3	5.6 ±0.3	7.1 ±0.7	6.1 ±0.2	2.8 ±0.1	2.3 ±0.2	7.9 ±0.3	8.6 ±0.6	9.4 ±0.5	11.2 ±1.8	6.2 ±0.3	11.0 ±1.3	5.5 ±0.6	8.4 ±0.8	4.2 ±0.4
<i>Propithecus coquereli</i> (Tsibahaka) n = 25	3.7 ±0.4	9.3 ±0.2	39.0 ±1.3	47.6 ±1.8	3.5 ±0.3	4.3 ±0.3	9.7 ±0.5	12.5 ±0.6	10.2 ±0.5	5.3 ±0.5	4.0 ±0.3	13.9 ±0.4	16.3 ±0.5	17.9 ±0.4					8.8 ±1.1	5.2 ±0.5
<i>Propithecus coquereli</i> females n = 9	3.7 ±0.5	9.7 ±0.7	37.4 ±3.4	49.1 ±5.1*	3.6 ±0.4	4.4 ±0.5	9.8 ±0.9	12.7 ±1.1	10.4 ±0.9	5.2 ±0.7	4.2 ±0.5	13.9 ±1.0	17.1 ±1.2	18.1 ±1.2					8.1 ±1.4	4.6 ±0.7
<i>Propithecus coquereli</i> males n = 16	3.7 ±0.6	9.1 ±1.2	39.3 ±4.6	46.2 ±6.1*	3.4 ±0.5	4.3 ±0.6	9.7 ±1.3	12.4 ±1.5	10.1 ±1.3	5.4 ±0.8	3.9 ±0.6	13.9 ±1.7	15.8 ±2.1	17.9 ±2.1	16.6 ±2.2	11.8 ±1.6	16.8 ±2.8	11.6 ±1.6	8.1 ±1.6	4.5 ±0.9

\*Diminished average values and inflated standard deviations are biased by the inclusion of *Propithecus coquereli* individuals measured and recorded with evidence of previously cut or damaged tails

## Discussion

Preservation of the pristine forests or as is becoming more and more appropriate, the pristine forest fragments, is essential to the conservation of the Malagasy biodiversity. Education of the local people and dialogue with the governmental conservation departments is proving to be successful in merging the interests of the scientific community and the people of Madagascar. The Mariano forest fragment is one of these that is being successfully managed by the Malagasy government and with the committed support of the local people. Requisite to the conservation is understanding both accurately and precisely the breadth and depth of the biodiversity that is harbored in these forests and forest fragments. Our study uses the lemur species as a barometer for comparison both across and within ecosystems. Additional studies are recommended for other taxa so that conservationists can pool knowledge to more thoroughly assess the uniqueness within and among these forest fragments.

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## References

- Mittermeier, R.A.; Langrand, O.; Lowry II, P.P.; Schatz, G.; Gerlasch, J.; Goodman, S.M.; Steininger, M.; Hawkins, F.; Raminosoa, N.; Ramiijaona, O.; Andriamaro, O.; Randrianasolo, H.; Rabarison, H.; Rakotobe Z.L. 2004. Madagascar and the Indian Ocean Islands. Pp. 138-144. In: Hotspots Revisited. Conservation International, New York.
- Sterling, E.J.; Rakotoariso, N. 1998. Rapid assessment of richness and density of primate species on the Masoala Peninsula, eastern Madagascar. *Folia Primatol.* 69 (suppl.1): 109-116.

## Les populations reliques de primates: les Propithèques

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Il aura fallu plus de 150 ans pour décrire les taxons modernes dans le genre *Propithecus* et les taxons du Nord auront été les derniers à avoir été découverts. Classiquement, et au moins jusqu'aux dernières découvertes du Nord, on distinguait un Propithèque de l'ouest et du sud, *Propithecus verreauxi* (Grandidier 1867) représenté par au moins 4 sous-espèces dont la dernière a été décrite en 1870 et un Propithèque de l'est, *Propithecus diadema* (Bennett 1832) avec 4 sous-espèces au moins dont la dernière a été décrite en 1931 du nord. En 1988, une troisième espèce du Nord-est a été décrite, *Propithecus tattersalli*, qui est affine avec le

propithèque occidental (Fig. 1). Plus récemment, certains auteurs ont élevé toutes les sous-espèces au rang d'espèces et proposent de considérer de nouveaux taxons à décrire dans le futur comme la forme affine de *P. diadema* rencontrée dans la forêt de Tsinjoarivo (Mittermeier *et al.*, 2006).

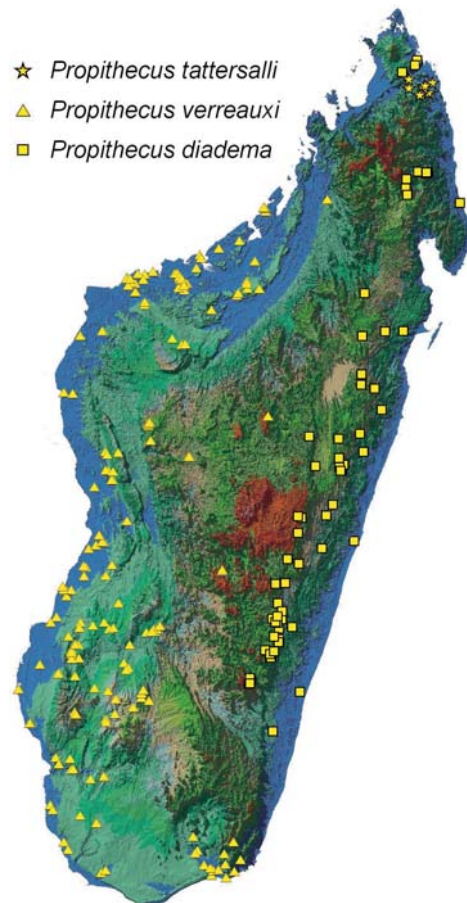


Fig. 1: Données de distribution des espèces actuelles du genre *Propithecus*.

## Sources de données

Les divers inventaires biologiques qui ont été réalisés au cours des dernières années ont livré de nombreuses informations pertinentes sur la distribution des taxons de propithèques. Les informations portant sur la distribution des lémuriens de Madagascar ont été intégrées dans une base de données Noe4D (Hertu et Elouard, 1985) en considérant les informations relatives aux données muséologiques issues de spécimens et des carnets de récolte ainsi que celles des données publiées, en veillant strictement à ne considérer que les informations à quatre dimensions, à savoir définies dans l'espace (longitude, latitude, altitude) et dans le temps (date ou période) afin d'éviter les erreurs inhérentes à la répétition des compilations. Des informations de quelques 2500 documents sont disponibles dans la base de données Noe4D pour documenter les lémuriens de Madagascar dans 709 stations entre février 1865 et août 2005 (Fig. 2; Wilmé *et al.*, 2006). Les informations relatives aux quatre dimensions ont été exportées pour les espèces et sous-espèces de *Propithecus* vers le SIG ArcView 3.2, soit un nombre total de 377 documents géoréférencés et vérifiés pour les seuls taxons du genre *Propithecus* (Tableau 1, Fig. 1).

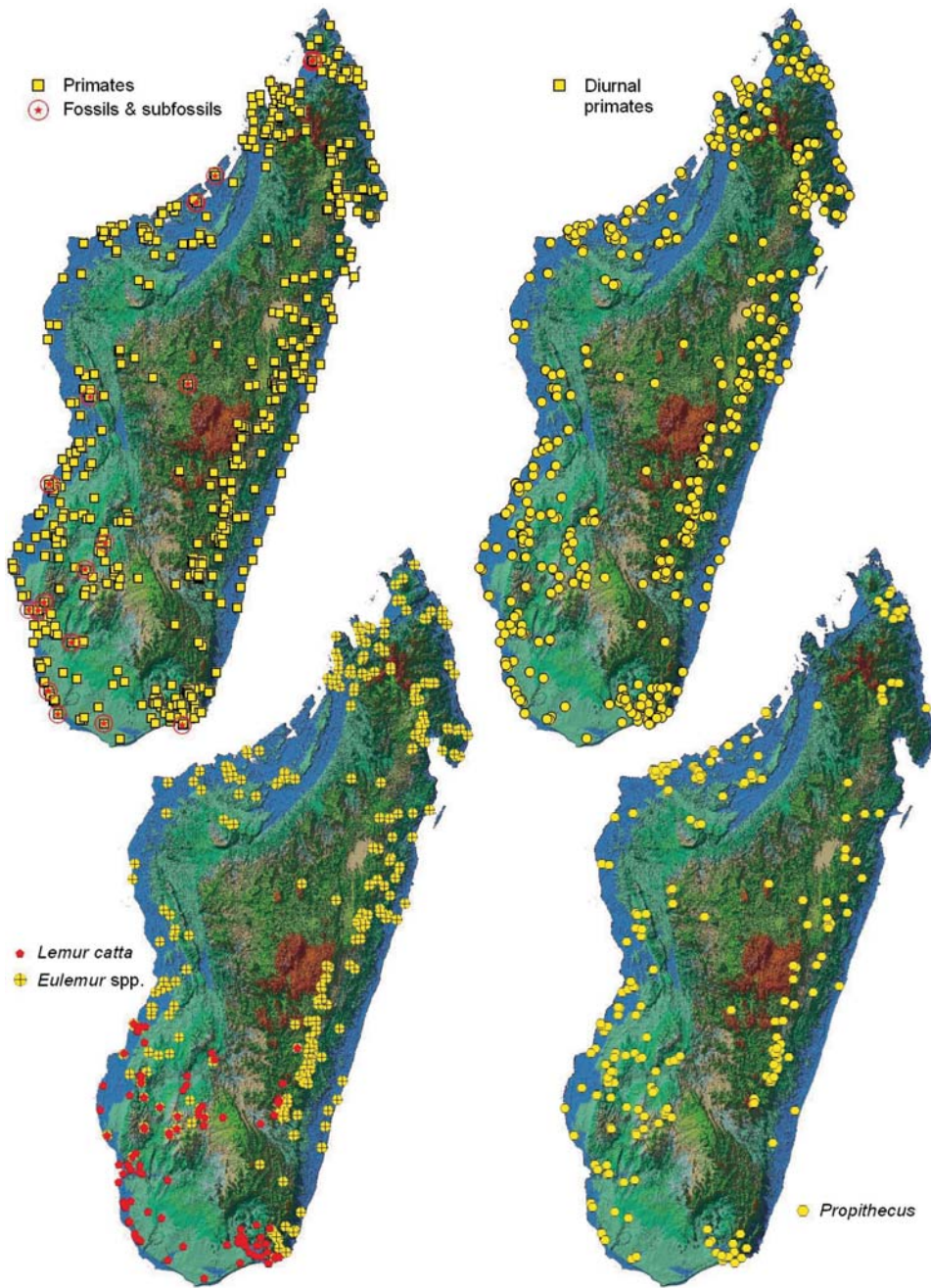


Fig. 2: Distribution des données géoréférencées et datées de la base de données Noe4D portant sur les lémuriens de Madagascar.

Tableau 1: Documents géoréférencés relatifs aux propithèques.

Taxons	Documents 4D			
	Total	Basés sur les spécimens	Basés sur la littérature	Nombre de stations
<i>Propithecus</i>	377	102	275	285
<i>Propithecus diadema</i>	93	28	65	78
<i>Propithecus d. diadema</i>	25	4	21	24
<i>Propithecus d. edwardsi</i>	43	14	29	34
<i>Propithecus d. perrieri</i>	7	3	4	6
<i>Propithecus d. candidus</i>	18	7	11	14
<i>Propithecus tattersalli</i>	9	2	7	8
<i>Propithecus verreauxi</i>	274	71	203	195
<i>Propithecus v. verreauxi</i>	161	41	120	109
<i>Propithecus v. deckeni</i>	63	14	49	52
<i>Propithecus v. coronatus</i>	18	3	15	16
<i>Propithecus v. coquereli</i>	28	10	18	320

Les lémuriens diurnes de Madagascar ont été considérés dans un concept de centres d'endémisme entre des bassins de retraite-dispersion en constituant quasiment un cas d'école. Les taxons illustrés incluaient les taxons diurnes de la famille des Lemuridae dont ceux du genre *Eulemur* (incluant les ssp. d'*E. fulvus*), *Lemur catta*, les taxons dans le genre *Varecia* ainsi que les taxons diurnes de la famille des Indridae dont ceux du genre *Propithecus* et les taxons décrits du versant occidental dans le genre *Microcebus*. Ici nous reprenons le concept des bassins versants en le détaillant au niveau des affluents et revoyons les particularités de la distribution des Propithèques, pour tenter d'appréhender des schémas de distribution qui restent obscures comme ceux des Propithèques du nord-ouest.

## Centres d'endémisme entre les bassins versants de retraite-dispersion

### *Rivières et forêts riveraines*

La prédilection pour les forêts riveraines est un phénomène qui est caricaturé chez *Lemur catta*, mais en ce qui concerne les mammifères et les oiseaux endémiques, au moins, on remarque que les taxons sylvoles sont tous représentés dans les forêts riveraines dans leur aire de distribution et qu'ils sont généralement présents en plus grande abondance dans ces habitats (Ganzhorn et Sorg, 1996). De grandes zones de l'île et notamment sur les hautes terres sont actuellement dénudées et des changements dans la végétation ont eu lieu au cours des temps géologiques mais aussi au cours des derniers siècles (Burney *et al.*, 2005). Au vu des distributions actuelles des oiseaux et des mammifères, de la pauvreté des informations portant sur les distributions anciennes, les fossiles, les subfossiles et les informations paléoclimatiques, il semble que les distributions des populations ainsi que les mouvements et les éventuelles extinctions locales ou historiques doivent être devinés.

### *Climat, orographie, hautes terres*

Les données paléoclimatiques de l'hémisphère Sud sont peu nombreuses, voire rares en comparaison de celles de l'hémisphère Nord, en même temps qu'il n'existe encore aucun consensus pour déterminer si les changements sont synchrones ou asynchrones entre les deux hémisphères ou encore si les effets étaient atténués ou non sur la zone pantropicale. Ce qui est sûr c'est que ces oscillations climatiques dues à l'alternance des périodes glaciaires et interglaciaires du Quaternaire ont eu un effet certain sur les distributions actuelles des taxons de la faune et de la flore en région tropicale qu'elles soient paléotropicales (Afrique, voir Linder, 2001; Australie, voir Crisp *et al.*, 2001) ou néotropicales (voir Pennington *et al.*, 2004). Nous disposons actuellement de peu de données pour comprendre les effets de ces périodes de manière précise sur l'ensemble de l'île. La partie Nord de Madagascar où la biogéographie est complexe et qui est loin d'avoir révélé tous ces secrets, pourrait être "une région-clé pour la connaissance du Quaternaire malgache" (Battistini, 1965).

Le plus haut sommet de Madagascar n'atteint que 2876 m d'altitude et les régions dont les altitudes dépassent 2000 m ne représentent guère que 0,24 % de la superficie de l'île. Les terres au-delà de 1000 m d'altitude représentent près d'un cinquième de la superficie de la grande île (18,35 %) et près de la moitié de l'île (47,69 %) se trouve à plus de 500 m d'altitude. Plus qu'un pic isolé, une chaîne de montagnes a une forte influence sur le climat et notamment sur les précipitations. Le climat de Madagascar est ainsi profondément influencé par la topographie, et plus particulièrement par les hautes terres avec des effets orographiques marqués par des chaînes de montagnes qui s'étendent du Nord au Sud de l'île.

### *Centres d'endémisme et bassins de retraite-dispersion*

En Afrique, la richesse spécifique des espèces a souvent été rapportée à des facteurs écologiques, comme la pluviométrie ou la géologie, et les centres d'endémisme aux fluctuations paléoclimatiques (Linder, 2001). À Madagascar, plusieurs alternatives ont été suggérées comme le récent concept des centres d'endémisme coincés entre les bassins versants de retraite-dispersion proposé par Wilmé *et al.* (2006). Ces auteurs recon-

naissent en effet de 12 à 14 centres d'endémisme entre 10 à 13 bassins de retraite-dispersion selon que les bassins de l'Antainambalana au nord-est et les bassins versants du Mandrare et de l'Onilahy soient considérés comme bassins de retraite-dispersion ou non. Dans cet exercice, les bassins versants de la Betsiboka et de la Maevarano ont également été adaptés. Le bassin versant de la Maevarano a été scindé en une partie septentrionale de retraite-dispersion et une partie méridionale incluse dans le centre d'endémisme localisé à l'est de la Mahajamba. Ce choix est justifié par le fait que les sources des affluents de la partie méridionale du bassin versant de la Maevarano sont sises à basse altitude et que la confluence est proche de l'embouchure. La classification de Chaperon *et al.* (1993) a ainsi été adoptée pour la Maevarano, ces auteurs n'ayant eux aussi retenu que le cours supérieur de ce fleuve dans les bassins des versants du Tsaratanana. Depuis un peu plus d'un siècle, la Mahajamba est partiellement devenu un affluent du Kamoro, de sorte que l'ensemble Betsiboka Mahajamba doit être considéré comme un seul bassin versant, ce qui en fait le plus grand de Madagascar devant celui du Mangoky (Battistini, 1959). Compte tenu de l'échelle de temps sur laquelle le concept des centres d'endémisme a été élaboré, le bassin de la Mahajamba est séparé de celui de la Betsiboka.

Les fleuves sont fortement déterminés par leurs bassins versants et sont structurés et déterminés longitudinalement (Gibon, 2003). Certains des grands fleuves de Madagascar montrent de grands affluents qui prennent leurs sources sur des massifs parfois fort distants. On peut ainsi considérer le Mangoro qui reçoit l'Onive ou encore la Tsiribihina qui reçoit la Mania et la Mahajilo. La Mania et la Mahajilo ont des caractéristiques et des histoires propres qu'elles apportent à la confluence et plus on va vers l'aval, plus le fleuve prend son autonomie. Les centres d'endémisme ainsi que les bassins de retraite-dispersion proposés préalablement ont donc été détaillés en distinguant les bassins versants des principaux affluents de l'ensemble du système hydrologique. Les affluents retenus dans cet exercice sont ceux qui présentent une toponymie sur les cartes FTM 1: 500 000. Les bassins versants de ces affluents ont été délimités ainsi que toutes les portions du fleuve principal entre les confluences de ces divers affluents afin de pouvoir évaluer l'altitude des sources dans chaque portion ainsi délimitée (Fig. 3).

## Distribution des *Propithecus* dans les centres d'endémisme

### *Propithecus diadema candidus* – *Propithecus d. diadema*

Sur les 12 centres d'endémisme retenus par Wilmé *et al.* (2006), un taxon est distribué sur deux centres d'endémisme (*P. v. verreauxi* depuis le Mandrare jusqu'à la Tsiribihina), 5 centres d'endémisme n'abritent aucun propithecus (4, 5, 10, 11, 12) et 3 centres d'endémisme abritent deux taxons. Dans ce dernier cas, le rôle de bassin de retraite-dispersion proposé pour l'Antainambalana (a2 sur Fig. 3) permet de scinder les deux taxons du nord-est, *P. d. candidus* entre les bassins de la Bemarivo et l'Antainambalana et la sous-espèce nominative entre les bassins de l'Antainambalana et du Mangoro en scindant le centre d'endémisme 2 de la Figure 3. *Propithecus diadema candidus* était connu de la région de Maroantsetra (André Peyrieras, pers. com.) et des observations récentes semblent confirmer cette pré-

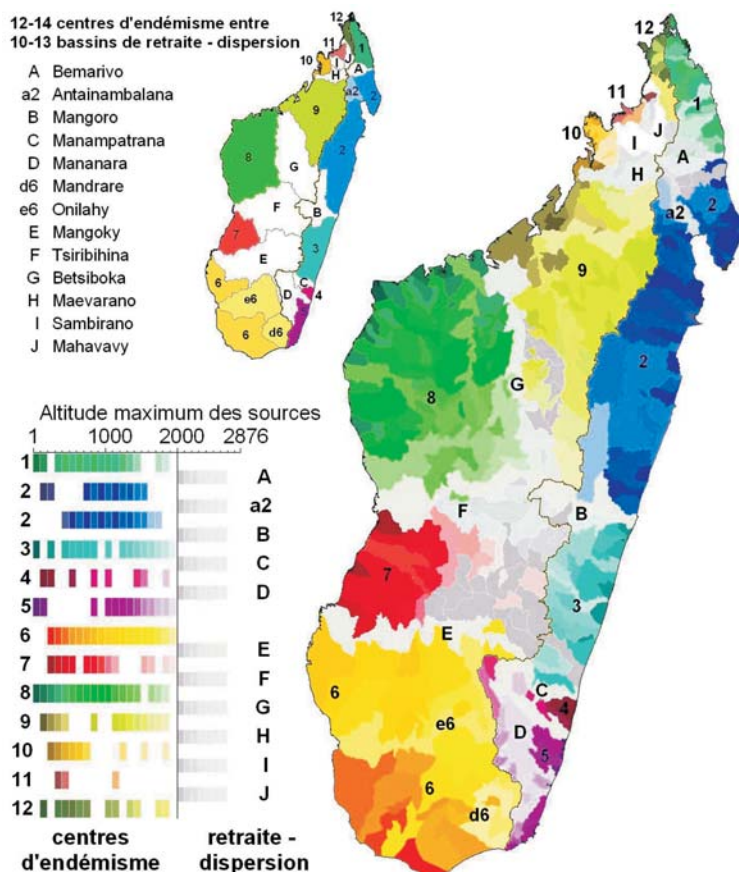


Fig. 3: Concept des centres d'endémisme (1 à 12) coincés entre les bassins de retraite-dispersion (A à J) de Wilmé *et al.* (2006) détaillé et adapté au niveau des affluents des ensembles hydrologi-

sence (Julien Ratsisakanana pers. comm.) mais aucun propithèque n'a encore été rapporté de la forêt Makira (Raharivolona *et al.*, 2003).

*Propithecus verreauxi deckeni* – *Propithecus verreauxi coronatus*

Les données de distribution historiques les plus précises dont nous disposons sur les deux taxons du nord-ouest proviennent de spécimens récoltés par la Mission Zoologique Franco-Anglo-Américaine en 1929 et en 1931, et les données les plus récentes sont issues de la bibliographie et remontent à 2001 (Fig. 4). De tous les Propithèques de la côte occidentale, *P. v. coronatus* est certainement celui qui est le moins connu et pour lequel peu d'informations sont disponibles. Une ancienne donnée le situe dans la RS d'Ambohitantly (Petter et Andriatsarafana, 1987) et ce taxon est observé régulièrement dans la région de Katsepy mais ce n'est qu'à partir de 1998 que des informations précises et étendues sur sa distribution ont été publiées (Curtis *et al.*, 1998; Müller *et al.*, 2000; Randrianarisoa *et al.*, 2001; Thalmann *et al.*, 2002; Rasoloharjaona *et al.*, 2005). Les deux taxons de Propithèques *P. verreauxi coronatus* et *P. v. deckeni* ont une distribution limitée au centre d'endémisme situé entre les bassins de retraite-dispersion de la Tsiribihina et de la Betsiboka (Wilmé *et al.* 2006). Lorsque nous considérons les stations de *P. v. coronatus* et de *P. v. deckeni* sur la carte détaillée ci-dessus, les bassins versants des fleuves prenant leur source aux plus hautes altitudes au sein de ce centre d'endémisme pourraient avoir joué un rôle de retraite-dispersion. Il en est ainsi des bassins des fleuves Ma-

nambolo, Manambaho et Mahavavy, en plus des bassins de la Tsiribihina et de la Betsiboka, dont les forêts riveraines auraient pu offrir refuge à certaines populations occidentales de propithèques alors que les régions les plus proches des côtes et les plus éloignées de ces bassins versants auraient isolées des populations qui se seraient adaptées à des conditions plus arides (Fig. 5).

*Propithecus diadema perrieri* – *Propithecus tattersalli*

Les deux taxons du nord sont les derniers décrits dans le genre *Propithecus* et datent respectivement de 1931 et de 1988. La plupart des informations dont on dispose sur ces deux taxons sont orales, intégrées dans des études et des rapports non publiés et ces deux taxons sont mal documentés dans la base de données Noe4D qui ne considère que 15 documents portant sur ces deux propithèques (Fig. 6). Lorsque nous considérons la carte de distribution de ces deux taxons, les fleuves Mananjeba et Manambato qui prennent leurs sources sur les versants de la montagne Sorata pourraient avoir été importants dans l'histoire de ces taxons. Lorsque nous considérons les altitudes des principales rivières du Nord dans le concept des centres d'endémisme coincés entre les bassins de retraite-dispersion, aucun schéma évident ne ressort qui permettrait d'expliquer la

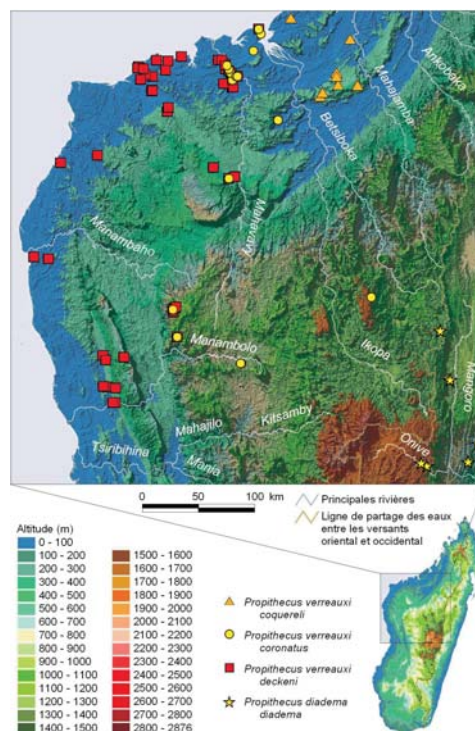


Fig. 4: Distribution des taxons du genre *Propithecus* dans la partie Nord-ouest de Madagascar, et plus particulièrement de *Propithecus verreauxi deckeni* et de *Propithecus v. coronatus* dans le centre d'endémisme situé entre les bassins versants de retraite-dispersion de la Tsiribihina et de la Betsiboka.

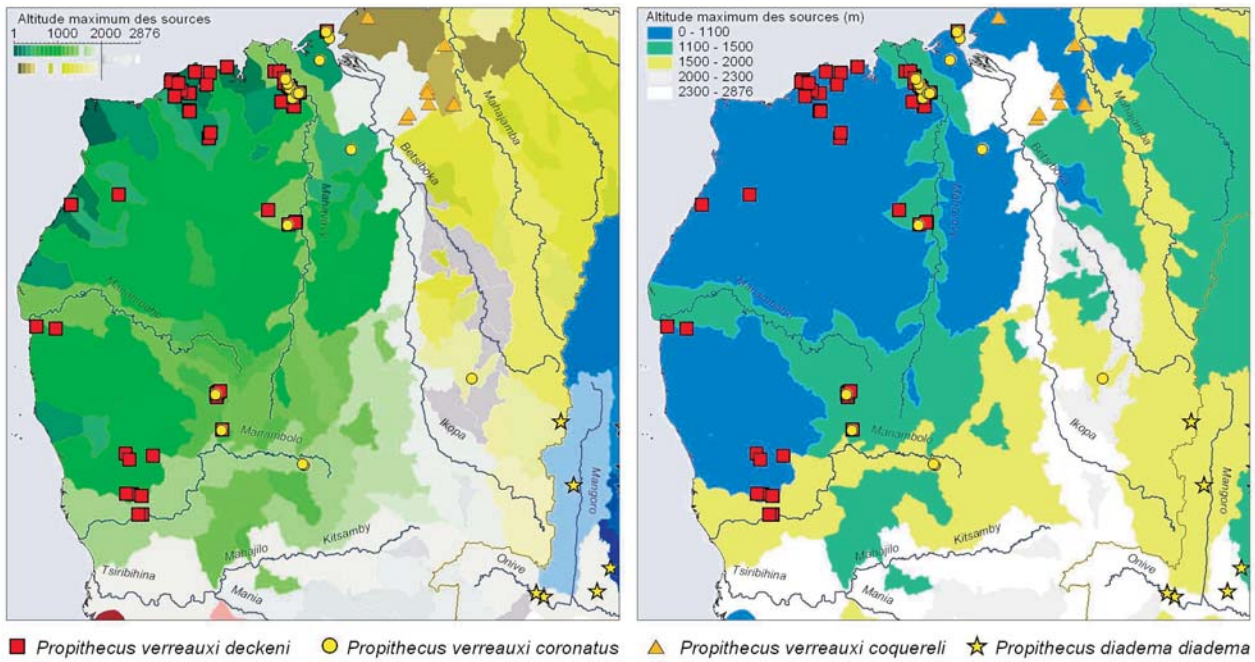


Fig. 5: Importance des fleuves dont les sources se trouvent aux altitudes moyennes par rapport à la distribution de *Propithecus verreauxi deckeni* et de *Propithecus v. coronatus* dans le centre d'endémisme du nord-ouest de Madagascar.

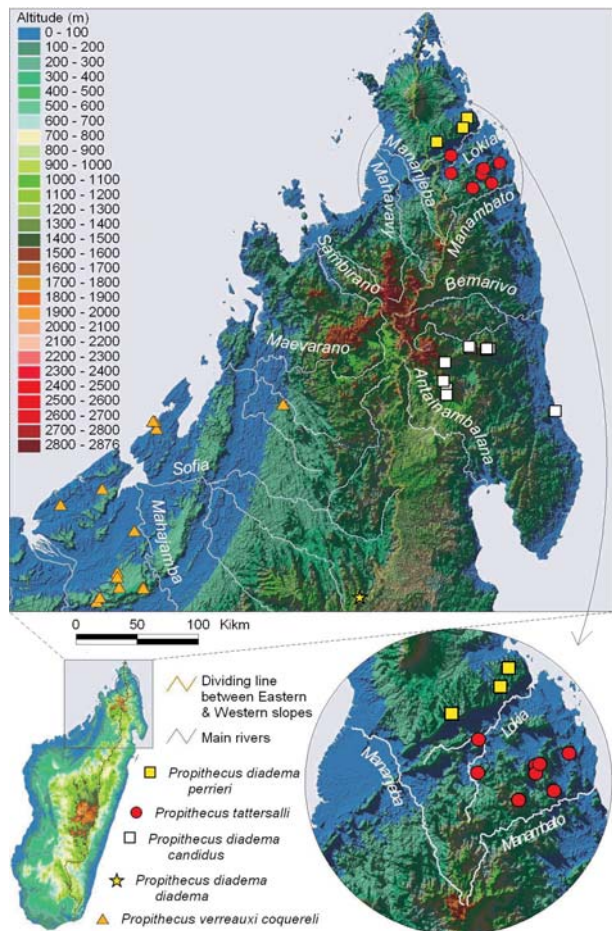


Fig. 6: Distribution des Propithèques actuels dans la partie septentrionale de l'île, en fonction de l'altitude et des versants.

distribution actuelle des propithèques de l'est (Fig. 7). La complexité et les relations des systèmes géologiques, géographiques, topographiques, orographiques et climatiques régissant encore aujourd'hui la partie Nord de l'île reflètent certainement une histoire biogéographique complexe et passionnante. Des études sur la faune et la flore de certaines régions parmi les moins connues de la Grande Ile (notamment à Daraina et dans les hauts massifs du Centre-Nord), aideront certainement à mieux comprendre la distribution actuelle de certaines espèces.

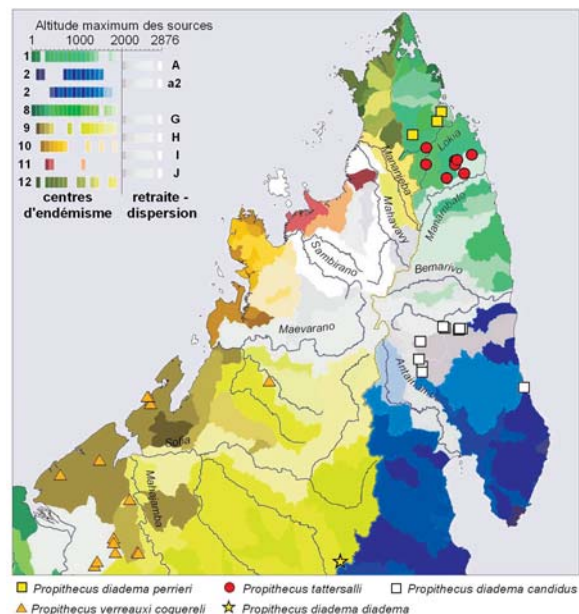


Fig. 7: Distribution des Propithèques actuels dans la partie septentrionale de l'île, par rapport au concept des centres d'endémisme coincés entre les bassins de retraite-dispersion détaillé au niveau de l'altitude des sources des affluents.

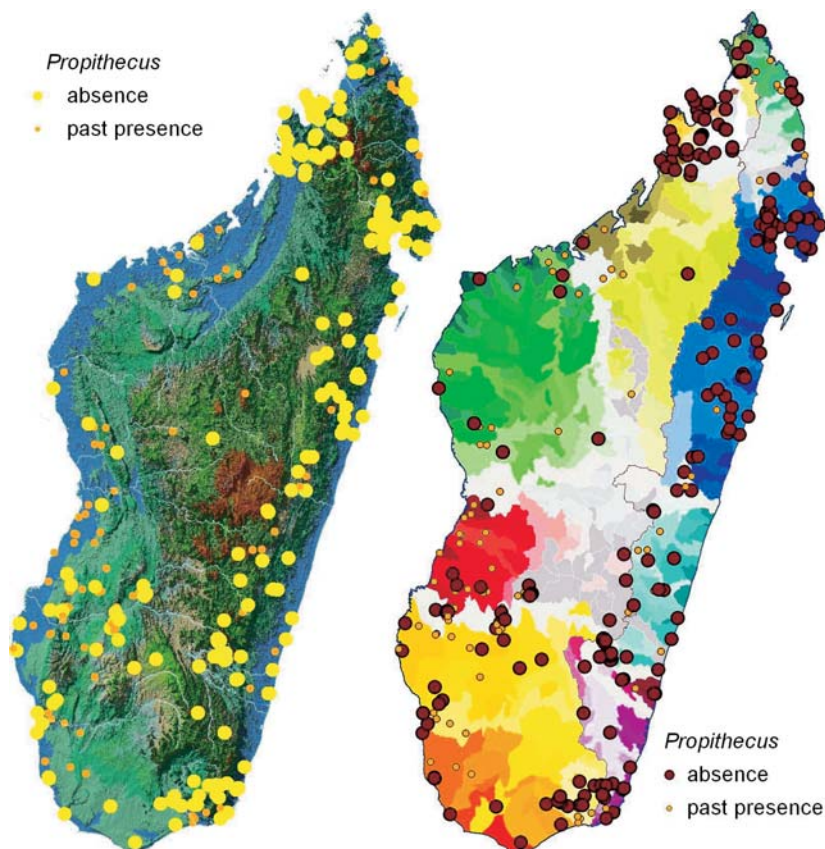


Fig. 8: Absence ou présence ancienne (aucune information depuis 1990) du genre *Propithecus* en fonction de l'altitude et des grands fleuves (gauche) ou des centres d'endémisme entre les bassins versants de retraite-dispersion détaillés aux affluents (droite).

### Absence des propithèques

Dans la mesure où nous avons accès à des centaines d'informations vérifiées, géoréférencées et datées portant sur la distribution des lémuriens actuels de Madagascar (> 1300 documents pour les lémuriens diurnes), et que le concept des centres d'endémisme et des bassins versants de retraite-dispersion fait nettement ressortir que nous ne pouvons observer que des populations reliques, nous nous intéressons ici non plus à la présence des propithèques dans les stations données mais à leur absence ou leur présence ancienne.

Nous considérons que les propithèques sont absents d'une station lorsque d'autres lémuriens diurnes (ou principalement diurnes) y ont été documentés et nous considérons que les propithèques montrent une présence ancienne lorsqu'ils n'ont plus été documentés de la station depuis 1990 (Fig. 8).

On observe trois régions desquelles *Propithecus* est absent qui sont d'une part la région entourant la baie de l'Antongil, le sud-est depuis le fleuve Manampatrana jusqu'au bassin de la Mandrare et enfin le nord-ouest depuis la Maevarano jusqu'aux versants de la Montagne d'Ambre en incluant le Sambirano et les versants du Tsaratanana.

Il apparaît ainsi clairement que les propithèques sont généralement endémiques d'un seul centre d'endémisme ou en sont totalement absents, à l'exception de *Propithecus v. verreauxi* qui présente la plus vaste répartition de tous les *Propithecus*. Les divers taxons de propithèques semblent s'être confinés au plus profond des centres d'endémisme, comme le montre *P. verreauxi deckeni* par rapport à *P. v. coronatus*, mais surtout *P. tattersalli* qui se trouve à plus de 230 km de la population la plus proche du taxon affine *P. verreauxi coque-reli*, ou encore *P. diadema perrieri* qui est distant de quelques 170 km de la population la plus proche de *P. diadema candidus*.

### Présence inattendue d'un propithèque

L'Itremo a attiré assez récemment quelques équipes d'inventaires dont une mission organisée par Steve Goodman en 1999. Depuis plusieurs années cette région fait l'objet d'un réel intérêt de la part du Missouri Botanical Garden (MBG) qui y a découvert plusieurs espèces endémiques (e.g. *Buxus itremoensis*, *Perrierodendron quartzitorum*). Pour les oiseaux comme pour les mammifères, la région est paucispécifique mais un seul lémurien diurne y est observé : *Propithecus v. verreauxi* (Chris Birkinshaw, comm. pers.). Les Propithèques de Verreaux ont ainsi une vaste distribution sur l'ensemble du versant occidental depuis la chaîne Anosyenne au sud-est de l'île jusqu'au Sambirano au nord-ouest, et comptent parmi les rares lémuriens diurnes à présenter des populations reliques sur les hauts plateaux du versant occidental comme l'attestent l'observation de l'Itremo ou encore l'ancienne donnée d'Ambohitantly.

### Conclusion

Alors que de multiples exercices statistiques et de modélisation opposent les présences de taxons aux absences, sans que les absences soient forcément documentées, ceux qui procèdent aux analyses et modélisations savent qu'ils font ainsi appel à un pis-aller. Au fur et à mesure que nos connaissances s'étendent et que nous sommes en mesure de rassembler plus d'informations sur certains groupes de vertébrés, les absences deviennent des informations pertinentes. Pour cela des inventaires doivent prochainement avoir lieu dans certains massifs, comme celui de la montagne Soratra, pour confirmer l'absence ou la présence de certaines espèces clés pour la compréhension globale de la biogéographie malgache.

En considérant les altitudes des sources des principales rivières de Madagascar et le concept des centres d'endé-

même coïncés entre les bassins versants de retraite-dispersion, un schéma peut être envisagé pour expliquer la distribution actuelle de *Propithecus verreauxi coronatus* et de *Propithecus verreauxi deckeni* ou encore pour envisager les absences des propitèques de certaines régions.

Les propitèques et les autres lémuriens de Madagascar ne vont certainement pas à eux seuls nous révéler toute la biogéographie de l'île. Nous savons en effet que les bassins versants du Mandrare et de l'Onilahy ont effectivement un rôle de bassins versants de retraite-dispersion conformément à l'endémisme révélé par divers autres taxons que les lémuriens, notamment par des espèces de l'avifaune, de l'herpétofaune, mais aussi par les invertébrés et les plantes. Les lémuriens ont constitué un cas d'école pour aborder des schémas possibles de dispersion et d'extinction dans le concept des centres d'endémisme coïncés entre les bassins versants de retraite-dispersion mais ils ne vont certainement pas révéler tous les secrets de la chorologie des animaux et des plantes de Madagascar. Les plantes sont les derniers survivants ou les reliques d'un environnement changeant, et seront considérées dans une suite prévue de nos analyses, en même temps que la paléoclimatologie, la palynologie, la géologie, la pédologie, l'hydrobiologie et bien d'autres domaines. Nous savons tous qu'une zone littorale est tout à fait justifiée dans les centres d'endémisme de Madagascar, et de nombreux taxons montrent effectivement une aire de distribution littorale. Les bassins versants devront vraisemblablement être détaillés longitudinalement en suivant par ailleurs certaines caractéristiques de fleuves malgaches et notamment la zone potamique d'altitude (Gibon, 2003).

Considérer les centres d'endémisme et comprendre les centres de richesses spécifiques malgaches grâce en partie aux bassins de retraite-dispersion permet de garder un œil dans l'histoire relativement récente de la faune et de la flore de Madagascar, d'expliquer des schémas de distribution, révéler des espèces et d'autres taxons discrets et surtout de mieux orienter les actions en faveur de la protection de la nature. Les espèces "les plus rares", qui sont probablement les plus menacées, c'est-à-dire, qui possède le plus grand risque d'extinction vont être révélées en partie par une meilleure connaissance de ces centres d'endémisme. Connaître la distribution de ces taxons révélera des sites irremplaçables, qui, dans la plupart des cas, hébergeront aussi d'autres espèces menacées (Callmander *et al.*, 2005).

Même si nous en sommes déjà réduits à n'observer que les reliques de la biodiversité malgache et qu'elle gardera certainement de nombreux secrets, en tenant compte de cette partie de son histoire, nous pourrions certainement éviter des erreurs qui pourraient avoir de graves répercussions pour la préservation future des espèces actuelles et de leur histoire. L'intuition de nos prédécesseurs, Humbert et Cours Darne (1965), doit être gardée à l'esprit et les expériences anciennes doivent nous montrer la voie d'autant que la carte illustrant le concept des centres d'endémisme de Wilmé *et al.* (2006) ou encore celle présentée ici n'en sont pas très éloignées (Fig. 9).

## Références

Battistini, R. 1959. Le problème de la déviation naturelle des eaux de la Mahajamba vers le Kamoro.

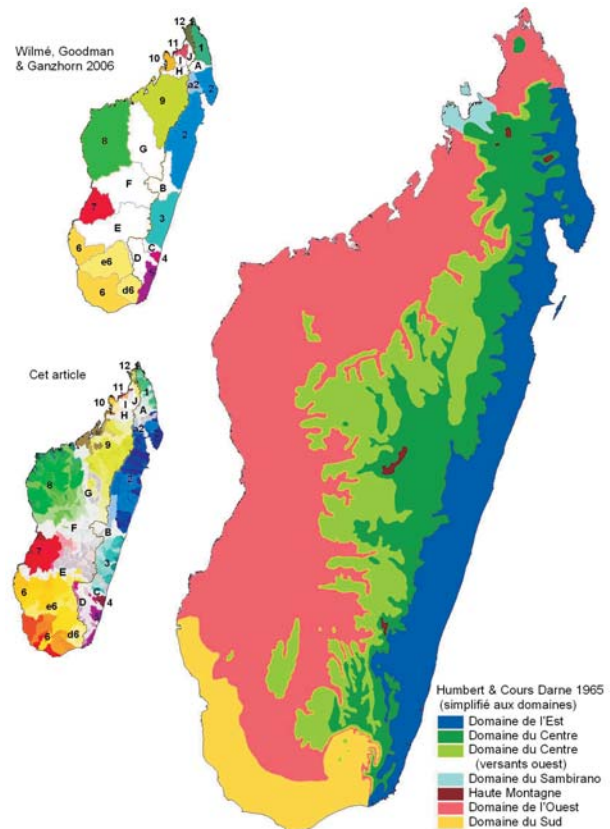


Fig. 9: Concept des centres d'endémisme (1 à 12) entre les bassins versants de retraite-dispersion (A à J) originel (haut gauche) et détaillé au niveau de l'altitude des sources des affluents (bas gauche) par rapport aux phytchories d'Humbert et Cours Darne qui influencent la plupart des cartes et concepts relatifs à la biogéographie ou la chorologie de Madagascar depuis près d'un demi siècle.

Mémoires de l'Institut Scientifique de Madagascar, Série D, Sciences de la Terre 9: 239-262.

Battistini, R. 1965. Problèmes morphologiques de l'Extrême-Nord de Madagascar. *Madagascar Revue de Géographie* 7: 1-60.

Callmander, M.W.; Schatz, G.E.; Lowry, P.P. 2005. IUCN Red List assessment and the Global Strategy for taxonomists must act now. *Taxon* 54: 1047-1050.

Chaperon, P.; Danloux, J.; Ferry, L. 1993. Fleuves et rivières de Madagascar. Éditions de l'ORSTOM, Paris.

Crisp, M.D.; Laffan, S.; Linder, H.P.; Monro, A. 2001. Endemism in the Australian Flora. *J. Biogeography* 28: 183-198.

Curtis, D.J.; Velo, A.; Raheliarisoa, E.-O.; Zaramody, A.; Müller, P. 1998. Surveys on *Propithecus verreauxi deckeni*, a melanistic variant, and *P. v. coronatus* in north-west Madagascar. *Oryx* 32 :157-164

Ganzhorn, J.U.; Sorg, J.-P. (eds.) 1996. Ecology and economy of a tropical dry forest in Madagascar. *Primate Report* 46-1.

Gibon, F.-M. 2003. Cadre théorique de l'étude des bihydrosystèmes malgaches. Pp. 23-35. In J.-M. Elouard et F.-M. Gibon, Eds. Biodiversité et biotypologie des eaux continentales de Madagascar, pp. 23-35. IRD Montpellier et CNRE Antananarivo.

Goodman, S.M.; Rakotoarisoa, S.V.; Wilmé, L. sous presse. The distribution and biogeography of the Ring-tailed Lemur (*Lemur catta*).



- Hertu, O.; Elouard J.-M. 1995. NOE: Nomenclature Ecologique et Environnementale. Logiciel IRD: Dépôt légal n° IDDDN.FR.001.420001.R.C.1994. 30200 à l'Agence pour la Protection des Programmes.
- Humbert, H.; Cours Darne, G. 1965. Carte internationale du tapis végétal et des conditions écologiques à 1/1.000.000. Notice de la carte. *Extraire des Travaux de la Section Scientifique et Technique de l'Institut Français de Pondichéry*, hors série No. 6.
- Linder, H.P. 2001. Plant diversity and endemism in sub-Saharan tropical Africa. *Journal of Biogeography* 28: 169-182.
- Mittermeier, R.A.; Konstant, W.R.; Hawkins, F.; Louis, E.E.; Langrand, O.; Ratsimbazafy, J.; Rasoloarison, R.; Ganzhorn, J.U.; Rajaobelina, S.; Tattersall, I.; Meyers, D.M. 2006. Lemurs of Madagascar. Second Edition. Conservation International, Washington, D.C.
- Müller, P.; Velo, A.; Rahelarisoa, E.-O.; Zaramody, A.; Curtis, D. J. 2000. Surveys of sympatric lemurs at Anjanena, north-west Madagascar. *Afr. J. Ecol.* 38: 248-257.
- Pennington, R.T.; Prado D.E.; Pendry C.A. (2000). Neotropical seasonally dry forests and quaternary vegetation changes. *J. Biogeography* 27: 261-273.
- Petter, J.-J.; Andriatsarafana, F. 1987. Conservation status and distribution of lemurs in the west and northwest of Madagascar. *Primate Conservation* 8: 169-171.
- Raharivololona, B.M.; Ratsisetraïna, R.I.; Day, S.R. 2003. Lémuriens des forêts humides du plateau de Makira, Maroantsetra (Madagascar). *Lemur News* 8: 18-19.
- Randrianarisoa, P. M.; Rasamison, A.; Rakotozafy, L. 2001. Notes sur la faune lémurienne de la Réserve Spéciale de Kasijy. *Lemur News* 6: 7-8
- Rasoloharijaona, S.; Randrianambinina, B.; Rakotosamimanana, B.; Zimmermann, E. 2005. Inventaires des lémuriens dans la forêt d'Andranovelona / Madirovalo (nord ouest de Madagascar), les "savoka" de Manehoko, la Réserve de Lokobe, la Réserve Spéciale de l'Ankarana, et la Réserve Spéciale d'Analamerana, au nord de Madagascar. *Lemur News* 10: 8-11.
- Thalman, U.; Kümmerli, R.; Zaramody, A. 2002. Why *Propithecus verreauxi deckeni* and *P. v. coronatus* are valid taxa - quantitative and qualitative arguments. *Lemur News* 7: 11-16.
- Vences, M.; Andreone, F.; Glaw, F.; Randrianirina, J. E. 2003. Molecular and bioacoustic divergence in *Mantidactylus granulatus* and *M. zavona* n. sp. (Anura: Mantellidae): bearings for the biogeography of northern Madagascar. *African Zoology* 38: 67-78.
- Wilmé, L.; Goodman, S.M.; Ganzhorn, J.U. 2006. Biogeographic evolution of Madagascar's microendemic biota. *Science* 312: 1063-1065.
- Parasite infections and host responses against parasites play major roles in sociobiological models for the evolution of social systems (Sterck *et al.*, 1997), mate choice and genetic properties associated with immune reactions (reviewed by Sommer, 2005). From a conservation point of view it is important to understand ways of infection and the potential of the transmission of parasites between species (native and introduced species; Goodman, 1995; Begon *et al.*, 1999; Laakkonen *et al.*, 2003). Finally the rate and intensity of parasitic infections are one of the means to assess the health of a population (e.g., Randriamadanana, 1998; Junge and Louis, 2002, 2005; Dutton *et al.*, 2003; Randrianjafy, 2003).
- Parasitological studies on lemurs are still in their infancies and there is no comprehensive standard literature which could be used for parasite identification without sophisticated molecular methods (e.g., Chabaud *et al.*, 1965; Safia, 2005). With respect to parasites of the digestive tract, it is difficult to assign different states of a parasite (eggs, larvae) to given species. Also, once a parasite has been found in the gut content or in the feces, it is difficult to know whether it is a parasite of the species studied or whether it is a parasite of a prey item consumed by the study species.
- Since the interest in parasitological studies increases in Madagascar, I would like to present some preliminary analyses of gastrointestinal parasites of *Cheirogaleus major*, *C. medius*, and *Microcebus murinus* with associated pictures. These could serve as reference for comparisons and should be updated as new information and more sophisticated identification keys become available. During a visit in the Muséum National d'Histoire Naturelle, Paris, France, no parasite eggs samples but only larva and adult worms could be located in the collection.
- In order to come to a uniform, open access database which can be used as a reference by other researchers, we would like to request feedback on the preliminary identifications presented here. Also we would welcome additional photos of parasites not illustrated here. Once identification has been finalized, these photos and an associated description will be made available on the homepage with open access (homepage of the Dept. Animal Ecology and Conservation, University of Hamburg [www.biologie.uni-hamburg.de/zim/oeko/ganz/forsch.html](http://www.biologie.uni-hamburg.de/zim/oeko/ganz/forsch.html)). The goal of this project is to compile a database for gut parasites which can be used for the visual identification of morphotypes based on size and morphological characteristics. People interested to contribute are asked to send photos and additional information (scale, host species, date and locality of collection) to Brigitte M. Raharivololona ([raharivololonabrigitte@yahoo.fr](mailto:raharivololonabrigitte@yahoo.fr)) and Jörg Ganzhorn ([ganzhorn@zoologie.uni-hamburg.de](mailto:ganzhorn@zoologie.uni-hamburg.de)).

## Gastrointestinal parasites of *Cheirogaleus* spp. and *Microcebus murinus* in the littoral forest of Mandena, Madagascar

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### Materials and methods

The study was carried out in fragments of the littoral forest of Mandena, some 12 km northeast of Tolagnaro in the southeast of Madagascar at sites near sea level with an altitude of 0-20 m (24° 57' S; 47° 00' E). The forest has a thick understory, is evergreen and 10-15 m high. Rainfall averages 1540 mm per year in the nearby town of Tolagnaro without a distinct dry season. *Cheirogaleus major*, *Cheirogaleus medius* and *Microcebus murinus* were captured with Tomahawk and Sherman Life Traps using standard procedures (Ramanamanjato and Ganzhorn, 2001) at permanent study sites set up in different forest fragments of Mandena

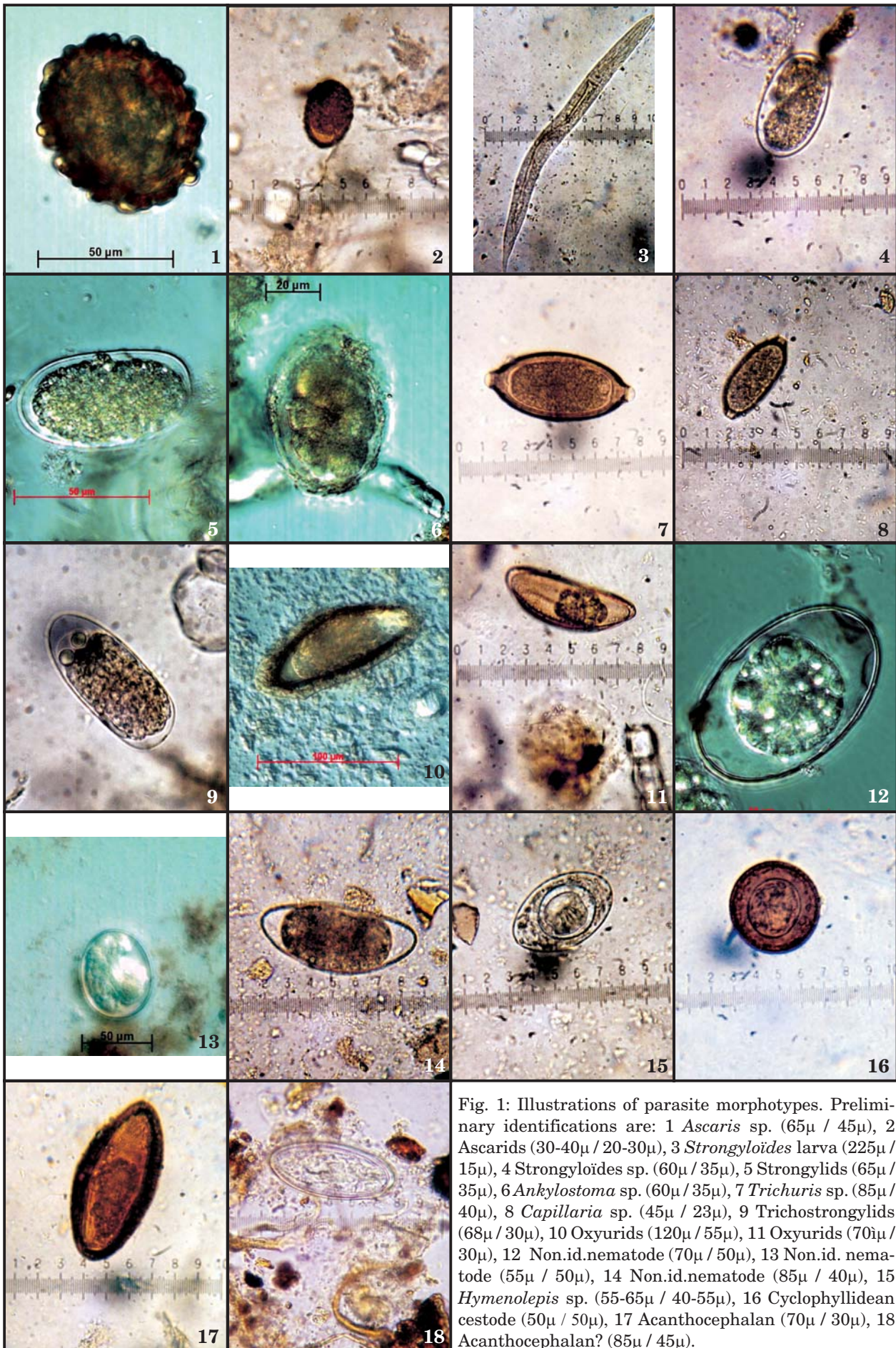


Fig. 1: Illustrations of parasite morphotypes. Preliminary identifications are: 1 *Ascaris* sp. (65µ / 45µ), 2 *Ascarids* (30-40µ / 20-30µ), 3 *Strongyloides* larva (225µ / 15µ), 4 *Strongyloides* sp. (60µ / 35µ), 5 *Strongylids* (65µ / 35µ), 6 *Ankylostoma* sp. (60µ / 35µ), 7 *Trichuris* sp. (85µ / 40µ), 8 *Capillaria* sp. (45µ / 23µ), 9 *Trichostrongylids* (68µ / 30µ), 10 *Oxyurids* (120µ / 55µ), 11 *Oxyurids* (70µ / 30µ), 12 Non.id.nematode (70µ / 50µ), 13 Non.id. nematode (55µ / 50µ), 14 Non.id.nematode (85µ / 40µ), 15 *Hymenolepis* sp. (55-65µ / 40-55µ), 16 *Cyclophyllidean* cestode (50µ / 50µ), 17 *Acanthocephalan* (70µ / 30µ), 18 *Acanthocephalan?* (85µ / 45µ).

(M5, M13, M15, M16, M20). Traps baited with banana were set for four nights per month at 80 or 100 localities per fragment between April and October 2003. Additional samples were provided by Petra Lahann. These samples had been collected in M15 between November 2003 and March 2004. All trapped animals were sexed, measured, weighed and marked permanently with subdermal transponders. Animals were released at the locality where they had been captured.

#### Fecal sampling and parasite identification

Fresh feces were collected from handling bags or traps and stored in vials containing 4 % formalin. A modification of the McMaster flotation egg counting technique (Sloss *et al.*, 1994) was applied to analyze egg shedding which has been considered a valid method of evaluating worm burdens in several studies (e.g., Gulland *et al.*, 1993; Paterson *et al.*, 1998; Coltman *et al.*, 1999; Cassinello *et al.*, 2001). Feces were screened for eggs and larvae by counting two chambers of McMaster for each sample and by using a flotation-dilution of potassium iodide with a specific weight of 1.5 g/ml (Meyer-Lucht, 2003). This follows the standard procedure applied in other studies (Meyer-Lucht and Sommer, 2005; Schad *et al.*, 2005). Parasites were measured with a calibrated ocular micrometer and photographed with a digital camera. Parasite identification was based on the size, shape and internal structure of eggs, oocysts, and larvae (Chabaud *et al.*, 1965; Euzeby, 1981).

For the purpose of this study only data on the prevalence of different parasites are listed. Prevalence is defined as the number of infected individuals divided by the number of examined individuals.

#### Results

Two hundred and ninety-five fecal samples from 129 individuals were collected. In total 2 *Cheirogaleus major*, 26 *Cheirogaleus medius* and 101 *Microcebus murinus* were caught. Some of them were recaptured repeatedly. Fecal samples of these animals contained Nematodea, Cestodea, Trematodea, Acanthocephala, and Protozoa (Table 1).

#### *Cheirogaleus major*

The feces of both individuals contained coccidia (Protozoa) and one non identified form of nematodes. The coccidia is likely to be *Eimeria* spp.

#### *Cheirogaleus medius*

Parasites were found in 73.1 % of all feces of *C. medius*. They belonged to:

Nematodea -- *Strongyloides* spp., strongylids, *Trichuris* sp., oxyurids, and 3 unidentified forms. Based on morphological structures, strongylids could be *Oesophagostomum* sp., *Ankylostoma* sp. and *Chabertia* sp. One form of strongylids could not be identified. Oxyurids found in the feces resemble *Heterakis* sp.

Cestodea -- *Hymenolepis* spp. and other cyclophyllidean species;

Protozoa -- Coccidia (probably *Eimeria*).

In total at least 13 parasite species were found in the feces of the 26 individuals. Intestinal parasites with the highest prevalences were *Trichuris* sp. (26.9 %), *Hymenolepis* spp. (26.9 %) and coccidia (26.9 %; Table 1).

#### *Microcebus murinus*

Parasites were found in 90.1% of all feces of *M. murinus*. They belonged to:

Nematodea -- *Ascaris* sp. found in only one individual; one non identified form of ascarids, *Strongyloides* spp., strongylids (probably *Oesophagostomum* sp. and *Ankylostoma* sp.), *Trichuris* sp., *Capillaria* sp.; Trichostrongylids (possibly *Trichostrongylus* sp. and *Nematodirus* sp.); Oxyurids -- *Enterobius* sp., two other forms seem to be *Lemuricola* sp. and *Syphacia* sp. Three forms could not be identified further.

Cestodea -- *Hymenolepis* spp. and other cyclophyllidean.

Trematodea and Acanthocephala were found in two individuals.

At least 20 species of gastrointestinal parasites have been found. Coccidia were the most common intestinal parasites with a prevalence of 68.3 %.

*Capillaria* sp., *Enterobius* sp., trichostrongylids, trematodes and acanthocephala were very rare. Apart from Coccidia infections, many animals were also infected by *Hymenolepis* spp. (33.7 %; Table 1).

Table 1: Prevalence of gastrointestinal parasites found in feces of *Cheirogaleus major*, *C. medius* and *Microcebus murinus* in the littoral forest of Mandena.

	No. in Fig. 1	C. major	C. medius	M. murinus
<b>Nematodea</b>				
<i>Ascaris</i> sp.	1			1.0
other Ascarids	2			25.7
<i>Strongyloides</i> spp.	3, 4		3.9	11.9
Strongylids	5, 6		11.5	4.0
<i>Trichuris</i> sp.	7		26.9	8.9
<i>Capillaria</i> sp.	8			1.0
Trichostrongylids	9			2.0
<i>Enterobius</i> sp.				1.0
other Oxyurids	10, 11		3.9	15.8
Non id. nematodes	12, 13, 14	50.0	26.9	59.4
<b>Cestodea</b>				
<i>Hymenolepis</i> spp.	15		26.9	33.7
Cyclophyllidean	16		3.9	5.0
<b>Trematodea</b>				
<b>Acanthocephals</b>	17, 18			2.0
Coccidia ( <i>Eimeria</i> spp.?)		100.0	26.9	68.3

#### Discussion

Chabaud *et al.* (1965) listed some intestinal nematode parasites of lemurs as: Strongylids -- *Lemurostrongylus residuus*; Trichostrongylids: *Pararhabdonema longistriata*; Oxyurids -- *Callistoura* spp., *Lemuricola* spp., *Biguetius trichuroides* and *Enterobius lemurus*; Subulurids -- *Subulura baeri*; Ascarids: *Ascaris petiti*; Spirurids -- *Spirura diplociphos* and *Rictularia lemurus*; Trichurids -- *Trichuris lemurus*.

In the present sample strongylids were identified as *Oesophagostomum* sp., *Ankylostoma* sp. and *Chabertia* sp.. *Oesophagostomum* sp. is also known to infect lemurs in captivity in the Tsimbazaza Zoo (Randriamiadamanana 1998). Trichostrongylids here are likely to be *Trichostrongylus* sp. Oxyurids are probably *Enterobius* sp., *Heterakis* sp., *Lemuricola* sp. and *Syphacia* sp. One non identified nematode of *C. medius* and *M. murinus* could be a subulurid, probably *Subulura* sp..

Due to the lack of documents and reference samples, I cannot confirm if the one non identified species of ascarids reported here is also *Ascaris petiti*. But the *Ascaris* sp. observed in the present sample seems to be *Ascaris lumbricoides*. Its occurrence in *M. murinus* can be explained by the use of space by this lemurs. The species

comes to the ground to catch invertebrates. Doing this, it is exposed to human intestinal parasites because people frequently enter the Mandena forest. It would be most important to follow-up on possible pathways of gut infections between humans and lemurs (and vice versa). One non identified nematode of *C. medius* and *Microcibus murinus* is likely to be a spirurid such as *Physaloptera* sp..

The Trichurid (*Trichuris lemuris*) described by Chabaud *et al.* (1965) seems to be the same species as found in the present study. *Capillaria* sp. have also been found in fecal samples from *M. murinus*.

The study presented here extends the database provided by Chabaud *et al.* (1965). In *M. murinus*, Chabaud *et al.* (1965) have identified four species of intestinal parasites while the fecal samples of the *M. murinus* collected in Mandena contained at least 20 different forms.

In *C. major*, Chabaud *et al.* (1965) have examined two parasite species: *Lemuricola contagiosus* and *Trichuris lemuris*. We did not find these but coccidia and one species of nematodes. In *C. medius*, Chabaud *et al.* (1965) have reported *Subulura baeri* and *Spirura diplocyphos* as intestinal parasites compared to at least 13 different forms in the Mandena sample. Finally, the fecal samples from Mandena contained cestodes (*Hymenolepis* and cyclophyllidean) in *C. medius* and *M. murinus*, a trematode and acanthocephala in *M. murinus* and coccidia in all three lemur species studied here.

Parasites such as ascarids, strongylids, trichurids and trichostrongylids are directly transmitted through feces. Inter-individual exchange of parasites is possible for example in sleeping groups. These social interactions generate a network of contacts through which many parasites spread within populations (Anderson and May 1979, 1991). Hosts living at high density or with frequent intraspecific contacts are expected to accumulate more parasite species (Morand, 2000; Roberts *et al.*, 2002). This might explain why parasite prevalence is higher in *M. murinus* than in the other two species.

Oxyurids, cestodes, trematodes and acanthocephalan have an indirect life-cycle with arthropods as an intermediate hosts (Flynn, 1973; Owen, 1992). Since all three lemur species considered here eat invertebrates (Mittermeier *et al.*, 2006) they can all be infected by their usual diet.

In summary, a diverse gastrointestinal parasite fauna was found in the small nocturnal lemurs of the Mandena forest. The possible parasite transmission from human to wildlife and vice versa deserves special attention (i.e., the occurrence of *Ascaris* sp. in *M. murinus*; see e.g., Lilly *et al.*, 2002).

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#### References

- Anderson, R.M.; May, R.M. 1979. Population biology of infectious diseases. I. *Nature* 280: 361-367.
- Anderson, R.M.; May, R.M. 1991. Infectious diseases of humans: dynamics and control. Oxford University Press, Oxford.
- Begon, M.; Hazel, S.M.; Baxby, D.; Brown, K.; Cavanagh, R.; Chantrey, J.; Jones, T.; Bennett, M. 1999. Transmission dynamics of a zoonotic pathogen within and between wildlife host species. *Proc. Royal Soc. London B, Biological Sciences* 266: 1-7.
- Cassinello, J., Gomendio, M.; Roldan, E.R.S. 2001. Relationship between coefficient of inbreeding and parasite burden in endangered gazelles. *Cons. Biol.* 15: 1171-1174.
- Chabaud, A.G.; Brygoo, E.-R.; Petter, A.-J. 1965. Les nématodes parasites de lémuriers malgaches. Description de six espèces nouvelles et conclusions générales. *Annales de Parasitologie (Paris)* 40: 181-214.
- Coltman, D. W.; Pilkington, J.G.; Smith, J.A.; Pemberton, J.M. 1999. Parasite-mediated selection against inbred Soay sheep in a free-living, island population. *Evolution* 53: 1259-1267.
- Dutton, C.J.; Junge, R.E.; Louis, E.E. 2003. Biomedical evaluation of free-ranging ring-tailed lemurs (*Lemur catta*) in Tsimanampetsotsa Strict Nature Reserve. *J. Zoo Wildl. Med.* 34: 16-24.
- Euzeby, J. 1981. Diagnostic expérimental des Helminthoses animales. Tome 1. Edition Informations Techniques des Services Vétérinaires, Ministère de l'Agriculture, Paris, France.
- Flynn, R.J. 1973. Parasites of Laboratory Animals. Iowa State University Press.
- Goodman S.M. 1995. *Rattus* on Madagascar and the dilemma of protecting the endemic rodent fauna. *Cons. Biol.* 9: 450-453.
- Gulland, F.M.D.; Albon, S.D.; Pemberton, J.M.; Moorcroft, P.R.; Clutton-Brock, T.H. 1993. Parasite associated polymorphism in a cyclic ungulate population. *Proc. Roy. Soc. Lond. B* 254: 7-13.
- Junge, R.E.; Louis, E.E. 2002. Medical evaluation of free-ranging primates in Betampona Reserve, Madagascar. *Lemur News* 7: 23-25.
- Junge, R.E.; Louis, E.E. 2005. Preliminary biomedical evaluation of wild Ruffed Lemurs (*Varecia variegata* and *V. rubra*). *Amer. J. Primatol.* 66: 85-94.
- Laakkonen, J.; Goodman, S.M.; Duchemin, J.-B.; Duplantier, J.-M. 2003. Trypomastigotes and potential flea vectors of the endemic rodents and the introduced *Rattus rattus* in the rainforests of Madagascar. *Biodiv. Cons.* 12: 1775-1783
- Meyer-Lucht, Y. 2003. Einfluss von Verstädterung auf Populationsstruktur, genetische Variabilität und Parasitenbefall bei der Gelbhalsmaus (*Apodemus flavicollis*). Diploma thesis, Universität Hamburg, Germany.
- Meyer-Lucht, Y.; Sommer, S. 2005. MHC diversity and the association to nematode parasitism in the

- yellow-necked mouse (*Apodemus flavicollis*). *Mol. Ecol.* 14: 2233-2243.
- Mittermeier, R. A.; Konstant, W.R.; Hawkins A.F.A.; Louis, E.E.; Langrand, O.; Ratsimbazafy, H.J.; Rasoloarison, M.R.; Ganzhorn, J.U.; Rajaobelina, S.; Tattersall, I.; Meyers, D. M. 2006. Lemurs of Madagascar. 2<sup>nd</sup> ed. Conservation International, Washington D.C.
- Morand, S. 2000. Wormy world: comparative tests of theoretical hypotheses on parasite species richness. Pp. 63-79. In: Evolutionary biology of host-parasite relationships. R. Poulin, S. Morand, A. Skorping (eds.). Elsevier, Amsterdam.
- Owen, D.G. 1992. Parasites of Laboratory Animals. Laboratory handbooks No 12. Laboratory Animal Ltd by Royal Society of Medicine Services, London.
- Paterson, S.; Wilson, K.; Pemberton, J.M. 1998. Major histocompatibility complex variation associated with juvenile survival and parasite resistance in a large unmanaged ungulate population (*Ovis aries* L.). *Evolution*. 95: 3714-3719.
- Ramanamanjato, J.-B.; Ganzhorn, J.U. 2001. Effects of forest fragmentation, introduced *Rattus rattus* and the role of exotic tree plantations and secondary vegetation for the conservation of an endemic rodent and a small lemur in littoral forests of southeastern Madagascar. *Animal Cons.* 4: 175-183.
- Randriamiadamanana, M. 1998. Contribution au diagnostic coprologique du parasite *Spirocerca lupi* chez les lémuriens du Parc Botanique et Zoologique de Tsimbazaza. Mémoire d'ingénieur, Ecole Supérieure des Sciences Agronomiques, Université d'Antananarivo, Madagascar.
- Randrianjafy, V.N.R. 2003. Contribution à la biologie de conservation de la communauté micromammalienne d'Ankarafantsika. Thèse de Doctorat de 3<sup>ème</sup> cycle: Université d'Antananarivo, Département Biologie Animale.
- Roberts, M.G.; Dobson, A.P.; Arneberg, P.; De Leo, G.A.; Krecek, R.C.; Manfredi, M.T.; Lanfranchi, P.; Zaffaroni, E. 2002. Parasite community ecology and biodiversity. Pp. 63-82. In: The ecology of wildlife disease. P.J. Hudson, A. Rizzoli, B.T. Grenfell, H. Heesterbeek, A.P. Dobson (eds.). Oxford University Press, Oxford.
- Safia, S. 2005. Contribution à l'étude des parasites sanguins des Lémuriens dans le Parc National de Ranomafana dans la zone périphérique. Mémoire de DEA de Biologie, Ecologie parasitaire. Département de Biologie Animale. Faculté des Sciences, Université d'Antananarivo, Madagascar.
- Schad J.; Ganzhorn J.U.; Sommer S. 2005. MHC constitution and parasite burden in the Malagasy mouse lemur, *Microcebus murinus*. *Evolution* 59: 439-450.
- Sloss, M. W.; Kemp, R.L.; Zajack, A. 1994. Veterinary Clinical Parasitology. Iowa State Univ. Press, Ames.
- Sommer S. 2005. The importance of immune gene variability (MHC) in evolutionary ecology and conservation. *Frontiers in Zoology* 2/1/16: 1-18.
- Sterck, E.H.M.; Watts, D.P.; van Schaik, C.P. 1997. The evolution of female social relationships in nonhuman primates. *Behav. Ecol. Sociobiol.* 41: 291-309.
- Key words:** Lemur communities, Madagascar, Réserve Spéciale de Marotandrano, inventory.
- A rapid survey of the primate fauna was conducted in the Réserve Spéciale de Marotandrano between 16 and 30 November 2004. Two sites of the reserve were visited and the presence and the relative abundance of lemurs was estimated from transect lines. A total of 12 lemur species were recorded, including 6 diurnal (*Indri indri*, *Propithecus d. diadema*, *Eulemur fulvus albifrons*, *E. rubriventer*, *Varecia v. variegata*, *Hapalemur g. griseus*) and 6 nocturnal species (*Avahi laniger*, *Lepilemur mustelinus*, *Cheirogaleus major*, *Microcebus cf. rufus*, *Allocebus trichotis*, and *Daubentonia madagascariensis*). The presence of *D. madagascariensis* was noted based on feeding signs.
- Madagascar is well known for its high level of biological diversity and endemism and is an international biodiversity hotspot (CEFP, 2002). However, since the arrival of human on the island about 2300 years ago (Burney *et al.*, 2004), the island was widely transformed. Between 1950 and 1985 Green and Sussman (1990) calculated a lost of 100,000 ha per year in the eastern rainforest and habitat destruction is the major threat to the island's endemic primate fauna (Mittermeier *et al.*, 2006). Primate diversity in Madagascar is exceptional and all five families are endemic. Lemurs occupy a wide range of forest types including eastern humid forests, western dry forests, and southern spiny forests (Mittermeier *et al.*, 2006). Due to forest degradation and hunting most lemur species are listed as threatened on the IUCN Red List. A lack of accurate distribution information for most taxa continues to prevent a proper assessment of their conservation status. The main goal of this paper is to provide further details on the primate fauna of a poorly known rainforest reserve in northeastern Madagascar.

### Methods

The Réserve Spéciale (RS) de Marotandrano is located north of Andilamena between RS d'Ambatovaky and RS de Tampoketsa-Analamaitso. Little information is available on the lemur fauna of Marotandrano yet (ZICOMA, 1999; Tombomadiana and Rakotondravony, 2000). To complement the existing data surveys were conducted at two sites within the reserve, Anjiabolo (16°16.8'S, 48°48.1'E; 950-1200 m; 16-23 Nov. 2004) and Riamalandy (16°17.1'S, 48°48.9'E; 730-870 m; 24-30 Nov. 2004).

At each location, two transect were used with A-1a (1000 m) and A-1b (1500 m) in Anjiabolo; R-2a (1000 m) and R-2b (1150 m) in Riamalandy. Whenever possible, existing trails were used in order to minimize forest disturbance. The observer walked slowly in the forest (approx. 1 km/h) along trails marked at 10 m cumulative intervals. The trails were selected in order to cover different types of microhabitat (valley, slopes, and crest). Surveys during the day were conducted in the morning (7:00-11:00) and in the afternoon (14:30-17:00), while nocturnal censuses were made between 18:30-22:00. At night, a headlamp was used to spot lemur eyeshine, and once detected, a maglite and binoculars were used as aids for species identification. For each contact with a lemur, the species, time of contact, transect code, microhabitat, number of individuals, height above ground the animal was first sighted, gene-

## A lemur survey of the Réserve Spéciale de Marotandrano, Madagascar

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ral activity and composition of the group, distance between the observer and the angle of the animal relative to the perpendicular, and estimate height and diameter (DBH) of the tree were noted. Whenever possible, age and sex were also recorded. Lemur densities were calculated as: number of individuals / (length of the transect x 2 x mean distance perpendicular to the trail at which the individuals were sighted) (Whitesides *et al.*, 1988). Apart from the transect surveys, other general day observations were also made. The characteristic feeding signs of *Daubentonia madagascariensis* (gnaw marks from excavation of dead wood) or sleeping sites of nocturnal species (tree holes used by *Microcebus* or *Cheirogaleus*) were noted as well as the vocalizations of some species (*Indri indri* and *Varecia variegata*). Interviews with local guides were also undertaken to collect information about the presence of lemurs not detected during the inventory.

### Results

A total of 18 diurnal and 7 nocturnal surveys and 20 diurnal and 5 nocturnal surveys were carried out at Anjiabolo and Riamalandy, respectively. In total, 12 species of lemurs were found at the two survey sites in the RS de Marotandrano, with six diurnal species (*Indri indri*, *Propithecus d. diadema*, *Eulemur fulvus albifrons*, *E. rubriventer*, *Varecia v. variegata*, *Hapalemur g. griseus*) and six nocturnal species (*Avahi laniger*, *Lepilemur mustelinus*, *Cheirogaleus major*, *Microcebus cf. rufus*, *Allocebus trichotis*, *Daubentonia madagascariensis*). Except for *D. madagascariensis*, all taxa were recorded by direct observation. The presence of *D. madagascariensis* was noted based on its characteristic feeding signs.

Twelve species were present at Anjiabolo and 11 species at Riamalandy (Table 1), thus despite representing different altitudes the lemur species richness was similar at both sites. *Eulemur rubriventer* was observed outside the transect lines and the vocalizations of *I. indri* were heard at Riamalandy. The taxonomic status of *Microcebus* occurring in the eastern rainforest of Madagascar is ambiguous (Yoder *et al.*, 2000), and we classified the *Microcebus* of the RS de Marotandrano as *Microcebus cf. rufus*.

The mean size of group for the diurnal species, an evaluation of lemur density (individuals / km<sup>2</sup>), and the abundance for diurnal and nocturnal species per transect kilometer are summarized in Tables 2 and 3.

Table 2: Average group size of diurnal lemurs ± SD, (range) and number of groups.

Species	Anjiabolo	Riamalandy
<i>I. indri</i>	2.8±1.2 (1-5) n=7	-
<i>P. d. diadema</i>	2.7±1.5 (1-4) n=3	1.6±0.5 (1-2) n=5
<i>V. v. variegata</i>	1.9±1.4 (1-6) n=14	2.3±1.2 (1-5) n=27
<i>E. f. albifrons</i>	5.6± 2.1 (2-8) n=10	4.6±2.4 (1-10) n=33
<i>E. rubriventer</i>	1.9±0.4 (1-2) n=8	#
<i>H. g. griseus</i>	2.0±1.4 (1-3) n= 2	3.7±0.6 (3-4) n=2

Table 3: Mean numbers of sighting per km transect and (mean detection distance ± SD). The detection distances are perpendicular to the transect; n = numbers of sightings.

Transect	A-1a	A-1b	R-2a	R-2b
<i>I. indri</i>	1.3 (19.3±12.1) n = 4	0.7 (51.0±39.1) n = 3		
<i>P. diadema</i>		0.25 (5.0) n = 3	0.6 (7.3±3.2) n = 4	0.17 (10.0) n = 1
<i>V. variegata</i>	1.8 (39.6±33.3) n = 10	0.8 (10.5±8.1) n = 4	1.9 (21.3±27.6) n = 11	3.8 (10.3±8.7) n = 16
<i>E. fulvus</i>	3.2 (11.2±3.6) n = 5	1.8 (13.0±15.0) n = 5	12.2 (9.6±6.8) n = 25	2.6 (8.1±5.6) n = 8
<i>E. rubriventer</i>	0.4 (8.0±2.8) n = 5	0.5 (29.6±26.6) n = 3		#
<i>H. griseus</i>	0.1 (15.0) n = 2			1.0 (7.3±6.8) n = 2
<i>A. laniger</i>	1.0 (7.0±4.24) n = 2	0.4 (7.0±0.0) n = 3	3.0 (4.8±5.0) n = 4	0.28 (14.0) n = 3
<i>L. mustelinus</i>	0.25 (3.0) n = 1	0.2 (18.0) n = 1		0.9 (3.5±1.8) n = 3
<i>C. major</i>	0.75 (12.7±7.2) n = 3	1.3 (13.3±12.8) n = 6	0.5 (3.0) n = 1	0.9 (13.0±8.2) n = 3
<i>M. cf. rufus</i>	0.5 (1.3±0.4) n = 2		1.5 (16.8±14.4) n = 3	1.7 (2.3±0.6) n = 6
<i>A. trichotis</i>	0.5 (1.5±0.7) n = 2			0.3 (8.0) n = 1
Number of species	10	8	6	9

Table 1: Densities of lemurs (ind. / km<sup>2</sup>) listed by campsite.

Family	Species	Vernacular names	Anjiabolo	Riamalandy	Conservation status
Cheirogaleidae	<i>Microcebus cf. rufus</i> (N)	Tsidy	+	375	LR
	<i>Allocebus trichotis</i> (N)	Tsidiala	+	+	EN
	<i>Cheirogaleus major</i> (N)	Tsitsihy	25	33	LR
Lepilemuridae	<i>Lepilemur mustelinus</i> (N)	Hataka, Fitsidika	38	75	LR
Lemuridae	<i>Hapalemur g. griseus</i> (D)	Bokombolo	+	13	LR
	<i>Eulemur fulvus albifrons</i> (D)	Varikosy	75	136	LR
	<i>Eulemur rubriventer</i> (D)	Varimena	10	#	VU
	<i>Varecia v. variegata</i> (D)	Varikandana	27	37	EN
Indridae	<i>Avahi laniger</i> (N)	Fotsife	44	125	LR
	<i>Propithecus d. diadema</i> (D)	Simpona	11	14	EN
	<i>Indri indri</i> (D)	Babakoto	14		EN
Daubentoniidae	<i>Daubentonia madagascariensis</i> (N)	Hahay	fd		EN
Total no. of species			12	11	

+: species present; D: diurnal; N: nocturnal; #: species sighted outside the transect; • : vocalization; fd: feeding signs. DD: data deficient; LC: least concern; VU: vulnerable; EN: endangered; CR: critically endangered; according to Mittermeier *et al.*, 2006.

## Discussion

The RS de Marotandrano is important for lemur conservation with its relatively high species diversity and relative abundance. According to IUCN criteria, 6 of the 12 species are threatened by extinction (Table 1). Furthermore, its lemur species richness is comparable to the other eastern rainforests such as the Réserve Naturelle Intégrale de Betampona (Britt *et al.*, 1999), the Parc National de Verezanantsoro, the RS d'Ambatovaky (Mittermeier *et al.*, 1994), and the Makira Plateau forest (Raharivololona *et al.*, 2003). This reserve contains more species than RS de Tampoketsa-Analamaitso (Ralison, 2000).

The density and group size of *Indri indri* and *Varecia variegata* at Marotandrano are similar to sites in other eastern rainforests (e.g. Petter *et al.*, 1977; Pollock, 1979). *Eulemur rubriventer* was observed at Anjibolo frequently at elevations above 1100 m. This species was noted outside the transects at 850 m at Riamalandy. One group at Marotandrano was composed of three individuals, including an adult male, an adult female and a sub-adult.

The density of *Microcebus* at Riamalandy was notably higher than in other eastern humid forests (Petter and Petter-Rousseaux, 1964; Ganzhorn, 1988). It has been noted previously that *Microcebus* is able to survive in human-modified habitats (e.g. Petter *et al.*, 1977), and it is more abundant in secondary than primary forests in some regions of Madagascar.

*Varecia v. variegata* was not observed in the nearby RS de Tampoketsa-Analamaitso (Ralison, 2000), to the west of RS de Marotandrano. Indeed, the western boundary of the geographical distribution of this subspecies may be the RS de Marotandrano.

Until recently, *Allocebus trichotis* was thought to have a very restricted geographical distribution and was only found in the Mananara-Nord Biosphere Reserve (Meier and Albignac, 1991). On the basis of more recent studies it is now known to have a broad distribution in eastern Madagascar (Rakotoarison, 1995; Rakotoarison *et al.*, 1997; Schmid and Smolker, 1998; Sterling and Rakotoarison, 1998; Garbutt, 2001; Goodman and Raselimanana, 2002; Mittermeier *et al.*, 2006).

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## References

- Britt, A.; Axel, A.; Young, R. 1999. Brief surveys of two classified forests in Toamasina Province, eastern Madagascar. *Lemur News* 4: 25-27.
- Burney, D.A., Burney, L.P.; Godfrey, L.R.; Jungers, W.L.; Goodman, S.M.; Wright, H.T.; Jull A.J.T. 2004. A chronology for late prehistoric Madagascar. *J. Hum. Evol.* 47: 25-63.
- CEPF 2002. Application Process. Ecosystems of Madagascar. [www.cepf.net/he/grant\\_profile\\_madagascar.htm](http://www.cepf.net/he/grant_profile_madagascar.htm).
- Ganzhorn, J.U. 1988. Food partitioning among Malagasy primates. *Oecologia* 75: 436-450.
- Garbutt, N. 2001. Brief observation of Hairy-eared dwarf lemur (*Allocebus trichotis*) in Analamazaotra Special Reserve, eastern Madagascar. *Lemur News* 6: 37.
- Goodman, S.M.; Raselimanana, A.P. 2002. The occurrence of *Allocebus trichotis* in the Parc National de Marojejy. *Lemur News* 7: 21.
- Green, G.M.; Sussman, R.W. 1990. Deforestation history of the eastern rainforest of Madagascar with satellite images. *Science* 248: 212-215.
- Meier, B.; Albignac, R. 1991. Rediscovery of *Allocebus trichotis* in north east Madagascar. *Folia Primatol.* 56: 57-63.
- Mittermeier, R.A.; Konstant, W.R.; Hawkins A.F.A.; Louis, E.E.; Langrand, O.; Ratsimbazafy, H.J.; Rasoloarison, M.R.; Ganzhorn, J.U.; Rajaobelina, S.; Tattersall, I.; Meyers, D.M. 2006. *Lemurs of Madagascar*. 2<sup>nd</sup> ed. Conservation International, Washington D.C.
- Petter J.-J.; Albignac, R.; Rumpler, Y. 1977. Mammifères: Lémuriens (Primates prosimiens). Faune de Madagascar No. 44. ORSTOM-CNRS. Paris.
- Petter, J.-J. ; Petter-Rousseaux, A. 1964. Première tentative d'estimation des densités de peuplement des lémuriens malgaches. *La Terre et la Vie* 18: 427-435.
- Pollock J.I. 1979. Spatial distribution and ranging behavior in lemurs. Pp. 359-409. In: G.A. Doyle, R.D. Martin (eds.). *The Study of Prosimian Behavior*. Academic Press, New York.
- Raharivololona B.M.; Ratsisetraina, R.I.; Day, S.R. 2003. Rapport d'inventaire rapide dans les forêts orientales du plateau du Makira. Projet Forêt de Makira, Madagascar. Wildlife Conservation Society, Antananarivo.
- 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.; Zimmermann, H.; Zimmermann, E. 1997. First discovery of the hairy-eared dwarf lemur (*Allocebus trichotis*) in a highland rain forest of eastern Madagascar. *Folia Primatol.* 68: 86-94.
- Ralison J.M. 2000. Observations of lemurs in the Réserve Spéciale de Tampoketsa-Analamaitso. *Lemur News* 5: 35.
- 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*, n°90.
- Sterling E.J.; Rakotoarison, N. 1998. Rapid assessment of primate species richness and density on the Masoala Peninsula, eastern Madagascar. *Folia Primatol.* 69 (Suppl. 1): 109-116.
- Tombomadiana S.; Rakotondravony, R. 2000. Inventaire des lémuriens de la Réserve Spéciale de Marotandrano. *Lemur News* 5: 35.
- Whitesides G.H.; Oates J.F.; Green S.M.; Kluberanz R.P. 1988. Estimating primate densities from transects in a West African rain forest: A comparison of techniques. *J. Anim. Ecol.* 57: 345-367.
- Yoder, A.D.; Rasoloarison, R.M.; Goodman, S.M.; Irwin, J.A.; Atsalis, S.; Ravosa, M.J.; Ganzhorn, J.U. 2000. Remarkable species diversity in Malagasy mouse lemurs (Primates, *Microcebus*). *Proceedings National Academy of Sciences* 97: 11325-11330.
- ZICOMA (1999): Les Zones d'Importances pour la Conservation des Oiseaux à Madagascar. Projet ZICOMA, Antananarivo.

## Totale disparition du Propithèque de Coquerel (*Propithecus verreauxi coquereli*) du nord de la réserve spéciale Bora (Province de Mahajanga)

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Le Propithèque de Coquerel (*Propithecus verreauxi coquereli*) a une large répartition dans l'ouest de Madagascar (Fig. 1). Il se trouve au nord de la rivière Mahavavy et la réserve Bora est en extrême limite nord-est de son aire de distribution. La réserve spéciale Bora, d'une superficie de 4780 ha, est limitée au nord par le fleuve Anjingo et au sud par le mont Bora. Elle est traversée, en son milieu, par la route de Bealanana. Randrianambinina *et al.* (2003) ont confirmé 4 espèces de lémuriens dans cette réserve: *Eulemur f. fulvus*, *Propithecus v. coquereli*, *Micocebus ravelobensis* et *Avahi occidentalis*. La présence de *Cheirogaleus medius* et *Daubentonia madagascariensis* étaient signalée par les villageois. Nos recherches entreprises dès l'an 2000 nous ont permis de trouver dès la première année une famille de Propithèques de 4 individus. Par la suite les recherches ont été moins fructueuses et ce n'est qu'en 2003 que nous avons retrouvé 1 individu isolé. En 2004 le même individu fut observé seul à plusieurs reprises avant d'être vu avec un second animal, ce qui nous a redonné pas mal d'espoir. La même année ces deux individus ont été observés par Olivieri *et al.* (2005). Ces derniers décrivaient déjà la réserve spéciale Bora comme étant dans un état pitoyable. Attaquée de toutes parts par les forestiers clandestins et les innombrables feux de forêt elle ne se réduisait plus qu'à une peau de chagrin. De tout temps cette réserve spéciale n'a fait l'objet d'aucune



Fig. 1: *Propithecus coquereli*.

surveillance. Pourtant les mêmes auteurs y ont observé 4 espèces et soupçonnaient la présence de 2 autres (Olivieri *et al.*, 2005). A part les 2 espèces citées plus haut il s'agit d'un Microcèbe (*Microcebus* sp.) et de l'Avahi occidental (*Avahi occidentalis*). Les deux espèces soupçonnées sont le petit Cheirogale (*Cheirogaleus medius*) et l'Aye-aye (*Daubentonia madagascariensis*). Cette dernière peut être certifiée par la découverte en 2003 d'une dépouille suspendue à un arbre (Koenig, 2005). En ce qui concerne le Propithèque de Coquerel le début de l'année a été plutôt faste avec la découverte d'une seconde famille de 4 (peut être 5) individus, dont au minimum 1 jeune de l'année, près du village Ambohimangai Bora en limite de réserve. Les deux familles distantes d'environ deux kilomètres semblaient prospérer et on aurait pu s'attendre à ce que le couple trouvé en 2004 ait un jeune lors de la prochaine saison de reproduction.

Malheureusement le mois d'octobre 2005 a été catastrophique pour la réserve spéciale Bora. Les feux répétés ont eu entièrement raison de cette réserve qui n'a plus d'existence véritable (Fig. 2). Plusieurs prospections dans les décombres des derniers arbres calcinés n'ont donné aucun résultat. Il faut simplement espérer que les lémuriens de toutes espèces aient réussi à fuir, ce qui n'est pas du tout certain, surtout en ce qui concerne les microcèbes. Deux dernières prospections ont eu lieu les 13 et 14 décembre 2005 et le premier jour nous avons eu la malheureuse surprise de découvrir, attachée à un arbre au bord de la route à environ 150 m du village d'Ambodimangai Bora (donc en limite de la réserve Bora), une queue de Aye-aye. Cet acte doit dater, d'après l'état de la queue, de seulement 1 ou 2 jours. Les derniers individus de cette espèce poussés dans leurs ultimes retranchements par les feux sont maintenant en plus massacrés par la population à cause de croyances stupides. Le dernier refuge, le plus au nord-est de Madagascar des Propithèques de Coquerel n'existe donc plus et leur disparition est définitive en ce lieu.



Fig. 2: La forêt de Bora brûlée au mois de décembre 2005.

### Bibliographie

- Koenig, P. 2005 Découverte d'une dépouille de Aye-aye (*Daubentonia madagascariensis*) dans le nord-ouest de Madagascar. Lemur News 10: 6-7.  
Olivieri, G.; Craul, M.; Radespiel, U. 2005 Inventaire des lémuriens dans 15 fragments de forêt de la province de Mahajanga. Lemur News 10: 11-16.



## Rapid assessment of lemurs in southern and southwestern Forests of Madagascar

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**Key words:** Lemur communities, abundance and density, southern and southwestern forests, Madagascar.

Between mid-February and April 2005, lemur surveys were conducted in the southern and southwestern forests of Madagascar. The sites were Tongaenoro, Antabore, Vombositse in the spiny bush and Vohondava, Andrendahy and Mahavelo in xerophytic forest. Transect line method was used to detect the presence and the relative abundance of lemurs. General observations and interviews with local guides were also undertaken to supplement the transect data. Furthermore, live traps were set to verify the identity of small nocturnal lemurs. A total of 5 species were identified during the survey, including two diurnal species (*Propithecus v. verreauxi* and *Lemur catta*) and three nocturnal species (*Lepilemur leucopus*, *Microcebus murinus*, and *M. griseorufus*). Lemur diversity was low in Tongaenoro and Antabore (3 species), 4 species at Vohondava, Andrendahy, and Mahavelo, and 5 species at Vombositse. *Cheirogaleus medius* was not noted during the survey.

In spite of the considerable efforts by different authorities for the conservation of fauna and flora in Madagascar, much of island's native biodiversity remains highly threatened by the regression of natural habitat. The natural forest remaining of Madagascar have diminished increasingly due to fires, extensive grazing by cattle and goats, conversion to charcoal and sometimes slash-and-burn agriculture (ANGAP, 2001). The arid ecosystems are of particular importance for conservation and should be a priority because the southern forests are poorly represented in the protected area network. Habitat destruction is the main threat to the lemurs of southern Madagascar (Mittermeier *et al.* 2006) and some species are also hunted for food or collected for pets. Previous surveys have shown that lemur diversity in the south is the lowest in Madagascar and is usually composed of *Propithecus v. verreauxi*, *Lemur catta*, *Lepilemur leucopus*, *Cheirogaleus medius*, and *Microcebus murinus* (Fenn *et al.*, 1999; Goodman *et al.* 2002). The aim of this paper is to supplement the information on lemur species and abundance in the unprotected southern forests of Madagascar. This is to extend the database on the distribution of these animals to help with biogeographical studies and conservation action plans.

### Methods

Six study sites located in the Province de Toliara were visited between mid-February and April 2005. Three

sites were located in the Plateau calcaire de Mahafaly (Tongaenoro, Antabore and Vombositse) and 3 in the Amboasary region (Vohondava, Andrendahy and Mahavelo). Names and positions are presented in Table 1 and Figure 1.

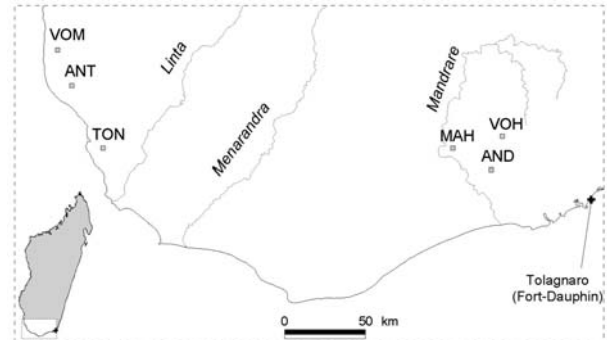


Fig. 1: Location of study sites (figure drawn by L. Wilomé).

Table 1: Characteristics of location during surveys in the south and southwest of Madagascar. All surveys were carried out in 2005.

Sites	Coordinates	Alt. (m)	Forest types	Time period	Mean temp. (°C/day)	Mean Rain (mm/day)
Tongaenoro (TON)	24°44'S, 44°01'E	120	Spiny bush	18-25 Feb	28.3	3.81
Antabore (ANT)	24°23'S, 43°50'E	100	Spiny bush	26 Feb-05 Mar	28.7	0.00
Vombositse (VOM)	24°11'S, 43°45'E	100	Spiny bush	17-24 Apr	25.4	0.00
Vohondava (VOH)	24°41'S, 46°27'E	220	Xerophitic	13-22 Mar	25.3	4.90
Andrendahy (AND)	24°52'S, 46°23'E	100	Xerophitic	27 Mar-03 Apr	26.5	0.01
Mahavelo (MAH)	24°45'S, 46°09'E	110	Xerophitic	05-12 Apr	23.2	0.08

Lemur density was estimated using transect methods. The observer walked slowly in the forest during the day (07:00-10:30 and 15:00-17:30) and at night (18:30-22:00). One transect of each was used in Tongaenoro (1000 m), Antabore (1500 m), Andrendahy (1000 m), Mahavelo (1000 m), and Vombositse (1200 m). At Vohondava 3 transects were established (1000 m, 1300 m, and 2000 m). Night surveys used a frontal lamp of weak intensity for detecting the species. Once detected, a maglite and binoculars were used for species identification. Species, time of contact, transect code, number of individuals, height above the ground where the animal was first sighted, general activity and composition of the group, distance between the observer and the animal with the angle of the perpendicular, estimate height and diameter (DBH) of the tree were noted. Lemur densities were calculated as: number of individuals / (length of the transect x 2 x mean distance perpendicular to the trail at which the individuals were sighted (Whitesides *et al.* (1988).

Whenever possible, age and sex were also recorded. Apart from the transect survey some active research have been done for information on lemurs not detected by transect lines. Furthermore, trapping was used to aid the identification of small nocturnal lemurs. Twenty Sherman traps were placed along the trail at heights of 0.5 to 2.0 m above the ground. Visits were made in the morning at 6:00 am (collection of animals captured) and in the afternoon at 5:30 pm (release of animals). Captured animals were always released at the site of capture.

Finally, interviews with local guides were undertaken to collect information about the presence of lemurs not detected in the methods mentioned above.

## Results

**Species diversity:** A total of 5 lemur species were found during the survey, consisting of two diurnal species (*Propithecus v. verreauxi*, and *Lemur catta*) and three lemur nocturnal species (*Lepilemur leucopus*, *Microcebus murinus*, and *M. griseorufus*). *Cheirogaleus medius* was not recorded at any of the 6 sites. Species richness was low in Tongaenoro and Antabore where only 3 species were present. Vohondava, Andrendahy, and Mahavelo presented 4 lemur species and only the site of Vombositse contained all 5 species (Table 2).

Table 2: Distribution of lemur species listed by campsite.

Family	Species	Vernacular names	TON	ANT	VOM	VOH	AND	MAH
Cheirogaleidae	<i>Microcebus murinus</i> (N)	tily, hataka		#	+	+	+	+
	<i>Microcebus griseorufus</i> (N)	tily, hataka	+	+	+		+	
Lepilemuridae	<i>Lepilemur leucopus</i> (N)	ongiky, songiky		*	#	+	+	+
Lemuridae	<i>Lemur catta</i> (D)	maki, hira	#	+	#	#	*	+
Indridae	<i>Propithecus v. verreauxi</i> (D)	sifaka	#	*	#	+	#	+
Total no. of species			3	3	5	4	4	4

+: Species present; D: diurnal; N: nocturnal; #: species sighted outside the transect walk; \*: by interviews with local guides

External characteristics of the different species are described below.

*Propithecus verreauxi verreauxi* (A. Grandidier, 1867):

The body has a white fūr, and the top of the head is brown chocolate or black. The ventrum had a yellow light color. Some individuals have a gray task in the back. An individual entirely dark brown fūr was observed in Mahavelo. Only the around the eye, the tail, and the inside of the leg have a white color. This color variation of *Propithecus v. verreauxi* could be the same as that has been observed in Isalo (e.g. Mittermeier *et al.*, 2006).

*Lemur catta* (Linnaeus, 1758): An average of  $6.1 \pm 3.4$  (n=12) was calculated and groups surveyed in Tongaenoro and Antabore were found close to the craters.

*Lepilemur leucopus* (Forsyth Major, 1894): The body fūr is of light gray color. The foot is white. The length of the head-body and the tail are nearly the same. Ears are rounded. Two individuals using vocalizations for their communication were often found in Vohondava and Andrendahy.

*Microcebus murinus* (J. F. Miller, 1777): The dorsal pelage is ochre yellow. The ventral pelage is of light neutral gray. The cinnamon back stripe is largely observed and is diffused along the back to the base of the tail. The patch above the nose and between eyes is white. The tail is cinnamon.

*Microcebus griseorufus*: The upperparts is gray clear whereas the underparts are white pine without grayish

underfūr. Eyes and ears are relatively large. The tail has dorsally brownish color and ventrally light color. Hairs at distal tip of the tail have dark color. The cinnamon back stripe is diffused.

Estimates of lemur densities (diurnal and nocturnal species) are summarized in Table 3. All sites surveyed had high densities of *Microcebus* spp. Tongaenoro and Vohondava have had more individuals than the other sites. Densities were low in Mahavelo and Antabore. More *Lepilemur leucopus* were found at Andrendahy than at Vohondava and Mahavelo. For diurnal species, the density of *Lemur catta* was high in Mahavelo and low in Antabore. *Propithecus v. verreauxi* was found in all sites except Antabore Forest. Its density was estimated only in Vohondava and Mahavelo with high density at the former site.

For nocturnal species, *Microcebus* spp. was most often encountered in Tongaenoro and Antabore respectively 70.2 and 79.2 %. The number of sightings of *Lepilemur leucopus* was higher in Andrendahy (19.2 %) than in Vohondava (7.4 %), Vombositse (2.9 %), and Mahavelo (1.5 %). For diurnal lemurs, *Lemur catta* was most common and found at every site except Andrendahy. *Propithecus v. verreauxi* was found at 5 sites and was most commonly encountered at Vohondava (47.1 %), while it was absent from Antabore. Group sizes of diurnal lemurs are presented in Table 4.

Table 3: Approximate density of lemurs recorded (individuals per km<sup>2</sup> transect). # = species sighted outside the transect walks.

Sites	Trans.	M. spp.	L. leucopus	L. catta	P. verreauxi
TON	1a	1000		#	#
ANT	2a	300		14	
VOM	6a	273	#	#	#
VOH	3a	1077	167	#	264
	3b	1046	143	#	116
	3c			#	75
AND	4a	569	239		#
MAH	5a	221	18	256	20

Table 4: Average group size of diurnal lemurs ( $\pm$  SD). Values in brackets represent the range of group sizes; n = number of groups sighted.

Species	TON	ANT	VOH	AND	MAH	VOM	Average
<i>P. verreauxi</i>	5.0 n=1		4.8 $\pm$ 1.91 (4-8) n=12	5.8 $\pm$ 1.64 (4-8) n=5	3.1 $\pm$ 1.77 (1-6) n=7	3.0 n=1	4.5 $\pm$ 1.94 (1-8) n=26
<i>L. catta</i>	4.5 $\pm$ 3.53 (2-7) n=2	3.3 $\pm$ 1.15 (2-4) n=3	4.5 $\pm$ 4.94 (1-8) n=2		8.2 $\pm$ 0.50 (8-9) n=4	12.0 n=1	6.1 $\pm$ 3.39 (1-12) n=12

Table 5 shows that the number of *Microcebus* spp. seen per kilometer of was higher in Tongaenoro than at the other sites. The abundance of *Lepilemur leucopus* varied from 0.25 ind./km to 3.5 ind./km with the maximum observed in Andrendahy. For diurnal species, the abundance of *Lemur catta* was high (3.6 ind./km) in Mahavelo. The abundance of *Propithecus v. verreauxi* was high on the transect 3a in Vohondava (3.4 ind/km).

Table 5: Average number of individuals per kilometer transect found in the different transects. The values in brackets represent the distance of detection (m) of the animal with standard deviation; # species sighted outside the trail.

Sites	Trans.	<i>Microcebus</i> spp.	<i>Lepilemur leucopus</i>	<i>Lemur catta</i>	<i>Propithecus v. verreauxi</i>
TON	1a	12.0 (4.9±4.1)		#	#
ANT	2a	5.5 (4.8±3.2)		0.8 (10.0)	
VOM	6a	3.0 (4.7±3.3)	#	#	#
VOH	3a	7.0 (3.6±2.3)	2.0 (5.2±2.9)	#	3.4 (7.0±3.6)
	3b	9.6 (4.0±1.8)	1.1 (6.0±3.5)	#	2.3 (12.5±3.5)
	3c	*	*	#	1.2 (10.0)
AND	4a	7.5 (5.6±3.0)	3.5 (5.6±2.6)		#
MAH	5a	2.5 (4.8±2.3)	0.25 (7.0)	3.6 (42.3± 32.2)	2.0 (29.5±47.2)

### Discussion

Although the arid formation in the south has a low lemur diversity (Goodman *et al.*, 2002; Rasoarimanana, 2005), many studies prove its high density for certain species. We found that the density of *Microcebus* spp. in some sites of survey is notably high. Some authors reported the same case in other areas of dry forests (Martin, 1972; Hladik *et al.*, 1980; Ausilio and Raveloarino, 1993). The presence and the abundance of *Microcebus* spp. at all sites could explain its tolerance in the southern condition (spiny bush and xerophytic forest). Otherwise, *Microcebus* is able to survive in altered habitats (Mittermeier *et al.*, 2006). *M. murinus* is more numerous in the spiny forest parcels of the Parc National d'Andohahela than in the gallery forest (M. Pidgeon, in lit.). Nash (2000) highlighted the abundance of *M. griseorufus* outside the Réserve Spéciale de Beza Mahafaly.

The abundance of *Lepilemur leucopus* was higher in xerophytic forest than in spiny bush of the Plateau calcaire Mahafaly. It was absent in Tongaenoro and Antabore and rarely sighted in Vombositse. Charles-Dominique and Hladik (1971) found similar differences between gallery and spiny bush for *Lepilemur leucopus* in Berenty.

*Lemur catta* was found at all sites except Andrendahy. However, local villagers signal its presence there. It was also found in the nearby Masiabiby Forest (Fenn *et al.*, 1999). Number and transect length used for certain sites were not sufficient to estimate the densities of diurnal lemurs. When estimating lemur density in the arid formation. Thus, it is necessary to increase the number and length of transect.

In conclusion, this survey shows that the dry forests of the south and southwestern of Madagascar have low lemur diversity. Although this natural formation has few lemur species, the density of certain species seems to be high. Finally, this region constitutes not only a good place for *Microcebus griseorufus* but also an option of ecotourism to appreciate the beauty of the arid ecosystem for its high lemur density.

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### References

- ANGAP 2001. Plan de Gestion du Réseau National des Aires Protégées de Madagascar.
- Ausilio, E.; Raveloarino, G. 1993. Statut et densité des espèces de lémuriers dans la région d'Antsalova (ouest de Madagascar) (Forêts de l'Antsingy, de Tsimembo et de la région de Tsiandro). Unpublished report to UNESCO-Project 507/INT/40. Antananarivo, Madagascar.
- Charles-Dominique, P.; Hladik, C.M. 1971. Le *Lepilemur* du Sud de Madagascar: Ecologie, alimentation et vie sociale. *La Terre et la Vie* 25: 3-66.
- Fenn, M.; Randriamanalina, M.H.; Raharivololona, B.M. 1999. Inventaire biologique dans le Sud malgache en vue d'une conservation pour l'écorégion de la forêt sèche de Madagascar: volet Primatologie. *Lemur News* 4: 23-25.
- Goodman, S.M.; Raheirilalao, M.J.; Rakotomalala, D.; Rakotondravony, D.; Raselimanana, A.P.; Razakarivony, H.V.; Soarimalala, V. 2002. Inventaire des vertébrés du Parc National de Tsimanampetsotsa (Toliara). *Akon'ny Ala* 28: 1-36.
- Hladik, C.M., Charles-Dominique, P.; Petter, J.-J. 1980. Feeding strategies of five nocturnal prosimians in the dry forest of the west coast of Madagascar. Pp. 41-73. In: P. Charles-Dominique, H.M. Cooper, A. Hladik, C.M. Hladik, E. Pages, G.F. Pariente, A. Petter-Rousseaux, J.-J. Petter, A. Schilling (eds.), *Nocturnal Malagasy Primates: Ecology, Physiology and Behavior*. Academic Press, New York.
- Martin, R.D. 1972. A preliminary field study of the lesser mouse lemur (*Microcebus murinus* J.F. Miller 1777). *Zeitschrift für Tierpsychologie*, Supplement 9: 43-89.
- Mittermeier, R. A.; Konstant, W.R.; Hawkins A.F.A.; Louis, E.E.; Langrand, O.; Ratsimbazafy, H.J.; Rasoarison, M.R.; Ganzhorn, J.U.; Rajaobelina, S.; Tattersall, I.; Meyers, D.M. 2006. *Lemurs of Madagascar*. 2<sup>nd</sup> ed. Conservation International, Washington D.C.
- Nash, L. 2000. Encounter rate estimates on *Lepilemur leucopus* and *Microcebus murinus* at Beza Mahafaly Special Reserve, Southwestern Madagascar. *Lemur News* 5: 38-40.
- Rasoarimanana, J. 2005. Suivi des lémuriers diurnes dans le Parc National d'Andohahela. *Lemur News* 10: 27-29.
- Whitesides, G.H.; Oates, J.F.; Green, S.M.; Kluberanz, R.P. 1988. Estimating primate densities from transects in a West African rain forest: A comparison of techniques. *J. Anim. Ecol.* 57: 345-367.

## Spider-catcher – Predation of *Eulemur fulvus* on an orb web spider

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Both a biodiversity and tourist hot spot (Dolch 2003), Andasibe has recently witnessed interesting new lemur observations. Surveys and captures by MITSINJO have led to the discovery of a population of *Prolemur simus* (Dolch *et al.*, 2004) and – in collaboration with the Zoo Zürich – a new species of Mouse Lemur, *Microcebus lehilahytsara* (Kappeler *et al.*, 2005).

Also of interest is the recent observation of unexpected food habits among several lemur species of the region. Here we report an individual of *Eulemur fulvus* preying on an orb-web spider (Araneidae). During a walk in the Analamazaotra forest in February 2006, a group of *Eulemur fulvus* was observed. The group members were feeding on the fruits of forest plants, when the attention of one individual was captured by the presence of an orb-web spider (cf. *Caerostris* sp.). After a first curious inspection of the spider, the lemur withdrew. Only moments later, the individual approached again, grabbed the spider with one hand and ate it. Although the cobweb appeared to irritate the lemur, it finally managed to remove it and chewed on the spider with obvious relish. Since plants usually form the bulk of lemur diet, predation on invertebrates has often gone unnoticed. The two predominantly folivorous lemur families (Indridae, Lepilemuridae) do not appear to feed on animal prey at all. Most lemur species known to regularly prey on invertebrates belong to the Cheirogaleidae (Mittermeier *et al.*, 2006). This is especially the case for both *Allocebus* and *Microcebus* (e.g. Atsalis, 1999b). In *Cheirogaleus cf major* invertebrate prey appears to constitute only a minor part of all food items (Ganzhorn, 1988, Wright and Martin, 1995). If invertebrates are taken, Cheirogaleidae (and Daubentonidae – see Sterling, 2003) mostly prey on insects. Spiders are an unusual diet (but see Fietz, 2003), and only *Mirza* is known to more often feed on arachnids (Pagès, 1980; Andrianarivo, 1981; Kappeler, 2003).

Lemuridae, although much more occasionally than Cheirogaleidae, are also known to include invertebrates in their diet. *Lemur catta*, *Eulemur coronatus*, *E. macaco* and *E. sanfordi* have all been reported to prey on invertebrates (Mittermeier *et al.*, 2006). *E. sanfordi* seems to be the only species that has been reported to also feed on spiders (Freed, 1996). *Eulemur* species are largely frugivorous (Overdorff and Johnson, 2003) and *E. fulvus* even has a highly variable diet of more than a hundred plant species (Rasmussen, 1999). Our observation of *E. fulvus* preying on a spider may be a further indication of invertebrate prey more often included in lemurid diet than previously thought.

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#### References

- Andrianarivo, C. 1981. Etude comparée de l'organisation sociale chez *Microcebus coquereli*. Mémoire DEA, Université d'Antananarivo.
- Atsalis, S. 1999. Diet of the Brown Mouse Lemur (*Microcebus rufus*) in Ranomafana National Park, Madagascar. *Int. J. Primatol.* 20: 193-199.
- Dolch, R. 2003. Andasibe (Périnet): are current efforts sufficient to protect Madagascar's biodiversity hotspot? Pp. 1480-1485. In: *The Natural History of Madagascar*. S.M. Goodman, J.P. Benstead (eds.). University of Chicago Press, Chicago.
- Dolch, R.; Hilgartner, R.D.; Ndriamiary, J.N.; Randriamahazo, H. 2004. The grandmother of all bamboo lemurs – evidence for the occurrence of *Hapalemur simus* in fragmented rainforest surrounding the Torotorofotsy marshes, Central Eastern Madagascar. *Lemur News* 9: 24-26.
- Fietz, J. 2003. Primates: *Cheirogaleus*, Dwarf Lemurs or Fat-tailed Lemurs. Pp. 1307-1309. In: *The Natural History of Madagascar*. S.M. Goodman, J.P. Benstead (eds.). University of Chicago Press, Chicago.
- Freed, B.Z. 1996. Co-occurrence among Crowned Lemurs (*Lemur coronatus*) and Sanford's Lemur (*Lemur fulvus sanfordi*) of Madagascar. Ph.D. Thesis, Washington University, St. Louis.
- Ganzhorn, J.U. 1988. Food partitioning among Malagasy primates. *Oecologia* 75: 436-450.
- Kappeler, P.M. 2003. *Mirza coquereli*, Coquerel's Dwarf Lemur. Pp. 1316-1318. In: *The Natural History of Madagascar*. S.M. Goodman, J.P. Benstead (eds.). University of Chicago Press, Chicago.
- Kappeler, P.M.; Rasoloarison, R.M.; Razafimanantsoa, L.; Walter, L.; Roos, C. 2005. Morphology, behaviour and molecular evolution of giant mouse lemurs (*Mirza* spp.) Gray, 1870, with description of a new species. *Primate Report* 71: 3-26.
- Mittermeier, R.A.; Konstant, W.R.; Hawkins A.F.A.; Louis, E.E.; Langrand, O.; Ratsimbazafy, H.J.; Rasoloarison, M.R.; Ganzhorn, J.U.; Rajaobelina, S.; Tattersall, I.; Meyers, D.M. 2006. *Lemurs of Madagascar*. 2<sup>nd</sup> ed. Conservation International, Washington D.C.
- Overdorff, D. J.; Johnson, S. 2003. Eulemur, true lemurs. Pp. 1320-1324. In: *The Natural History of Madagascar*. S.M. Goodman, J.P. Benstead (eds.). University of Chicago Press, Chicago.
- Pagès, E. 1980. Ethoecology of *Microcebus coquereli* during the dry season. Pp. 97-116. In: *Nocturnal Malagasy Primates*. P. Charles-Dominique, H.M. Cooper, A. Hladik, C.M. Hladik, E. Pagès, G.F. Pariente, A. Petter-Rousseaux, J.J. Petter, A. Schilling (eds.). Academic Press, New York.
- Rasmussen, M.A. 1999. Ecological influences on activity cycle in two cathemeral primates, the Mongoose Lemur (*Eulemur mongoz*) and the Common Brown Lemur (*Eulemur fulvus fulvus*). Ph. D. Dissertation, Duke University, Durham, NC.
- Sterling, E. 2003. *Daubentonia madagascariensis*, Aye-aye. Pp. 1348-1351. In: *The Natural History of Madagascar*. S.M. Goodman, J.P. Benstead (eds.). University of Chicago Press, Chicago.
- Wright, P.C.; Martin, L.B. 1995. Predation, pollination and torpor in two nocturnal prosimians - *Cheirogaleus major* and *Microcebus rufus*. Pp. 45-60. In: *Creatures of the dark*. L. Alterman, G.A. Doyle, M.K. Izard (eds.). Plenum Press, New York.

## Activity Budget, Ranging, and Group Size in Silky Sifakas (*Propithecus candidus*)

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Measures of ranging, activity budget, group size, and life history are crucial for both conservation management and hypothesis testing in behavioral ecology. Group size and ranging information are only currently available from two of the four species of rainforest sifaka (Sussman, 2000). Published rainforest sifaka activity budgets are presently available only from *Propithecus edwardsi* (Hemingway, 1999), although the activity budget of *Propithecus d. diadema* (and *Indri*

*indri*) can be found in Powzyk's (1998) PhD Dissertation. As the first of three objectives of this report, silky sifaka (*Propithecus candidus*) ranging, group size, and life history data are presented and compared to that of other sifakas. Silky sifakas have been elevated to species rank recently (Mayor *et al.*, 2004), and are one of the Top 25 most endangered primates (Mittermeier *et al.*, 2005; Fig. 1). As the second goal, the first silky sifaka daily activity budget is presented. Finally, lemur females may feed more than males and perhaps be less vigilant (Overdorff, 1998; Wright, 1999; but for a contrary evidence see: Gould *et al.*, 1997; Hussmann and Kappeler, 1998; Hemingway, 1999). Thus I test the prediction that these general activity budgets will demonstrate more feeding and less movement for females than males.



Fig. 1: *Propithecus candidus* male (photo by Eric Patel).

### Methods

All data for this report, except 'social structure', 'mean group size', and 'range in group size' were collected on the group of 8 silky sifakas at Camp 2 (775 m; 49° 45.7' S / 14° 26.0' E) of Marojejy National Park (Fig. 2) from August 3 2001 - November 18 2001 and July 24, 2002 to June 12, 2003. The group consisted of 1 fully adult male, 2 young or subadult males, 2 adult females, 1 juvenile male, and 2 female infants. The extremely steep cliffs of the Marojejy mountains and the official prohibition against the creation of any sort of trail system precluded the intensive study of more than 1 group. 'Social structure', 'mean group size', and 'range in group size' were calculated from encounters with the following silky sifaka groups: 1) Camp 2 of Marojejy, 2) Between Camp 2 and Camp 3 of Marojejy, 3) Camp 3 of Marojejy,

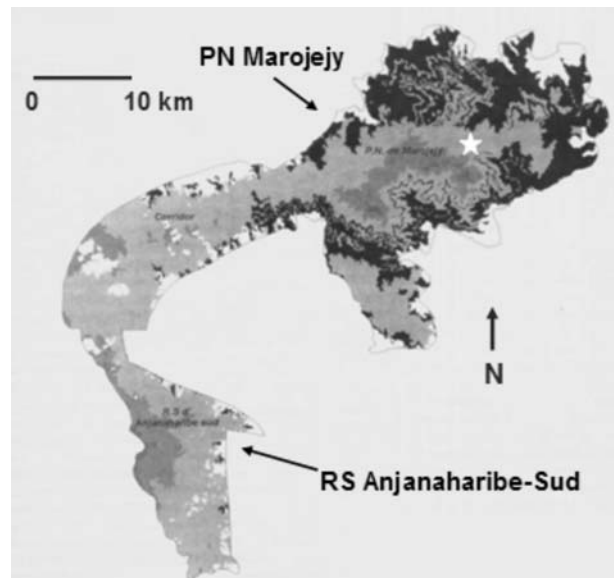


Fig. 2: Map of Marojejy National Park and Anjanaharibe-Sud Special Reserve Location of Marojejy Camp 2 and 3 (marked by star); from Garreau and Manant-sara (2003).

4) Site 1a of Anjanaharibe-Sud (see Schmid and Smolker 1998). Further details about Camp 2 and Camp 3 of Marojejy can be found in Goodman (2000). 'Home range size' and 'elevation' were calculated using a Garmin eTrex Vista GPS in the more open regions along the periphery of the home range, such as river beds. 'Daily path length' was calculated from 85 dawn to dusk follows using a Sportline pedometer calibrated to the local terrain. 'Daily travel duration' was calculated using a Timex Ironman stopwatch during 85 dawn to dusk follows. During stationary rest and feeding periods, the stopwatch was paused. 'Activity budget' presented here was calculated from 128 continuous random 30 minute focal animal samples using an ethogram of 64 behaviors. For this analysis, only uninterrupted focals of adult males and females were included. Continuous focal animal sampling was used because, although much more labor intensive than more commonly used instantaneous behavior samples, it provides a more accurate measure of the duration of behaviors (Altmann, 1974). After the completion of behavioral data collection, behaviors were re-coded into 6 mutually exclusive categories for the activity budget: Forage, Move, Sleep, Rest, Social, and Other (scent-marking, vocalizations, directed gaze, urination/defecation).

Mating season was considered the months of November, December, and January based upon personal observation of mountings, long-term data from *P. edwardsi* (Pochron *et al.*, 2005), and the birth of infants in late June or early July.

### Results

Six different groups were encountered in both Marojejy and Anjanaharibe-Sud. These groups ranged in size from 2 to 9 individuals with a mean group size of 4.7. The social structure was 'variable' with three groups polygynandrous and three groups pair-living. The main study group at Camp 2 of Marojejy National Park had a home range size (100 % MCP) of 44 hectares. Elevation ranged from 775 m at Camp 2 up to 1300 m. On several occasions, the group ascended 525 m in vertical eleva-

tion from the lowest to the highest elevation in a single day. Daily path length averaged  $712 \pm 502$  m while mean daily travel duration was a little under 1 hour at  $57.5 \pm 25.9$  min. Table 1 compares ranging and group size across different *Propithecus* taxa. Three infants were born during the study. Litter size was always one. Mean inter-birth interval was 1.67 years which deviates from the expectation of 2 years that is typical of rainforest sifakas. In this study, the oldest adult female gave birth to a healthy infant in consecutive years.

Table 1: Comparisons of sifaka ranging and group size.

	Home Range (ha)	Day Range (m)	Group Size	Reference
<i>P. verreauxi</i>	3-8.5	110-550	2-13	Richard (1978); Jolly <i>et al.</i> (1982); Richard <i>et al.</i> (1993)
<i>P. tattersalli</i>	8-12	460-1077	3-10	Meyers (1995)
<i>P. edwardsi</i>	50	320-2080	3-9	Wright (1995, pers. comm.)
<i>P. diadema</i>	33-42	1629	3-8	Powzyk (1997)
<i>P. candidus</i>	44 <sup>1</sup>	712±502 <sup>1</sup>	2-9 <sup>1,2,3,4</sup>	<sup>1</sup> This Manuscript; <sup>2</sup> Patel (2003); <sup>3</sup> Duckworth <i>et al.</i> (1995); <sup>4</sup> Sterling and McFadden (2000)

The activity budget is displayed in Figure 3. The number of focal samples was approximately evenly distributed across the birth, gestation, lactation, and mating seasons ( $X^2_3 = 4.69$ ;  $p > 0.19$ ). The sex differences in the percentage of time spent moving, resting, and in social behavior were significant. Males moved and engaged in more social behavior than females. Female rested more than males. Although significant, the effect size index (Cohen's  $d$ ) was low for all three of these categories. No significant sex differences were found for the activity categories 'Forage', 'Sleep', and 'Other' (Table 2).

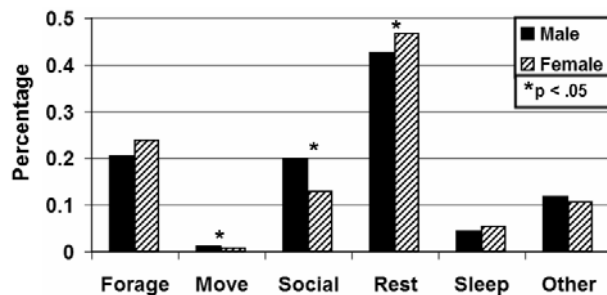


Fig. 3: Silky sifaka activity budget by sex.

Table 2: Sex differences in Silky sifaka activity bout durations; Z and p values are based on Mann-Whitney-U-tests (\*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ ).

	Z	Sex Difference	Effect Size Index (d)
<b>Forage</b>	Z = 0.22	None	N/A
<b>Move</b>	Z = 2.67**	Male > Female	0.05
<b>Social</b>	Z = 6.97***	Male > Female	0.12
<b>Rest</b>	Z = 2.35*	Female > Male	0.10
<b>Sleep</b>	Z = 1.421	None	N/A
<b>Other</b>	Z = 1.230	None	N/A

## Discussion

Taken as a whole, these results suggest that silky sifaka ranging, group size, and life history resemble that of other rain forest sifakas (Table 1). However, *P. edwardsi* may have a somewhat larger home range and *P. diadema* a larger day range. As the only major differ-

ence, the extreme elevational range of *P. candidus* may exceed all other sifakas. As in *P. edwardsi*, silky sifaka social structure is variable and females may sometimes give birth to 1 infant in consecutive years, although the typical inter-birth interval is 2 years (Wright, pers. comm.; Pochron and Wright, 2003). However, these and other interpretations below must be tempered by the fact that most of the results of this report are limited to a single group of silky sifakas.

This report presented the first silky sifaka activity budget. As is typical of folivores, adult silky sifakas spend most of their day resting (44.4 %) and foraging (21.9%), while also devoting a substantial amount of time to social behavior (16.8 %). Of the six major activity categories, movement consumed the least amount of time (0.9 %). By comparison, *Propithecus d. diadema* may spend more time feeding (37.9 %) and resting (49.4 %), but less time engaged in social behavior (2.4 %). These differences may be species differences or may be due to methodological differences, such as the number of categories and the sampling procedure.

Consistent with prior sifaka research (reviewed in Hemingway, 1999), this activity budget revealed no significant sex difference in foraging duration. However there was a nonsignificant trend for females to forage longer than males which has been found in *Indri indri* (Pollock, 1977).

Silky sifaka adult males did devote slightly, but significantly, more time to movement and social behavior, but less time to resting than females. I often observed long bouts of male-only play on the ground which may well account for the sex difference in social behavior. This may not be true of other rainforest sifakas. For example, female Milne-Edwards' sifakas are known to be full participants in terrestrial play bouts (Wright, pers. comm.). These slight sex differences could reflect the importance of energy conservation to female lemur biology (Wright, 1999), could reflect male vigilance (Overdorff, 1998), or could be nonfunctional. While some work suggests that female lemurs may suffer uniquely high reproductive or metabolic costs (reviewed in Pochron *et al.*, 2003), others question the extent to which female lemurs bear high metabolic costs and possess compensatory behavioral adaptations (Pereira *et al.*, 1999; Hemingway, 1999).

## Acknowledgements

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## References

Altmann, J. 1974. Observational study of behavior: Sampling methods. *Behav.* 49: 227-265.

- Duckworth, J.W.; Evans, M.I.; Hawkins, A.F.A.; Safford, R.J.; and Wilkinson, R.J. 1995. The lemurs of Marojejy Strict Nature Reserve, Madagascar: A status overview with notes on ecology and threats. *Int. J. Primatol.* 16: 545-559.
- Garreau, J.M.; Manantsara, A. 2003. The protected-area complex of the Parc National de Marojejy and the Reserve Speciale d'Anjanaharibe-Sud. Pp. 1451-1458. In: *The Natural History of Madagascar*. S.M. Goodman. J.P. Benstead (eds.). University of Chicago Press.
- Goodman, S.M. 2000. Description of the Parc National de Marojejy, Madagascar, and the 1996 biological inventory of the reserve. *Fieldiana Zoology* 97: 1-18.
- Gould, L.; Fedigan, L.M.; Rose, L.M. 1997. Why be vigilant? The case of the alpha animal. *Int. J. Primatol.* 18: 401-414.
- Hemingway, C.A. 1999. Time budgets and foraging in a Malagasy primate: Do sex differences reflect reproductive condition and female dominance? *Behav. Ecol. Sociobiol.* 45: 311-322.
- Hussmann, S.; Kappeler, P.M. 1998. Are male sifakas (*Propithecus verreauxi verreauxi*) more vigilant than females, and could this be interpreted as a service towards females? *Folia Primatol.* 69: 210-211.
- Jolly, A.; Gustafson, H.; Oliver, W.L.R.; and O'Connor, S.M. 1982. *Propithecus verreauxi* population and ranging at Berenty, Madagascar, 1975 and 1980. *Folia Primatol.* 39: 124-144.
- Mayor, M.L.; Sommer, J.A.; Houck, M.L.; Zaonarivelo, J.R.; Wright, P.C.; Ingram, C.; Engel, S.R.; Louis, E.E. Jr. 2004. Specific status of *Propithecus* spp. *Int. J. Primatol.* 25: 875-900.
- Meyers, D.M. 1995. The effects of resource seasonality on behavior and reproduction in the golden-crowned sifaka (*Propithecus tattersalli*, Simons, 1988) in three Malagasy forests. *Dissertation Abstracts International*, A55 (11).
- Mittermeier, R.A.; Valladares-Padua, C.; Rylands, A.B.; Eudey, A.A.; Butynski, T.M.; Ganzhorn, J.U.; Kormos, R.; Aguiar, J.M.; Walker, S. 2005. *Primates in Peril: The World's 25 Most Endangered Primates 2004-2006*. Washington, D.C.: IUCN Species Survival Commission.
- Overdorff, D.J. 1998. Are *Eulemur* species pair-bonded? Social organization and mating strategies in *Eulemur fulvus rufus* from 1988-1995 in southeast Madagascar. *Am. J. Phys. Anthro.* 105: 153-166.
- Patel, E.R. 2003. Behavioral ecology, communication, and conservation of wild silky sifakas. Unpublished exit report to the Madagascar Institut pour la Conservation des Ecosystèmes Tropicaux.
- Pereira, M.E.; Strohecker, R.A.; Cavigelli, S.A.; Hughes, C.L.; Pearson, D.D. 1999. Metabolic strategy and social behavior in Lemuridae. Pp. 93-118. In: *New Directions in Lemur Studies*. B. Rakotosamimanana, H. Rasamimanana, J.U. Ganzhorn, S.M. Goodman (eds.). New York: Kluwer Acad/Plenum.
- Pochron, S.T.; Wright, P.C. 2003. Variability in adult group compositions of a prosimian primate. *Behav. Ecol. Sociobiol.* 54: 285-293.
- Pochron, S.T.; Fitzgerald, J.; Gilbert, C.C.; Lawrence, D.; Grgas, M.; Rakotonirina, G.; Ratsimbazafy, R.; Rakotosoa, R.; Wright, P.C. 2003. Patterns of female dominance in *Propithecus diadema edwardsi* of Ranomafana National Park, Madagascar. *Am. J. Primatol.* 61: 173-185.
- Pochron, S.T.; Morelli, T.L.; Terranova, P.; Scirbona, J.; Cohen, J.; Kunapareddy, G.; Rakotonirina, G.; Ratsimbazafy, R.; Rakotosoa, R.; Wright, P.C. 2005. Patterns of male scent marking in *Propithecus edwardsi* of Ranomafana National Park, Madagascar. *Am. J. Primatol.* 65: 103-115.
- Pollock, J.I. 1977. The ecology and sociology of feeding in *Indri indri*. Pp. 37-69. In: *Primate Ecology*. T.H. Clutton-Brock (ed.). London. Academic Press.
- Powzyk, J.A. 1998. 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. *Dissertation Abstracts International* B58(12): 6357.
- Richard, A.F. 1978. *Behavioral variation: Case study of Malagasy lemur*. New Jersey: Associated University Press.
- Richard, A.F.; Nicoll, M.E. 1987. Female social dominance and basal metabolism in a Malagasy primate, *Propithecus verreauxi*. *Am. J. Primatol.* 12: 309-314.
- Richard, A.F.; Rakotomanga, P.; Schwartz, M. 1993. Dispersal by *Propithecus verreauxi* at Beza Mahafaly, Madagascar: 1984-1991. *Am. J. Primatol.* 30: 1-20.
- Schmid, J.; Smolker, R. 1998. Lemurs of the Reserve Speciale d'Anjanaharibe-Sud, Madagascar. *Fieldiana Zoology* 90: 227-240.
- Sterling, E.; McFadden, K. 2000. Rapid census of lemur populations in the Parc National de Marojejy, Madagascar. *Fieldiana Zoology* 97: 265-274.
- Sussman, R.W. 2000. *Primate Ecology and Social Structure*. Vol. 1: Lorises, Lemurs and Tarsiers. Heights, MA: Pearson Custom Publ.
- 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.
- Wright, P.C. 1999. Lemur traits and Madagascar ecology: Coping with an island environment. *Yearbook Phys. Anthro.* 42: 31-72.

## Cytogenetic and molecular characteristics of a new species of sportive lemur from Northern Madagascar

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**Key words:** *Lepilemur*, Cytogenetics, mtDNA, Taxonomy, New species

A cytogenetic and molecular study of the sportive lemurs (*Lepilemur*) in northern Madagascar provides evidence that sportive lemurs from the Ampasindava peninsula constitute a separate species, *Lepilemur* sp. nov. The karyotype (2N = 24) differs from the two parapatric species *L. dorsalis* and *L. sahamalazensis* (2N = 26).

The genetic distances obtained from complete mitochondrial cytochrome *b* sequences are of the same magnitude as those observed between other sportive lemur species.

Sportive lemurs (*Lepilemur*) are small nocturnal primates of Madagascar living in almost all primary forests. The classification of sportive lemurs based on morphological features is difficult because pelage coloration and other external characteristics are inconspicuous in this nocturnal genus. Their classification was disputed until a cytogenetic approach allowed the recognition of eight species (Petit, 1933; Petter *et al.*, 1977; Rumpler and Albignac, 1978). In a recent study the distinctiveness of these eight species was confirmed by applying molecular genetic methods such as the sequencing of mitochondrial genes (Andriaholinirina *et al.*, 2006). Additionally within two of the eight species, *L. ruficaudatus* and *L. dorsalis* large genetic differences among geographic populations were found, leading to the identification of three new species (Andriaholinirina *et al.*, 2006). Thus, *L. ruficaudatus* was subdivided into *L. ruficaudatus*, *L. randrianasoli* and *L. aeeclis*, all of them representing the same karyotype (2N = 20) (Table 1). *L. dorsalis* was divided into *L. dorsalis* and *L. sahamalazensis*, the two species also being characterized by a unique karyotype 2N = 26 (Table 1) (Andriaholinirina *et al.*, 2006).

In this paper, we report the identification of another new sportive lemur species based on karyotype and mtDNA sequences. It was discovered in the region of the Ampasindava peninsula during a systematic study of *Lepilemur*, *Avahi* and *Hapalemur* from the North-West and West of Madagascar.

Table 1: Diploid number (2N) and number of chromosomal rearrangements among the different sportive lemur species (Andriaholinirina *et al.*, 2005) and the sportive lemur from the Ampasindava peninsula.

	2N	Lru	Lra	Lae	Led	Lmi	Lsa	Lam	Ldo	Lan	Lse	Lmu
Lru	20	-										
Lra	20	0	-									
Lae	20	0	0	-								
Led	22	12	12	12	-							
Lmi	24	11	11	11	3	-						
Lsa	26	10	10	10	8	7	-					
<b>Lam</b>	<b>24</b>	<b>11</b>	<b>11</b>	<b>11</b>	<b>9</b>	<b>8</b>	<b>1</b>	-				
Ldo	26	10	10	10	8	7	0	<b>1</b>	-			
Lan	36/ 38	12	12	12	14	13	10	<b>11</b>	10	-		
Lse	34/ 36	11	11	11	13	12	9	<b>10</b>	9	1	-	
Lm	34	17	17	17	19	18	15	<b>16</b>	15	15	14	-

Abbreviations are: Lru = *L. ruficaudatus*; Lra = *L. randrianasoli*; Lae = *L. aeeclis*; Led = *L. edwardsi*; Lmi = *L. microdon*; Lsa = *L. sahamalazensis*; **Lam** = *Lepilemur* from the Ampasindava peninsula; Ldo = *L. dorsalis*; Lan = *L. ankaranensis*; Lse = *L. septentrionalis*; Lmu = *L. mustelinus*.

### Material and methods

Samples of three animals were collected in the area of the Ampasindava peninsula in northern Madagascar (Fig. 1). Skin biopsies were taken under general anesthesia with a 2 mg/kg injection of ketamine solution (Ketalar® Parke-Davis). A part of each sample was directly frozen in liquid nitrogen while the other part was conserved in MEM, 15 % FCS, 10 % DMSO as a prepara-

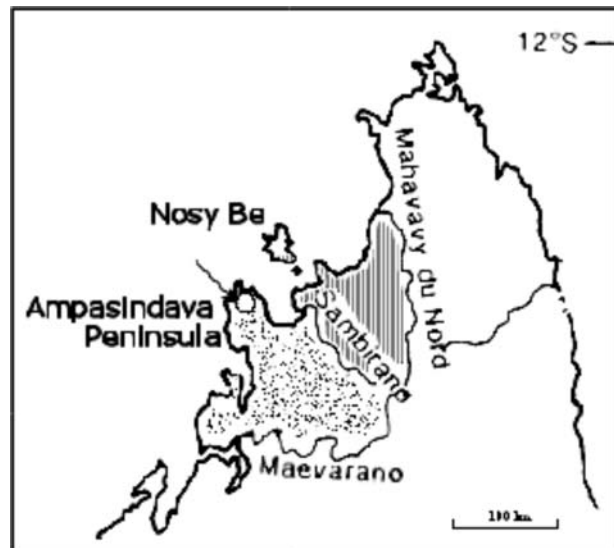


Fig. 1: Assumed distribution of *Lepilemur dorsalis* (dotted) and *L. sahamalazensis* (hatched). Indicated is also the locality where the three specimens of the sportive lemurs from Ampasindava were captured (arrow).

tion for growing a fibroblast culture. Animals were released in their respective capture areas immediately after recovery from anaesthesia.

Karyotypes were established on fibroblast cultures following classical methods (Dutrillaux and Couturier, 1986). Giemsa staining, R- and G-banding techniques were applied on the chromosomes (Dutrillaux and Couturier, 1986).

Molecular investigations were performed following methods described in Andriaholinirina *et al.* (2006). DNA was extracted from the skin biopsies with the QIAamp DNA minikit as recommended by the supplier. The complete mitochondrial cytochrome *b* gene (1140 bp) was PCR-amplified using oligonucleotide primers and PCR conditions as described in Andriaholinirina *et al.* (2006).

Aliquots of the PCR amplification were checked by agarose gel electrophoresis. PCR products were sequenced on an automatic ABI sequencer with the Taq dye deoxy terminator cycle sequencing kit (Applied Biosystems). Each sample was sequenced from both directions. The respective sequences were deposited in GenBank and are available under the accession numbers DQ444301 - DQ444303.

For phylogenetic reconstructions we used cytochrome *b* sequences from ten other sportive lemur species available from GenBank (*Lepilemur aeeclis* DQ234899; *L. ankaranensis* DQ109027, DQ109030; *L. dorsalis* DQ108993, DQ108995, DQ108996, DQ234887; *L. edwardsi* DQ109006, DQ109004; *L. microdon* DQ234889, DQ109008, DQ109009; *L. mustelinus* DQ109033; *L. randrianasoli* DQ109019,

DQ234890, DQ451104, DQ451105; *L. ruficaudatus* DQ234895, DQ451102, DQ451103; *L. sahamalazensis* DQ108990, DQ108991, DQ234883; *L. septentrionalis* DQ234900). Sequences were easily aligned by eye due to the lack of indels and checked for their potential to be correctly transcribed. For a comprehensive evaluation of the sequences, we expanded our data set with ortho-



logous sequences from other sportive lemur species and *Avahi laniger*, which was used as outgroup in tree reconstructions (DQ451106). Uncorrected pairwise differences were calculated with PAUP 4.0b10 (Swofford, 2000). Phylogenetic tree reconstructions using maximum parsimony (MP) (Fitch, 1975), neighbor-joining (NJ) (Saitou and Nei, 1987) and maximum-likelihood (ML) algorithms were performed with PAUP 4.0b.10 or TREEPUZZLE 5.0 (Strimmer and von Haeseler, 1987). For MP analyses, all characters were treated unordered and equally weighted throughout. NJ and ML trees were constructed with the HKY + G (=0.2627) model of sequence evolution as it was selected as best-fitting model with MODELTEST 3.06 (Posada and Crandall, 1998). Relative support of internal branches was performed by bootstrap analyses with 1,000 replications (MP, NJ), or by the quartet puzzling support values on the basis of 10,000 puzzling steps (ML).

**Results**

The diploid number of chromosomes of the two specimens of sportive lemurs from Ampasindava is  $2N = 24$  (Fig. 2a). This trait is shared with only one other sportive lemur species, *L. microdon*, however, the karyotype of the Ampasindava specimens shows eight rearrangements compared to *L. microdon* (Fig. 2b; Table 1). In

Phylogenetic reconstructions clearly show that *L. ankaranensis*, *L. dorsalis*, *L. sahamalazensis* and the sportive lemurs from Ampasindava constitute four distinct and well-supported clades (Fig. 4), although their phylogenetic relationships stay partly unresolved.

**Discussion**

In the sportive lemurs, pelage coloration or other morphological traits are not suitable characters for distinguishing among taxa (Ravaoarimanana, 2001). In contrast, cytogenetic and molecular methods, such as sequencing of marker genes, offer powerful tools for taxonomy. Many lemur species are characterized by both cytogenetic and molecular data (Yoder *et al.*, 2000; Rumpler and Albignac, 1973). Among sportive lemurs eight species were characterized by both cytogenetic and molecular data while three additional species could only be distinguished by differences in their mtDNA sequences (Andriaholinirina *et al.*, 2006).

In the case of the sportive lemurs from Ampasindava the cytogenetic and molecular characteristics provide arguments for their classification as a distinct species, well separated from the parapatric *L. dorsalis* and *L. sahamalazensis*.

The karyotype differs from those of all other sportive lemurs by diploid chromosome numbers or numerous

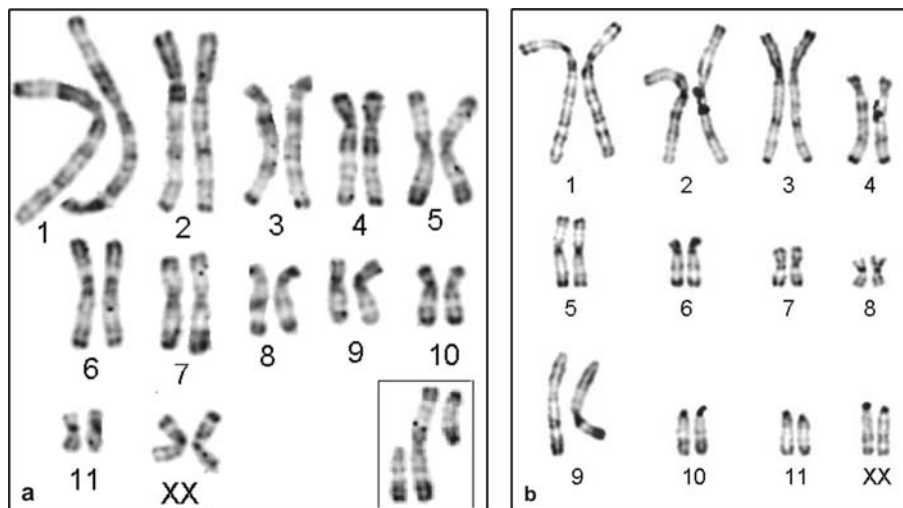


Fig. 2: Female R-banding karyotype of the sportive lemur from Ampasindava (a). The insert shows the correspondence between the metacentric chromosome number 5 of the sportive lemurs from Ampasindava and the two acrocentric chromosomes of *L. dorsalis* female R-banding karyotype of *L. microdon* (b).

contrast, the diploid number of chromosomes of the two parapatric species to the Ampasindava specimens (*L. dorsalis* and *L. sahamalazensis*) are  $2N = 26$  (Table I). Furthermore, the Ampasindava karyotype differs from that of *L. dorsalis* and *L. sahamalazensis* by one chromosomal rearrangement, which could be either a Robertsonian translocation or a centromeric fission. One pair of metacentric chromosomes (chromosome 5) corresponds to the two pairs of acrocentric chromosomes from *L. dorsalis* and *L. sahamalazensis* (LDO 11 and LDO 12; Fig. 2a and Fig. 3).

We compared the complete cytochrome *b* sequences with those of all other *Lepilemur* species, excluding *L. leucopus*. Differences between species are in the range of 2.98-16.84 %, while differences within species range from 0.00-2.11 %. The differences observed between *L. dorsalis* from Ambanja/Nosy-Be and the Ampasindava individuals and between them and *L. sahamalazensis* are 4.74-4.91 % and 4.83-5.18 %, respectively and hence are in the range of interspecific differences within this genus (Table 2).



Fig. 3: Male karyotype of *L. dorsalis* (R-banding).

Table 2: Minimum and maximum uncorrected pairwise differences (in %) within and among analysed species and populations based on complete cytochrome *b* sequences. For abbreviations see Table 1.

	Lru	Lra	Lae	Led	Lmi	Lsa	Lam	Ldo	Lan	Lse	Lmu
Lru	0.00-0.79										
Lra	6.14-7.02	0.00-2.11									
Lae	7.37-7.46	6.32-6.75	-								
Led	12.46-12.54	11.67-11.93	12.46	0.00							
Lmi	11.75-12.19	11.32-11.75	12.37-12.54	9.21-9.39	0.18-0.53						
Lsa	11.23-11.67	11.58-12.02	12.72-13.07	12.02-12.37	10.97-11.49	0.18-0.35					
Lam	11.05-11.14	10.97-11.05	11.49	10.44	9.83	4.83-5.18	0.00				
Ldo	10.97-11.40	11.49-11.67	10.97	10.70	10.44-10.62	5.18-5.53	4.74-4.91	0.00-0.18			
Lan	10.53-10.79	10.79-10.97	11.05-11.14	10.70-10.79	10.00-10.26	4.47-4.91	4.12-4.21	2.98-3.25	0.18		
Lse	11.14-11.23	10.97-11.40	11.84	10.61	9.83-10.09	9.30-9.65	8.33	7.46-7.63	7.54-7.63	-	
Lmu	15.18-15.44	15.26-15.79	15.79	16.32	15.88-16.05	16.49-16.84	15.35	15.97-16.14	15.26-15.35	16.23	-

chromosomal rearrangements (Table 1). Important are also the differences to the two parapatric species, *L. dorsalis* and *L. sahamalazensis*. With 2N=24 the Ampasindava taxon has two chromosomes less than *L. dorsalis* and *L. sahamalazensis* (2N=26) due to one chromosomal rearrangement between the new taxon and the two parapatric species. Two other species of sportive lemurs, *L. septentrionalis* and *L. ankaranensis* also differ by only a single chromosomal rearrangement (Rumpler *et al.*, 2001). These differences in the karyotypes alone provide strong arguments for the delimitation of a new species, because chromosomal events can either be a trigger for the speciation process by erecting a reproductive barrier between two populations or they can simply be indicators of the existence of such a barrier between two well-differentiated species.

Additional arguments follow from our genetical analysis. The genetic differences as estimated from the cytochrome *b* dataset are similar or larger than those reported among other sportive lemur species (Table 2). The phylogenetic tree reconstructions reveal an independent clade of the Ampasindava sportive lemurs (Fig. 4), although their exact phylogenetic relationships with other sportive lemur species from northern Madagascar remain unclear, due to ambiguous tree topologies provided by different reconstruction methods.

The molecular data, although based on only one mitochondrial gene and from a small number of tested individuals support our conclusion from the cytogenetic analysis to classify the sportive lemurs from Ampasindava as distinct species.

The Ampasindava peninsula was before included in the range of *L. dorsalis* (Mittermeier *et al.*, 1994) and later it was hypothesized that it belongs to the range of *L. sahamalazensis* (Andriaholinirina, 2006). The type locality of *L. dorsalis* is very imprecisely labeled as "Madagascar" (Gray, 1871). Most museum specimens are from the Ambanja region and hence we presume that this is also the case for the holotype. The type locality of *L. sahamalazensis* is the Sahamalaza peninsula to the south of Ampasindava. Therefore the population from the Ampasindava peninsula needs to be named:

***Lepilemur mittermeieri* sp. nov.**

**Type series:** Tissue and DNA from three individuals stored at the University Louis Pasteur Strasbourg, France (Lamp1-Lamp3).

**Type locality:** Ampasindava peninsula, Province d'Antsiranana (Diego-Suarez) (approx. 47°54 E; 13°36 S).

**Diagnosis:** Differs from most other sportive lemurs in diploid chromosome number (2N = 24). *L. microdon*, the only sportive lemur species showing the same diploid chromosome number as *L. mittermeieri*, differs from it in eight rearrangements. *L. mittermeieri* differs from its closest relatives, *L. dorsalis* and *L. sahamalazensis* in the diploid number of chromosomes (both 2N = 26), in one chromosomal rearrangement and in the complete cytochrome *b* gene in 4.74-4.91 % and 4.83-5.18 %, respectively.

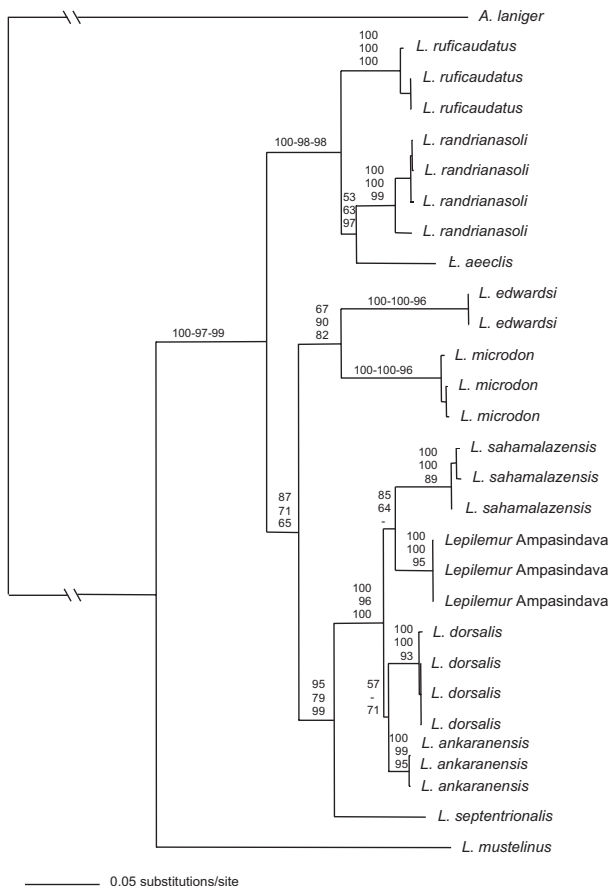


Fig. 4: Phylogenetic relationships as obtained from complete mitochondrial cytochrome *b* gene sequences, with branch lengths drawn according to those estimated by the NJ algorithm and by applying the HKY + G model of sequence evolution. Numbers on internal branches indicate bootstrap or puzzling support values (first: MP, second: NJ; third: ML). Abbreviations refer to those listed in Table 1.

**Etymology:** *Lepilemur mittermeieri* is named in honour of Russell A. Mittermeier, President of Conservation International, who initiated and supported many important conservation activities in Madagascar.

**Distribution:** The species is restricted to the type locality of the Ampasindava peninsula, but further field studies are required to determine the exact distribution range, in particular in relation to *L. sahamalazensis* and *L. dorsalis*.

#### Acknowledgements

We thank the Direction des Eaux et Forêts of Antananarivo and Mahajanga, the Association Nationale pour la Gestion des Aires Protégées of Antananarivo and Mahajanga for their permission to do the field work. We are thankful to the Faculty of Sciences of Antananarivo and the Institut Pasteur of Antananarivo for their support. We thank M. Hauwy and M. Lavaux for their technical assistance, and Linn F. Groeneveld for her comments on an earlier version of the manuscript. Grants came from Conservation International, A.E.E.C.L. and ULP-EA3428.

#### References

- Andriaholinirina, N.; Fausser, J.-L.; Roos, C.; Zinner, D.; Thalmann, U.; Rabarivola, C.; Ravoarimanana, I.; Ganzhorn, J.U.; Meier, B.; Hilgartner R.; Walter, L.; Zaramody, A.; Langer, C.; Hahn, T.; Zimmermann, E.; Radespiel, U.; Craul, M.; Tomiuk, J.; Tattersall, I.; Rumpler, Y. 2006. Molecular phylogeny and taxonomic revision of the sportive lemurs (*Lepilemur*, Primates), BMC Evolutionary Biology 6: 17.
- Andriaholinirina, N.; Rabarivola, C.; Hauwy, M.; Rumpler, Y. 2005. Cytogenetic study of *Lepilemur microdon*, Folia Primatol. 76: 238-241.
- Dutrillaux, B.; Couturier, J. 1981. La pratique de l'analyse chromosomique, Masson (Ed.), Paris.
- Fitch, W. M. 1975. Toward finding the tree of maximum parsimony, in: Proceedings of the Eighth International Conference on Numerical Taxonomy, G.F. Estabrook (Ed.), W.H. Freeman (Pub.), San Francisco, Pp. 189-230.
- Saitou, N.; Nei, M. 1987. The Neighbor-joining method: a new method for reconstructing phylogenetic trees, Mol. Biol. Evol. 4: 406-425.
- Gray J. 1871. in: C. Groves: Primate Taxonomy, Smithsonian Institution Press (Ed.), Washington, p. 86, 2001.
- Mittermeier, R.A.; Tattersall I.; Konstant; W.R.; Meyers; D.M.; Mast, R.B. 1994. Lemurs of Madagascar. Conservation International. Washington, DC.
- Petit, G. 1933. Le genre *Lepidolemur* et sa répartition géographique, C. R. Soc. Biogéogr. 10: 33-37.
- Petter, J.J.; Albignac, R.; Rumpler, Y. 1977. Mammifères lémurien (Primates prosimiens). In: Faune de Madagascar, vol. 44, C.N.R.S./O.R.S.T.O.M. (Eds), Paris, Pp. 1-513.
- Posada, D.; Crandall, K.A. 1998. Modeltest: testing the model of DNA substitutions. Bioinformatics 14: 817-818.
- Ravoarimanana, 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 de l'Université Louis Pasteur, Strasbourg I, n° 3846, 28 août.
- Rumpler, Y.; Albignac, R. 1973. Cytogenetic study of the endemic Malagasy lemurs subfamily Cheirogaleinae (Gregory 1915), Am. J. Phys. Anthropol. 38: 261-264.
- Rumpler, Y.; Albignac, R. 1978. Chromosomes studies of the *Lepilemur*, an endemic Malagasy genus of lemurs: Contribution of the cytogenetics to their taxonomy, J. Hum. Evol. 7: 191-196.
- Rumpler, Y.; Ravoarimanana, B.; Hauwy, M.; Warter, S. 2001. Cytogenetic arguments in favour of taxonomic revision of *Lepilemur septentrionalis* species, Folia Primatol., 72: 308-315.
- Swofford, D. 2000. PAUP\*4.0b.4a. Phylogenetic analysis using parsimony\* (and other methods), Sunderland, MA, Sinauer Associates.
- Strimmer, K.; von Haeseler, A. 1996. Quartet puzzling: A maximum likelihood method for reconstructing tree topologies, Mol. Biol. Evol. 13: 964-969.
- Yoder, A.D.; Rasoloarison, R.M.; Goodman, S.M.; Irwin, J.A.; Atsalis, S.; Ravosa, M.J.; Ganzhorn, J.U. 2000. Remarkable species diversity in Malagasy mouse lemurs (Primates, *Microcebus*), Proc. Natl. Acad. Sci. USA 97: 11325-11330.

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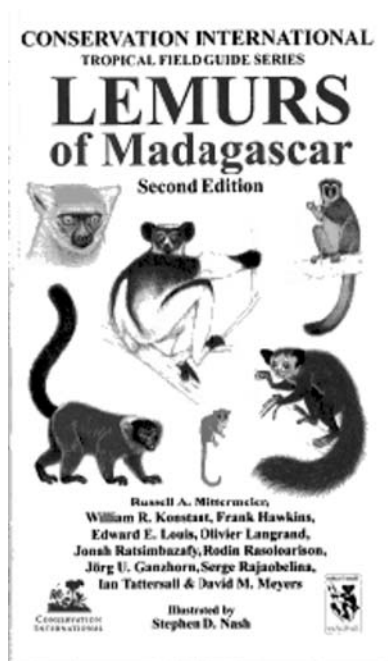
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## Recent Publications

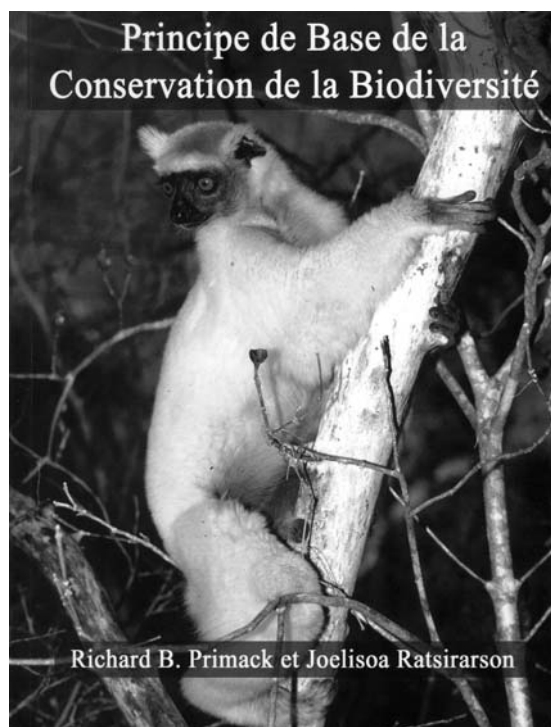
**Mittermeier, R. A., W. R. Konstant, A. F. A. Hawkins, E. E. Louis, O. Langrand, H. J. Ratsimbazafy, M. R. Rasoloarison, J. U. Ganzhorn, S. Rajaobelina, I. Tattersall, and D. Meyers 2006. Lemurs of Madagascar. Conservation International, Washington, D.C.**

The second edition of Conservation International's Tropical Field Guide, *Lemurs of Madagascar* has been completely revised from its original edition printed in 1994. The book contains extensive scientific information with chapters including: origin of lemurs, discovery and study of living lemurs, extinct lemurs, conservation of lemurs, geographic range and distribution of lemurs, ecology and behavior of lemurs, conservation status and threats to lemurs. The guide is illustrated with over 200 drawings, photos and maps to assist in field identification. The three appendices include a) national maps depicting island topography, cities, rivers and protected areas, b) descriptions and representative photos of Madagascar's principal terrestrial habitats, c) listings of key sites for lemur watching.



Price: \$25.00 (includes UPS Ground shipping within the continental United States; For orders requiring faster service than UPS Ground, you will be responsible to pay all shipping costs). The book is available from: **Jill Lucena**, Conservation International, 1919 M Street NW, Suite 600, Washington, DC 20036 USA, [j.lucena@conservation.org](mailto:j.lucena@conservation.org), Phone: +1 202 912-1208, Fax: +1 202 912-1026

**Primack, R. B. and J. Ratsirarson 2005. Principe de Base de la Conservation de la Biodiversité. Sedico, Antananarivo. 295 pp. ISBN: 2-915064-13-X; 30 000 Ariary.**



The book by Primack and Ratsirarson is a pleasure to read. It is a truly Malagasy version of an internationally renowned textbook on principles of conservation biology.

Richard Primack has published several regional and general textbooks on conservation biology. Joelisoa Ratsirarson has worked for many years in conservation in Madagascar. The combination of the two turned out to be a "dream team" and their book represents a hallmark for conservation and teaching in Madagascar. The book provides a fine introduction to conservation issues. It then applies these principles to genuine problems in Madagascar and illustrates them with data and approaches from Madagascar. The book is nicely illustrated with many figures and photos. The book is available at the Centre d'Information Technique et Economique, Antananarivo ([www.cite.mg](http://www.cite.mg)).

#### Mammal species of the world

You can visit the MSW website for the full taxonomy (checklist) from MSW3 at: [nmnhgoph.si.edu/msw](http://nmnhgoph.si.edu/msw). Updated content will be available online later in 2006.

#### Schwitzer, C., S. Brandt, O. Ramilijaona, M. Rakotomalala Razanahoera, D. Ackermann, T. Razakamanana, and J. U. Ganzhorn 2006. Proceedings of the German-Malagasy research cooperation in life and earth sciences. Concept-Verlag, Berlin.

The book summarizes some of the contributions of a meeting on malagasy-German research collaborations held in October 2004 in Antananarivo. It includes chapters on geology, biodiversity and conservation, and sustainable use of agricultural resources. The book is available from the German Embassy in Antananarivo, or from Christoph Schwitzer ([studpri@zoo-koeln.de](mailto:studpri@zoo-koeln.de)) or Jörg Ganzhorn ([ganzhorn@zoologie.uni-hamburg.de](mailto:ganzhorn@zoologie.uni-hamburg.de)).

#### Theses completed

Andrianirina, H.Z.R. 2006. L'éducation environnementale dans les zones périphériques du Parc National Tsingy de Bemaraha. Mémoire de CAPEN (Certificat d'Aptitude Pédagogique de l'Ecole Normale). Département de Formation initiale scientifique, Centre d'Etude et de Recherche Sciences Naturelles, Ecole Normale Supérieure, Université d'Antananarivo. Le Parc National "Tsingy de Bemaraha" est unique au monde grâce à ses diversités floristiques, faunistiques et géologiques avec le majestueux relief karstique: les Tsingy. Les formations végétales sont classées dans la zone écofloristique occidentale de basse altitude et se divisent en quatre grandes parties: Forêts dense sèche de l'Ouest dans les éboulis ou dalles calcaires (*Euphorbia aphylla*, *Adenia* sp., *Commiphora aphevalis*, *Chrysalidocarpus madagascariensis*, *Poupartia silvatica*...); Forêt sub humide dans les Avens et bordures des cours d'eau (*Adansonia*, *Hildergardia*, *Commiphora*, *Dalbergia*, *Rhopalocarpus*, *Euphorbia enterophora*, *Humbertochlou bambusina*, *Adina microcephala*, *Medemia* sp., *Noronhia alleizettei*, *Rinorea arborea*, *Blotia* sp., *Diospyros gneissicola*, *Combretum coccineum*, *Vepris perrieri*...); Savane arborée (*Dalbergia* sp., *Givoutia madagascariensis*, *Grewia africanus*, *Adiantum* sp., *Clinogyne comorensis*, *Liparis* sp...); Végétations Xérophitiques ripicoles sur les plateaux calcaires (*Trenna madagascariensis*, *Kalankoe gastronis borniri*, *Erythroxyllum pachycladium*, *Adenia holabensis*, *Pachypodium lamerei*, *Platicerium madagascariensis*, *Gynocarpus americanus*, *Pandanus pristri*, *Omphalea occidentalis*, *Gelonium adenophorum*, *Poupartia silvatica*). La population des lémuriens représente le un cinquième des espèces les plus connues à Madagascar. On dénombre 12 espèces dont

huit nocturnes (*Microcebus murinus*, *Microcebus myoxinus*, *Mirza coquereli*, *Cheirogaleus medius*, *Avahi occidentalis*, *Avahi cleesei*, *Daubentonia madagascariensis*, *Phaner pallescens*) et quatre diurnes (*Lepilemur ruficaudatus*, *Hapalemur occidentalis*, *Eulemur fulvus rufus*, *Propithecus deckenii*). On constate aussi la présence des Mammifères (*Nesomys rufus*, *Cryptoprocta ferox*, *Galidia elegans occidentalis*, *Viverricula indica*, *Potamochoerus porcus*), des Chauves souris (*Pteropus* sp., *Hipposideros* sp.), des Oiseaux (*Haliaeetus vociferoides*, *Anas bernieri*...) des Reptiles (*Erymnochelys madagascariensis*, *Crocodylus niloticus*, *Brookesia* sp., *Vroptalus fimbriatus*, *Zonosaurus laticaudatus*, *Sanzinia madagascariensis*). Malgré les interventions de l'Homme, cette biodiversité a connu des dégradations tant sur les espèces animales que végétales. En face de la dégradation de cette biodiversité et ses conséquences, le Personnel du programme Bemaraha, Responsable du Parc, fait appel à l'éducation environnementale. Cette éducation englobe tous les domaines où interviennent les rapports homme-environnement. L'activité du programme Bemaraha ne s'arrête pas uniquement à l'éducation de la population locale mais améliore à la fois l'état du lieu et la condition de vie de ces habitants. On constate actuellement qu'il faut améliorer l'éducation de la population riveraine par le biais des "OLOBE", des détenteurs de pouvoir et décideurs traditionnels. En même temps, la gestion des ressources naturelles s'avère important par la maîtrise des latrines afin d'avoir un développement rapide et durable de la région par l'écotourisme.

**Mots-clés:** Education environnementale, zone écoforestique, diversité faunistique, dégradation, sensibilisation, Tsingy de Bemaraha.

Rakotonirina, L.H.F. 2005. Etude comparative du microhabitat, des activités et de l'alimentation d'*Eulemur rubriventer*. (I. Geoffroy, 1850) des deux sites : Talatakely et Vatoharanana dans le Parc National de Ranomafana – Madagascar. Mémoire de DEA de Primatologie – Anthropologie, spécialité Primatologie, Département de Paléontologie et d'Anthropologie Biologique, Faculté des Sciences, Université d'Antananarivo, Madagascar.

Cette étude s'est déroulée dans le Parc National de Ranomafana durant cinq mois d'observations, à compter du mois de décembre jusqu'au mois d'avril. En vue de comparer le microhabitat, les activités, ainsi que l'alimentation d'*Eulemur rubriventer* dans deux milieux de dégradations différentes, le site de Talatakely et celui de Vatoharanana ont été choisis. En ce qui concerne son milieu de vie, le test t confirme, en général, la différence entre les dimensions de ces paramètres. La station dégradée se caractérise par des arbres à paramètres plus faibles que l'autre; à l'exception de l'épaisseur de sa couronne. Ainsi, en comparant avec le site de Vatoharanana, le déplacement est plus fréquent et le repos s'avère moins important à Talatakely. D'une manière générale, cette dégradation de l'habitat influence les activités et l'alimentation de l'animal. Ceci est dû probablement à la distribution et répartition différentielle des aliments. Donc cette activité varie suivant le mois et la disponibilité alimentaire. Quant à l'alimentation, le coefficient de Jaccard confirme les résultats des recherches antérieures qui affirment que l'espèce est hautement frugivore quel que soit le milieu. Mais le pourcentage de consommation change suivant le mois et la disponibilité des fruits.

**Mots-clés:** *Eulemur rubriventer*, Ranomafana, Talatakely, Vatoharanana, microhabitat, régime alimentaire, Alimentation, activités, dégradation, perturbation

Randriamahaleo, S.I. 2005. Effets de la dégradation de la forêt et impacts sur les activités sociales de *Propithecus diadema edwardsi* (A. Grandidier, 1871) dans deux sites Talatakely et Valohoaka du parc National de Ranomafana. Mémoire de DEA de Primatologie – Anthropologie, spécialité Primatologie, Département de Paléontologie et d'Anthropologie Biologique, Faculté des Sciences, Université d'Antananarivo, Madagascar.

Cette étude a été réalisée durant trois mois: mois de février au mois d'avril 2002, dans le site perturbé de Talatakely et le site de Valohoaka au Parc National de Ranomafana. Nous avons utilisé la méthode de DUVIGNEAUD pour l'étude de l'habitat et celle d'AUTMANN pour les collectes des données comportementales. Généralement, la structure de l'habitat est différente entre les deux sites. Talatakely dispose d'un DHP petit et de strates moins élevées avec l'ouverture remarquable de la canopée. Dans le site perturbé, *Propithecus diadema edwardsi* adopte des strates moins élevées et elle se déplace plus, se repose plus, se nourrit plus et pratique plus le toilettage et l'agression que dans la zone non perturbée où le jeu est favorisé. Les deux types d'agression, directe et indirecte sont significativement différents entre les deux sites. D'une certaine manière, la fréquence d'agression de Talatakely est plus élevée que celle de Valohoaka mais dans tous les cas, la femelle est toujours plus agressive. En général, la raison du conflit est d'origine alimentaire même si la différence n'est pas significative pour les deux sites. Il existe d'autres facteurs qui engendrent de telles agressions qui sont plus élevées dans le site perturbé de Talatakely. Chez cette dernière la vocalisation est plus nombreuse et après agression, l'agresseur pratique plus l'alimentation que l'agressé. Indépendamment de la perturbation du site, la distance de la fuite de l'agressé n'est pas significative entre les deux sites.

**Mots-clés:** Madagascar, Ranomafana, *Propithecus diadema edwardsi*, habitat, dégradation, activités, hauteur fréquentée, agressions.

Ravoahangy, A. 2005. Etho-écologie de *Eulemur fulvus collaris* (GEOFFROY, 1796) après translocation dans la région de Tolagnaro, Madagascar. Mémoire de DEA de Biologie, Ecologie et Conservation animales. Département de Biologie Animale. Faculté des Sciences, Université d'Antananarivo, Madagascar.

Dans la forêt littorale de Mandena, Tolagnaro (24°58 de latitude Sud et 47°00 longitude Est), 18 individus de *Eulemur fulvus collaris* ont été transférés d'une zone forestière à forte pression humaine (M3) vers la zone de conservation (M15-M16), bien gardée, afin de conserver la sous espèce. L'étho-écologie de cette sous-espèce après translocation dans la région de Tolagnaro, a pu être évaluée grâce à des suivis pendant quatre mois morcelés en deux périodes (mi-novembre 2000 à mi-janvier 2001 et mi-octobre à mi-décembre 2001).

Deux groupes marqués par des radios colliers ont été suivis d'une manière continue. *Eulemur fulvus collaris* transféré garde son biorythme normal du type cathémérale avec une moyenne d'activités diurnes de 31 %; celles nocturnes sont de 34 %. Le régime alimentaire du groupe étudié révèle 73 espèces végé-

tales et 5 taxons animaux constitués par des Arthropodes. Les plantes les plus utilisées appartiennent aux familles des Verbenaceae, Myrtaceae, Lauraceae, Meliaceae, Fabaceae, Rubiaceae et Bursereaceae. Le groupe est principalement frugivore (64 % du temps de feeding) mais mange aussi des feuilles (18 %) et des fleurs (12 %). Le reste, 6 %, est constitué d'insectes et de champignons. Le dortoir utilisé est formé d'arbres à formes particulières avec une canopée soit circulaire soit triangulaire. Les individus fréquentent à la fois la forêt littorale (84 % des observations) et la partie marécageuse (16 %) de la forêt ainsi que toutes les subdivisions stratigraphiques à partir du sol jusqu'à la strate supérieure. Le nouveau milieu semble bien convenir aux besoins vitaux de *Eulemur fulvus collaris*. Le domaine vital d'un groupe est évalué à 68ha.

**Mots-clés :** *Eulemur fulvus collaris*, Lemuridae, Primates, Lémuriens, cathémérale, translocation, forêt littorale, éthoécologie, Mandena, Tolagnaro, Madagascar.

Razafimandranto, M. 2005. Contribution à l'étude de l'Alimentation de *Avahi laniger* (Gmelin, 1778) dans la station de Vatoharanana, Parc National de Ranomafana (Madagascar).

Mémoire de DEA de Primatologie – Anthropologie, spécialité Primatologie, Département de Paléontologie et d'Anthropologie Biologique, Faculté des Sciences, Université d'Antananarivo, Madagascar.

Cette étude se rapporte au comportement alimentaire de *Avahi laniger*, Lémurien exclusivement nocturne dans la station de Vatoharanana du parc National de Ranomafana. Elle a été faite pendant la saison sèche et froide (juin et juillet 2004). Les données ont été récoltées le long des pistes de recensement et de suivi pendant la nuit. La taille moyenne du groupe dans cette station est de l'ordre de 1.7. L'étude comportementale a montré que cette espèce de lémurien adopte une stratégie de conservation d'énergie en se nourrissant pendant une courte durée et en passant la majeure partie de son temps à se reposer. On a remarqué que son comportement est influencé par les facteurs climatiques, ainsi *Avahi laniger* est plus actif au mois de juillet qu'en juin. Cet animal utilise des supports à orientation oblique, à une hauteur entre 7 et 15 m pendant l'alimentation et le repos, il préfère des arbres ayant un diamètre large (> à 10 cm) pour se nourrir. Pour les 9 espèces végétales mangées par cet animal pendant l'observation, les jeunes feuilles sont plus exploitées que les feuilles matures. Puis en ne tenant compte que des espèces analysées qualitativement on a remarqué que la teneur en protéines, en sucre, et en tanin varie en fonction du temps et de l'espèce. Ainsi *Avahi laniger* essaie d'équilibrer son alimentation. L'étude de la consommation journalière montre que les aliments riches en sucre et en tanin sont plus mangés avant minuit, tandis que les aliments riches en protéines sont plus consommés après minuit. Comme il a été impossible de déterminer l'apport journalier en protéines, en sucre et en tanin, on propose que des recherches plus approfondies concernant l'étude qualitative sur les aliments de ce petit soit effectuée ultérieurement.

**Mots clés:** *Avahi laniger*, alimentation Vatoharanana, Parc National de Ranomafana, Madagascar.

*dica*) dans la Réserve privée de Berenty. Mémoire de CAPEN (Certificat d'Aptitude Pédagogique de l'Ecole Normale). Département de Formation initiale scientifique, Centre d'Etude et de Recherche Sciences Naturelles, Ecole Normale Supérieure, Université d'Antananarivo.

La présence des Lemurs bruns hybrides entre *Eulemur fulvus rufus* et *Eulemur fulvus collaris* dans la Réserve de Berenty est actuellement devenue un grand problème. Ces Hybrides possèdent la même ressource clé que les Makis (*Lemur catta*): le Tamarinier. Les parties telles que bourgeons, feuilles nouvelles et fruits verts sont les plus préférées. D'après la présente étude, ces Lemurs bruns sont des grands consommateurs de fruits verts de l'espèce végétale *Tamarindus indica*, pourtant la survie des petits des Makis dépend des fruits mûrs de cette essence végétale. Cette année (2005), les Lemurs bruns de la Réserve de Berenty ont consommé la quasi-totalité des fruits verts disponibles dans la forêt, sans parvenir à mûrir. Le phénomène est devenu une grande menace pour la survie des Makis natifs de la Réserve. En outre, le nombre de la population de Lemurs bruns ne cesse de croître, particulièrement depuis la mise en place de bassins d'eau dans la Réserve. A priori, l'élimination progressive de ces bassins d'eau pourrait résoudre ce problème.

**Mots clés:** Lémurs bruns, Tamarinier, consommateur, pression, impact négatif.

Safia, S. 2005. Contribution à l'étude des parasites sanguins des Lémuriens dans le Parc National de Ranomafana dans la zone périphérique. Mémoire de DEA de Biologie, Ecologie parasitaire. Département de Biologie Animale. Faculté des Sciences, Université d'Antananarivo, Madagascar.

Ce travail a été effectué dans le Parc National de Ranomafana et dans la zone périphérique. La présente étude a pour but d'étudier la morphologie et la systématique des parasites sanguins des Lémuriens du Sud-Est de Madagascar. Chaque Lémurien capturé fait l'objet d'un prélèvement de sang en vue d'effectuer des frottis sanguins. L'étude des parasites s'effectue sur le frottis fixé au méthanol et coloré au Giemsa à 5 %. Quatre vingt quatre (84) Lémuriens appartenant à 8 espèces différentes ont été examinés. Douze (12) individus sont relevés porteurs d'hétoparasites dont: 7 individus appartenant au genre *Eulemur fulvus rufus* et *Eulemur rubriventer* sont porteurs de plasmodium; 4 individus appartenant au genre *Eulemur fulvus rufus* et *Eulemur rubriventer* sont infectés par une microfilaire; 1 *Eulemur fulvus rufus* est parasité à la fois par le plasmodium et la microfilaire. Les espèces plasmodiales rencontrées sont: *Plasmodium girardi*, *Plasmodium coulangesi* et *Plasmodium lemuris*. La parasitémie est faible, de l'ordre de 0,005 à 0,017%. En ce qui concerne la microfilaire, la position taxonomique reste encore à déterminer. Il se trouve que les espèces positives étudiées au cours de ce travail appartiennent toute à la famille de Lemuridae.

**Mots clés:** Lémuriens, *Eulemur fulvus rufus*, *Eulemur rubriventer* parasites sanguins, *Plasmodium girardi*, *Plasmodium coulangesi*, *Plasmodium lemuris*, Microfilaires, Parc National de Ranomafana, Madagascar.

Razafindramanana.J. 2005. Impacts de l'introduction des Lemurs bruns (*Eulemur fulvus rufus*, *Eulemur fulvus collaris*) sur le Tamarinier (*Tamarindus in-*

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#### Example – book:

Soulé, M.E. 1987. *Viable Populations for Conservation*. Cambridge University Press, Cambridge.

#### Example – dissertation:

Homewood, K.M. 1976. Ecology and Behaviour of the Tana Mangabey (*Cercocebus galeritus galeritus*). Unpubl. Ph.D. thesis, University College, London.

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Please send your contribution to Jonah Ratsimbazafy, Rodin Rasoloarisonor or Jörg Ganzhorn.

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