

# TSITONGAMBARIKA FOREST, MADAGASCAR

Biological and socio-economic surveys,  
with conservation recommendations



RioTinto





# TSITONGAMBARIKA FOREST, MADAGASCAR

**Biological and socio-economic surveys, with  
conservation recommendations**

Edited by

John Pilgrim, Narisoa Ramanitra, Jonathan Ekstrom, Andrew W. Tordoff and Roger J. Safford

Maps by

Andriamandranto Ravoahangy

Translation by

Kobeke Keita and Andry Rakotomalala



Fieldwork  
coordinated by



Fieldwork funded  
and additional  
fieldwork by



Additional  
fieldwork by



Additional  
fieldwork by



French translation  
checked by



Recommended citation: BirdLife International (2011) *Tsitongambarika Forest, Madagascar. Biological and socio-economic surveys, with conservation recommendations*. Cambridge, UK: BirdLife International.

© 2011 BirdLife International  
Wellbrook Court, Girton Road, Cambridge CB3 0NA, United Kingdom  
Tel: +44 1223 277318 Fax: +44 1223 277200 email: [birdlife@birdlife.org](mailto:birdlife@birdlife.org)  
Internet: [www.birdlife.org](http://www.birdlife.org)

BirdLife International is a UK-registered charity 1042125

ISBN 978-0-946888-78-8

British Library-in-Publication Data  
A catalogue record for this book is available from the British Library

First published 2011 by BirdLife International

Designed and produced by NatureBureau Limited, 36 Kingfisher Court, Hambridge Road, Newbury, Berkshire, RG14 5SJ, United Kingdom

Printed by Information Press, Oxford, United Kingdom

Available from the Natural History Book Service Ltd, 2–3 Wills Road, Totnes, Devon TQ9 5XN, UK.  
Tel: +44 1803 865913 Fax: +44 1803 865280 Email: [nhbs@nhbs.co.uk](mailto:nhbs@nhbs.co.uk)  
Internet: [www.nhbs.com/services/birdlife.html](http://www.nhbs.com/services/birdlife.html)

# CONTENTS

iv	<b>Participants and authors</b>	28	<b>Chapter 4: The lemurs of Tsitongambarika Forest</b>
vi	<b>Acknowledgements</b>	28	Objectives
1	<b>Introduction</b>	28	Study sites
2	<b>Summary of findings</b>	28	Methods
4	Ny alan' i Tsitongambarika, Madagasikara <b>Famintinana</b> (Summary in Malagasy)	30	Results
6	<b>Recommendations</b>	32	Discussion
8	Ny alan' i Tsitongambarika, Madagasikara <b>Tolo-Kevitra</b> (Recommendations in Malagasy)	33	Conclusions
10	<b>Chapter 1: Overview of the biological importance of Tsitongambarika Forest</b>	33	Recommendations
10	Background	34	<b>Chapter 5: The herpetofauna of Tsitongambarika Forest</b>
10	The surveys	34	Introduction
10	Vegetation and flora	34	Study sites
12	Mammals	36	Methods
12	Reptiles and amphibians	36	Results
12	Birds	40	Discussion
14	Ants	41	Conclusions
14	Other values of the Tsitongambarika Forests	41	Recommendations
15	Socio-economic situation	42	<b>Chapter 6: The birds of Tsitongambarika Forest</b>
15	Management situation	42	Objectives
16	Relevance of survey results for conservation planning	42	Methods
16	Direct payments project	45	Study sites
17	<b>Chapter 2: The flora of Tsitongambarika Forest</b>	47	Results
17	Introduction	53	Discussion
17	Objectives	55	Recommendations
17	Study site	57	<b>Chapter 7: The ants of the Ivohibe region of Tsitongambarika Forest</b>
17	Methodology	57	Introduction
17	Results	57	Study sites
22	Conservation	57	Survey methods
22	Recommendations	57	Results and discussion
22	Conclusions	60	<b>Chapter 8: Socio-economic survey of the Tsitongambarika area</b>
23	<b>Chapter 3: The bats of Tsitongambarika Forest</b>	60	Objectives
23	Introduction	60	Methodology
23	Objectives	60	Social organisation
25	Study sites	62	Demographic situation
25	Methods	67	Discussion
25	Results	68	Importance of biodiversity to communities
26	Discussion	70	Threats to biodiversity
27	Recommendations	71	Conservation of biodiversity
		72	Conclusions
		72	Recommendations
		74	<b>References</b>
		77	<b>Appendix: Community involvement in management of Tsitongambarika Forest: 2010 update</b>



## PARTICIPANTS AND AUTHORS

**Lalao Andriamahefarivo** (Botanist)  
Missouri Botanical Garden, BP 3391,  
Antananarivo, Madagascar

**Maminiaina Andriamahenitsoa** (Socio-economist)  
Asity Madagascar, BP 1074, Antananarivo,  
Madagascar

**Patrice Antilahimena** (Botanist)  
Missouri Botanical Garden, BP 3391,  
Antananarivo, Madagascar

**Mara Berge** (Guide and President of Antsotso  
*Communauté de Base*)  
Antsotso, Fort Dauphin/Tolagnaro, Madagascar

**Chris Birkinshaw** (Botanist)  
Missouri Botanical Garden, BP 3391,  
Antananarivo, Madagascar

**Ramisy Edmond** (Parataxonomist)  
Rio Tinto QMM, BP 225, Fort Dauphin/  
Tolagnaro, Madagascar

**Jonathan Ekstrom** (Editor)  
BirdLife International, Wellbrook Court, Girton  
Road, Cambridge, UK  
*Current address:* The Biodiversity Consultancy,  
4 Woodend, Trumpington, Cambridge, UK

**Brian Fisher** (Entomologist)  
California Academy of Sciences, 55 Music  
Concourse Drive, San Francisco, USA

**Soanary Claude Hery** (Assistant)  
Rio Tinto QMM, BP 225, Fort Dauphin/Tolagnaro,  
Madagascar

**Porter P. Lowry II** (Botanist)  
Missouri Botanical Garden, P.O. Box 299, St.  
Louis, MO, 63166-0299, USA  
and Département Systématique et Evolution (UMR  
7205), Muséum National d'Histoire Naturelle, CP  
39, 57 Rue Cuvier, 75213 Paris CEDEX 05, France

**Eric Lowry** (Student, MBG trainee)  
Missouri Botanical Garden, BP 3391,  
Antananarivo, Madagascar

**Tsibara Mbohoahy** (Chiropterologist)  
Madagasikara Voakajy, BP 5181, Antananarivo,  
Madagascar  
and Biodiversité et environnement, Département de  
la Biologie, Faculté des Sciences de l'Université de  
Toliara, Toliara, Madagascar  
*Current address:* Biodiversité et Environnement,

Département de la Biologie, Faculté des Sciences de  
l'Université de Toliara, Toliara, Madagascar

**John Pilgrim** (Editor)  
The Biodiversity Consultancy, 4 Woodend,  
Trumpington, Cambridge, UK

**Rivo Rabarisoa** (Ornithologist)  
Asity Madagascar, BP 1074, Antananarivo,  
Madagascar

**Marc Rabenandrasana** (Ornithologist)  
Asity Madagascar, BP 1074, Antananarivo,  
Madagascar  
*Current addresses:* Development and Biodiversity  
Conservation Action for Madagascar, Lot II A  
93L, Anjanahary, Antananarivo, Madagascar  
and ECOMAR (Marine Ecology Laboratory),  
Sciences and Technology Faculty, University of  
La Réunion, 15 Avenue René Cassin, BP 7151 –  
97715 Saint-Denis, La Réunion.

**Johny Rabenantoandro** (Botanist)  
Rio Tinto QMM, BP 225, Fort Dauphin/  
Tolagnaro, Madagascar

**Marie Beatrice Yvonne Rahasinandrasana**  
(Socio-economist)  
Asity Madagascar, BP 1074, Antananarivo,  
Madagascar

**Rivo Rajoharison** (Forestry Technician)  
Rio Tinto QMM, BP 225, Fort Dauphin/  
Tolagnaro, Madagascar

**Mamy Julia Christobelle Ralavanirina**  
(Primatologist)  
Asity Madagascar, BP 1074, Antananarivo,  
Madagascar  
and Département Biologie Animale, Université  
d'Antananarivo  
*Current address:* 2 Allée du Collier, 40230 St  
Vincent de Tyrosse, France

**Jean Baptiste Ramanamanjato** (Herpetologist)  
Rio Tinto QMM, BP 225, Fort Dauphin/  
Tolagnaro, Madagascar

**Michael Ramanesimanana** (Ornithologist)  
Asity Madagascar, BP 1074, Antananarivo,  
Madagascar  
and Département Biologie Animale, Université  
d'Antananarivo  
*Current address:* Maromizaha Project Coordinator,  
GERP Madagascar (Groupe d'Etude et de Recherche  
sur les Primates), BP 779, Antananarivo, Madagascar

**Narisoa Ramanitra** (Ornithologist, Programme Coordinator and Editor)  
Asity Madagascar, BP 1074, Antananarivo,  
Madagascar  
and Département Biologie Animale, Université  
d'Antananarivo

**Faly Randriatafika** (Botanist)  
Rio Tinto QMM, BP 225, Fort Dauphin/  
Tolagnaro, Madagascar

**Lovahasina Rasolondraibe** (Ornithologist)  
Asity Madagascar, BP 1074, Antananarivo,  
Madagascar  
and Département Biologie Animale, Université  
d'Antananarivo  
*Current address:* Biologist, GERP Madagascar  
(Groupe d'Etude et de Recherche sur les Primates),  
BP 779, Antananarivo, Madagascar

**Bruno Raveloson** (Ornithologist)  
Asity Madagascar, BP 1074, Antananarivo,  
Madagascar

**Andriamandranto Ravoahangy** (Tsitongambarika  
Programme Coordinator)  
Asity Madagascar, BP 1074, Antananarivo,  
Madagascar

**Julien Razafimandimby** (Assistant)  
Rio Tinto QMM, BP 225, Fort Dauphin/  
Tolagnaro, Madagascar

**Richard Razakamalala** (Botanist)  
Missouri Botanical Garden, BP 3391,  
Antananarivo, Madagascar

**Roger Safford** (Editor)  
BirdLife International, Wellbrook Court,  
Girton Road, Cambridge, UK

**Andrew W. ("Jack") Tordoff** (Editor)  
BirdLife International, Wellbrook Court,  
Girton Road, Cambridge, UK  
*Current address:* Critical Ecosystem Partnership  
Fund, Conservation International, 2011 Crystal  
Drive, Suite 500, Arlington, Virginia, USA

Collared Nightjar *Caprimulgus enarratus* (ANDRIAMANDRANTO RAVOAHANGY)



## ■ ACKNOWLEDGEMENTS

The biological survey and socio-economic study of Tsitongambarika forest and its surrounding areas were carried out with contributions from many organizations and individuals specialised in different disciplines and taxa.

We first thank Rio Tinto and BirdLife International who were jointly responsible for initiating this programme of surveys. In particular, we thank the partners of Rio Tinto and BirdLife International, including Rio Tinto QMM (QIT Madagascar Minerals, QMM) and the BirdLife International Madagascar Programme, and their partners Asity Madagascar (formerly Asity), the Missouri Botanical Garden (MBG), and Madagasikara Voakajy.

This study would not have been possible without the financial and logistical support of Rio Tinto and Rio Tinto QMM, where we especially thank Stuart Anstee and Manon Vincelette respectively.

We also thank the Whitley Awards Foundation for International Nature Conservation: Rufford Small Grants for funding research in Tsitongambarika I and II in 2002. The design and organization of this program were facilitated by BirdLife International, at the time of the work operating through its Madagascar Programme; the BirdLife International Madagascar Programme closed in 2008, when Asity Madagascar became the BirdLife International Affiliate NGO in Madagascar and took on the management of BirdLife programmes in Madagascar. Logistics and herpetological studies were performed by Rio Tinto QMM. The coordination of the work, and ornithological, primatological and socio-economic surveys were carried out by Asity Madagascar. The flora survey was carried out by an MBG/Rio Tinto QMM team. Bat surveys were carried out by Madagasikara Voakajy.

All members of the team strongly supported the field efforts and subsequent writing-up: Jean Baptiste Ramanamanjato, Ramisy Edmond, Johny

Rabenantoandro, Faly Randriatafika, Julien Razafimandimby, Rivo Rajoharison and Soanary Claude Hery from Rio Tinto QMM; Tsibara Mbohoahy from Madagasikara Voakajy; Mamy Julia Christobelle Ralavanirina, Marc Rabenandrasana, Michael Ramanesimanana, Lovahasina Rasolondraibe, Maminiaina Andriamahenintsoa, Marie Beatrice Yvonne Rahasinandrasana and Andriamandranto Ravoahangy from Asity Madagascar; Richard Razakamalala, Pete Lowry, Chris Birkinshaw, Patrice Antilahimena and Eric Lowry from MBG; Mara Berge from CoBa Antsotso; Brian Fisher from the California Academy of Sciences; Jonathan Stacey and Luciana Vega from BirdLife International; and Helen Temple at The Biodiversity Consultancy. Our sincere thanks go also to the staff members of Fikambanana Mitantana (FIMPIA, the community association at Sainte Luce), and the heads of other CoBas and heads of Districts for their efficient help during the field work. Jennifer Talbot assisted in completion of this volume in numerous ways. Maps were prepared by Andriamandranto Ravoahangy. Translation between English and French was carried out by Kobele Keita of The Biodiversity Consultancy, and Andry Rakotomalala, and the French finally checked by Marion Grassi of LPO (BirdLife in France). The Summary and Recommendations were translated into Malagasy by Voninavoko Raminoarisoa (Asity Madagascar).

The work was kindly authorised by the Ministry of Environment, through the Directorate General of Environment, Water and Forest as well as its regional office (Circonscription Régionale de l'Environnement, des Eaux et Forêts) for Anosy Region in Fort Dauphin/Tolagnaro. The implementation of this work and the herpetological field data collection are the result of collaboration between Rio Tinto QMM, FIMPIA and the Committee of Protected Areas Management in the Sainte Luce area.

## INTRODUCTION

The biological and socio-economic studies in this volume were initiated as part of the Rio Tinto-BirdLife International partnership. This partnership was established in 2001 in order for BirdLife to assist Rio Tinto in the development and implementation of its biodiversity strategy and goal of a Net Positive Impact (NPI) on biodiversity at mining operations, including the Rio Tinto QMM (QIT Madagascar Minerals, QMM) ilmenite project in Anosy region of south east Madagascar.

The Rio Tinto QMM project was chosen as a pilot operation for NPI because of Madagascar's highly endemic and threatened biodiversity, and the risks and opportunities that biodiversity presents to the site. Achievement of NPI is based on a mitigation hierarchy, which begins with the avoidance, mitigation and restoration of the impacts on biodiversity of a mining operation. When those have been optimised, NPI looks to the use of offsets as “quantifiable conservation actions taken to compensate for residual, unavoidable harm to biodiversity”.

A biodiversity offsets strategy needs to account for biodiversity gains and losses in a transparent manner, consider intrinsic values (scientific, conservation) and service values (economic and cultural), involve relevant stakeholders at multiple levels and be based on adequate information (including both scientific and traditional knowledge). Offsets should be designed to achieve the best outcomes for conservation and traditional use and thus must consider similar habitat types to those impacted, consider opportunities for better conservation outcomes in other habitats, and may include actions to manage habitat that build capacity in institutions, people and knowledge, and that secure ecosystem services.

In order to design a successful NPI strategy for the Rio Tinto QMM ilmenite project, it is thus

necessary to obtain relevant biological and socio-economic information from potential offset sites within the Anosy region of Madagascar. Tsitongambarika humid forest was identified as a key conservation site with high biodiversity value and therefore an important potential offset site in Rio Tinto QMM's NPI strategy.

The Tsitongambarika Protected Area was created in 2008 by the Malagasy Ministry of Water and Forests with technical and financial support from Asity Madagascar (the country Affiliate of BirdLife International), Rio Tinto, Rio Tinto QMM, USAID, and Conservation International. It covers an area of over 60,000 hectares of humid lowland and mid-altitude forest, located just north of the town of Tolagnaro (Fort Dauphin). In addition to being an important conservation area, protecting many endemic and threatened species, it also serves as the principal watershed for the region—providing water for irrigation as well as for Tolagnaro town. The forest also provides numerous other ecosystem goods and services that ensure the economic and cultural well-being of the surrounding population. The Tsitongambarika Protected Area is currently co-managed by Asity Madagascar and more than 60 community forest management groups located around the forest.

The research in this volume has been carried out to provide the biological data which Rio Tinto/Rio Tinto QMM and their conservation partners used to develop Rio Tinto QMM's NPI strategy. The decision to publish these data and make them available to a wider public and scientific community serves not only to increase our collective knowledge of the biodiversity and socio-economic situation of Tsitongambarika, but will, we hope, stimulate and encourage future biological and socio-economic research in the area.



**Plate 1.** View of Tsitongambarika Forest (ANDRIAMANDRANTO RAVOAHANGY)



## SUMMARY OF FINDINGS

Lowland humid evergreen forest is one of the most threatened vegetation types in Madagascar. Nonetheless, significant areas can still be found in south-eastern Madagascar, most notably the Andohahela and Tsitongambarika (Vohimena) forests in Anosy Region. Until recently, however, these forests had been the focus of little biodiversity study, and recognition of their biological importance was limited. The surveys presented in this report highlight the biological importance of the Tsitongambarika forests. In particular, they indicate that these forests are floristically and faunistically distinct from lowland humid evergreen forests elsewhere in Madagascar. Among the key findings of the surveys were the discoveries of several species of amphibian, reptile and plant new to science, and confirmation of the presence of a number of globally threatened and restricted-range species.

The major conclusions from the surveys can be found below. In the following section, a number of recommendations are drawn from these conclusions for those considering conservation intervention within the Tsitongambarika massif, including altitudes, sites and species that deserve particular attention.

### VEGETATION AND FLORA

While eastern humid forest is the most abundant natural forest formation in Madagascar, about 80% of it is mid-altitude forest between 800 and 1,500 m altitude, and relatively little remains at low elevations. However, the Tsitongambarika forests are mainly distributed below 800 m altitude, and, almost uniquely for humid forests in south-eastern Madagascar, include significant areas below 400 m.

Surveys of flora focused on Bemangidy-Ivohibe Forest in Tsitongambarika III, which is notable for the presence of relatively undisturbed humid forest below 400 m altitude. In total, nearly 600 species were collected during the surveys, representing 366 genera in 121 families. Although identification of all specimens has yet to be completed, almost 70 plant species new to science may have been found in Tsitongambarika to date. The survey team estimated the flora of this area to exceed 1,000 species.

### MAMMALS

Mammal surveys focused on lemurs and bats. Seven species of lemur were identified within

Tsitongambarika, of which two (Collared Brown Lemur *Eulemur collaris* and Grey Gentle Lemur *Haplemur griseus*<sup>1</sup>) are globally threatened, one (Aye-aye *Daubentonia madagascariensis*) is Near Threatened and two more are so poorly known that they are classified as Data Deficient. Although all three sites surveyed held all seven lemur species, Ivorona appeared to hold the highest densities. All of the lemur species recorded at Tsitongambarika can also be found at the nearby Andohahela National Park, where eight species have been recorded.

Seven bat species were found during surveys, including two globally threatened (Vulnerable) species and one Data Deficient species. Particularly significant populations of the threatened Madagascar Flying-fox *Pteropus rufus* were found, numbering about 2,000 individuals among four roosts, notably at Ivolo. Given the relatively short survey period, it is likely that further surveys at Tsitongambarika would reveal additional bat species.

### REPTILES AND AMPHIBIANS

The mountains of Anosy Region are one of the two areas in Madagascar with the highest number of globally threatened amphibian species, and the Anosy Region is also one of the richest in Madagascar for reptile species, with a number of species not known from elsewhere in the country. Comparison between amphibian and reptile species known from Tsitongambarika and those known from nearby littoral forests and the humid forests of Andohahela National Park reveals significant differences.

Surveys of the Tsitongambarika forests to date, summarised in this report, have recorded 70 reptile species and 57 amphibian species. These include 12 species believed restricted to the Anosy Region, six globally threatened species, four Near Threatened species, and six Data Deficient species. Although collections made during the 2006 survey have yet to be fully identified, they include four frogs (*Boophis* sp. and *Mantidactylus* spp.), a day gecko (*Phelsuma* sp.) and a snake (*Liophidium* sp.) that are thought probably to represent new species to science. Highest amphibian and reptile species richness has been recorded at Ivorona and Manantantely, but globally threatened and potentially new species are distributed patchily: all sites except Lakandava and Ivohibe held species of conservation concern not found at other sites.

<sup>1</sup> Under alternative taxonomic arrangements, the *Haplemur* found at Tsitongambarika, here called *H. griseus*, is treated as the more geographically restricted Southern Bamboo Lemur *H. meridionalis*. Under either arrangement, the species is threatened; see end of Chapter 4.

## BIRDS

The avifauna of Tsitongambarika includes a number of lowland forest specialists—such as Scaly Ground-roller *Brachypteracias squamiger*, Nuthatch Vanga *Hypositta corallirostris* and Red-tailed Newtonia *Newtonia fanovanae* — and other species characteristic of undisturbed humid forest, such as Brown Mesite *Mesitornis unicolor*, Short-legged Ground-roller *Brachypteracias leptosomus*, Pollen’s Vanga *Xenopirostris polleni* and Wedge-tailed Jery *Neomixis flavoviridis*. Because of its importance for globally threatened and restricted-range species, Tsitongambarika was recognised as an Important Bird Area by BirdLife International (ZICOMA 1999).

Surveys of the Tsitongambarika forests to date, summarised in this report, have recorded 97 bird species, 57 (59%) of which are endemic to Madagascar. These include eight globally threatened and six Near Threatened species, for which the most important sites surveyed were Ivohibe and Ivorona. The avifauna of Tsitongambarika does not appear to differ greatly from that of the nearby Andohahela National Park. Further surveys at higher altitudes of Tsitongambarika, which have not been surveyed to date, are likely to emphasise similarities to Andohahela.

## ANTS

In addition to the BirdLife International-coordinated surveys, an ant survey of Ivohibe Forest in Tsitongambarika III was conducted by scientists from California Academy of Sciences and the Madagascar Biodiversity Centre. A total of 105 species were recorded, with two species known only from this forest.

## OTHER VALUES

In addition to their intrinsic biodiversity values, the Tsitongambarika forests are an important source of ecosystem goods and services. Socio-economic surveys presented in this report show that the forests are an important source of forest products for local people, including firewood, charcoal, construction materials, bushmeat and medicinal plants. Since the local economy is largely subsistence-based and there is a high incidence of poverty, local communities have a high level of dependence on forest products to meet their daily needs. Loss and degradation of forests thus has major implications for the livelihoods of local people.

The Tsitongambarika forests also play an important role in carbon storage, prevention of soil

erosion, and protect the catchments of two of the Anosy region’s major rivers: the Manampanihy and Efaho. These rivers and their tributaries are the main source of water for agricultural irrigation and domestic use for rural communities in the east of the region. Further, the forests of Tsitongambarika I protect the water sources of the Lakandava pumping station and Lanirano Lake, which provide, respectively, 75% and 25% of the water for Fort Dauphin town.

The Tsitongambarika forests also hold significant cultural importance for the local population. There is much evidence of historical settlement, burial sites, terraced rice cultivation and cattle pasturing within the village territories that have been designated as protected forest. In addition, the rivers, pools, and cliffs in the forest, along with actual and mythical forest creatures, are important to the traditions, beliefs and cultural identity of local people.

## FOREST IMPACTS AND CONSERVATION

Forest clearance for shifting cultivation has the most significant impacts on the Tsitongambarika forests. Further forest clearance and degradation comes from poorly controlled fires, often set to clear cattle pasture, and timber harvesting. Although not at high levels, hunting and collecting of non-timber forest products are both starting to locally deplete some natural resources.

At present, the major conservation potential has been seen to lie with the transfer of forest management to local associations. Unfortunately, since local cultural norms do not favour working in local associations and since these associations are seen as imposed by NGOs and the government, many of those that have been established remain weak. If there is agreement with the theory of these local associations, then significant support to these associations in terms of training, mentoring and oversight will be critical. However, these local associations may not be the ideal mechanism for managing the forest. There may be a need to look for a new model for working with local populations to manage the forest that recognises local rights, unequal power relations and fundamentally different value and belief systems among local, regional, national and international stakeholders. Whatever the case, multiple actors will need to commit to additional efforts in both research and management in order to ensure the long-term integrity of the Tsitongambarika forests for their unique biodiversity, for local livelihoods, well-being and culture, and for continued provision of ecosystem services for south-eastern Madagascar.

## FAMINTINANA

Ireo ala mando tsy mihintsan-dravina eny amin'ny haabo iva no anisan'ireo karazan-javamaniry tandindomin-doza indrindra. Na izany aza dia mbola ahitana faritra manan-danja amin'io haabo io any amin'ny faritra atsimo antsinanan'i Madagasikara : ny alan'Andohahela sy Tsitongambarika (Vohimena raha ny marimarina kokoa). Hatramin'izao anefa dia tsy mba anisan'ireo nanaovana fikarohana, na zara raha nisy, mikasika ny zava-boahary ao aminy ireo karazan'ala ireo, hany ka tsy dia fantatra loatra ny zava-dehibe ananany. Ny voka-pikarohana izay aseho ato anatin'ity tatitra ity dia mampiseho ny lanja ara-biolojika ananan'ny alan'i Tsitongambarika. Maneho indrindra izy ity fa miavaka ireo ala ireo raha mitaha amin'ny ala mando tsy mihintsan-dravina amin'ny haabo iva hafa eto Madagasikara. Anisan'ny vokatry ny fikarohana misongadina dia ny fahitana karazana sahona sy reptilia ary zava-maniry vaovao ho an'ny siansa ; ao koa ny fahitana ireo karazan-java-manan'aina izay mila ho lany tamingana na koa tsy fahita raha tsy ao anatin'ny faritra voafetra.

Ireo fehin-kevitra nisongadina tamin'io fikarohana io dia hita etsy ambany. Manarak'izany dia hisy tolo-kevitra maromaro nosintonina tamin'ireo voka-pikarohana, ho an'ireo mikasa hanao asa fiarovana ao amin'ny alan'i Tsitongambarika. Anisan'izany ireo tolo-kevitra mahakasika ireo haabo sy ny toerana ary ny karazana zava-manan'aina izay mendrika fiheverana manokana.

### ZAVA-MANIRY

Ny ala mando atsinanana no tangoron'ala natoraly betsaka indrindra eto Madagasikara. Manodidina ny 80% ny velaran'ny ala amin'ny haabo antonony eo anelanelan'ny 800 sy 1500 m ary vitsy ihany no hita amin'ny haabo iva. Nefa kosa ny ny alan'i Tsitongambarika dia manana velarana lehibe hita amin'ny haabo ambanin'ny 400 m, izay mampiavaka azy amin'ny ala atsimo atsinanana rehetra eto amin'ny nosy.

Ny fanisana ireo karazana zava-maniry dia natao tao amin'ny alan'i Bemangidy-Ivohibe, Tsitongambarika faha-III, izay miavaka noho ny fisian'ny ala mbola tsara amin'io haabo latsaky ny 400 m io. Eo amin'ny 600 karazana eo no zava-maniry voalisa izay ahitana taranaka 366 sy fianakaviana 121. Na dia mbola tokony ho vitaina aza ny famaritana ireo karazana ireo, dia mety eo amin'ny 70 eo ny karazana zava-maniry vaovao hita ao Tsitongambarika ankehitriny. Ireo mpanao fikarohana dia manombana ho 1000 ny karazana zava-maniry ao aminy.

### BIBY MAMPINONO

Ny fanisana natao dia niompana tamin'ny gidro sy ny ramanavy. Fito ny karazana gidro hita tao Tsitongambarika ka ny roa amin'ireo (*Eulemur collaris* sy *Hapalemur griseus*) dia tandindomin-doza maneran-tany, iray tandindomin-doza ary ny roa kosa dia tsy mbola fantatra ka nokilasiana ho “tsy ampy fahalalana”. Na dia samy nahitana ireo karazana gidro fito ireo aza ny toerana telo nanaovana ny fikarohana dia Ivorona no tena mananana azy maro indrindra. Ireo karazana gidro ireo dia hita ihany koa tao amin'ny alan'Andohahela, manakaiky an'i Tsitongambarika, izay ahitana karazana valo.

Karazana Ramanavy fito no hita tao ka ny roa dia tandindomin-doza maneran-tany ary ny iray dia tsy ampy fahalalana. Tangoron-dramanavy, *Pteropus rufus*, karazana tandindomin-doza ivondronana ramanavy 2000 isa, no hita tao amin'ny toeram-ponenany efatra, indrindra fa tao Ivolo. Koa satria fohy loatra ny fotoana nanaovana ny fikarohana dia inoana fa mety mbola hahita karazana ramanavy maro hafa amin'ny fanisana manaraka.

### SAHONA SY REPTILIA

Ireo tendrombohitra'Anosy dia iray amin'ireo faritra roa ahitana karazana sahona tandindomin-doza maneran-tany betsaka indrindra ary ny faritra'Anosy dia anisan'ny manankarena reptilia indrindra eto Madagasikara. Ny fampitahana ireo reptilia sy sahona hita ao amin'ny alan'i Tsitongambarika amin'ireo hita manodidina toy ny ala amin'ny sisindrano sy ny ala ao anatin'ny valan-javaboaharin'i Andohahela dia maneho fahasamihafana goavana. Ny fanisana natao tao Tsitongambarika, voafintina ato anatin'ity tatitra ity, dia nahitana karazana reptilia 70 sy karazana sahona 57. Karazana 12 amin'ireo dia heverina fa tsy ho hita raha tsy ao amin'ny faritra Anosy, enina tandindomin-doza maneran-tany, karazana efatra tandindomin-doza ary enina tsy tsy ampy fahalalana.

Na dia mbola tsy tanteraka aza ny fikarohana mahakasika ny famaritana ny karazana izay natao tamin'ny 2006, dia fantatra fa misy karazana sahona 4 sy androngo iray vaovao ho an'ny siansa hita tao.

Ny nahitana ny karazana sahona sy reptilia, maro indrindra dia ao Ivorona sy Manatantely. Ireo karazana efa tandindomin-doza sy ireo mety ho vaovao kosa dia samy manana ny azy. Ankoatr' Ivohibe sy Lakandava anefa, ny toerana rehetra ao dia mananana karazana manan-daja ho an'ny fiarovana ary koa tsy fahita raha tsy ao amin'izy ireo ihany.

## VORONA

Ao Tsitongambarika dia misy Karazana voron'ala amin'ny haabo iva maromaro toy ny *Brachypteracias squamiger*, *Newtonia fanovanae*, *Hypositta corallirostris*. Ao koa ny karazana izay fahita any amin'ny ala mando mbola tsara toy ny *Mesitornis unicolor*, *Brachypteracias leptosomus*, *Xenopirostris polleni* sy *Neomixis flavoviridis*. Nohon' ny fananany karazana vorona tandidomin-doza sy miparitaka amin'ny faritra voafetra, Tsitongambarika dia voakilasy ho Faritra manan-danja ho fiarovana ny vorona (ZICO), izay nofaritan'ny BirdLife International, eto Madagasikara (ZICOMA 1999).

Ny fanisana vorona natao tao Tsitongambarika izay fintinina ato anatin'ity tatitra ity dia mampiseho 97 karazana ka ny 57 (59%) amin'ireo dia tsy hita raha tsy eto Madagascar. Sivy amin'izy ireo dia tandindomin-doza maneran-tany ary enina tandindomin-doza. Ny toerana manan-danja indrindra dia Ivorona sy Ivohibe.

Tsy dia misy mahasamihafa azy amin'ny vorona hita ao amin'ny valan-javaboahary Andohahela izay manakaiky azy ny vorona ao amin'ny alan'ny Tsitongambarika. Ny fikarohana hafa hatao any amin'ny faritra avo, izay tsy mbola nisy fanisana koa dia mety mbola hampisongadina io fitoviana io.

## VITSIKA

Ankoatry ny fanadihadiana notantanin'ny BirdLife International dia nisy koa fanisana karazana vitsika izay nataon'ireo manam-pahaizana avy ao amin'ny California Academy of Science sy ny Madagascar Biodiversity Centre tao amin'ny alan'Ivohibe Tsitongambarika III. Vitsika mitotaly 105 karazana no voaisa ary karazana 2 amin'ireo ihany no efa fantatra fa efa nisy teo an-toerana taloha.

## LANJA Hafa

Ankoatra ny fananana lanja ho an'ny zavaboahary, ireo alan'ny Tsitongambarika koa dia manan-danja amin'ny tolotra ara-rohy voahary. Ny fanadihadiana ara-tsosialy sy ekonomika natao dia mampiseho fa io ala io dia loharam-bokatry ny ala goavana ho an'ny mponina eny ifotony. Toy ny kitay, saribao, fitaovana fanorenana, hena dia, zava-maniry fanao fanafody. Koa satria ny harikarena eny ifotony dia mifototra amin'ny hoenti-mivelona ary koa nohon' ny taham-pahatrana avodia avo dia miantehatra amin'ny vokatra ny ala ny mponina mba hamaly ny filàny andavan'andro. Ny fahaverezana sy fahapotehan'ny ala izany dia misy fiantraikany mafy amin'ny fahafaha-mivelon'ny mponina eny ifotony. Ny alan'i Tsitongambarika dia mandray anjara betsaka koa amin'ny fitehirizana karinbôna, ny fiarovana amin'ny asan'ny riaka ary amin'ny fiarovana ny ala mamefy ny renirano roa lehibe indrindra ao amin'ny faritra

Anosy : Manampanihy sy Efaho. Ireo renirano lehibe ireo sy ny sampany no rano manondraka ny fambolena sy fampiasa ao an-tokatrano ho an'ireo mponina any atsinana amin'ny faritra. Ankoatr'izay, ny alan'i Tsitongambarika I dia miaro ny loharano ao amin'ny toerana fisintonan-drano ao Lakandava sy ny farihin'ny Lanirano izay miantoka 75% sy 25% ny rano ho an'ny tananan'i Tolagnaro. Manana lanja ara-koltoralny ho an'ny mponina ifotony koa ny alan'i Tsitongambarika. Misy sisan-tanàna manan-tantara maro, toerana masina, voly vary am-bohitra, toeram-piraofan'ny biby ao anatin'ny faritra heverina ho ala arovana. Ankoatr'izay dia ireo toerana voahary rehetra toy ny renirano, honahona, farihy sy ny ala dia manan-danja tokoa ho an'ny nentim-paharazana, ny finoana sy ny maha izy azy ara-kolotsain'ny mponina eny ifotony.

## FIANTRAIKAN'NY ALA SY NY FIAROVANA AZY

Ny fandripanahana ny ala avy amin'ny fanaovana Tavy no manana fiantraikany lehibe indrindra amin'ny alan'i Tsitongambarika. Ny fandripanahana sasany dia avy amin'ny afo tsy voafehy izay matetika natao ho fanadiovana ny toerana firaofan'ny biby sy fakana hazo. Na tsy dia misy fiantraikany firy aza ny fihazana sy ny fakana ny vokatra hafa ao an'ala dia manomboka mandany ireo loharanon-karena voajanahary sasany koa izany.

Ankehitriny, ireo fomba heverina ho mahomby indrindra amin'ny fiarovana dia ny famindram-pitantanana ny ala amin'ireo fikambanan eny ifotony. Mampalahelo anefa fa tsy mety amin'ny fomba fiasan'ny fikambanana ny fenitra koltoralny eny ifotony ary koa ireo fikambanana ireo dia toy ny voaterin'ny ONG sy ny fitondram-panjakana ka dia maro amin'izy ireny no efa mijoro nefa dia mbola osa. Raha toa ka mahita fomba fifanarahana amin'ny fiainan'ny fikambanana eny ifotony dia ny fanampiana miompana amin'ny fiofanana, torohevitra sy fanarahamaso no tokony homena azy ireo. Na izany aza, mety tsy ny fampiasana ireo fikambanana ireo no tetika mahoby amin'ny fitantanana ny ala. Mety ho ilaina ny mahita modely vaovao ho fiaraha-miasa amin'ny olona eny ifotony izay mifanaraka amin'ny lalàna ambanivohitra, fifandraisan'ny fahefana tsy mitovy, ny lanja sy ny finoana izay tena samihafa tokoa ho an'ny mpisehatra ifotony, rezionaly sy nasionaly ary iraisam-pirenena. Na inona na inona anefa ny vahaolana ho raisina, ireo mpisehatra rehatra dia tokony handray andraikitra amin'ny fanampin'ezaka maharitra, amin'ny fikarohana sy fitantanana mba hiantohana ny fahatomombana'ny alan'i Tsitongambarika sy mba hikajina ireo zavaboahary tsy manampaharoa ireo, ireo fiveloman'ny mponina, ny fiainana sy ny kolotsaina ary mba hitohizan'ny tolotra ara-rohy voahary any atsimo atsinanan'i Madagasikara.



## RECOMMENDATIONS

Based on the findings of the report, a series of recommendations for those considering conservation intervention in the Tsitongambarika massif is given below. These recommendations are grouped in three categories—the first category includes recommendations on areas, sites and species deserving particular attention, the second and third focus on the kind of interventions that are needed to ensure that successful long-term biodiversity conservation is achieved without compromising the livelihoods and cultural values of local communities.

### PRIORITY AREAS, SITES AND SPECIES AT TSITONGAMBARIKA

- Lowland humid evergreen forest is one of the most threatened vegetation types in Madagascar. Almost uniquely for humid forests in south-eastern Madagascar, Tsitongambarika includes significant areas below 400 m. These **lowland areas (e.g. Bemangidy-Ivohibe)** are particularly high priorities for conservation, especially given their importance for restricted-range plant species.
- Flying foxes provide significant ecosystem service benefits (pollination) as well as being a threatened species. **Flying fox roosts** (four have been identified in Tsitongambarika, notably at Ivolo) are priorities for site protection.
- **Cultural sites** warrant particular attention. Historical settlements, burial sites, and spiritual sites linked to natural features such as rivers, pools and cliffs have been identified in the forest, and are potentially of significant importance to local people. Since these will differ among clan territories particular attention will need to be paid to these in each area.
- For some taxonomic groups—e.g. reptiles and amphibians—it is difficult to select priority sites because globally threatened and potentially new species are distributed patchily (all sites except Lakandava and Ivohibe hold species of conservation concern not found at other sites). Similarly, many ecosystem service values (e.g. non-timber forest products, broader-scale services such as water purification) are dispersed throughout the forest. Consequently **conservation management for the whole of Tsitongambarika is needed**, not just for particular special sites or species.
- Priority species include **globally threatened and restricted-range species**. Tsitongambarika is home to many such species, including some Endangered and site-endemic species which rank among the highest priorities.
- Species research should focus on **information relevant to conservation management of priority species** (e.g. distribution, threats, conservation actions needed and their effectiveness), taking into account that in many cases species will be most efficiently protected by measures aimed at preserving their habitat.
- Clarifying the status of **species potentially new to science** is a particular priority for species research. The surveys reported here found almost 70 plant species new to science and six reptile and amphibian species probably new to science.

### CONSERVATION MANAGEMENT NEEDS AT TSITONGAMBARIKA

- Management activities are needed that will ensure **persistence of viable populations of priority species, maintain the integrity of habitats, provide alternative livelihoods** to local communities for foregone unsustainable forest use, and **address specific threats** identified in this report.
- Although some conservation activities have been implemented at Tsitongambarika, infrastructure and capacity are limited. Any future programme would need to make significant investment in **infrastructure, training and capacity building**, coupled with ongoing mentoring and support.
- To assist with planning future conservation or offset programmes, a short-term recommendation is to produce a short report detailing biodiversity values, costs and opportunities for each area (Tsitongambarika I, II and III).
- At present, the main mechanism for conservation is the **transfer of forest management to local associations**. However, since local cultural norms do not favour working in local associations and since these associations are seen as imposed by NGOs and the government, these local associations may not be the ideal mechanism for managing the forest, and **there may be a need to look for a new model (and/or significantly adjust the current model) for working with local populations** to manage the forest.
- In the long term, conservation management at Tsitongambarika will only be successful if it **addresses the underlying causes of biodiversity loss**.

The main pressure on Tsitongambarika is clearance for subsistence agriculture with additional major pressures from illegal timber harvesting and hunting. High rates of poverty and rapid population growth exacerbate this pressure.

- **Sustainable livelihood programmes** are needed that reduce human pressures on biodiversity and link biodiversity conservation with alternative appropriate benefits. Villagers will only be willing to conserve (which inevitably causes short-term natural resource use restrictions) if they receive commensurate benefits, such as support for rural development.

### ENSURING THAT LOCAL COMMUNITIES BENEFIT FROM BIODIVERSITY CONSERVATION AT TSITONGAMBARIKA

---

- Given that the Tsitongambarika Forest provides for local, regional, national, and international livelihoods and well being, research and programmes oriented on understanding and ensuring the continued supply of the diverse **ecosystem services** will be necessary.
- Given that the conservation and use of the forest are **social endeavours** at their core, future research and programmes need to focus on **critical social research** to increase our understanding of the local socio-cultural context including knowledge systems, traditions, and concepts and realities of forest management. It is only by better understanding these local socio-cultural contexts that we will be able to more effectively collaborate with the local forest managers, to manage and conserve the forest.
- Given that there are very different and often contradictory perceptions of the forest held by stakeholders at the local, regional, national, and international levels, it will be important to recognise and address serious issues of **unequal power relations, local rights, environmental justice, and fundamentally different value and belief systems among multiple stakeholders**. This will be essential for conserving the Tsitongambarika forests for their unique biodiversity in a socially just way that also ensures local livelihoods, well-being and culture.
- Given the widely divergent stakeholder values regarding the biodiversity in the Tsitongambarika Forest, it may be necessary to broker agreements with communities to stop unsustainable use of forests in return for direct community development benefits. This will need to follow the principles of former, prior, and informed consent (FPIC). This will require **culturally appropriate “deals”, rigorous external and local participatory monitoring, and adequate compensation**.
- Given that the **rural production systems and livelihoods in different areas around the forest are quite varied**, programmes for forest conservation and livelihoods will need to be specifically tailored to local contexts and flexible enough to respond to local needs.
- Given that there are already more than 60 **community forest management groups** in place throughout the forest, and that these are the *de facto* on-the-ground day-to-day managers of the forest, future efforts must ensure that these evolve into cultural appropriate operational and effective forest management mechanisms. The considerable support and attention that is necessary to achieve this should not be underestimated.

## ■ TOLO-KEVITRA

Mifototra amin'ny voka-pikarohana avy amin'ity tatitra ity, dia misy tolo-kevitra maromaro izay napetraka mba ho an'ireo izay mety handray anjara amin'ny asa fiarovana ny alan'i Tsitongambarika, izay nosokajina telo. Ny sokajy voalohany dia ireo tolo-kevitra mahakasika ny faritra, toerana sy ny karazana ilaina fijerena manokana, ny faharoa sy ny fahatelo dia manasongadina ny karazana hetsika ilaina mba hiantohana ny fahombiazan'ny fiarovana ny zavaboahary amin'ny ho avy nefa tsy maningotra ny fahavelomana sy ny lanja ara kolotsain'ny fiarahamonina ifotony.

### IREO FARITRA, TOERANA SY KARAZANA LAHARAM-PAHAMEHANA AO TSITONGAMBARIKA

- Ny ala mando tsy mihintsan-dravina amin'ny haabo iva dia iray amin'ny karazan-java-maniry tandindomin-doza indrindra eto Madagasikara. Amin'ny maha tsy manam-paharoa azy amin'ny ala atsimo atsinan'i Madagasikara, ny alan'i Tsitongambarika dia manana faritra lehibe amin'ny haabo ambanin'ny 400 m. Ireo faritra manana haabo iva ireo (oh Bemangidy-Ivohibe) dia laharam-pahamehana ho an'ny fiarovana noho ireo karazana zava-maniry manana fiparitahana voafetra ao amin'izy ireo.
- Ny ramanavy dia manana andraikitra tsara manokana ao anaty rohy voahary (fanapiritahana vovobony) na dia Karazana tandindomin-doza aza. **Ireo toeram-pihantonan'izy ireo (misy efatra ao Tsitongambarika indrindra fa ao Ivolo)** dia laharam-pahamehana amin'ny fiarovana ihany koa.
- Ireo toerana kolotoraly dia mila fiheverana manokana. Hita ao anaty ala ny tanàna manantantara, ny toerana fanaovana fomba sy fivavahana mifandraika amina singa natoraly toy ny renirano, honahona sy ny hantsana morondranomasina ary tena manan-danja tokoa ho an'ny mponina eny ifotony. Noho izy ireo samihafa isaky ny andiana foko dia ilaina ny fijerena manokana isaky ny faritra.
- Sarotra ny mamantatra ny toerana laharam-pahamehana ho an'ny fiarovana ny ny vondrona sasany toy ny sahona sy ny reptilia satria ireo karazana tandindomin-doza sy ireo karazana mety ho vaovao dia samy manana ny fiparitahany izay tsy mitovy (ireo toerana rehatra ankoatry Lakandava sy Ivohibe dia ahitana ireo karazana manan-danja amin'ny fiarovana manokana izay tsy

hita any amin'ny toerana hafa). Toy izany koa ireo tolotra ara-rohy voahary manan-danja maro (toy ny vokatra tsy hazo, ireo tolotra avo lenta toy ny fanadiovana ny rano) dia miparitaka eran'ny ala. **Noho izany dia ilaina ny miaro manontolo an'i Tsitongambarika fa tsy voafetra ho an'ny toerana na karazana voafaritra manokana fotsiny.**

- Ny karazana manana lahara-pahamehana dia **ireo karazana manana sata tandindomin-doza manerantany sy ny karazana manana fiparitahana voafetra**. Tsitongambarika dia betsaka an'ireo karazana ireo, anisan'izany ny karazana efa ho lany tamingana sy ireo izay tsy fahita amin'ny toerankafa izay voakilasy ho anatin'ny laharam-pahamehana.
  - Ny fikarohana mikasika ny karazana dia tokony hiompana amin'ireo **fanadihadiana tena ilaina amin'ny fitantanana ny fiarovana ireo karazana manana laharam-pahamehana** (oh Ny fiparitahana, ireo loza mitatao, ireo fepetra fiarovana tokony ho raisina sy ny fahombiazany) ireo, nohon'ny fahatsapana tamin'ny tranga hafa maro fa voaro kokoa ny karazana izay ampiharana fiarovana mikendry fikajiana ny toeram-ponenany.
  - Ny fandalinanana ny satan'ireo karazana heverina ho vaovao eo amin'ny siansa dia laharam-pahamehana manokana ho an'ny fikarohana ny karazana. Ireo fanadihadiana naseho teto dia nanambara fa 70 ny karazana zava-maniry vaovao ary 6 kosa karazana ho an'ny sahona sy ny reptilia.
- ### NY TOKONY HATAO HO AN'NY FITATANANA NY FIAROVANA AO TSITONGAMBARIKA
- Ny asa fitantanana ilaina dia ireo izay **miantoka ny faharetan'ny andiany tokony ho velona ho an'ireo Karazana manana laharam-pahamehana, mitana ny fahatsaran'ny toeram-ponenany ary manolotra solona fomba fivelomana** ho an'ny mponina ifotony ho fanitsiana ny fampiasana tsy maharitra ireo ala, ary mijery manokana ireo loza mitatao voatanisa tato amin'ity tatitra ity.
  - Na dia eo aza ireo asa fiarovana efa natomboka tao Tsitongambarika, ny foto-drafitr'asa sy ny fahaiza manao dia tsy ampy. Ny lamin'asa rehetra amin'ny ho avy dia tokony hampiasa vola betsaka amin'ny lafiny foto-drafitr'asa, **fampiofanana sy fanamafisana fahaiza-manao** arahina fanarahamaso sy fanampiana mitohy.

- Hanampiana ny rafitr'asa fiarovna na ny lamin'asa onitra amin'ny ho avy dia misy fepetra tokony hatao avy hatrany dia ny famoahana tatitra fohy mikasika ireo lanja, ireo teti-bidy sy ireo zay tsara fanararaotra ho an'ny faritra tsirairay (Tsitongambarika I, II, III).
- Ankehitriny, ny fomba fiarovana misongadina dia ny **Famindram-pitantanana ny ala amin'ireo fikambanan eny ifotony**. Koa satria tsy mety amin'ny asa ao amin'ny fikambanana ny fenitra kolotoraly eny ifotony ary koa ireo fikambanana ireo dia toy ny voabaikon'ny ONG sy ny fitondram-panjakana, dia heverina fa tsy fomba idealy ny fampiasana ny fikambanana : tsy maintsy heverina ny hahita modely vaovao (sy/na hanova am-pitandremana ny modely efa misy ) hiaraha-miasa amin'ny mponina mba hiarovana ny ala.
- Any aoriana any, ny fitantanana ny fiarovana an'i Tsitongambarika dia tsy hahomby **raha tsy mahakasika ireo tena antony fototra** mahatonga ny fahaverezan'ny zavaboahary. Ny tena tsindry mahazo an'i Tsitongambarika dia ny fandranganana ala hanaovana fambolena hivelomana, ampian'ny tsindry fanampiny sady manan-danja mifandraika amin'ny fihazana sy ny fakana tsy ara-dalana ireo hazo. Ny taha avon'ny fahantrana sy ny fitombon'ny mponina dia vao maika manampy trotraka ireo tsindry ireo.
- Ny **fisian'ny lamin'asa ho amin'ny fahafaha-mivelona maharitra** dia ilaina mba hampihenana ny tsindry avy amin'olombelona amin'ny zava-boahary ary hampifandray ny fiarovana ny zava-boahary sy ny famoronana solon'antompivelomana mety. Tsy afaka hiaro ny voahary ny mponina (izay tsy azo ialana ny hisian'ny famerana ao anatin'ny fotoana fohy) raha tsy mahazo tombotsoa mifanaraka amin'izany toy ny fanampiana amin'ny fampandrosoana ambanivohitra.

## NY FIARAHA-MONINA ENY IFOTONY DIA MAHAZO TOMBONY AMIN'NY FIAROVANA NY ZAVA-BOAHARY AO TSITONGAMBARIKA

- Koa satria ny alan'i Tsitongambarika dia manome fomba ahafaha-mivelonaho an'ny eny ifotony, rezionaly, nasionaly sy iraisam-pirenena, ny fikarohana sy ny lamin'asa ahazoana antoka sy ahafantarana fa ilaina ny **tolotra rohy voahary** samihafa dia tena ilaina tokoa.
- Koa satria ny fiarovana sy ny fampiasana ny ala dia mifototra indrindra amin' ny ezaka aratsosialy, ny fikarohana sy ny lamina'asa amin'ny ho avy rehetra dia tokony hanasongadina ny fanadihadiana matotra mikasika ny ara-tsosialy izay mikendry ny fahazahoantsika bebe kokoa ny toe-draharaha ara kolotoraly sy soasialy eny ifotony, ao anatin'izany ny fahalalana, ireo nentimpaharazana ary ireo endrika sy zava-misy marina mifandraika amin'ny fitantanana ny ala. Ny fahazahoana tsara ireo endrika kolotoraly sy sosialy eny ifotony mantsy no ahafahantsika manana fiaraha-miasa mahomby miaraka amin'ireo mpitantana ala sy hitantanana ary hiarovana ny ala.
- Koa satria ny fahatsapan'ireo andaniny sy ankilany mpifanaiky eny ifotony, rezionaly, nasionaly sy iraisam-pirenena dia tena samy hafa ary mifanohitra aza matetika dia tena ilaina arak'izany ny mahalala sy mijery ireo singa fototra toy ny **fifandraisan'ny fananam-pahefana tsy mitovy, ny zo eny ifotony, ny fahamarinana aratontolo iainana, ary ny fahasamihafana fototra eo amin'ny lanja sy ny finoan'ny mpiray tan-tsoroka tsirairay**. Ireo dia zava-dehibe amin'ny fiarovana ny alan'i Tsitongambarika, mba hiarovana io zava-boahary tokana aman-tany io amin'ny alalan'ny fiantohana ny fahaveloman'ny olona sy ny fiadanany ary ny kolo-tsaina.
- Eo anatrehan'ny karazana lanja ananan'ny andaniny sy ny ankilany mpifanaiky tsirairay mikasika ny zava-boahary ao Tsitongambarika dia tokony ilaina ny mandamina ny fifanarahana amin'ny rehetra mba hisorohana ny fampiasana tsy maharitra ny ala ho takalon'ny tombotsoa mivantana ho amin'ny fampandrosoana ny vahoaka. Amin'izany dia tokony harahina ny foto-kevitra (CLPE) fanekena malalaka, mialoha sady mazava . **Mitaky fifanarahana ara-kolotsaina mifandrindra, fanaraha-maso iraisana avy ivelany sy ifotony matotra ary onitra azo ekena tsara izany**.
- Nohon'ny fahasamihafana **misy amin'ny fomba fahafaha-mivelona eny ambanivohitra ao amin'ireo faritra tsirairay manodidina ny ala**, ireo lamin'asa amin'ny fiarovana ny ala sy ny fomba fiveloman'ny olona dia tokony hifanaraka tsara amin'ny zava-misy ary koa afaka amboarina mba hamaly ireo hetahetan'ireo mponina eny ifotony.
- Koa satria efa misy Fikambanana **mpitantana ala 60 isa** ao ary izy ireo dia mpitantana isan'andro ny ala, ny hetsika rehetra amin'ny ho avy dia tsy maintsy hiantoka ny fivoaran'ireo vondrona ireo ho amin'ny fomba fitantanana mihodina sy mahomby ireo ala izay mifanentana tsara amin'ny kolotsaina. Tsy tokony hatao ambanin-javatra ny fanampiana sy ny fiheverana manokana mikasika ny fomba hatao mba hahatratrara io tanjona io.



# Chapter 1: OVERVIEW OF THE BIOLOGICAL IMPORTANCE OF TSITONGAMBARIKA FOREST

ANDREW W. TORDOFF

## BACKGROUND

The Tsitongambarika forests comprise three forest management units (termed Tsitongambarika I, II and III) in Anosy Region, south-eastern Madagascar. These forests lie along the Vohimena mountains, which run north from Tolagnaro (Fort Dauphin) for a distance of around 100 km. These mountains run parallel to the Anosyenne mountains, where Andohahela National Park is situated. The Vohimena mountains reach a maximum altitude of 1,358 m, while the Anosyenne mountains are significantly higher, reaching a maximum altitude of 1,956 m.

The Tsitongambarika forests are characterised by a mountainous relief, with steep slopes rising abruptly from the narrow coastal plain. Generally speaking, the soils of Tsitongambarika comprise laterites and ferralites, deposited on Pre-Cambrian gneiss and granitic rocks (Bourgeat 1972). The soils are generally rich, humus-bearing and of varying depth; rock outcrops are frequent.

Tolagnaro experiences a tropical climate, with an average annual rainfall of 1,679 mm, equivalent to 140 mm per month. There are nine perhumid months per year but no dry months. Average annual temperature is 23.4°C, with relatively little seasonal variation. There appears to be a north-south gradient in rainfall along the Tsitongambarika forests, with Manantenina (near the northern end) receiving an average of 3,000 mm per year, compared with Nahampoana (near the southern end), which receives only 2,130 mm annually (Paulian *et al.* 1973). Moist easterly winds provide orographic rainfall on the windward slopes of the Vohimena and Anosyenne chains, leading to the development of humid forest; this contrast sharply with the semi-arid climate prevalent to the west of the Anosyenne mountains.

Following the classification of Humbert (1955), the Tsitongambarika forests comprise humid forest at low altitude (0–800 m) and humid forest at medium altitude (800–2,000 m asl) of the eastern Madagascar Region. Humid forest at low altitude is the most endangered vegetation type in Madagascar (Langrand 1990), particularly as a result of clearance for *tavy* (shifting cultivation) and exploitation for fuelwood. According to the results of the *Inventaire Ecologique et Forestier National*, in the mid 1990s, there were only around 2 million ha of lowland dense forests (including Sambirano formations) with little or no modification, plus around 500,000 ha in a degraded or secondary condition (Dufils 2003). According to Langrand (1990), the only large tracts of lowland humid forest remaining “are those surrounding the

Bay of Antongil and south of Mananara”. Nevertheless, significant areas of lowland humid forest can still be found in south-eastern Madagascar, most notably the Tsitongambarika forests. Until recently, these forests had been the focus of little biodiversity study, and recognition of their biological importance was limited.

## THE SURVEYS

During 2005 and 2006, the Tsitongambarika forests were the focus of a series of biodiversity surveys conducted by a team of Malagasy and international scientists from Missouri Botanical Garden, Rio Tinto QMM (QIT Madagascar Minerals, QMM), and two Malagasy NGOs: Asity Madagascar and Madagasikara Voakajy. These surveys were coordinated by BirdLife International, and funded through BirdLife’s partnership with Rio Tinto, a leading mineral resources company, which is the major shareholder in Rio Tinto QMM.

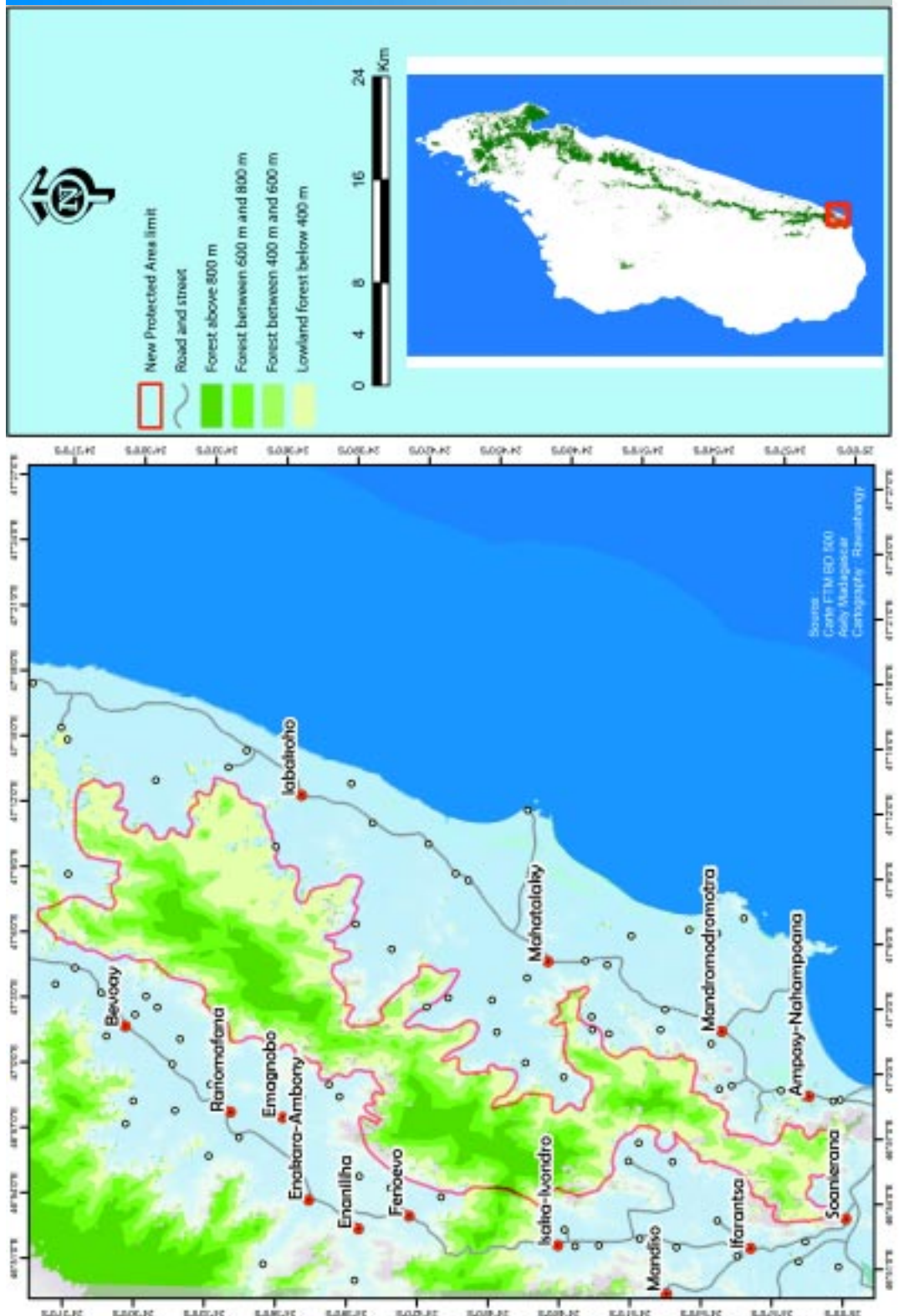
The surveys highlighted the biological importance of Tsitongambarika. In particular, they revealed that the Tsitongambarika forests include some of the most intact areas of primary humid forest remaining at very low elevations in south-eastern Madagascar, and indicated that they are floristically and faunistically distinct from lowland humid forests elsewhere in the country.

## VEGETATION AND FLORA

Although the Tsitongambarika forests reach a maximum altitude of 1,358 m, they contain significant areas below 800 m, and, almost uniquely for humid forests in south-eastern Madagascar, include sizeable areas below 400 m. Although the humid forests of south-eastern Madagascar are south of the Tropic of Capricorn, they are typically tropical in structure and composition (Goodman *et al.* 1997). Indeed, at 25°S, Tsitongambarika is one of the lowest latitude “tropical” humid forests in the Old World (Goodman *et al.* 1997).

While eastern humid forest is the most abundant natural forest formation in Madagascar, about 80% of it is mid-altitude forest between 800 and 1,500 m, and relatively little remains at low elevations (Morris and Hawkins 1998). In south-eastern Madagascar, lowland forest on lateritic soils is thought to have been previously extensive but little now remains, as a result of clearance for shifting cultivation (Goodman *et al.*

Map 1. Topographic map of vegetation



1997). It is not clear why the Tsitongambarika forests have survived while others growing on similar terrain have been cleared, although the fact that local people did not practice shifting cultivation until recently may offer a partial explanation (Nicoll 2003). This may reflect a relative unsuitability of the area for shifting cultivation, due to some underlying feature of climate, topography and/or geology.

Three vegetation and flora surveys were conducted by the botanical team during November 2005, February 2006 and May 2006. These surveys focused on Bemangidy-Ivohibe Forest in Tsitongambarika III. This area of forest is notable because of the presence of relatively undisturbed humid forest at altitudes below 100 m.

To date, in the Bemangidy-Ivohibe Forest and other sites in Tsitongambarika, nearly 600 species have been identified in 366 genera and 121 families, suggesting that the total flora of Tsitongambarika probably includes well over 1,000 species. Given the relative lack of previous botanical collections from lowland humid forests in south-eastern Madagascar, it is reasonable to expect that further surveys will reveal yet more new species.

Newly described plant species from Tsitongambarika include *Gnidia razakamalalana*, a treelet in the Thymelaeaceae family, collected at 90 m altitude. Based on a known area of occupancy of less than 10 km<sup>2</sup>, this species has been provisionally assessed as globally Endangered (P. Lowry *in litt.* 2007). The new discoveries also include three species in the Araliaceae family: *Polyscias bemangidiensis*, an understory shrub to treelet that is reasonably common at Bemangidy-Ivohibe Forest; *Polyscias emargiata*, a small tree known only from a single population restricted to a granite slab at c.100 m altitude; and *Schefflera bemangidiensis*, a slender forest tree known only from Bemangidy-Ivohibe Forest (P. Lowry *in litt.* 2007).

These species are currently known only from Tsitongambarika. While some of them may have had wider distributions previously, the extensive loss of lowland humid forest from other parts of south-eastern Madagascar suggests that at least some of them may now be restricted to the Tsitongambarika forests.

## MAMMALS

The mammal surveys recorded seven bat species, including four species of conservation concern: Madagascar Flying-fox *Pteropus rufus* (Vulnerable), Madagascan Fruit Bat *Eidolon dupreanum* (Vulnerable), Peter's Sheath-tailed Bat *Emballonura atrata* (Vulnerable) and Madagascan Rousette *Rousettus madagascariensis* (Near Threatened). The population of *Pteropus rufus* is particularly significant, numbering around 2,000 individuals divided among four roosts. Also of note, *Eidolon dupreanum* was hitherto unknown from Anosy

Region. Considering the relatively short survey period, it is likely that further survey effort at Tsitongambarika would reveal additional bat species.

In addition to bats, the mammal surveys also focused on lemurs. Seven species of lemur were identified, comprising two diurnal species (Collared Brown Lemur *Eulemur collaris* and Grey Gentle Lemur *Hapalemur griseus*) and five nocturnal species (Brown Mouse-lemur *Microcebus rufus*, Greater Dwarf Lemur *Cheirogaleus major*, Southern Woolly Lemur *Avahi meridionalis*, Greater Sportive Lemur *Lepilemur mustelinus* and Aye-aye *Daubentonia madagascariensis*). Two of these species (Collared Brown Lemur and Grey Gentle Lemur) are globally threatened. All of the lemur species recorded at Tsitongambarika can also be found at the nearby Andohahela National Park, where eight species have been recorded (Feistner and Schmid 1999).

## REPTILES AND AMPHIBIANS

The Global Amphibian Assessment revealed that the Anosy (including Vohimena i.e. Tsitongambarika) mountains are one of the two areas in Madagascar with the highest number of globally threatened amphibian species, the other one being the northern and north-eastern highlands (Andreone *et al.* 2005). The Anosy Region is also one of the richest in Madagascar in terms of number of reptile species, with a number of species not known from elsewhere in the country.

The reptile and amphibian surveys conducted during 2006 focused on two lowland humid forest sites within Tsitongambarika III: Ampasy Forest and Ivohibe Forest. These surveys complemented the results of earlier studies conducted at Tsitongambarika II in 2002 and Tsitongambarika I in 1989 and 1990 (Ramanamanjato 1993). Taken together, all surveys to date have recorded 70 species of reptile and 57 species of amphibian in the Tsitongambarika forests. These include 12 species known only from Anosy Region, such as *Boophis haematopus* (Vulnerable), *Mantella haraldmeieri* (Vulnerable), *Paragehyra gabriellae*, *Zonosaurus anelanelany* and *Pseudoxyrhopus sokosoko*. Although the collections made during the 2006 survey have yet to be fully identified, they include four frogs (two *Boophis* spp., one *Gephyromantis* sp. and one *Mantidactylus* sp.) and two snakes (one *Liophidium* sp. and one *Liopholidophis* sp.) that are thought probably to represent new species to science.

## BIRDS

The main bird survey of Tsitongambarika was conducted between December 2005 and January 2006, focusing on four sites between 85 and 775 m altitude. Supplementary observations made up to

2008 are also included. A total of 97 species were recorded, of which 57 are endemic to Madagascar and a further 25 are restricted to Madagascar and other Indian Ocean islands. Among the bird species recorded in the Tsitongambarika forests were five globally threatened species (Madagascar Red Owl *Tyto soumagnei*, Brown Mesite *Mesitornis unicolor*, Short-legged Ground-roller *Brachypteracias leptosomus*, Scaly Ground-roller *B. squamigera* and Red-tailed Newtonia *Newtonia favovanae*) all of which are assessed as Vulnerable, and six Near Threatened species (Madagascar Crested Ibis *Lophotibis cristata*, Madagascar Sparrowhawk *Accipiter madagascariensis*, Henst's Goshawk *A. henstii*, Grey-crowned Tetraka *Bernieria cinereiceps*,

Pollen's Vanga *Xenopirostris polleni* and Wedge-tailed Jery *Neomixis flavoviridis*). In addition, the globally threatened Meller's Duck *Anas melleri*, Madagascar Grebe *Tachybaptus pelzelinii* and Madagascar Pondheron *Ardeola idae* were recorded on wetlands close to, but outside, Tsitongambarika forest. Because of its importance for globally threatened and restricted-range species, Tsitongambarika is recognised as an Important Bird Area by BirdLife International (ZICOMA 1999).

The avifauna of Tsitongambarika includes a number of species considered by Morris and Hawkins (1998) to be lowland forest specialists, or, at least, more common there than elsewhere. These include Scaly Ground-roller, Red-tailed Newtonia and



**Plate 2.** The small nocturnal chameleon *Brookesia nasus* (ANDRIAMANDRANTO RAVOAHANGY)



**Plate 3.** Red-tailed Newtonia *Newtonia favovanae*. This photograph, taken at Tsitongambarika, may be the first published of this rare lowland forest species (ANDRIANDRAOTAMALAZA BRUNO RAVELOSON)



Nuthatch Vanga *Hypositta corallirostris*. Other species recorded at Tsitongambarika, including Brown Mesite, Short-legged Ground Roller, Pollen's Vanga and Wedge-tailed Jery, are described by Langrand (1990) as being characteristic of undisturbed humid forest.

On the basis of the survey results, the avifauna of Tsitongambarika does not differ greatly from that of the nearby Andohahela National Park. The major difference between the two avifaunas is the absence from Tsitongambarika of a number of species characteristic of upper elevation humid forest that are found at Andohahela. This difference can be readily explained by the very limited area of forest above 1,200 m altitude at Tsitongambarika, and the fact that survey effort there was concentrated at elevations below 800 m.

Although no evidence of either was found during the surveys, Tsitongambarika could potentially support two enigmatic bird taxa collected in the Tolagnaro area during the first half of the 20th century: *Coua cristata maxima* and *Hypositta perdita*. The former taxon was collected in humid forest near Tolagnaro in 1948 (Milon 1952). It was described as a new subspecies of Crested Coua (Milon 1950), from which it differs in terms of size and plumage coloration. The precise taxonomic status of the form is open to question, however, as it may possibly represent a full species or, even, a hybrid between Crested Coua and another coua species. A series of avifaunal surveys of south-eastern Madagascar conducted between 1983 and 1995 failed to record anything resembling *C. c. maxima* (Goodman *et al.* 1997), as a result of which Goodman and Wilmé (2003) concluded that "the remaining forest blocks surrounding [Tolagnaro] are ornithologically well known, and it is certain that this form is extinct". However, these surveys did not cover the Tsitongambarika forests, which, given what is known about the collecting locality of *C. c. maxima*, could conceivably still support the taxon.

Peters (1996) described *Hypositta perdita* from two specimens collected by Bluntschli in 1931 near Eminiminy village, outside of Andohahela National Park. The specimens are juveniles, and several authorities (e.g. Goodman *et al.* 1997, Schulenberg 2003) have speculated that they might represent the as-yet-undescribed juvenile of the congeneric Nuthatch Vanga. However, major differences in foot morphology render this hypothesis unlikely. If *Hypositta perdita* does represent a separate species, it is plausible that it still occurs at Tsitongambarika.

## ANTS

Outside of the framework of the BirdLife International-coordinated surveys, an ant survey of Ivohibe Forest in Tsitongambarika III was conducted in December 2006 by scientists from California Academy of Sciences (CAS) and the Madagascar

Biodiversity Centre (MBC) of Parc Tsimbazaza. The results indicate that Ivohibe Forest has good ecosystem health, with high species richness and endemism. A total of 105 species were recorded, with two species, *Camponotus* MG038 and *Pheidole* MGs074, known only from this forest. One other species, *Camponotus* MG080, was discovered for the first time during this survey, although it has since been found at two other locations. Species composition changes over an elevation gradient between 200 and 650 m asl, making it important to conserve forests at different elevations if the full diversity of ant species is to be conserved.

CAS and MBC scientists have conducted arthropod inventories at over 175 sites across Madagascar, in all habitats and geological formations found on the island. These surveys allow the results of the December 2006 survey to be analysed in context. Overall, the results demonstrate that Ivohibe Forest has high conservation importance at both regional and national levels. In particular, compared with nearby forests, where selective logging has degraded the majority of the forest and facilitated the arrival of invasive ant species, Ivohibe Forest is in a pristine condition, with disturbance limited to the forest edge. No invasive ant species were collected at Ivohibe.

## OTHER VALUES OF THE TSITONGAMBARIKA FORESTS

In addition to their intrinsic biodiversity values, the Tsitongambarika forests are an important source of ecosystem goods and services. First of all, they are an important source of forest products, including firewood, charcoal, construction materials, bushmeat, *Flagellaria indica* lianas and *Ravenala madagascariensis* leaves. In the context of a largely subsistence economy with a high incidence of poverty, local communities exhibit a high level of dependence on forest products to meet their daily needs. Loss and degradation of forests has, therefore, major implications for the livelihoods of local people.

Second, the Tsitongambarika forests are expected to play an important role in assisting the regeneration and restoration of littoral forests on Rio Tinto QMM's mining leases. Recent studies show that, during the first succession stages following mining, frugivorous birds and fruit bats will be of great importance in dispersing pioneer and heliophilic species (Bollen and Donati 2006). In addition, fruit bats have been shown to be responsible for over 50% of the pollination within and around the conservation zones established by Rio Tinto QMM. It is significant, therefore, that almost all fruit bat roost sites close to the Rio Tinto QMM mining leases are located within or close to the Tsitongambarika forests, which also support large populations of frugivorous birds, such as pigeons, parrots and bulbuls.

Third, the Tsitongambarika forests have a catchment protection function of potentially major,

albeit unquantified, economically importance. The forests protect the catchments of two of the Anosy region's major rivers: the Manampanihy (which drains north-east and enters the sea at Manantenina) and Efaho (which drains south and meets the sea west of Tolagnaro). These rivers and their tributaries are the main source of water for irrigation (essential for paddy rice cultivation) and domestic use for rural communities in the east of the region. In addition, the forests of Tsitongambarika I protect the water sources of the Lakandava pumping station and Lanirano Lake, which provide, respectively, 75% and 25% of the water for Tolagnaro town.

## SOCIO-ECONOMIC SITUATION

Most of the local inhabitants living in and around the Tsitongambarika forests belong to the Antanosy, the majority ethnic group in Anosy Region. However, some communities on the eastern side of the Vohimena mountains originate from coastal areas to the north of Anosy Region, while some communities in Ranomafana valley, to the west of the mountains, belong to the Betsileo and Bara ethnic groups, which originate from the Malagasy highlands. These inhabitants have been joined by recent waves of immigrants from the south of Madagascar, who mainly belong to the Antandroy ethnic group.

The local economy is largely subsistence-based. Local villagers cultivate food crops, such as rice, manioc (cassava), taro, yam and plantain, as well as varying amounts of cash crops, such as coffee, sugar cane, banana and other fruits. Coffee was previously an important source of income for many households but it is now less important than in the past, due to a drop in price and deterioration of the transport infrastructure. Most rural households have small numbers of livestock, principally pigs, zebu and poultry. Lobster fishing is an important source of income for many households, particularly those on the eastern (seaward) side of the Vohimena mountains, and has been reported to reduce communities' dependence on forest resources.

Hunting is practiced by a significant proportion of households, at least on an occasional basis. The main target species include lemurs, pigeons and fruit bats. There are some indications, however, that hunting at Tsitongambarika may be lower than elsewhere in Madagascar. For example, Brown Mesite (a target species for hunters throughout its range) is relatively common at Tsitongambarika. This contrasts with the situation at Andohahela National Park, where Goodman *et al.* (1997) failed to detect this species during seven weeks of intensive fieldwork in humid forest in 1995.

Although hunting is a concern, the most serious threat to the intrinsic and service values of the Tsitongambarika forests is deforestation, which is being caused by expansion of *tavy* (shifting cultivation, principally of manioc) and, to a lesser

degree, unsustainable exploitation of fuelwood (firewood and charcoal). An analysis of forest cover change over the period 1990–2000 revealed a net loss of forest cover throughout the Tsitongambarika forests, especially in the north-east of Tsitongambarika III. Deforestation was concentrated at altitudes below 800 m, which are the most suitable areas for shifting cultivation but, significantly, also the most important areas from a biodiversity conservation perspective. As a result, primary formations now tend to be concentrated in remoter areas, in the interior of the forest and at high elevations, particularly in rocky areas and on steep slopes.

Local people report that expansion of shifting cultivation is being driven by shortage of irrigated rice land, declining agricultural productivity (due to a lack of fertilisers and drying up of water sources) and rapid population growth. The impact of shifting cultivation is compounded by the fact that cleared areas are generally not recolonised by forest, due to frequent fires. Local people report that deforestation is leading to low stream flows during the dry season and siltation of rice fields. Deforestation has also been reported to have negative impacts on water quality and sedimentation rates at the Lakandava pumping station, the main water source for Tolagnaro (Goodman *et al.* 1997).

## MANAGEMENT SITUATION

The Tsitongambarika forests comprise three management units, with a combined area of 67,703 ha. The southernmost units, Tsitongambarika I and II, were designated as *Forêts Classées* (Classified Forests) in 1965 and 1970, respectively. The northernmost unit, Tsitongambarika III, is designated as a *Forêt Domaniale* (Public Domain Forest).

Beginning in 1999, management responsibility for Tsitongambarika I and II has been transferred to village associations (*communautés de base*, known as CoBas). There are more than 60 CoBas in total, covering the two forest management units, many of which have signed Transfer of Management (*transfert de gestion*) agreements with the *Circonscription des Eaux et Forêts* (regional Water and Forest Service of the Malagasy Government) in Tolagnaro for a period of three years. These CoBas have established management committees to oversee the implementation of the agreements but many of them are largely inactive and the government forestry service has limited capacity to support them. In Tsitongambarika III, Transfer of Management agreements are in process.

In the absence of effective management, there are indications that pressures on the Tsitongambarika forests are increasing, due to population growth and depletion of fuelwood supplies elsewhere. There is a need, therefore, to strengthen management of the Tsitongambarika forests.

## RELEVANCE OF THE SURVEY RESULTS FOR CONSERVATION PLANNING

---

The results of the surveys have relevance for conservation planning at sub-national and national levels. Tsitongambarika represents one of the last significant areas of lowland humid forest remaining in Madagascar, and the best remaining example of this ecosystem at low latitudes. Lowland humid forest is the most endangered vegetation type in Madagascar, and relatively little is included within the protected area system. In their review of Madagascar's protected areas, Nicoll and Langrand (1989) calculated that only around 87,168 ha of the Eastern Domain (lowland dense forests) was included in protected areas, of which only an estimated 12,920 ha was below 19°S, most of which was either heavily deforested or subject to continuing deforestation. As well as addressing a gap in the coverage of the national system, protection of Tsitongambarika forests in 2008 has helped to fill gaps in the protected area coverage of Anosy Region. Because of the larger area of humid forest at low elevations, the habitat coverage of Tsitongambarika is complementary to that of Andohahela National Park, to which it is connected by a corridor of forest. Moreover, the preliminary results of the recent biological surveys indicate that, at least for some groups (e.g. plants, amphibians, reptiles and ants), there are significant differences in community composition between Tsitongambarika and Andohahela, with the former site potentially supporting a number of localised endemics.

## DIRECT PAYMENTS PROJECT

---

In order to address pressing conservation issues on the ground, BirdLife International and Asity Madagascar

began implementing the *Tsitongambarika Watershed Management Project* in November 2006, with funding from Rio Tinto. This project combines participatory monitoring and direct payment approaches to promote more sustainable management of forest and forest resources among targeted communities. In this regard, the project draws on the experience of Durrell Wildlife Conservation Trust, which has had significant successes in Alaotra and Menabe using community-based ecological monitoring competitions.

The project was piloted in two villages in 2007, and was expanded to six villages in the two following years. In each pilot village, an initial period of awareness-raising is followed by participatory mapping with local communities, to map out forest areas with different management objectives (e.g. conservation, rehabilitation, sustainable use). This mapping is based upon the existing *Transfer of Management* agreements. The next stage is to assist the communities to select and monitor key indicators of biodiversity and ecosystem health (e.g. abundance of key species, number of cut stumps per hectare, area burnt per annum). The monitoring results are then presented at community festivals, where prizes are awarded in the form of money to be dedicated to development projects chosen by the community. Larger prizes are awarded if the state of the forest and its wildlife populations are shown to increase or if pressures are shown to decrease. The festivals introduce a competitive element among villages, thereby providing a further incentive for good environmental performance. If this pilot phase is successful (it continues at the time of writing), it is hoped that the direct payments project can be extended into other villages around Tsitongambarika in the future, to provide a mechanism for sustainable development and community co-management of forest resources.

## Chapter 2: THE FLORA OF TSITONGAMBARIKA FOREST

RICHARD RAZAKAMALALA, JOHNY RABENANTOANDRO, PORTER P. LOWRY II,  
LALAO ANDRIAMAHEFARIVO AND CHRIS BIRKINSHAW

### INTRODUCTION

As part of the Tsitongambarika Project, funded in part by QIT Madagascar Minerals (Rio Tinto QMM)/Rio Tinto, botanical inventory activities were carried out in technical collaboration with the Missouri Botanical Garden (MBG), Rio Tinto QMM and BirdLife International. These started in November–December 2005, focusing primarily on the forest of Bemangidy-Ivohibe, with additional field work conducted in other parts of Tsitongambarika. This chapter focuses on the initial surveys in 2005, but includes results from later surveys to provide further detail across Tsitongambarika.

### OBJECTIVES

The Tsitongambarika III forest botanical survey of 2005 aimed to:

1. Carry out a botanical inventory of one of the most poorly known areas of Tsitongambarika and of Madagascar as a whole;
2. Compare species richness and local endemism in the study area with those of other low- to mid-elevation humid forests in Madagascar;
3. Assess pressures on and threats to the native vegetation of Tsitongambarika.

### STUDY SITE

The Bemangidy-Ivohibe Forest is part of the larger Tsitongambarika III Forest, which is situated in the Anosy Region, Iabakoho Commune, Antsotso Area, located to the west of PK 65 on the National Road 12A to the North of Tolagnaro (Fort Dauphin). The eastern boundary of the Bemangidy-Ivohibe Forest is located at 24°563.73 S, 047°204.44 E, about 5.5 km from the east coast and 3.6 km from National Road 12A, making it quite easy to access. Altitude of the forest ranges from about 90 to 440 m.

### METHODOLOGY

An inventory of all plant species encountered with flower and/or fruit (required for accurate identification) in the Bemangidy-Ivohibe Forest was conducted using the standard protocol for botanical sampling developed and adopted by MBG. For every

collection made, four or five individual pressed herbarium specimens were made for distribution to the major institutions with significant holdings of material from Madagascar (including the two main herbaria in Madagascar, the Missouri Botanical Garden, and the Muséum National d'Histoire Naturelle in Paris) and to international specialists working at other institutions. The wide distribution of duplicate specimens is important for ensuring accurate identification of collections and greatly facilitates the recognition of species new to science.

### RESULTS

#### ■ Flora

To date more than 75 days of botanical inventory work have been carried out in the Bemangidy-Ivohibe Forest and other sites in Tsitongambarika. The field teams have made nearly 2,000 collections representing nearly 600 species in 366 genera and 121 families, suggesting that the total flora of Tsitongambarika probably includes well over 1,000 species. Identification of recent collections, as well as some problematic specimens made over the last several years, is pending and will require comparison with the material in the Paris herbarium, which has by far the most complete representation of the Malagasy flora.

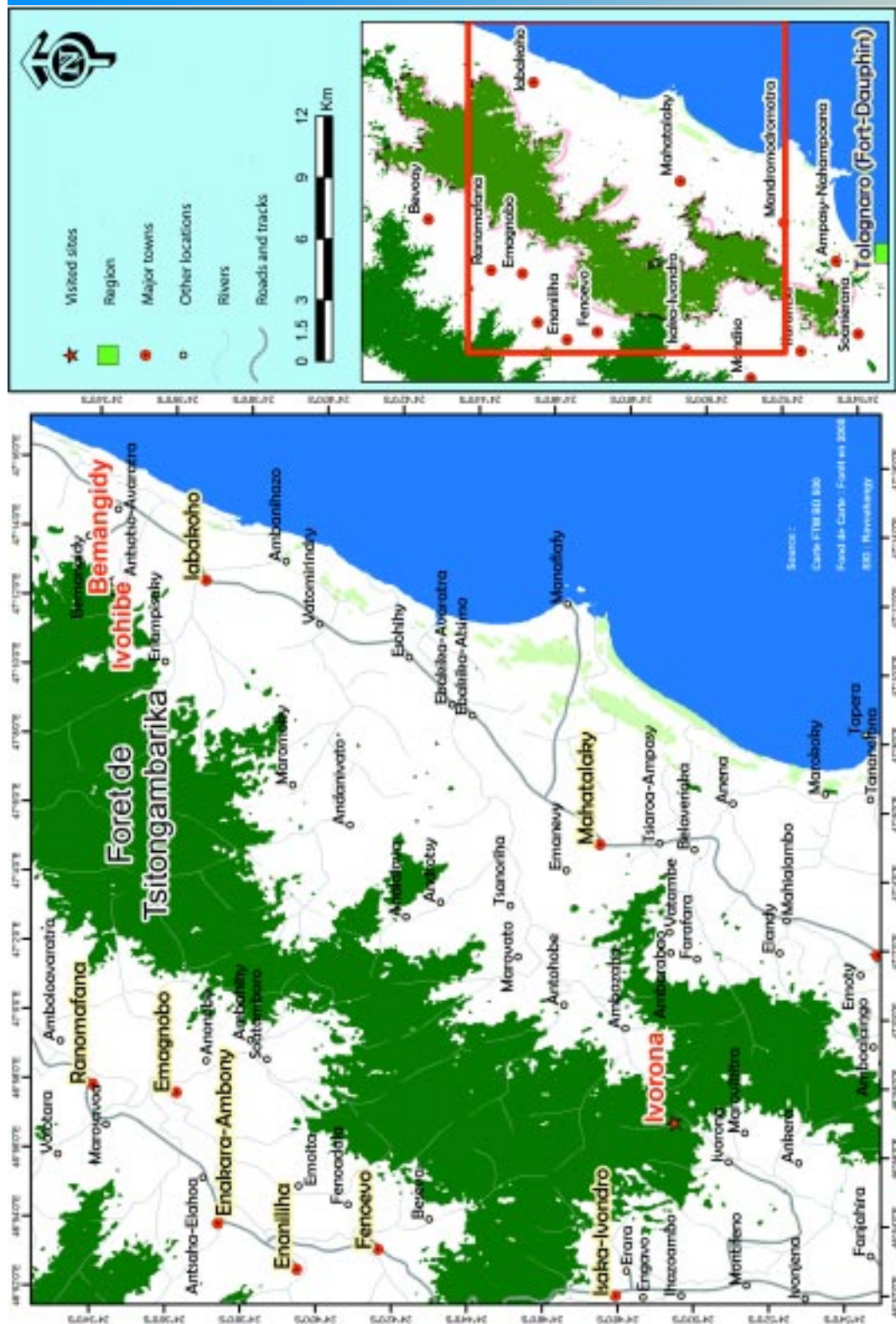
Historically very few collections had been made at Tsitongambarika, but what little was known of the flora hinted at its richness and local endemism, as exemplified by *Ixora bemangidiensis*, collected in the 1960s. The identification of the recent collections made to date has confirmed that this area indeed has a remarkable flora, with higher species diversity and a greater concentration of local endemics than was ever imagined. Current data (Table 1) indicate a total of 20 confirmed species new to science discovered during recent inventory work, and an additional 28 possible or probable new species, joining 19 previously described local and regional endemics—astonishing figures, even for a biodiversity-rich country such as Madagascar. The inventory work has also identified several species known to occur in the littoral forests of the Rio Tinto QMM mine site, in particular those at Sainte Luce.

#### ■ Vegetation and threats

The main type of primary vegetation at Tsitongambarika is low- and mid-altitude humid forest, an increasingly rare vegetation type that is particularly threatened in Madagascar. Ivohibe Peak,



### Map 2. Plant survey sites



**Table 1. Endemic plants of Tsitongambarika**

<b>Taxon</b>	<b>Collection number(s) from Tsitongambarika</b>	<b>Endemicity</b>
<b>New species awaiting publication (20 species)</b>		
<i>Croton</i> "daphniphyllum" Radel, ined.	Razakamalala 4339	Local
<i>Diospyros</i> "bemangidiensis" G.E. Schatz & Lowry, ined.	Lowry 6735	Local
<i>Diospyros</i> "Sclerophylla group" sp. 14, ined.	Rajoharison 118	Local
<i>Ivodia</i> "anosiensis" Rabarimanarivo <i>et al.</i> , ined.	Rajoharison 185, Lowry 6679, 6725, Razakamalala 2316, 2594	Local
<i>Hyperacanthus</i> "rajeriarisoniae" Rakotonas. & A.P. Davis, ined.	Razakamalala 4252	Local
<i>Hyperacanthus</i> "gereau" Rakotonas. & A.P. Davis, ined.	Razakamalala 4221	Local
"Lowryanthus" Pruski, ined.	Lowry 6648, Antilahimena 4801, Razakamalala 2369, 3790	Local
<i>Polyscias</i> "bemangidiensis" Lowry & G.M. Plunkett, ined.	Birkinshaw 1621, Lowry 6701, 6704, 6705, 7171, Razakamalala 2308, 3793	Local
<i>Polyscias</i> "ericii" Lowry & G.M. Plunkett, ined.	Antilahimena 4833, 4862, Lowry 6702, Rabenantoandro 1894, Randriantafika 875, Razakamalala 4095	Local
<i>Polyscias</i> "manonae" Lowry & G.M. Plunkett, ined.	Lowry 6777, 7140, 7163, Rabenantoandro 1879	Local
<i>Polyscias</i> "purpuristyla" Lowry & G.M. Plunkett, ined.	Lowry 7161, 7168	Local
<i>Polyscias</i> "urceolata" Lowry & G.M. Plunkett, ined.	Lowry 7145, Rabenantoandro 1893, Rajoharison 200, Randriantafika 908, Razakamalala 2443, 3841, 3857, 4078, 4087, Ramison 580	Local
<i>Schefflera</i> "vohimensis" Lowry & G.M. Plunkett, ined.	Lowry 6703, 7142, 7156, 7157, Rabenantoandro 1908, Randriantafika 897, Razakamalala 3865	Local
<i>Schizolaena</i> "charlotteae" Lowry <i>et al.</i> , ined.	Service Forestier 28662, Ramison 581, Antilahimena 5786	Local
<i>Schrebera</i> "trifoliata" C. Frasier & G.E. Schatz, ined.	Razakamalala 2681	Local
<i>Tsebona</i> sp. nov.	Lowry 6657	Local
<i>Dypsis</i> sp. nov. 1	Rakotoarinivo 531	Local
<i>Dypsis</i> sp. nov. 2	Dransfield 7791	Local
<i>Dypsis</i> sp. nov. 3	Rakotoarinivo 538	Local
<i>Ravena</i> sp. nov.	Dransfield 7786, 7787	Local
<b>Previously described locally and regionally endemic species (19 species)</b>		
<i>Buxus rabenantoandroi</i> G.E. Schatz & Lowry	Razakamalala 4156	Regional
<i>Centauroopsis antanosii</i> (Scott-Elliot) Humbert	Razakamalala 4319	Regional
<i>Dombeya mandenensis</i> Arènes	Razakamalala 4329	Regional
<i>Garcinia dauphinensis</i> P. Sweeney & Z.S. Rogers	Razakamalala 4217	Regional
<i>Gnidia razakamalalana</i> Z.S. Rogers	Rabenantoandro 1725, 1912, Razakamalala 2670, 3835	Local
<i>Ixora bemangidiensis</i> Guédès	Service Forestier 22333	Local
<i>Leptolaena delphinensis</i> G.E. Schatz & Lowry	Razakamalala 4294	Regional
<i>Micronychia bemangidiensis</i> Randrian. & Lowry	Birkinshaw 1622, 1634	Local
<i>Barthlottia madagascariensis</i> Eb. Fisch	Razakamalala 4560, 5591	
<i>Dypsis aquatilis</i> Beentje	Rakotoarinivo 539	Local
<i>Dypsis brevicaulis</i> (Guillaumet) Beentje & J. Dransf.	Rakotoarinivo 537	Local

Table 1 ... continued. Endemic plants of Tsitongambarika

Taxon	Collection number(s) from Tsitongambarika	Endemicity
<b>Previously described locally and regionally endemic species ... continued</b>		
<i>Dypsis culminis</i> Rakotoarin. & J. Dransf.	Rakotoarinivo 532	Regional
<i>Dypsis elegans</i> Beentje	Rakotoarinivo 530	Regional
<i>Dypsis eriostachys</i> J. Dransf.	Dransfield 7783	Regional
<i>Dypsis nauseosa</i> (Jum. & H. Perrier) Beentje & J. Dransf.		Regional
<i>Dypsis prestoniana</i> Beentje		Regional
<i>Dypsis psammophila</i> Beentje		
<i>Dypsis saintelucei</i> Beentje	Rakotoarinivo 534	Local
<i>Ravenea hypoleuca</i> Rakotoarin. & J. Dransf.		
<b>Possible new species (28 species)</b>		
<i>Acalypha</i> sp. nov.	Randriatafika 811	
<i>Acridocarpus</i> sp. nov.	Razakamalala 4585	
<i>Ardisia</i> sp. nov.	Razakamalala 4180	
<i>Brexia</i> sp. nov.	Razakamalala 4167, Randriatafika 911, Ramison 218	
<i>Cremocarpon</i> sp. nov.	Rakotovao 5000	
<i>Croton</i> sp. 1 (= sp. nov?)	Rajoharison 199, Razakamalala 2412, 2324, 3764	
<i>Croton</i> sp. 2 (= sp. nov?)	Lowry 6767, Razakamalala 3928, 2426	
<i>Croton</i> sp. 4 (= sp. nov?)	Rajoharison 226, Razakamalala 2668, 4005, 4133	
<i>Croton</i> sp. 6 (= sp. nov?)	Razakamalala 3901	
<i>Croton</i> sp. 10 (= sp. nov?)	Razakamalala 2351	
<i>Elaeodendron</i> sp. nov.	Razakamalala 3939	
<i>Galeola</i> sp. nov.	Razakamalala 3758	
<i>Gravesia</i> sp. nov.	Razakamalala 5292	
<i>Melicope</i> sp. nov.	Rakotovao 4975	
<i>Noronhia</i> sp. nov.	Razakamalala 2565, Razakamalala 2666, Razakamalala 2424	
<i>Oncostemum</i> sp. nov. 1	Ramison 622	
<i>Oncostemum</i> sp. nov. 2	Razakamalala 5055	
<i>Payera</i> sp. nov.	Rakotovao 4375	
<i>Polyscias</i> sp. nov.	Rakotovao 4341	
<i>Phyllanthus</i> sp. nov. (= <i>P. bemangidiensis</i> ?)	Razakamalala 4170	
<i>Rousseauxia</i> sp. nov.	Lowry 6734, Razakamalala 2420	
<i>Tabernaemontana</i> sp. nov.	Lowry 6776, Razakamalala 2425, 3842, 3774, Randriatafika 597, Antilahimena 4807	
<i>Thunbergia</i> sp. nov.	Razakamalala 4283	
<i>Trichilia</i> sp. nov.	Rakotovao 4366	
<i>Vernonia</i> sp. nov. 1	Razakamalala 4179	
<i>Vernonia</i> sp. nov. 2	Razakamalala 4561	
<i>Viguieranthus</i> sp. nov.	Lowry 6728, Razakamalala 2452, 2366, 3914, Antilahimena 4847	
<i>Weinmannia</i> sp. nov.	Service Forestier 28664, CB 1653, Randriatafika 643, Razakamalala 3760, 3930, 4026	
Note: Local endemism refers to species known only from Tsitongambarika, whereas regional endemics are also known from nearby areas, such as Ste. Luce or Andohahela National Park.		



**Plates 4a and 4b.** “*Lowryanthus*” ined., a new and endemic genus of Asteraceae, not yet described, discovered in 2006 in lowland rain forest at Bemangidy (PORTER P. LOWRY II)

which culminates at 677 m, is still surrounded by a block of almost entirely intact forest estimated to cover about 27,000 ha. In the 1960s, a sawmill was operated at Bemangidy as part of a timber industry project (indeed, the word ‘Bemangidy’, meaning “very bitter”, corresponds to the old campsite of the sawmill). The vast areas of forest that were once found in northern Ivohibe and in the gently sloped areas around the old Bemangidy campsite have been completely removed and today these areas are covered with highly degraded and biodiversity-poor secondary vegetation. Until recently, slash-and-burn agricultural practices were ravaging the low altitude forest on the eastern edge of Ivohibe, but according to Mara Berge—our guide and also the current president of



**Plate 5.** *Polyscias* “*manonae*”, a new, undescribed species of Araliaceae, discovered in 2006 at Bemangidy, of which only two populations are known, restricted to granite outcrops (PORTER P. LOWRY II)

the local community forest management association (*communauté de base*, commonly known as a CoBa)—this activity has been reduced in recent years as the remaining forests, located on steep and rocky slopes, are harder to remove and it is easier to earn income from lobster fishing. However, if the prices offered for lobster drop or if lobsters become rare (due to overexploitation), the forests of Ivohibe will likely be subjected once again to intensive pressure from shifting (slash-and-burn) agriculture.

The village of Antsotso, directly to the east of Ivohibe, is settled essentially by fishermen who exploit lobsters, tuna and other commercial species from the sea. The forest of Bemangidy-Ivohibe is primarily used by the local population for the selective harvesting of large trees more than 50 cm in diameter, which are prized for boat making. A boat made of *Calophyllum inophyllum* (known locally as *vintagno*) may be worth 300,000 Ariary (about \$US 150, which represents a very significant amount in poor rural Madagascar). The forest also provides raw materials for making lobster traps, in particular the rachis (central axis) of the leaves of the Amboza palm and the trunk of *Flagellaria indica* (*vahipiky*). Logging for wood to construct huts and for other purposes has also been observed inside the forest, but at low levels that are thought to have very little impact on the structure and composition of the forest.



Despite these pressures, the forest of Bemangidy-Ivohibe remains in good condition, and is characterised by a particularly rich flora with a high concentration of locally endemic species. The height and the diameter of the trunks of canopy trees (as exemplified by members of important timber genera such as *Mimusops*, *Calophyllum*, *Symphonia* and *Uapaca*) are particularly impressive. It must be noted, however, that in other parts of the Vohimana range, slash-and-burn agriculture is being practised in an increasingly intense way, and in some areas virtually no lowland forest remains, although other sites, such as Bevoay, located on the western slope directly across the range from Ivohibe, the local CoBa has successfully curtailed unsustainable shifting (slash-and-burn) cultivation and is keen to protect their remaining forests.

## CONSERVATION

The long-term protection of the forest of Bemangidy-Ivohibe and other sites that still have large areas of forest at low- and mid-elevation should be integrated into the context of a broad programme of biodiversity conservation and sustainable natural resource management throughout the Vohimana range. This will require a programme of community-based conservation activities that are intimately linked to local development initiatives in order concurrently to achieve the twin goals of biodiversity conservation and improving the wellbeing of those living in the areas adjacent to new protected areas. Such a programme could include the following elements:

1. Creation of new protected areas as part of Madagascar's new initiative to expand the network of parks and reserves (known as the SAPM process), with the objective of protecting the most important parts of the remaining forest, which will without any doubt include Bemangidy-Ivohibe in the North;
2. Sustainable management of forest in carefully managed buffer zones that are not included in the new protected areas;
3. Restoration to maintain and reinforce forest corridors between blocks of intact forest and to facilitate the expansion of forest into abandoned agricultural land;
4. Establishment of alternate sources of logs and firewood to reduce pressure on native forests. This

should involve planting fast-growing exotic species in abandoned areas in conjunction with reforestation of the anthropic grasslands focusing on native species;

5. Support for farming and other development activities that can introduce substitutes for slash-and-burn agriculture.

## RECOMMENDATIONS

In order to develop a conservation strategy for the Tsitongambarika Forest, we propose the following activities:

1. Continue botanical inventory work throughout Tsitongambarika, focusing on those watersheds with large remaining areas of forest and where the local community has expressed willingness and interest in developing a strategy that incorporates biodiversity conservation and sustainable use of natural resources;
2. Socio-economic diagnoses in these areas involving detailed discussion with the full range of local stakeholders, and where possible and appropriate, the development and implementation of a plan that includes a proposal to establish new protected areas;
3. Research throughout Tsitongambarika to gather information for a detailed description of current conditions and to evaluate alternative management strategies to ensure effective protection and sustainability.

## CONCLUSIONS

The botanical inventory work conducted to date, largely focusing on the humid low- and mid-elevation forest of Bemangidy-Ivohibe, has clearly shown that the flora of Tsitongambarika is exceptionally rich and has a high level of local endemism. This is without doubt linked to the continued existence of intact forest at very low altitude, extending to below 100 m in some places, a situation that appears to be virtually unique in southeastern Madagascar. The establishment of a new protected area at Bemangidy-Ivohibe, as part of a well-designed and carefully implemented community-based project, must be regarded as a high priority, and must be integrated into a broader initiative targeting the conservation and sustainable management of key parts of the Vohimana range.



## Chapter 3: THE BATS OF TSITONGAMBARIKA FOREST

TSIBARA MBOHOAHY

### INTRODUCTION

There are now thought to be close to 40 bat species on Madagascar, 70% of which are endemic (Racey *et al.* 2009). The three Malagasy Old World fruit bat (Pteropodidae) species are important seed dispersers and pollinators, which face growing threats from the demand for bushmeat and damage to their roosting habitats (e.g. Ranivo 2001, Bollen and Van Elsacker 2002, MacKinnon *et al.* 2003, Andriafidison *et al.* 2006, Rakotonandrasana and Goodman 2007). Madagascar's diverse insectivorous bat fauna has associations with both Africa and Asia, and a number of new species have recently been described (e.g. Goodman *et al.* 2005b, 2006b, 2007, Bates *et al.* 2006). These bats are threatened by habitat degradation and some species are also hunted by people (Goodman 2006). Only three insectivorous species (in comparison to all three fruit bat species) are considered of global conservation concern: *Eptesicus malagasyensis* (Endangered), *Triaenops auritus* (Vulnerable) and *Hipposideros commersoni* (Near Threatened).

Bat conservation in Madagascar is in its infancy. Bats were omitted from many of the mammal inventories undertaken in the 1990s (e.g. Goodman and Rasolonandrasana 1999, Goodman and Wilmé 2003) and have only relatively recently received the attention of biologists. None of Madagascar's bats are protected under national wildlife laws (Durbin 2007). Hunting is permitted between May and September for fruit bats, and between February and May for *Hipposideros commersoni*. The closed season is rarely respected, however, while the popularity of bat meat and the accessibility of bat colonies combine to result in high, and probably unsustainable, levels of hunting in some regions (MacKinnon *et al.* 2003).

Bats spend the daylight hours in roosts, where they usually aggregate to form colonies. These sites are important for social contact, breeding and digestion (Kunz 1982). In Madagascar, they are also frequented by hunters or subject to other forms of disturbance from people (e.g. Jenkins *et al.* 2007, Rakotoarivelo and Randrianandrianana 2007). Because of the mobility of bats and their capacity for travelling long distances at night (particularly the Pteropodidae and Molossidae), roost sites are the obvious focus for abundance assessments and conservation efforts (e.g. Entwistle and Corp 1997, Entwistle *et al.* 1997, Sedgeley and O'Donnell 1999, Granek 2002). In Madagascar too, there have been calls for bat conservation to be focused on roost sites (Goodman

*et al.* 2005a), and efforts are underway to protect some *Pteropus rufus* colonies in the Alaotra Mangoro Region (Jenkins *et al.* 2007). Malagasy bats roost in a number of different localities, either in cavities (caves, fissures, roof spaces of buildings, tree holes, etc.) or in foliage (suspended from branches, inside unfurled leaves, etc.). These features are not necessarily restricted to protected areas, and important roost sites are known to occur in areas without intact forest (e.g. Goodman *et al.* 2005a). The current expansion of Madagascar's protected area system provides an ideal opportunity for bat roosts to be included within new conservation zones, even if the site, whether a small forest fragment or cave, is located outside of the priority forest areas for other animals and plants.

This chapter presents the results of a short survey of the bat roosts in Tsitongambarika Forest of south-east Madagascar. Taxonomy and nomenclature here follow IUCN (2010), even though significant taxonomic changes continue to be made (e.g. see Goodman and Ranivo 2009 for a description of *Triaenops menamena*, formerly considered to be *T. rufus*<sup>1</sup>). Previous field studies in the south-east of Anosy region reported 12 bat species but only five of these were found in Tsitongambarika Forest, at two low elevation sites (Creighton 1992, Jenkins *et al.* 2007). The littoral forests between the foothills of Tsitongambarika Forest and the sea have been the subject of more intense surveys. In addition to the presence of insectivorous bat species like *Myzopoda aurita* and *Hipposideros commersoni* (Goodman 1999), these littoral forests also contain a number of *Pteropus rufus* roosts (Bollen and Van Elsacker 2002). Since there had been no previous survey of bat roosts in Tsitongambarika Forest, the survey reported herein sought to complement simultaneous surveys for other fauna and flora by searching for important bat roost sites for possible inclusion in the proposed Tsitongambarika protected area.

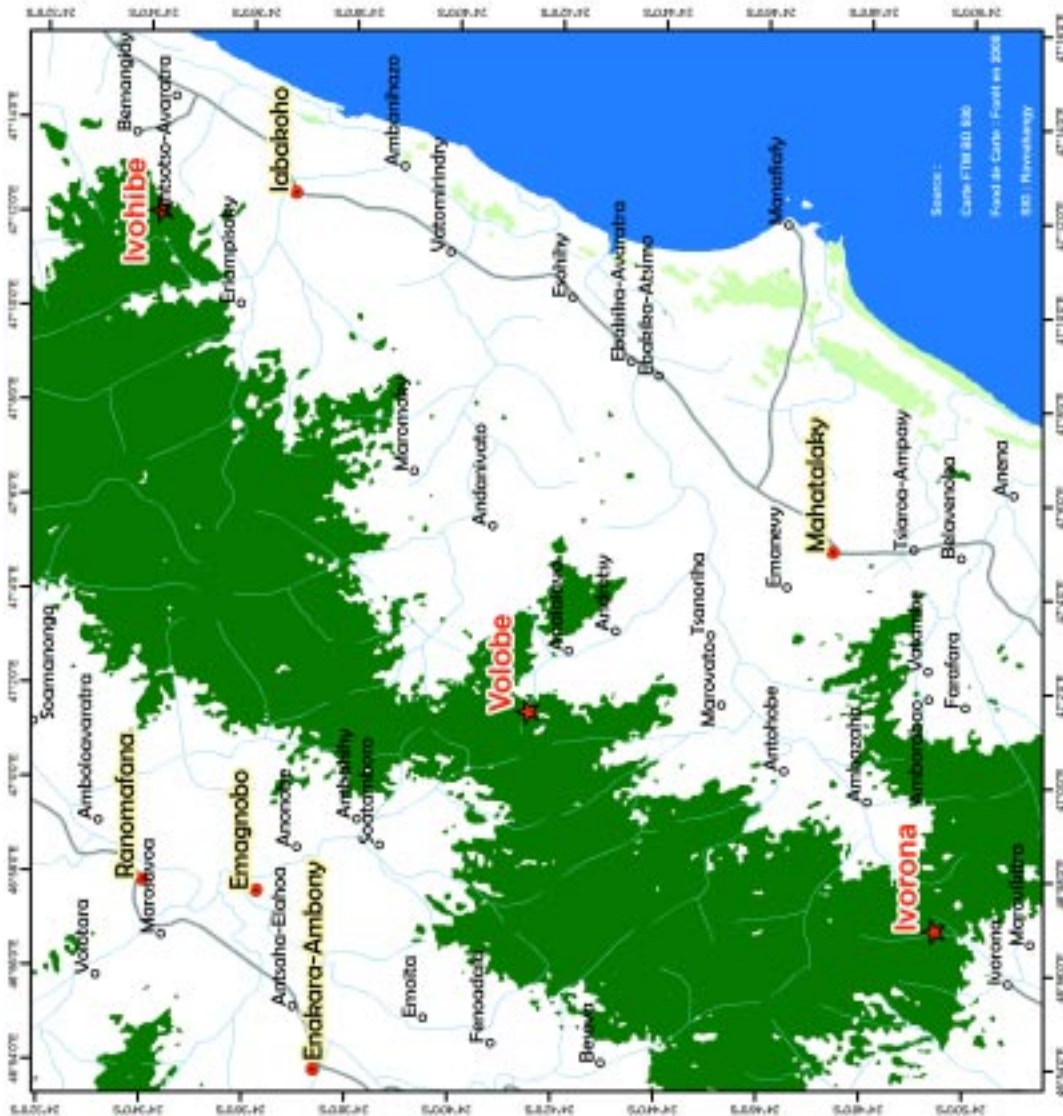
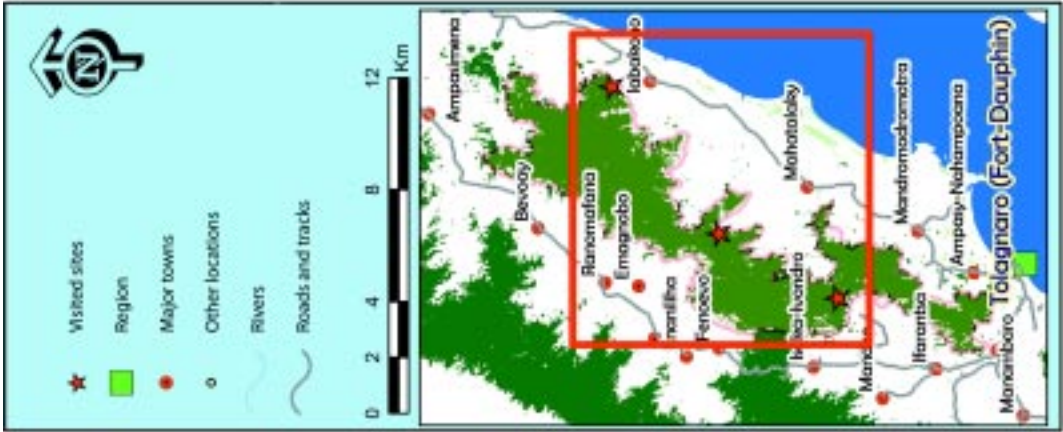
### OBJECTIVES

The survey had three specific objectives:

1. To locate bat roosts in and near Tsitongambarika Forest;
2. To determine priority bat roosts for conservation and further study;
3. To develop a framework for the inclusion of bat roosts within a new protected area.

<sup>1</sup> For consistency with the red list treatment (IUCN 2010), these animals are referred to as *T. rufus* here, although the new name should be used in future, including red list updates. Eds.

Map 3. Bat survey sites



## STUDY SITES

The survey for bat roosts was conducted in all three sectors of Tsitongambarika Forest between 1 and 20 December 2005 (Table 2).

## METHODS

Survey effort was mainly restricted to sampling bat roosts. Mist nets at cave entrances, or direct observations within caves, were used (Table 3). Mist nets were occasionally placed across rivers in some sites. Surveys were undertaken with local guidance because most large bat colonies and roosts are known to local people. Local guides have been used successfully in the past in Madagascar (e.g. MacKinnon et al. 2003) and are the most efficient way of locating bat roosts in a short time.

Identification was based on direct observation or after capture with mist nets. No voucher specimens were collected. The geographical location and habitat features of each roost were recorded, and an assessment of threats made. Bat abundance was counted directly (for *Pteropus rufus*) or estimated (for cave-roosting species).

**Table 2. Study sites for bat roost surveys in and around Tsitongambarika Forest**

Site	Coordinates	Nearest village	Commune
Ivohibe Forest	24°34'12"S 47°12'22"E	Antsofso	labakoho
Volobe Forest	24°40'15"S 47°04'49"E	Volobe	Mahatalaky
Ivorona Forest	24°50'18"S 46°56'44"E	Ivorona	Ifarantsa

## RESULTS

The roosts of six bat species were located during the survey (Table 3), comprising three fruit bat (Pteropodidae) species and three insectivorous species. Fourteen roost sites were visited, of which 11 contained bats and three appeared to have been abandoned (Table 4). In addition, a single *Myotis goudoti* (Vespertilionidae) was mist-netted in forest over a small river near Ivorona (24°50'12"S 46°56'44"E) in Ifarantsa Commune.

### ■ Roost type

Seven roosts were located in caves, including all of the *Emballonura atrata* (Emballonuridae), *Triaenops rufus* (Hipposideridae), *Miniopterus* sp. (probably *petersoni* based on distribution) (Vespertilionidae) and *Rousettus madagascariensis* (Pteropodidae) colonies. A single *Eidolon dupreanum* (Pteropodidae) colony was found on a cliff face, and four *Pteropus rufus* roosts were found in forest fragments (although one of these, at Antranopanihy, was not within the boundary of Tsitongambarika Forest).

### ■ Abundance

Colony size was generally small for the insectivorous bats with no roost site containing more than 60 individuals. Fruit bat roosts were larger, numbering in the hundreds for *Rousettus madagascariensis* and up to a thousand for *Pteropus rufus*.

### ■ Threats

The insectivorous bats roosted in small caves that were in relatively open, deforested areas. On-going slash and burn agriculture appeared to threaten two of these roosts through their proximity to land that is regularly burned. Two of the *Pteropus rufus* roosts

**Table 3. Geographical positions of all roosts visited during the bat survey**

Roost name	Commune	Location	Dates visited	Bat species
Mahatalaky Ambolo	Ifarantsa	24°49'15.6"S 46°56'27.8"E	1–7 December 2005	No bats
Tafiandahy	Ifarantsa	24°49'47.0"S 46°56'35.5"E	1–7 December 2005	<i>Emballonura atrata</i>
Andriankolo	Ifarantsa	24°51'42.2"S 46°54'55.9"E	1–7 December 2005	<i>Emballonura atrata</i>
Anjoliky	Ifarantsa	24°50'04.9"S 46°57'34.0"E	1–7 December 2005	No bats
Ivolo (1)	Ifarantsa	24°55'37.7"S 46°54'57.5"E	1–7 December 2005	<i>Pteropus rufus</i>
Ivolo (2)	Ifarantsa	24°55'37.7"S 46°54'57.5"E	1–7 December 2005	<i>Pteropus rufus</i>
Angavobe	Ifarantsa	24°56'10.8"S 46°54'18.8"E	1–7 December 2005	<i>Eidolon dupreanum</i>
[No local name]	labakoho	24°33'54.1"S 47°12'47.9"E	11–14 December 2005	<i>Emballonura atrata</i>
Antranopanihy	labakoho	24°37'08.0"S 47°13'58.5"E	11–14 December 2005	<i>Pteropus rufus</i>
Antranokananavy	labakoho	24°35'50.2"S 47°11'10.1"E	11–14 December 2005	No bats
Andakato	labakoho	24°33'28.7"S 47°12'30.2"E	11–14 December 2005	<i>Emballonura atrata</i>
Manantenina	labakoho	24°31'53.5"S 47°12'13.7"E	11–14 December 2005	<i>Rousettus madagascariensis</i> & <i>Triaenops rufus</i>
Volobe	labakoho	24°41'10.4"S 47°05'44.5"E	16–19 December 2005	<i>Pteropus rufus</i>
Esiasia	Mahatalaky	24°44'35.1"S 47°00'24.0"E	16–19 December 2005	<i>Miniopterus</i> sp. (probably <i>petersoni</i> ; DD)

Table 4. Results of the survey of bat roosts in and around Tsitongambarika Forest

Roost name	Altitude (m)	Roost type	Habitat	Protection	Threats	Bat species (and IUCN status*)	Abundance
Mahatalaky Ambolo	580	Cliff	Agriculture	None	–	No bats	–
Tafiandahy	220	Cave	Humid forest	None	None	<i>Emballonura atrata</i>	15–20
Andriankolo	87	Cave	Agriculture	None	Fire	<i>Emballonura atrata</i>	10–15
Anjoliky	410	Cliff	Humid forest	None	–	No bats	–
Ivolo (1)	73	Trees	Humid forest	Sacred forest	None	<i>Pteropus rufus</i> (VU)	1,000
Ivolo (2)	73	Trees	<i>Eucalyptus</i> plantation	None	Hunting (guns)	<i>Pteropus rufus</i> (VU)	200
Angavobe	343	Cliff	Agriculture	High position	None	<i>Eidolon dupreanum</i> (VU)	10–15
[No local name]	227	Cliff	Humid forest	None	None	<i>Emballonura atrata</i>	10–20
Antranpanihy	12	Trees	Littoral forest	None	Hunting (guns)	<i>Pteropus rufus</i> (VU)	100–150
Antranokananavy	48	Cave	Agriculture	None	–	No bats	–
Andakato	226	Cave	Agriculture	None	Fire	<i>Emballonura atrata</i>	10–15
Manantenina	143	Cave	Agriculture	None	Hunting (traps)	<i>Rousettus madagascariensis</i> (NT) & <i>Triaenops rufus</i>	400–500 & <10
Volobe	27	Trees	Humid forest	Sacred forest	None	<i>Pteropus rufus</i> (VU)	50–60
Esiasia	139	Cave	Agriculture	None	Fire	<i>Miniopterus</i> sp. (probably <i>petersoni</i> ; DD)	<10

Notes: \* Global IUCN Red List status: VU = Vulnerable; NT = Near Threatened; DD = Data Deficient.

were subject to hunting by people with guns, and the *Rousettus madagascariensis* colony was also exploited for its meat by farmers using a trap made with local plants (170 bats were taken by this method in a single day).

### ■ Conservation

The *Eidolon dupreanum* roost, by virtue of its location in a high rock face, appeared well protected. Two of the *Pteropus rufus* roosts were in sacred forests where hunting is prohibited.

## DISCUSSION

The proposed new protected area at Tsitongambarika provides a unique opportunity to secure roosting colonies of bats, and the important ecological service they provide. This survey located 11 occupied bat roosts, including the first colonies of *Rousettus madagascariensis* and *Eidolon dupreanum* known to biologists in Tsitongambarika Forest.

Four roosts of the small insectivorous bat *Emballonura atrata* were found during the survey. This species was once considered to occur throughout Madagascar but recent taxonomic studies revealed that it is restricted to the east, where it appears to be associated with relatively intact forest (Goodman *et al.* 2006a). This species was not recorded during surveys by Creighton (1992) but Peterson *et al.* (1995) noted its presence in the western Vohimana mountains. *Triaenops rufus* is a relatively widespread trident-nosed bat, more common in the west than in the east, but occasionally reported from Anosy region (Creighton 1992, Peterson *et al.* 1995). *Miniopterus* species and *Myotis goudoti* are common and

widespread in Madagascar, and none is thought to be threatened based on current taxonomy.

Malagasy fruit bats pose a major challenge for conservationists. There are only a few roosts known from within the existing protected area network and colonies elsewhere are subject to chronic exploitation for meat, with growing evidence that extraction levels are unsustainable (Racey *et al.* 2009). On the other hand, opportunities for inclusion of bat roosts within new protected areas and successful engagement of communities to assist in bat conservation projects provide hope for the future.

Of the six fruit bat roosts found during the survey, three were considered to be relatively secure. One of these, *Eidolon dupreanum*, is inaccessible to humans and two *Pteropus rufus* roosts benefit from community-based protection. The bats arrived at the forest in 1999 and roost on trees in a traditional human burial site. There was no information on the origin of these bats but *Pteropus rufus* in the region appear to move between roost sites (Bollen and Van Elsacker 2002). Roost switching is a behaviour used by bats in response to disturbance or shifting food supplies, and has been reported for *Pteropus rufus* in eastern Madagascar (Jenkins *et al.* 2007). This behaviour should not discourage roost-based conservation measures, because natural roost switching occurs as bats interact with their landscape and should be incorporated into conservation planning by including a network of roosts. With over 1,000 bats, the Ivolo roost is one of the most important *Pteropus rufus* roosts known from the region, and should be regularly monitored to follow changes in bat abundance and any hunting. Single-visit surveys like the one reported here may not capture the importance of a given roost site, because of seasonal variation in abundance (e.g. Jenkins *et al.* 2007). The

*Pteropus rufus* roost at Volobe, for example, had a small colony of bats but, as this site is a sacred forest, it may contain more individuals at different times of the year or in the future.

*Rousettus madagascariensis* roosts in caves and, although they are frequently caught in nets by biologists, only a few roost sites are known (MacKinnon *et al.* 2003). The cave roost located in this study is, therefore, of major significance and requires protection. Cave-roosting bats are exceptionally vulnerable to hunting and, at Tsitongambarika, the *Rousettus madagascariensis* were reportedly collected at the roost entrance. It is unlikely that the colony could sustain the reported harvests unless there was movement and mixing with other, as yet undiscovered, roosts in the region. Being notably smaller than *Pteropus rufus* or *Eidolon dupreanum*, *Rousettus madagascariensis* is able to fly inside forests and appears to have a potentially unique role in pollination and seed dispersal. The *Rousettus madagascariensis* roost needs to be monitored and protected and a study conducted on the socio-economic value of the bat meat coming from it.

## RECOMMENDATIONS

---

1. Include the Ivalo, Vohidrahara, Volobe and Angavobe roosts within the new protected area at Tsitongambarika.
2. Make visits every two months to each of the fruit bat roosts over a two-year period to provide a baseline for future monitoring and vital information on movement among roosts.
3. Determine whether the communities at Ivalo and Volobe sacred forests require any assistance in maintaining current levels of forest protection. Possible activities include environmental education on bats in schools and villagers participating in bat counts.
4. Conduct an assessment of bats as bushmeat in the area, to provide socio-economic information to inform future conservation plans to reduce or prohibit hunting.
5. Visit insectivorous bat roosts twice a year.
6. Continue to search for other bat roosts within the new protected area.



## Chapter 4: THE LEMURS OF TSITONGAMBARIKA FOREST<sup>1</sup>

MAMY JULIA CHRISTOBELLE RALAVANIRINA

### OBJECTIVES

A survey of lemurs of Tsitongambarika Forest was undertaken between 9 December 2005 and 14 January 2006. The aims were to:

1. Inventory the lemur species in Tsitongambarika Forest;
2. Determine the relative abundance of the lemur species present;
3. Identify sites of importance for lemurs (where conservation actions are required).

### STUDY SITES

Study sites were chosen with reference to a cartographic map and by asking local authorities, such as the community forest management associations (*communautés de base* or CoBas), to indicate areas of forest that may provide suitable habitat for lemurs. Consequently, three sites were selected:

1. Ivohibe Forest, near Antsofso Avaratra village, east of Tolagnaro (Fort Dauphin). Between 11 and 19 December 2005, the survey team camped at 24°34'12"S 47°12'23"E (altitude 148 m) and collected data along two transects located nearby (Table 5);
2. Antsiriky Forest, in Mahatalaky Commune. Between 20 and 30 December 2005, the survey team camped at Analalava village (24°41'28"S 47°01'30"E, altitude 306 m) and collected data along two transects about two hours' walk away (Table 5);
3. Ivorona Forest, in Ifarantsa Commune of Ivorona Sub-prefecture. Between 2 and 9 January 2006, the

survey team camped at 24°49'25"S 46°56'56"E (altitude 284 m) and collected data along two transects about one hour's walk away (Table 5).

### METHODS

All data were collected in lowland humid forest (between altitudes of 87 and 420 m; Table 5). Inventory of lemurs was made by using a linear transect method (e.g. Ganzhorn 1994). At each site, two transects were selected. The survey team chose existing trails that had been created by villagers or wild boars, in order not to damage the forest ecosystem by creating new trails. Transects were selected along different topographies, including ridge crests and slopes, and each varied in length according to the forest condition. Transects were marked with coloured plastic flags at 20 m intervals. The surveyors halted at these points, to listen for lemur vocalisations.

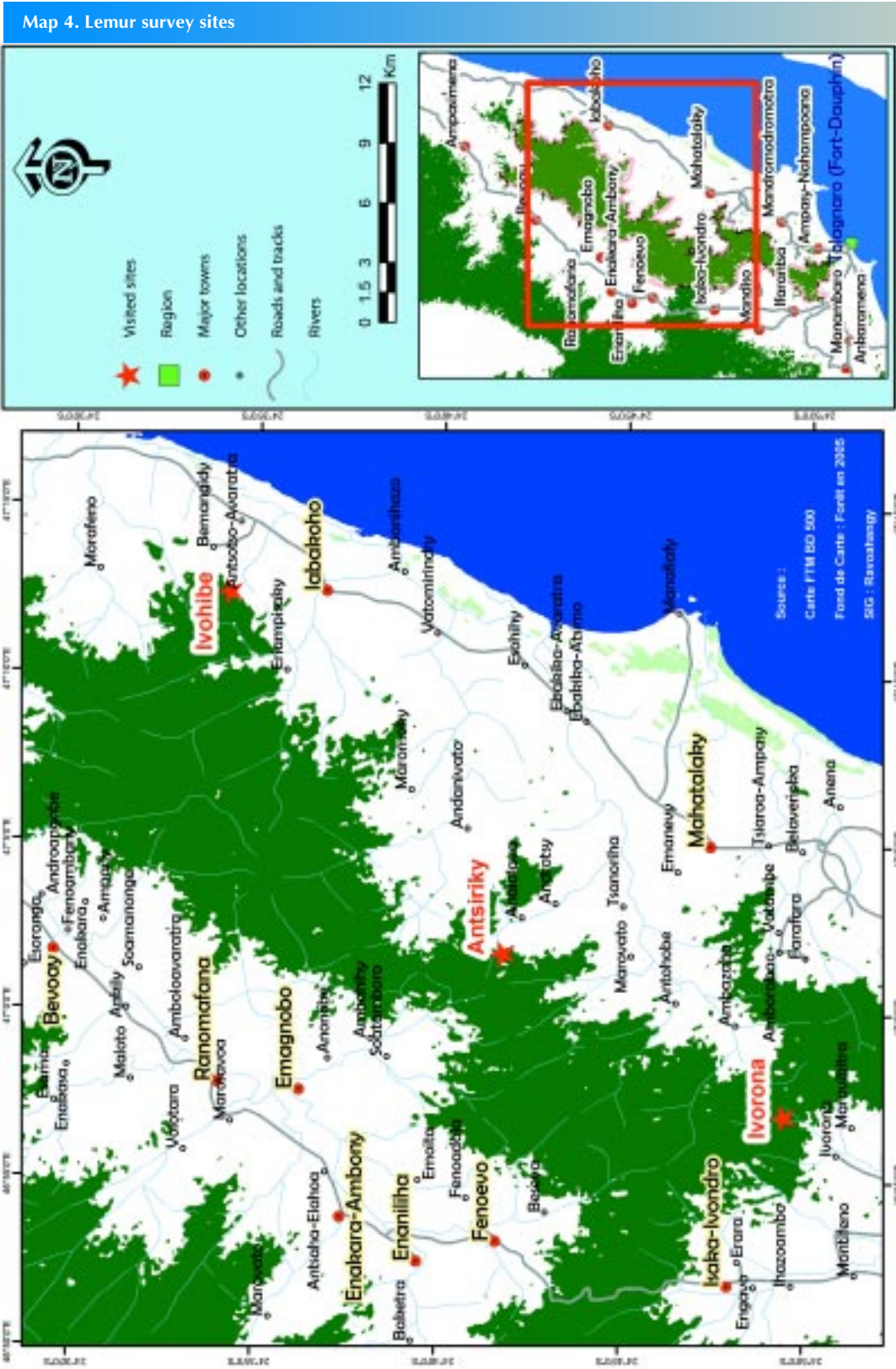
Day-time observations were made between 06h30 and 11h30, and again between 15h00 and 17h30. Night-time observations were made between 18h30 and 21h00, with the help of a head torch, in order to locate nocturnal lemurs from eye-shine. Once animals had been located, more powerful torches (Maglites) and a pair of binoculars were used to identify the species. Each visit (day or night) lasted for two hours, and the surveyors walked at a very low speed (0.5km/h).

Each transect was visited between two and four times for night-time observations, and from six to eight times for day-time observations, and efforts were made to cover each transect in different directions. During each visit (day or night), all lemurs seen or heard were recorded, noting the observation time, location, canopy height, the number of animals observed, the position relative to the trail (left or

Table 5. Description of the study sites in Tsitongambarika Forest

Site	Coordinates	Altitude (m)	Transect (m)	Habitat
Ivohibe	24°33'00"S 47°11'42"E	87	960	Ridge crest, open canopy (12–15 m high), dominated by <i>Uapaca</i> sp.
	24°34'09"S 47°12'26"E	302	1,000	Slope, semi-open canopy, dominated by <i>Uapaca</i> sp.
Antsiriky	24°41'30"S 47°01'33"E	340	1,000	Ridge crest, open canopy (4–8 m high)
	24°41'21"S 47°01'31"E	420	1,200	Slope, semi-open canopy (10–12 m high), presence of <i>Uapaca</i> sp.
Ivorona	24°49'35"S 46°57'03"E	282	1,000	Ridge crest, open canopy
	24°49'32"S 46°56'59"E	300	1,000	10–15 m high canopy, understorey dominated by lianas

<sup>1</sup> Nomenclature and taxonomy of lemurs has changed very significantly in recent years. The text of this chapter follows the author's own treatment. A note at the end of the chapter relates this to a recent treatment, widely but not universally accepted, with many more species recognised (Mittermeier *et al.* 2010). Eds.



right), the distance between the observer and the animal(s), and the behaviour of the animal(s).

The linear transect method allows the relative abundance of each species inventoried per kilometre of transect walked to be calculated. At each site, other places away from the transects were also visited, in order to contribute additional presence-absence data on lemur species.

For small nocturnal lemur species, a capture-release method was also used. This involved installing Sherman traps baited with banana along each transect (Table 6). Traps were hung on trees, between 1.5 and 2 m above the ground. Traps were placed at 20 m intervals along each transect (or section of transect), and opened only from 17h30, because: (i) Small nocturnal lemurs do not start their activities until 18h00 onwards, so the scent of the banana should not be released until they come out; (ii) Capture of other small mammals and diurnal reptiles should be avoided as far as possible.

Traps were checked early in the morning on the following day, and any small lemurs captured were brought to the camp site for measuring. After measuring, the animals were released very late in the afternoon at the place where they were captured. The capture-release method allowed identification of the lemurs captured. The survey period was too short and capture rates were too low to allow estimation of population size or density using this method.

**Table 6. Number of Sherman traps used at each site**

Site	Altitude (m)	Transect (m)	Number of traps
Ivohibe	87	960	48
	302	1,000	100
Antsiriky	340	1,000	100
	420	1,200	50
Ivorona	282	1,000	100
	300	1,000	50

## RESULTS

### Linear transect results

During the survey of Tsitongambarika Forest, six transects were used. A total distance of 39.04 km was covered during day-time visits and 15.32 km during night-time visits. Two cathemeral species (species with irregular activity patterns) were recorded in Tsitongambarika Forest: Collared Brown Lemur *Eulemur collaris* (Vulnerable) and Grey Gentle Lemur *Haplemur griseus* (Vulnerable). In addition, five strictly nocturnal species were recorded: Rufous Mouse-lemur *Microcebus rufus*, Greater Dwarf Lemur *Cheirogaleus major*, Eastern Woolly Lemur *Avahi meridionalis* (Data Deficient), Greater Sportive Lemur *Lepilemur mustelinus* (Data Deficient) and Aye-aye *Daubentonia madagascariensis* (Near Threatened). All of these species were directly observed, except *D. madagascariensis*, which was

recorded by observation of recent feeding signs and traces, and the presence of nests.

Each site was found to support all seven lemur species recorded (Table 7). However, the sites differed in terms of relative abundance of different species (Tables 8 and 9). One site (Ivorona) appeared to support higher densities (individuals/km) of several species than the other two sites (Antsiriky and Ivohibe).

The relative abundance of lemurs was greatest at Ivorona, and lowest at Antsiriky, where forest degradation was intense. At Antsiriky, a combination of forest exploitation and hunting appeared to be responsible for reduced abundance of lemurs.

### *Microcebus rufus* Rufous Mouse-lemur

*Microcebus rufus* was observed at all three sites but was not recorded along the 420 m elevation transect

**Table 7. Lemur species recorded in lowland humid forest at Tsitongambarika**

	Site Ivohibe		Antsiriky		Ivorona	
	Altitude (m)	87 302	340 420	282 300		
<i>Microcebus rufus</i>		+	+	+	-	+
<i>Cheirogaleus major</i>		+	+	+	+	+
<i>Avahi meridionalis</i>		+	+	+	+	+
<i>Lepilemur mustelinus</i>		+	+	+	+	+
<i>Daubentonia madagascariensis</i>		Tr	Tr	-	Tr	Tr
<i>Eulemur fulvus collaris</i>		+	+	+	+	+
<i>Haplemur griseus</i>		+	+	+	+	+
<b>Total species</b>		<b>7</b>	<b>7</b>	<b>6</b>	<b>6</b>	<b>7</b>

Notes: + = species observed; +\* = species recorded through vocalisation or information provided by villagers; - = species not recorded; Tr = feeding traces and/or nest present.

**Table 8. Average number of individuals encountered per km at night at each study site**

	Site Ivohibe		Antsiriky		Ivorona	
	Altitude (m)	87 302	340 420	282 300		
<i>Microcebus rufus</i>		2.08	2	2	0	4
<i>Cheirogaleus major</i>		0	0.75	0.5	0.8	3.5
<i>Avahi meridionalis</i>		0	0.5	1	1.66	6
<i>Lepilemur mustelinus</i>		0.5	0.5	0	0.41	3
<b>Total species</b>		<b>2</b>	<b>4</b>	<b>3</b>	<b>3</b>	<b>4</b>

**Table 9. Average number of individuals encountered per km during the day-time at each study site**

	Site Ivohibe		Antsiriky		Ivorona	
	Altitude (m)	87 302	340 420	282 300		
<i>Eulemur fulvus collaris</i>		1.30	2.50	0.83	0.69	2.60
<i>Haplemur griseus</i>		0.78	0.25	0.33	0.13	1.60
<b>Total species</b>		<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>



at Antsiriky. The relative abundance of *M. rufus* calculated by the linear transect method ranged from 0–4 individuals/km across the six transects, with a maximum along the 282 m elevation transect at Ivorona. It is a very active species, seen everywhere but preferring lianas.

***Cheirogaleus major* Greater Dwarf Lemur**

*Cheirogaleus major* was recorded at all three sites. The relative abundance of *C. major* ranged from 0 to 3.5 individuals/km across the six transects; most abundantly at Ivorona. In general, this is a solitary species, which runs along large branches and jumps rarely.

***Avahi meridionalis* Southern Woolly Lemur**

While *Avahi meridionalis* was relatively scarce at two study sites (Ivohibe and Antsiriky), it was the commonest lemur species encountered in Ivorona Forest, with a relative abundance of 6 individuals/km along the 282 m elevation transect. During the day, two adult and one juvenile *A. meridionalis* were seen at their nest in Ivorona Forest.

**Plate 6.** Southern Woolly Lemur *Avahi meridionalis* (Data Deficient) (ANDRIAMANDRANTO RAVOAHANGY)



**Plate 7.** Greater Sportive Lemur *Lepilemur mustelinus* (Data Deficient) (ANDRIAMANDRANTO RAVOAHANGY)

***Lepilemur mustelinus* Greater Sportive Lemur**

*Lepilemur mustelinus* was the least abundant of the four nocturnal lemur species observed during the survey. At Ivorona, *L. mustelinus* was found in a tree hole (nest) during the day, with the entrance of the hole displaying their teeth marks. At night, *L. mustelinus* can be difficult to distinguish from *A. meridionalis*, if animals are high in trees.

***Eulemur collaris* Collared Brown Lemur**

*Eulemur collaris* is a cathemeral species, which exhibits sexual dimorphism. It was usually encountered in groups, except along the 300 m elevation transect at Ivorona, where only a single male was found. The relative abundance of *E. collaris* was lowest at Antsiriky, where hunting appeared to be very intense. Away from the transects, a total of 46 individuals were observed incidentally at the three sites.

***Hapalemur griseus* Grey Gentle Lemur**

*Hapalemur griseus* is a small lemur that is very active in the early morning and late afternoon. At Tsitongambarika, it generally frequents areas of shifting cultivation, where it feeds on rice and coffee. For this reason, *H. griseus* was recorded infrequently along the transect lines, with relative densities ranging from 0.13–1.16 individuals/km.

***Daubentonia madagascariensis* Aye-aye**

*Daubentonia madagascariensis* was not observed directly during the survey. However, the species was recorded at all three study sites on the basis of recent feeding traces and the presence of nests. Several tree trunks or bamboos hollowed out by the animal's teeth were observed. Many traces of this species were found at Ivohibe.

■ **Capture-release results**

Only one species, *Microcebus rufus*, was captured with the help of Sherman traps. The number of individuals

captured was very low, and even zero at Antsiriky (Table 10). This low capture rate can be explained by the fact that natural food sources (fruit, insects, etc.) were abundant during the time of the survey, so animals were not attracted to the traps. Five individuals were trapped at Ivohibe, among which was a pregnant female.

**Table 10. Capture/release results in the three sites**

Site	Traps used	<i>Microcebus rufus</i> captured
Ivohibe	148	5
Antsiriky	150	0
Ivorona	150	1

### ■ Incidental observations

A number of incidental observations were made away from the linear transects. At Ivohibe, the survey team encountered three groups of *Eulemur collaris*, totalling 12 individuals, plus two groups of *Hapalemur griseus*, totalling five animals. Encounter rates at Antsiriky, were similar, with two groups of *E. collaris*, totalling 10 individuals, and two groups of *H. griseus*, totalling five individuals, being observed. At Ivorona, significantly more incidental sightings of catemeral lemurs were made; the survey team encountered four groups of *E. collaris*, composed of 24 individuals, as well as six *H. griseus*. These observations reinforced the findings from the linear transects that Ivorona Forest, among the three study sites, supports the highest lemur densities, with Ivohibe ranked second.

*Microcebus rufus*, *Eulemur collaris* and *Avahi meridionalis* females with babies were often encountered during the survey. This suggests that the months of November and December are the breeding period for these lemur species at Tsitongambarika.

### ■ Human pressures

The human pressures (threats) on lemur populations and their habitats that were identified during the survey include: hunting, wood-cutting and shifting (slash-and-burn) cultivation (*tavy*). These pressures were found to be more intense at Ivohibe and Antsiriky than at Ivorona, perhaps accounting for the higher lemur densities at the latter site.

Some local people reported that they hunted large lemurs for adding flavour to the stock that they prepared food with. Specialised lemur traps were seen during the survey. The protection of lemurs from hunting is an important step for conservation of biodiversity in the Anosy region.

Local people practice shifting cultivation for growing coffee, bananas and other crops. Villagers reported that their objective was to get good yields and that, moreover, they did not have enough fertile land suitable for fixed cultivation. The practice of shifting cultivation appears to be resulting in soil erosion and deforestation. As well as practising shifting cultivation, villagers cut trees for a

number of reasons, including the manufacture of fishing boats.

## DISCUSSION

During the survey, seven lemur species were recorded. The composition of the lemur community of Tsitongambarika Forest is very similar to that of the nearby Andohahela National Park. The humid forest sector of Andohahela National Park (Parcel I) supports eight species of lemur (Feistner and Schmid 1999), including all seven species found at Tsitongambarika. This indicates that there is no ecological barrier between the two forests; indeed, they are connected by a corridor of forest. Only one species is known from Andohahela Parcel I but not from Tsitongambarika: Fork-marked Lemur *Phaner furcifer*. Feistner and Schmid (1999) reported that they heard the call of this species only at an altitude of 1,500 m. Because the survey of Tsitongambarika focused on lowland humid forest (below 420 m), it is quite possible that Tsitongambarika supports *P. furcifer* at higher elevations.

A comparison of the relative densities of lemur species at the three survey sites with those at Andohahela reveals that lemur densities at lower at Tsitongambarika. This is understandable, given that Tsitongambarika Forest is currently unprotected. Within Tsitongambarika, relative abundance of lemurs appears to be low in Ivohibe Forest and very low in Antsiriky Forest. Differences in the type and intensity of human pressures among the three study sites seem to explain these differences in relative lemur abundance.

Recorded lemur species richness in Tsitongambarika Forest (only seven species) is low compared with that of the other humid forests. For example, 13 lemur species have been recorded at Andringitra Nature Reserve (Sterling and Ramaroson 1996), 12 species have been recorded at Ranomafana National Park (Mittermeier *et al.* 1992), 10 species have been recorded at Anjanaharibe-Sud Special Reserve (Schmid and Smolker 1998), 11 species have been recorded in Zahamena Reserve, and 10 species have been recorded on the Masoala Peninsula (Sterling and Rakotoarison, 1998).

The low richness of diurnal lemur species in Tsitongambarika Forest can be partly explained by the low number of *Hapalemur* species. Only one species of *Hapalemur* was recorded at Tsitongambarika, compared with three species at Andringitra. Another factor was the absence of any strictly diurnal lemur species. For example, the Group for Study and Research on the Primates (Groupes d'Etudes et de Recherches sur les Primates; GERP) of Madagascar confirmed that the humid forests of Maromizaha and Ambato (Moramanga) support four strictly diurnal lemur species: Indri *Indri indri*, Red-bellied Lemur *Eulemur rubriventer*, Black-and-white Ruffed Lemur *Varecia variegata variegata* and



Diademed Sifaka *Propithecus diadema* (GERP 2003). None of these species was observed at Tsitongambarika. The geographical distribution of *Eulemur rubriventer* and *Varecia variegata* is limited to the south by the Mananara River, that of *Indri indri* by the Mangoro River, and that of *Propithecus diadema* by Andringitra National Park and the Rienana River.

## CONCLUSIONS

All seven lemur species recorded during the survey were found at all three study sites but at different relative abundances. The variation in abundance may be due to a combination of two pressures: forest destruction and hunting. *Eulemur collaris* seems to be the most susceptible to these threats, followed by *Haplemur griseus*, *Avahi meridionalis* and *Lepilemur mustelinus*. The pressures with the most irreversible impacts are wood cutting and clearance of forest through shifting (slash-and-burn) cultivation, because these totally remove lemurs' forest habitats.

Although Tsitongambarika Forest does not appear to be as rich in lemur species as some other forests, it remains a high conservation priority because it includes a significant area of lowland humid forest, which supports two globally threatened lemurs, one Near Threatened and one Data Deficient lemur, as well as three other lemur species.

## RECOMMENDATIONS

1. All three study sites seem to require conservation action, as the relative abundance of lemurs appears low compared with other (protected) humid forests.
2. Shifting (slash-and-burn) cultivation is leading to deforestation and soil erosion. Local people should be taught different farming methods, and informed about the consequences of this harmful practice.
3. To reduce the need for hunting to meet local people's protein requirements, livestock-raising should be considered.
4. The local population should be made aware of the need to protect the forest and its biodiversity, and more responsibility should be given to the local authorities.
5. Ecotourism should be promoted as a source of income for local communities, and as an incentive for them to protect the forest. In this regard, Ivorona Forest has significant potential for ecotourism development, because it is the most accessible site for visitors from Tolagnaro, and the relative abundance of lemurs is still high compared with the other two sites.
6. The results of the survey are not sufficient to precisely identify the most important sites for lemur conservation within Tsitongambarika Forest. Therefore, further studies should be carried out periodically, as in other protected areas.

## Editors' note

The following table assesses the likely identity of lemurs at Tsitongambarika, if the taxonomic arrangement of compares taxonomic treatment used in the field guide *Lemurs of Madagascar*, 3rd edition (Mittermeier *et al.* 2010) were followed; IUCN adopts this taxonomy in threat assessment, and so threat categories are also given: VU, Vulnerable; NT, Near Threatened; DD, Data Deficient; LC, Least Concern.

Name used in this chapter	Name used in <i>Lemurs of Madagascar</i> , 3rd edition (Mittermeier <i>et al.</i> 2010), and IUCN 2010 threat level	Notes from Mittermeier <i>et al.</i> (2010)
<i>Microcebus rufus</i> Rufous Mouse-lemur	<i>Microcebus</i> sp. unidentified mouse lemur	No DNA studies carried out at Tsitongambarika; nearest animals tested ( <i>M. rufus</i> ) c.180 km away and unlikely to be same species.
<i>Cheirogaleus major</i> Greater Dwarf Lemur	<i>Cheirogaleus major</i> Greater Dwarf Lemur (LC)	Animals from the "Vohimena mountains" i.e. Tsitongambarika specifically identified as <i>C. major</i> .
<i>Avahi meridionalis</i> Southern Woolly Lemur	<i>Avahi meridionalis</i> Southern Woolly Lemur (DD)	
<i>Lepilemur mustelinus</i> Greater Sportive Lemur	<i>Lepilemur fleuretae</i> Andohahela Sportive Lemur (DD)	Known only from Manangotry parcel of Andohahela National Park, and no other <i>Lepilemur</i> sp. is known in the region. Manangotry is contiguous with Tsitongambarika, so both may hold <i>L. fleuretae</i> .
<i>Eulemur collaris</i> Collared Brown Lemur	<i>Eulemur collaris</i> Red-collared Brown Lemur (VU)	
<i>Haplemur griseus</i> Grey Gentle Lemur	<i>Haplemur meridionalis</i> Southern Bamboo Lemur (VU)	All <i>Haplemur</i> in far SE Madagascar are mapped as this species
<i>Daubentonia madagascariensis</i> Aye-aye	<i>Daubentonia madagascariensis</i> Aye-aye (NT)	

## Chapter 5: THE HERPETOFAUNA OF TSITONGAMBARIKA FOREST

JEAN BAPTISTE RAMANAMANJATO AND SOANARY CLAUDE HERY

### INTRODUCTION

Reptiles and amphibians make up half of Madagascar's vertebrate species, and are unique globally, with endemism of 95% and 99% respectively. 235 amphibian and 370 reptile species are recognised for the island, not counting at least 150 new amphibian and 50 new reptile species discovered between 1994 and 2007 but not yet described (Glaw and Vences, 2007). The first studies initiated by Rio Tinto QMM (QIT Madagascar Minerals, QMM) to assess the effects of the implementation of its ilmenite project on the regional herpetofauna, in 1989 and 1990, showed that the Anosy region is one of special interest owing to the high degree of endemism and the presence of many amphibian and reptile species of conservation concern (Blanc 1985, Blommers-Schlösser and Blanc 1991). The remaining forests of the Anosy region are subject to a diverse range of threats (Asity Madagascar 2009), of which shifting (slash-and-burn) cultivation, selective timber exploitation, charcoal production and hunting are the most important. The lowland rain forests, including those of Tsitongambarika, have been classified as one of the most threatened habitats in Madagascar and over 10% of the original extent of Tsitongambarika has been lost between 1999 and 2005 (Andriamasimanana 2008, Asity Madagascar 2009).

Knowledge of the distribution and status of the herpetofauna of Tsitongambarika dates back to surveys of Tsitongambarika I in 1990. More than a decade later, these were complemented by biological inventories of Tsitongambarika II and III. In the 2002 rainy season, inventories were made at one site within Tsitongambarika II. In 2006, a further site in Tsitongambarika II and two sites in Tsitongambarika III were surveyed. Results from these surveys can be consolidated to provide a preliminary checklist of the herpetofauna of Tsitongambarika Forest, and compared with data from other sites in the Anosy region collected by QIT Madagascar Minerals SA over the last 15 years (Ramanamanjato 2007) and with the results of surveys by other scientists at Andohahela National Park.

### STUDY SITES

Between 1990 and 2006, seven sites were visited inside Tsitongambarika Forest. These were all lowland humid forest sites, at elevations below 850 m:

1. Manantantely, Lakandava and Farafara in Tsitongambarika I;

2. Ivorona, and Maromoky in Tsitongambarika II;
3. Ampasy and Ivohibe in Tsitongambarika III.

### Tsitongambarika I

Herpetofauna inventories of three sites in Tsitongambarika I Classified Forest were carried out by Rio Tinto QMM in 1990 (Creighton 1992, Ramanamanjato 1993). Manantantely is situated on a south-facing catchment, 7 km from Tolagnaro (Fort Dauphin), while Lakandava is located on an east-facing catchment, 10 km north of Tolagnaro. Both sites supported dense humid forest close to the transition zone between the dense humid forests of eastern Madagascar and the dry deciduous forests of western Madagascar. They experience marked seasonality, with a pronounced dry season.

During the early 1990s, the forest at Manantantely and Lakandava played an important role in protecting catchments of streams and rivers essential for irrigated rice cultivation in Soanierana and Ampasy Nahampoana communes. Over the last decade, however, the deforestation rate has increased to 2.56% per year (Andriamasimanana 2008), mainly owing to shifting (slash-and-burn) cultivation, extraction of construction timber and ebony (at Enato) and charcoal production (at Andranara).

The village of Farafara is situated 23 km north of Tolagnaro, in Mahatalaky commune. The survey site was located nearby in Andohavolo Forest (24°50'42"S 47°00'56"E), near the boundary between the classified forests of Tsitongambarika I and II.

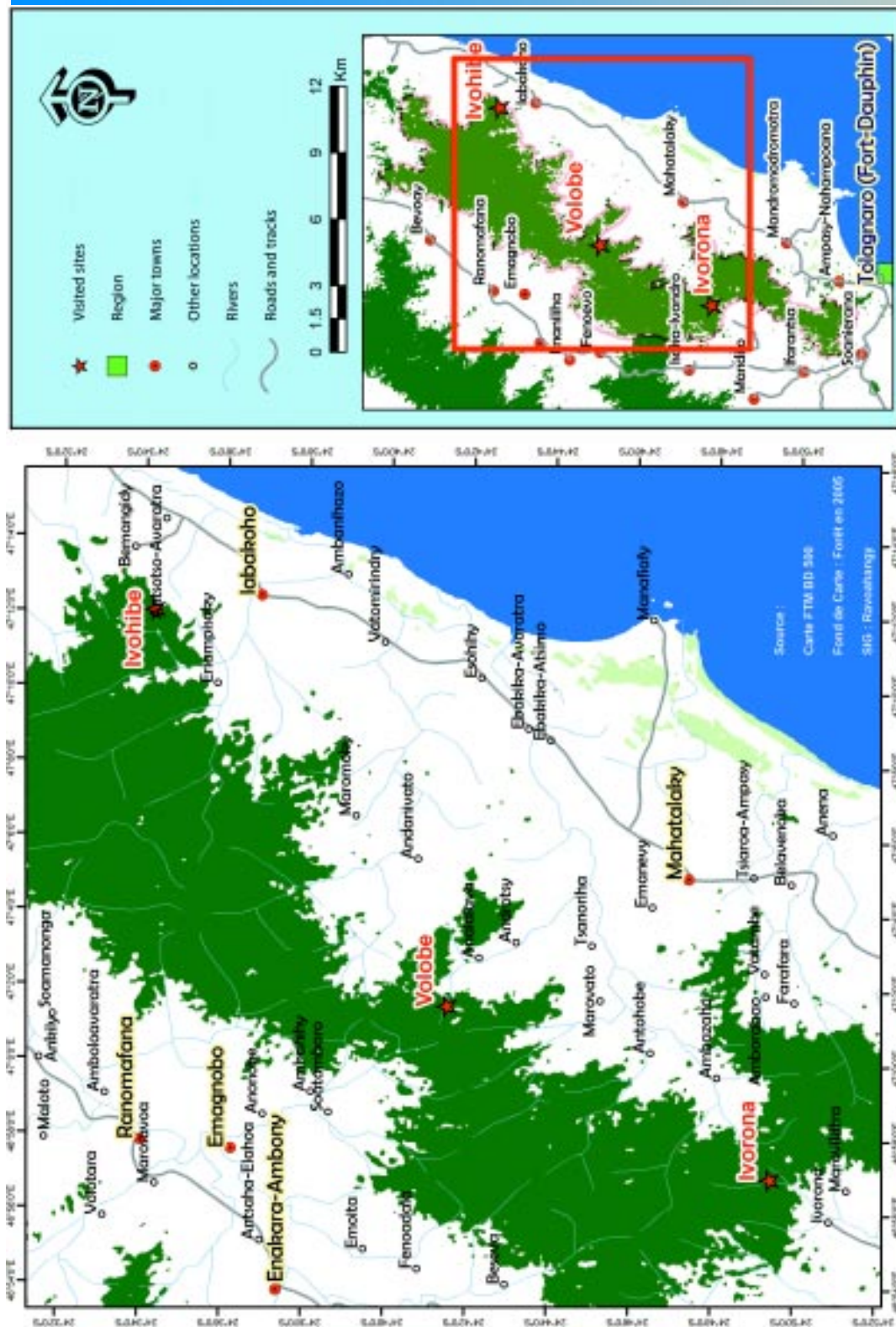
The Farafara survey site supports dense lowland humid evergreen forest with a closed canopy at 15–17 m (Ravelonahina and Ramarosandratana 2002). Several rivers have their sources in this forest before flowing north-east to the Indian Ocean, including the Antorendriky, the Mandromondromotra and the Anandrano.

### Tsitongambarika II

Ivorona, located to the south of the Ebakika River, was surveyed in 2002 and Maramoky Forest, north of the Ebakika River but south of the Iaboakoho River, was surveyed in 2006.

The village of Ivorona is located 24 km north-west of Tolagnaro, in Ifarantsa Commune. The survey site (24°49'36"S 46°57'05"E) was located 5 km north of Ivorona, in the southern limit of Tsitongambarika II. The site supports dense humid evergreen forest at low to medium elevations, with a closed canopy at 15–18 m. It constitutes the only extant forest corridor linking Tsitongambarika Forest in the east with Andohahela National Park in the west. The Mamoarenny and

### Map 5. Herpetofauna survey sites



Marohala rivers both have their sources in Ivorona Forest, the former flowing south and the latter north-east.

Maromoky Forest is situated at the northern limit of Tsitongambarika II, between the Ebakika and Vatimirindry rivers. The site supports lowland humid forest, with a closed canopy which can reach 15–20 m high. River valleys are very degraded by agriculture. The eastern slope of this forest used—a long time ago—to be linked to Sainte Luce littoral forest 20 km away.

Shifting (slash-and-burn) cultivation is prevalent in Tsitongambarika II, and constitutes a major threat to the forest. A community-based forest management programme has been initiated among the local villagers.

### ■ Tsitongambarika III

The forest north of Tsitongambarika II, provisionally called Tsitongambarika III, stretches across Mahatalaky, as far north as Manambato. It is limited to the north and west by the Manampanihy River. In 2006, an inventory was made at Ampasy and Ivohibe forests, respectively south and north of the Iabakoho River. Both are dense lowland humid evergreen forests at 80–400 m elevation with a closed canopy at 12–20 m. The forest is under considerable pressure, particularly from shifting (slash-and-burn) cultivation which is causing very serious habitat fragmentation.

## METHODS

Pitfall traps and direct observations were used to inventory herpetofauna at each study site. For every animal observed or captured, the following data were recorded: date, location, habitat type, micro-habitat type and behaviour.

Direct observation aimed to record the maximum possible number of species, focusing particularly on globally threatened and locally endemic species (i.e., those whose global ranges are entirely confined to south-east Madagascar).

Systematic searches were made during the day and night of all locations where reptiles and amphibians were likely to hunt, shelter or breed, across all habitats and topography. A six volt head torch was used for night-time observations, in order to locate animals by their eye-shine (along transects, from nightfall to around midnight).

At each site, two lines of pitfall traps were employed simultaneously, one in a valley and one on a hillside or ridge crest. Each trap line comprised 11 15-litre plastic buckets, spaced at 10 m intervals. The buckets were set in the ground so that the brim was level with the ground, and were interspaced with a plastic fence, 50 cm high, constituting a barrier to animals and thus guiding them into the buckets. Trap lines were left functional for seven days in each location, and checked once a day.

Where necessary, voucher specimens were collected for identification and to form a reference

collection. Collected individuals were anaesthetised with chlorotone before being fixed with a 10% formalin solution. Afterwards, they were transferred into an aqueous mixture containing 20% formalin. Voucher specimens were deposited at the Terrestrial Population Laboratory at the Department of Animal Biology of the University of Antananarivo. All animals not retained as specimens were released where captured.

## RESULTS

In total, 126 species were recorded in Tsitongambarika, comprising 57 amphibians and 69 reptiles (Table 11). The chameleon *Brookesia nasus* has also been recorded by others, bringing the total to 70 reptiles. The full list of species recorded during the surveys is presented in Table 12. Of these, 12 are thought to be endemic to the Anosy region, and six (four amphibians and two reptiles) are probably new to science.

Table 11. Species richness per site

Site	Amphibian species	Reptile species	Total species
Manantantely	30	36	66
Lakandava	24	16	40
Ivorona	28	35	63
Farafara	26	33	59
Maromoky	28	23	51
Ampasy	31	20	51
Ivohibe	30	27	57
<b>Total</b>	<b>57</b>	<b>69</b>	<b>126</b>

Figure 1 shows herpetological species-accumulation curves for each site. It appears that plateaux of discovery were reached at some sites (e.g. Manantantely) by the last survey day, but that at others (e.g. Farafara, Ivohibe) further surveys would have uncovered even more species.

Figure 1. Herpetological species-accumulation curves for each study site

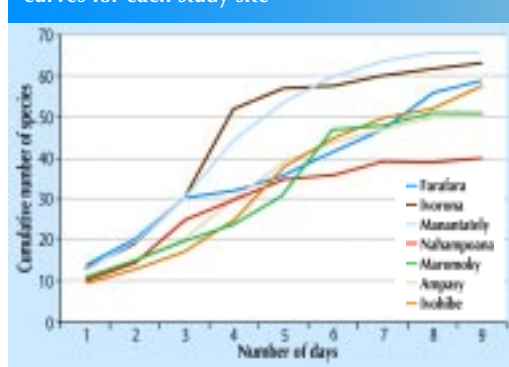


Table 12. Full list of amphibian and reptile species recorded at Tsitongambarika

Species	TGK I			TGK II		TGK III		No. sites	IUCN status*
	1990 Manantantely	1990 Lakandava	2002 Farafara	2002 Ivorona	2006 Maromoky	2006 Ampasy	2006 Ivohibe		
AMPHIBIANS									
<i>Agyptodactylus madagascariensis</i>	1	1	1	1	1	1	1	7	
<i>Anodonthyla boulengerii</i>	1	1		1	1	1	1	6	
<i>Anodonthyla nigrigularis</i>			1		1			2	DD
<i>Blommersia domerguei</i>							1	1	
<i>Boehmantis microtympaum</i>	1	1	1	1	1	1	1	7	EN
<i>Boophis andohahela</i>				1	1			2	DD
<i>Boophis brachychir</i>					1			1	DD
<i>Boophis doulioti</i>	1	1						2	
<i>Boophis erythrodactylus</i>	1	1		1	1	1		5	
<i>Boophis luteus</i>	1	1	1	1		1	1	6	
<i>Boophis madagascariensis</i>	1	1	1	1	1	1	1	7	
<i>Boophis majori</i>	1			1				2	NT
<i>Boophis miniatus</i>	1							1	
<i>Boophis opisthodon</i>		1	1	1				3	
<i>Boophis</i> sp. n. 1				1	1	1		3	
<i>Boophis</i> sp. n. 2					1			1	
<i>Gephyromantis asper</i>			1	1				2	
<i>Gephyromantis decaryi</i>	1	1	1	1	1	1	1	7	NT
<i>Gephyromantis eiselti</i>				1	1	1	1	4	DD
<i>Gephyromantis klemmeri</i>			1					1	VU
<i>Gephyromantis leucocephalus</i>			1	1			1	3	NT
<i>Gephyromantis luteus</i>			1	1	1	1	1	5	
<i>Gephyromantis redimitus</i>			1	1		1		3	
<i>Gephyromantis thelenae</i>				1		1	1	3	DD
<i>Gephyromantis ventrimaculatus</i>					1			1	
<i>Gephyromantis</i> sp. n. 1	1			1	1	1	1	5	
<i>Guibemantis bicalcaratus</i>					1		1	2	
<i>Guibemantis depressiceps</i>	1	1					1	3	
<i>Guibemantis liber</i>			1				1	2	
<i>Guibemantis tornieri</i>	1	1				1		3	
<i>Heterixalus boettgeri</i>	1	1					1	3	
<i>Laliostoma labrosum</i>	1							1	
<i>Mantella haraldmeieri</i>	1	1	1	1	1	1	1	7	VU
<i>Mantidactylus aerumnalis</i>			1	1				2	
<i>Mantidactylus betsileanus</i>	1	1	1	1	1	1	1	7	
<i>Mantidactylus biporus</i>	1	1	1		1	1	1	6	
<i>Mantidactylus curtus</i>			1					1	
<i>Mantidactylus femoralis</i>	1	1	1		1	1	1	6	
<i>Mantidactylus grandidieri</i>	1	1	1	1	1	1	1	7	
<i>Mantidactylus aff. grandidieri</i>						1		1	
<i>Mantidactylus lugubris</i>	1	1	1	1	1	1	1	7	
<i>Mantidactylus majori</i>						1		1	
<i>Mantidactylus opiparis</i>	1	1	1	1	1	1		6	
<i>Mantidactylus ulcerosus</i>	1	1	1	1	1	1	1	7	
<i>Mantidactylus</i> sp. n. 1					1	1	1	3	
<i>Paradoxophyla palmata</i>						1		1	



Table 12 ... continued. Full list of amphibian and reptile species recorded at Tsitongambarika

Species	TGK I			TGK II		TGK III		No. sites	IUCN status*
	1990 Manantantely	1990 Lakandava	2002 Farafara	2002 Ivorona	2006 Maromoky	2006 Ampasy	2006 Ivohibe		
<i>Platypelis grandis</i>	1			1	1	1	1	5	
<i>Plethodontohyla bipunctata</i>	1	1				1	1	4	
<i>Plethodontohyla inguinalis</i>	1	1	1	1				4	
<i>Plethodontohyla notosticta</i>	1					1	1	3	
<i>Ptychadena mascareniensis</i>	1	1		1			1	4	
<i>Rhombophryne allaudi</i>	1							1	
<i>Scaphiophryne spinosa</i>						1		1	
<i>Spinomantis aglavei</i>			1					1	
<i>Spinomantis bertini</i>					1		1	2	NT
<i>Spinomantis brunae</i>					1			1	EN
<i>Stumpffia</i> sp. aff. <i>tetradactyla</i> "Southeast"	1	1	1			1	1	5	DD
Total number of species per site	30	24	26	28	28	31	30		
<b>REPTILES</b>									
<i>Acrantophis dumerili</i>	1							1	VU
<i>Amphiglossus macrocercus</i>	1							1	
<i>Amphiglossus melanurus</i>			1	1			1	3	
<i>Amphiglossus ornaticeps</i>	1						1	2	
<i>Amphiglossus punctatus</i>					1			1	
<i>Amphiglossus</i> sp.				1				1	
<i>Bibilava lateralis</i>	1	1	1	1	1	1	1	7	
<i>Bibilava epistibes</i>					1		1	2	
<i>Bibilava infrasignatus</i>				1	1	1		3	
<i>Brookesia nasus</i>			1	1	1	1	1	5	
<i>Brookesia superciliaris</i>					1	1	1	3	
<i>Calumma nasutum</i>	1		1	1	1		1	5	
<i>Compsophis boulengeri</i>					1	1		2	
<i>Compsophis infralineata</i>				1	1	1	1	4	
<i>Crocodylus niloticus</i>			1		1	1		3	
<i>Dromicodryas bernieri</i>	1		1				1	3	
<i>Ebenavia inunguis</i>	1			1		1	1	4	
<i>Furcifer balteatus</i>				1				1	
<i>Furcifer lateralis</i>	1	1	1	1				4	
<i>Furcifer oustaleti</i>							1	1	
<i>Furcifer verrucosus</i>			1	1			1	3	
<i>Geckolepis maculate</i>			1	1			1	3	
<i>Geckolepis typical</i>	1	1						2	
<i>Hemidactylus mercatorius</i>							1	1	
<i>Ithycyphus goudoti</i>	1	1	1					3	
<i>Ithycyphus miniatus</i>				1				1	
<i>Ithycyphus oursi</i>	1							1	
<i>Ithycyphus perineti</i>			1	1				2	
<i>Langaha madagascariensis</i>	1							1	
<i>Leioheterodon madagascariensis</i>	1	1	1	1				4	
<i>Leioheterodon modestus</i>	1			1				2	
<i>Liophidium rhodogaster</i>	1		1		1		1	4	
<i>Liophidium torquatum</i>	1	1	1	1				4	
<i>Liophidium vaillanti</i>	1							1	

Table 12 ... continued. Full list of amphibian and reptile species recorded at Tsitongambarika

Species	TGK I			TGK II		TGK III		No. sites	IUCN status*
	1990 Manantantely	1990 Lakandava	2002 Farafara	2002 Ivorona	2006 Maromoky	2006 Ampasy	2006 Ivohibe		
<i>Liophidium</i> sp. n.						1		1	
<i>Liopholidophis</i> sp. n.			1	1		1		3	
<i>Lygodactylus madagascariensis</i>			1	1			1	3	
<i>Lygodactylus miops</i>	1	1					1	3	
<i>Lygodactylus</i> sp.					1			1	
<i>Trachylepis elegans delphinensis</i>	1	1	1	1	1	1	1	7	
<i>Trachylepis gravenhorstii</i>	1	1	1	1	1	1	1	7	
<i>Madagascarophis colubrinus</i>	1	1	1	1	1	1	1	7	
<i>Madascincus igneocaudatus</i>	1							1	
<i>Madascincus melanopleura</i>	1		1	1	1		1	5	
<i>Micropisthodon ochraceus</i>				1				1	
<i>Mimophis mahfalensis</i>	1	1	1	1	1	1	1	7	
<i>Oplurus quadrimaculatus</i>	1	1	1	1		1		5	
<i>Paragehyra gabriellae</i>	1	1	1	1				4	
<i>Phelsuma lineate</i>	1	1	1		1			4	
<i>Phelsuma madagascariensis</i>			1				1	2	
<i>Phelsuma modesta</i>	1							1	
<i>Phelsuma quadriocellata</i>			1	1	1			3	
<i>Phelsuma</i> sp.						1	1	2	
<i>Pseudoxyrhopus heterurus</i>	1							1	
<i>Pseudoxyrhopus microps</i>	1		1	1				3	
<i>Pseudoxyrhopus sokosoko</i>			1					1	
<i>Pseudoxyrhopus tritaenatus</i>					1			1	
<i>Sanzinia madagascariensis</i>	1	1	1	1	1		1	6	VU
<i>Stenophis arctifasciatus</i>	1			1			1	3	
<i>Stenophis betsileanus</i>			1	1				2	
<i>Stenophis gaimardi</i>	1							1	
<i>Stenophis guentheri</i>		1						1	
<i>Typhlops ocellaris</i>	1							1	
<i>Uroplatus malahelo</i>			1					1	
<i>Uroplatus sikorae</i>					1	1	1	3	
<i>Zonosaurus aeneus</i>						1		1	
<i>Zonosaurus anelanelany</i>			1	1	1	1		4	
<i>Zonosaurus laticaudatus</i>	1			1				2	
<i>Zonosaurus maximus</i>	1		1	1		1		4	
<b>Total number of species per site</b>	<b>36</b>	<b>16</b>	<b>33</b>	<b>35</b>	<b>23</b>	<b>20</b>	<b>27</b>		
<b>Unrecorded potential species</b>									
<b>AMPHIBIANS</b>									
<i>Madecassophryne truebae</i>									EN
<b>REPTILES</b>									
<i>Calumma brevicorne</i>									
<i>Calumma gastrotaenia</i>									
<i>Calumma oshaughnessyi</i>									
<i>Phelsuma antanosy</i>									CR
<i>Phelsuma malamakibo</i>									
<i>Pseudoxyrhopus kely</i>									EN
<i>Uroplatus malama</i>									

Notes: \* Global IUCN Red List status: CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; DD = Data Deficient. Taxonomy and nomenclature follows Glaw and Vences (2007) and IUCN (2010).

## ■ Notes on threatened and restricted-range species

*Boehmantis microtympnum* is a globally Endangered Anosy endemic frog. This species was found abundantly on rocks of watercourse or the rivers in the closed-canopy forest. It is active during both daytime and night and is abundant in Tsitongambarika. However, some streams harbouring this species are now deprived of water except during the rainy season, perhaps owing to habitat loss or climate change.

*Heterixalus boettgeri* is known from only six sites. It was observed on the leaves of vegetation located at the forest periphery.

*Mantella haraldmeieri* (Plate 8) is a globally Vulnerable Anosy endemic. It was only found in Tsitongambarika I during this study. Males called during the daytime. Its habitats comprise herbaceous plants and rocks by watercourses near or in the forest, including the Marohala River at Ivorona. In Farafara Forest, this species appears to be threatened by microclimate change. Some streams harbouring this species now lack water except during the rainy season, perhaps owing to habitat loss or climate change.

*Paragehyra gabriellae* (Plate 9) is an Anosy endemic gecko restricted to rocks in the humid dense forest of Ivorona and Farafara, and may well be

globally threatened. It is a nocturnal species, staying in rocky cavities by day, and adheres its eggs to the underside of a sloping rock. Some rocks that provide shelter for *Paragehyra gabriellae* are exposed to sun in the study sites, owing to habitat loss. The species was discovered in 1990 during a study by Rio Tinto QMM in the forest of Ambatorongorongo and Manantantely (Nussbaum and Raxworthy 1994) and recorded again by Ramanamanjato in 2001 (Ramanamanjato *et al.* 2002).

## DISCUSSION

South-east Madagascar holds a remarkable variety of natural habitats ranging from evergreen humid forests to sub-desert spiny bush, including littoral forests, coastal areas and high mountains (Goodman *et al.* 1997). According to data collected by Rio Tinto QMM (in 1989/90 and from 1998 on), and by the World Wide Fund for Nature (in 1995), only the humid forest of the Anosy mountain chain holds a comparable total vertebrate species richness to Tsitongambarika. In Anosy, the majority of species are also reptiles and amphibians.

To date, within Tsitongambarika, the most amphibian and reptile species have been recorded at



**Plate 8.** *Mantella haraldmeieri* (Vulnerable)  
(ANDRIAMANDRANTO RAVOAHANGY)



**Plate 9.** *Paragehyra gabriellae*  
(ANDRIAMANDRANTO RAVOAHANGY)

Ivorona and Manantantely. The former is a unique corridor between the Vohimena and Anosy mountain chains and the latter constitutes a rare example of remaining habitat on the southern slope of the Vohimena chain.

Some similarities can be seen among the humid forests of the region: on the one hand between littoral forests (Mandena and Sainte Luce) and the forest of Tsitongambarika, and on the other between the Anosy and Tsitongambarika mountain chains. For example, Tsitongambarika shares 19 amphibian and 42 reptile species with the littoral forests. Now, however, habitat fragmentation has led to a long period of isolation of Tsitongambarika from other areas. For example, Farafara has no direct contact with Andohahela National Park and now only Ivorona links Manangotry and Tsitongambarika, with a corridor that is now only about 0.5 to 1 km wide.

If such habitat loss and fragmentation continues, the endemic and characteristic species of the region, particularly lowland species, may well disappear soon, leaving predominantly generalists (Ramanamanjato 2000) and increased numbers of invasive exotic species such as *Rattus rattus* (Ramanamanjato and Ganzhorn 2001).

Lowland forest has been most reduced, then dry forest, mid-altitude humid forest, and littoral forest. From 1950 to 1995, the area of Manantenina, in the northern Anosy region was most impacted—losing 19,052 ha of lowland forest through shifting (slash-and-burn) agriculture—followed by Analamary, which lost 9,518 ha. Unfortunately, eight species endemic to the Anosy region are found only in lowland forest, often very locally (e.g. *Boehmantis microtympanum*, *Mantella haraldmeieri*, *Paragehyra gabriellae*, *Phelsuma antanosy* and *Pseudoxyrhopus kely*). Habitat loss may cause the extinction of these species (Ramanamanjato 2000, Ramanamanjato *et al.* 2002).

Six apparently new species were discovered during surveys (two *Boophis*, one *Gephyromantis*, one *Mantidactylus*, one *Liophidium* and one *Liopholidophis*). These are, on current knowledge, endemic solely to Tsitongambarika.

The rare snake *Micropisthodon ochraceus* was observed at Ivorona. It is a littoral forest species known previously from Mananara, Itampolo in

Fénérive Est and Sainte Luce (Ramanamanjato unpublished data) and its presence in south-east Madagascar is a major range extension. Likewise, records of *Ithycyphus perineti*, known previously from the region of Perinet and Moramanga, from Tsitongambarika are the first in south-east Madagascar. The known distributions of *Boehmantis microtympanum*, *Mantella haraldmeieri* and *Paragehyra gabriellae* were extended northwards. These species are endemic to south-east Madagascar.

A number of endemic species with very restricted distributions within south-east Madagascar were not recorded during surveys and may not occur at Tsitongambarika. These include *Phelsuma antanosy*, *Phelsuma malamakibo* and *Calumma capuroni*. The latter two remain known only from Andohahela National Park.

## CONCLUSIONS

Twenty species of reptiles and amphibians, including 12 found in Tsitongambarika, are not found anywhere in Madagascar except the Anosy region. Several of them are known only from two forest blocks totalling less than 10 km<sup>2</sup>. Moreover, little is known of the ecology and population dynamics of most of these species. This preliminary analysis shows the priority of lowland forest, of which the largest block is found in the Vohimena chain under 800 m. The restricted-range species are sensitive to habitat changes, and even fragmentation of the Tsitongambarika Forest into three big blocks exposes several to risk. If habitat loss continues at its current speed, these Anosy endemic species may become extinct within the next ten years.

## RECOMMENDATIONS

The massif of Tsitongambarika should be included in the Madagascar protected area network to ensure sustainable management, with a core conservation zone, a buffer zone for sustainable natural resource exploitation and another zone for social and economic activities. The forest corridor of Ivorona should be included in the core conservation zone.

## Chapter 6: THE BIRDS OF TSITONGAMBARIKA FOREST

MARC RABENANDRASANA, MICHAEL RAMANESIMANANA, LOVAHASINA RASOLONDRABE,  
BRUNO RAVELOSON AND RIVO RABARISOA

### OBJECTIVES

Bird surveys of Tsitongambarika Forest had the following objectives:

1. Make an inventory of the avifauna that complements past studies;
2. Collect information on species that trigger Important Bird Area (IBA) status for Tsitongambarika: globally threatened species (IBA category A1), restricted-range species (IBA category A2) and biome-restricted species (IBA category A3);
3. Identify priority sites for the conservation of the avifauna of Tsitongambarika Forest where ecological monitoring, forest restoration and ecotourism programmes could be initiated in future;
4. Briefly describe the micro-habitats and sites that support important forest bird species, and identify threats to forest birds and their habitats;
5. Propose measures for reducing these threats;
6. Propose an ecological monitoring programme for priority sites identified.

### METHODS

#### ■ Inventory and census of forest bird species

As the main objective of the survey was to compile a biological inventory, the approach adopted was to look for the maximum number of species present in the forest areas that were studied. To this end, the following methods were used in a systematic manner: observation of birds from visual detection, a fixed watch point and call playback.

Recording of birds by visual detection is possible when the observer is armed with a prior knowledge of the type of habitat used by the species. Species are identified with the help of a pair of binoculars or by listening to their characteristic calls. Rates of detection can be increased by: locating roosting birds by the presence of excrement beneath them; locating nests; and using a prior knowledge of the stratum used by the species in the forest (e.g. forest floor, undergrowth, forest canopy, etc.). These approaches allow many species to be easily located within appropriate habitat, even if they do not vocalise. The inventory was timed to coincide with the breeding season of many forest birds. Systematic searches for active nests enabled detailed observations to be made

of breeding pairs building their nests, feeding young, and leading dependent young away from the nest.

Fixed watch points involved the observer stopping at a point affording a view over a large area of forest, particularly including the tops of trees. This allows bird species flying above the canopy, such as swallows and birds of prey, to be recorded. The observer may stay at the watch point for period of time ranging from a few minutes to a few hours.

Call playback involves playing back a species's characteristic calls from a cassette-player, CD player or MP3 player and listening to hear whether any birds respond to the call of their own species. This method can be used to ascertain the presence of particular bird species within a habitat. It is important that the surveyor has prior knowledge of the calls of the birds being surveyed for.

#### ■ Other complementary inventory methods

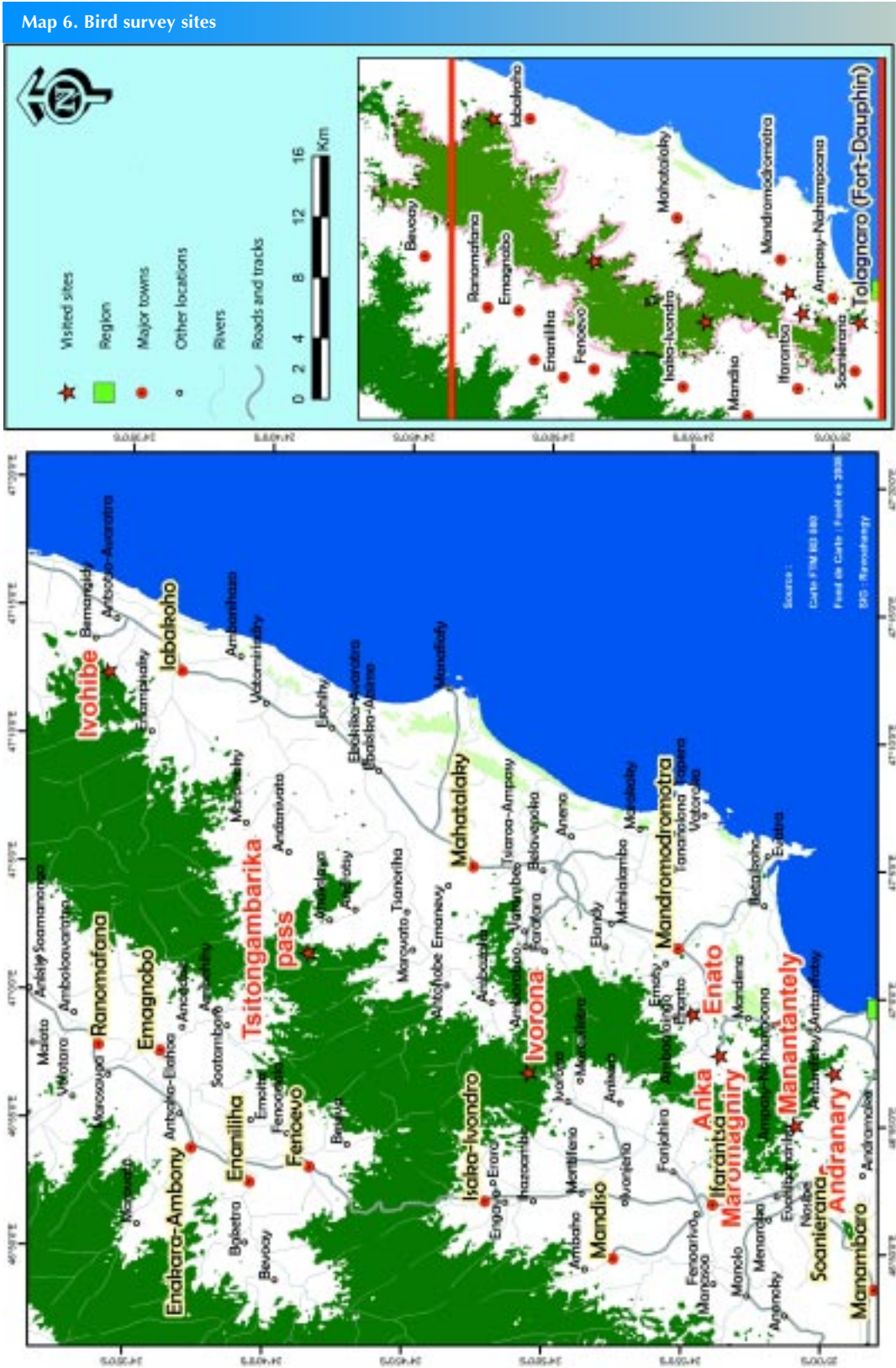
The aforementioned methods were complemented by identifying birds on the basis of traces left by them, such as feathers, nests or pellets of waste regurgitated by birds of prey. During visits to the forest, surveyors aimed to cover as large an area as possible, in order to look for evidence of birds.

During each visit to the forest, the survey team noted the presence of other vertebrate taxa encountered, particularly lemurs, and made a general assessment of threats facing the habitat being visited. Conversational and indirect questioning surveys were carried out with guides, local authorities and some villagers, to collect further information on threats to bird species and their habitats.

#### ■ Additional data collection after the main survey

Following the main survey in 2005–2006, additional data on the avifauna of Tsitongambarika Forest were collected during various conservation activities implemented by the BirdLife International Madagascar Programme, Asity Madagascar (formerly Asity) and Rio Tinto QMM (QIT Madagascar Minerals, QMM). These activities included participatory monitoring with local communities from Anka-Maromagniry and Enato villages on the eastern side of Tsitongambarika I (June and November 2007), a series of birdwatching events held in Ivorona Forest on the western side of Tsitongambarika I (November 2006 and October 2007), and *ad hoc* observations made during visits by scientists and birdwatchers.





## ■ Evaluation of the relative abundance of forest bird populations

### MacKinnon lists

Bird surveys were timed to coincide with periods of high bird activity: from dawn until 10h00, from 16h00 until 18h00 and 19h00 to 21h00. The observer walked along a predetermined track at an average speed of about 1.5 km per hour. All species detected during the journey were recorded in the form of MacKinnon lists. Occasionally, bird calls were recorded or photographs were taken.

MacKinnon lists were compiled by recording the first 10 species encountered (whether individually or in groups). Species encountered were only added to the list if they were not previously included on it, and a new list was started once the previous one contained 10 different species. No fixed itinerary is followed or

set distance covered during the compilation of MacKinnon lists. However, it is necessary to avoid inventorying the same route twice, in order to avoid repeat counts of the same individuals.

The MacKinnon list method was chosen because it offers a robust method for collecting data on the relative abundance of different bird species in forest habitats. However the method has some limitations. It is not a reliable method for collecting data on the relative abundance of nocturnal species or species that are particularly rare, shy or cryptic. Moreover, the method tends to over-estimate the relative abundance of species that are particularly vocal or conspicuous.

### Jaccard Similarity Index

The Jaccard Similarity Index was chosen for studying the differences between the specific composition of the bird communities at pairs of sites.

**Table 13. Location and description of each study site, with a summary of uses of and threats to bird species and their habitats**

Location	Description
<b>IVOHIBE FOREST</b> Maximum elevation: 675 m Elevations visited: 87–307 m Campsite 1: 24°34'11.7"S 47°12'22.9"E Located 2.5 hours' walk west of Antsofso village Campsite 2: 24°32'53.9"S 47°11'55.4"E Located 5 hours' walk north-west of Antsofso village	<p>This site is an area of eastern evergreen forest located on a very uneven relief formed by hills and valleys. Slopes on the windward side of the mountain, located directly in front of the coastal area, support drier forest vegetation. Slopes on the more sheltered western side of the mountain are covered with very thick rainforest.</p> <p>The forest canopy is only half-closed along ridge crests and on the summits of hills. In basins and valleys, however, the canopy is closed, the forest undergrowth is very dark, the herbaceous layer is not well developed and the ground is sometimes covered with very thick piles of dead leaves. Dominant understorey species include: <i>Cyathea</i> sp. (Cyathecaceae), <i>Pteridium</i> sp. (Pteridaceae) and herbaceous species belonging to the Poaceae family.</p> <p>The shrub layer is formed of shrubs and very dense young trees measuring 3–8 m high. The canopy layer is formed of big trees, exceeding 20 m in height. The following species are present: Travellers' Palm <i>Ravenala madagascariensis</i> (Strelitziaceae), <i>Ocotea</i> sp. (Lauraceae), <i>Calophyllum</i> sp. (Clusiaceae), <i>Faucherea</i> sp. (Sapotaceae) and <i>Uapaca</i> sp. (Phyllanthaceae). The latter three species are more abundant in the eastern side of the visited area. In places, very dense creeping bamboo (Poaceae) entirely covers the big trees and forms an undergrowth that is often impenetrable. On tree branches in the canopy layer, some orchid species of the genera <i>Asplenium</i> and <i>Bulbophyllum</i> can be found. Mosses are rare on the trees and cover only a tiny part of the trunks and the branches.</p> <p><b>Uses of and threats to bird species and their habitats</b></p> <p><b>Uses</b></p> <ul style="list-style-type: none"> <li>Collecting forest products (lianas) for the production of nets used by lobster fishermen;</li> <li>Collecting medicinal plants and wild honey;</li> <li>A community forest management association (<i>communauté de base</i> or CoBa) has recently been created to protect Ivohibe Forest, conserve biodiversity and support sustainable development.</li> </ul> <p><b>Threats</b></p> <ul style="list-style-type: none"> <li>Selective logging for boat construction, particularly of <i>Faucherea</i> sp. (Sapotaceae) and <i>Calophyllum</i> sp. (Clusiaceae). Trees with slightly curved trunks are often the most highly sought after;</li> <li>Five trees cut for boat construction were observed within the study site;</li> <li>Collecting timber for house construction;</li> <li>Clearing for shifting cultivation (or <i>tavy</i>). The most extensively cleared forest areas are located in the north-eastern parts of valleys and hills with gentle slopes;</li> <li>Poaching of terrestrial species.</li> </ul> <p><b>Bird species</b></p> <ul style="list-style-type: none"> <li>Richness: 63</li> <li>Madagascar-endemic species: 35</li> <li>Threatened species: 2</li> <li>Near Threatened species: 2</li> </ul>

$$\text{Jaccard Similarity Index} = \frac{C}{N_1 + N_2 + C}$$

$N_1$ : Number of species at site 1  
 $N_2$ : Number of species at site 2  
 $C$ : Number of species in common to both sites

## STUDY SITES

The following sites were visited during the avifauna survey of Tsitongambarika Forest between 11 December 2005 and 13 January 2006:

1. Ivohibe Forest: located in the north-western part of Antsofso Fokontany in Tsitongambarika III.
2. Tsitongambarika Pass: located along the trail between Androtsy and Mahatalaky Ambony in Tsitongambarika II.

3. Ivorona Forest: located in the north-eastern part of Ivorona Fokontany, Ifarantsa Commune, in the west of Tsitongambarika I.
4. Andranary Forest: located on the west of Pic St Louis, at the southern end of Tsitongambarika I.

The forest of the Manantantely Private Reserve was not visited but data from this site were collated from reports on previous studies.

After the main survey, additional data were collected from: Vatofotsy community forest near Enato village, Androkabe and Tsirandranina community forests near Anka Maromagniry village (both in Ampasy Nampoina Commune), the sacred lake of Isakatelo in Ifarantsa Commune, and Ankorabe forest near Beseva village. Additional visits were also made to Ivorona forest (Dutson 2006, Asity Madagascar pers. comm.).

**Table 13 ... continued. Location and description of each study site, with a summary of uses of and threats to bird species and their habitats**

Location	Description
<b>TSITONGAMBARIKA PASS</b> <b>(Andrasery and Etafaro Forests)</b> Elevations visited: 216–774 m Campsite 1: 24°41'28.4"S 47°01'29.8"E Located 1.5 days' walk from Mahatalaky, via Analalava Androtsy, following the trail that leads to Ranomafana Commune	<p>This site comprises an area of eastern humid evergreen forest distributed on a very uneven relief formed by steep-sided hills and valleys. Several rivers have their sources in this area, including the Etoketo River, which flows west into Ranomafana Commune, and the Betoho and Ebakika rivers, which flow east into the littoral plain. The site is crossed by a forest trail, Tsitongambarika Pass, which links Ranomafana Commune in the west with Mahatalaky Commune in the east.</p> <p>The site has a humid microclimate, which gets damper with increasing altitude. Forest at 100–300 m elevation is not very humid, as can be seen by the scarcity of moss on tree trunks and branches. Above 300 m, however, the forest becomes progressively more humid due to an abundance of orographic rainfall caused by the sudden change of altitude of the wind from the coast, which creates permanent damp cloud cover. Mosses and orchids of the genera <i>Bulbophyllum</i> and <i>Asplenium</i> are quite abundant and almost entirely cover the trunks and branches of trees.</p> <p>Along ridge crests and on the tops of hills, tree heights diminish to about 10 m and the canopy is more open. In basins and valleys, however, the canopy is closed, the forest undergrowth is very dark, the herbaceous layer is not well developed and the ground is sometimes covered with very thick piles of dead leaves. Dominant understorey species include: <i>Cyathea</i> sp. (Cyatheaceae), <i>Pteridium</i> sp. (Pteridaceae) and herbaceous species belonging to the Poaceae family. The shrub layer is formed of young trees, 3–8 m in height, with abundant <i>Cyathea</i> sp. (Cyatheaceae) tree ferns and the presence of <i>Vanilla madagascariensis</i> (Orchidaceae). Pleomele <i>Dracaena reflexa</i> (Dracaenaceae), emergent palms and <i>Pandanus</i> sp. (Pandanaceae) are abundant near to rivers. The canopy layer is formed of big trees, at 20–25 m. In places, these are entirely covered by very dense creeping bamboo (Poaceae), which forms an undergrowth that is often impenetrable. The canopy layer is characterised by the presence of <i>Ravenala madagascariensis</i> (Strelitziaceae), <i>Ocotea</i> sp. (Lauraceae), <i>Oncostemum</i> sp. (Myrsinaceae) and lianas.</p>
<b>Uses of and threats to bird species and their habitats</b>	
<b>Uses</b> <ul style="list-style-type: none"> <li>• Collecting forest products (lianas) for ropes to fasten the roofs of huts made of <i>Ravenala madagascariensis</i>;</li> <li>• Collecting palm trunks for making planks to build the walls of huts.</li> </ul>	
<b>Threats</b> <ul style="list-style-type: none"> <li>• Selective logging for boat making, particularly of <i>Faucheria</i> sp. (Sapotaceae) and <i>Calophyllum</i> sp. (Clusiaceae). Trees with slightly curved trunks are often the most highly sought after;</li> <li>• Three trees cut for boat making were observed within the study site;</li> <li>• Clearance for shifting cultivation (or tavy). The most extensively cleared forest areas are located near the villages of Volobe in the east and Mahatalaky Ambony in the west;</li> <li>• Poaching of terrestrial species and lemurs. Catapults are frequently used for these activities, which take place especially along the trail between Androtsy and Mahatalaky Ambony villages.</li> </ul>	
<b>Bird species</b> <ul style="list-style-type: none"> <li>• Richness: 55</li> <li>• Madagascar-endemic species: 32</li> <li>• Threatened species: 1</li> <li>• Near Threatened species: 2</li> </ul>	
Note: The globally threatened Meller's Duck <i>Anas melleri</i> was found in the Ebakika river outside the study site. It is not a forest species. Ivorona Forest	

**Table 13 ... continued. Location and description of each study site, with a summary of uses of and threats to bird species and their habitats**

Location	Description
<b>IVORONA FOREST</b> <b>(Ivorona and Ambato Forests)</b> Maximum elevation: 1,312 m Elevations visited: 280–774 m Campsite 1: 24°49'25.0"S 46°56'56.2"E Located 1 hour's walk from Ivorona village, Ifarantsa Commune	<p>This site comprises an area of eastern humid evergreen forest distributed on very uneven rocky relief formed by steep-sided valleys. The study site is located on the western flank of the Vohimena range, and is crossed by the trail linking Ambazaha village in the east with Ivorona village in the west. The Ifarantsa River constitutes the main watercourse in the area.</p> <p>Ivorona Forest is characterised by an increasingly humid microclimate with increasing altitude. Forest at 100–300 m elevation is not very humid, as can be seen by the scarcity of moss on tree trunks and branches. Above 300 m, however, the forest becomes progressively more humid due to an abundance of orographic rainfall caused by the sudden change of altitude of the wind from the coast, which creates permanent damp cloud cover. Mosses and orchids of the genera <i>Bulbophyllum</i> and <i>Asplenium</i> are quite abundant and almost entirely cover the trunks and branches of trees.</p> <p>Along ridge crests and on the tops of hills, tree heights diminish to about 10 m and the canopy is more open. In basin and valley regions, however, the canopy is closed, the forest undergrowth is very dark, the herbaceous layer is not well developed and the ground is sometimes covered with very thick piles of dead leaves. The dominant species of the understorey are <i>Pteridium</i> sp. (Pteridaceae) and herbaceous species in the Poaceae family. The shrub layer is formed of young trees, 2 to 5 m in height, and tree ferns <i>Cyathea</i> sp. (Cyatheaceae). Creeping ferns on the trunks of young trees are common. <i>Dracaena reflexa</i> (Dracaenaceae) and emergent palms are abundant near watercourses. The canopy layer is formed of big trees, at 20–25 m. In places, these big trees are entirely covered by very dense creeping bamboo (Poaceae), which forms an undergrowth that is often impenetrable. The canopy layer is characterised by the presence of <i>Ocotea</i> sp. (Lauraceae), <i>Dombeya</i> sp. (Malvaceae), <i>Ficus</i> sp. (Moraceae), <i>Weinmannia</i> sp. (Cunoniaceae) and <i>Ravenala madagascariensis</i> (Strelitziaceae).</p>
	<b>Uses of and threats to bird species and their habitats</b>
	<b>Uses</b> <ul style="list-style-type: none"> <li>Collecting forest products (lianas) for ropes to fasten the roofs of huts made of <i>Ravenala madagascariensis</i>;</li> <li>Collecting palm trunks for making planks to build the walls of huts;</li> <li>Ivorona CoBa has signed a management transfer agreement to co-manage the forest for a three-year period (2005–2008).</li> </ul> <b>Threats</b> <ul style="list-style-type: none"> <li>The management transfer agreement, in the absence of any accompanying support or appropriate monitoring is contributing to forest exploitation that does not comply with the regulations in force. At Ivorona, the forest is being exploited in an anarchic way, with the selective cutting of big trees for making planks and square wood for sale to traders from Tolagnaro (Fort Dauphin), particularly of ebony and rosewood for export overseas. In spite of the management transfer agreement, Ivorona CoBa seems to be powerless in the face of offences, whether these be clearance of forest for shifting cultivation or selective logging in areas where this is prohibited;</li> <li>Nine cut ebony trees were seen in restricted areas of forest at the study site;</li> <li>Clearance for shifting cultivation. Forest areas with gentle slopes are often the most extensively cleared;</li> <li>Poaching of terrestrial species. Slipknot traps and catapults are frequently used for these activities, which take place especially along the trail between Ivorona and Mahatalaky Ambony villages.</li> </ul> <b>Bird species</b> <ul style="list-style-type: none"> <li>Richness: 59</li> <li>Madagascar-endemic species: 37</li> <li>Threatened species: 2</li> <li>Near Threatened species: 3</li> </ul>
Location	Description
<b>ANDRANARY FOREST</b> Maximum elevation: 1,312 m Visited elevations: 329–420 m Campsite 1: 25°00'21.2"S 46°57'03.4"E	<p>This site is an area of eastern humid evergreen forest, located at the southernmost extent of the Vohimena range, west of Pic St Louis. Seen from a distance, the vegetation still appears in a good condition but in reality most of the big trees have already been cut down. Only the area along the ridge line is still covered with intact humid forest.</p> <p>Because the duration of the visit to this site was limited to two mornings, it was only possible to make a preliminary reconnaissance of the bird fauna.</p>
	<b>Uses of and threats to bird species and their habitats</b>
	<b>Threats</b> <ul style="list-style-type: none"> <li>Selective exploitation of big trees for making planks and square wood;</li> <li>The proximity of the site to Tolagnaro makes it permanently vulnerable to human pressure.</li> </ul> <b>Bird species</b> <ul style="list-style-type: none"> <li>Richness: 24</li> <li>Madagascar-endemic species: 8</li> <li>Threatened species: 0</li> <li>Near Threatened species: 0</li> </ul>



**Table 13 ... continued. Location and description of each study site, with a summary of uses of and threats to bird species and their habitats**

Location	Description
<b>MANATANTELY PRIVATE RESERVE</b> Elevation range: 50–600m Coordinates: 24°59'S 46°55'E	This site is an area of eastern humid evergreen forest located on very uneven rocky relief formed by very abrupt-sided valleys. The forest is characterised by an increasingly humid microclimate with increasing elevation. Manantely Private Reserve is a tourist site, easily accessible from Tolagnaro. It is managed by a private tour operator, which protects the forest.
	<b>Uses of and threats to bird species and their habitats</b>
	<b>Bird species</b> <ul style="list-style-type: none"> <li>• Richness: 37</li> <li>• Madagascar-endemic species: 22</li> <li>• Threatened species: 2</li> <li>• Near Threatened species: 0</li> </ul> Note: Data were obtained from the report by Goodman <i>et al.</i> (1997). Further studies of Manantely are needed.
Location	Description
<b>ENATO VILLAGE</b> Elevation: 520 m Coordinates: 24°55'16"S 46°59'18"E	This site comprises an area of eastern humid evergreen forest, characterised by a thin leaf litter layer, a clear herbaceous layer, a sparse shrub layer and a semi-open canopy on rocky slopes. Canopy trees reach 40–60 cm in diameter and 30 m in height.
	<b>Uses of and threats to bird species and their habitats</b>
	<b>Uses</b> <ul style="list-style-type: none"> <li>• The forest is managed by the community of Enato village.</li> </ul> <b>Threats</b> <ul style="list-style-type: none"> <li>• Logging;</li> <li>• Hunting and poaching.</li> </ul>
Location	Description
<b>ANKA-MAROMAGNIRY VILLAGE</b> Elevation range: 100–270 m Coordinates: 24°56'15"S 46°57'41"E	This site is similar to the preceding one, comprising an area of eastern humid evergreen forest, characterised by a thin leaf litter layer, a clear herbaceous layer, a sparse shrub layer and a semi-open canopy on rocky slopes. Canopy trees reach about 40–60 cm in diameter and 30 m in height.
	<b>Uses of and threats to bird species and their habitats</b>
	<b>Uses</b> <ul style="list-style-type: none"> <li>• The forest is managed by the community of Anka Maromagniry village.</li> </ul> <b>Threats</b> <ul style="list-style-type: none"> <li>• Logging;</li> <li>• Bushfire;</li> <li>• Hunting and poaching.</li> </ul>

The details of the geographical location, habitat types, threats and bird community composition for each study site are presented in Table 13.

## RESULTS

Information on the avifauna of Tsitongambarika Forest has been collected by a number of biologists visiting south-east Madagascar over the years. The most detailed study prior to the one presented here was a one-week visit to Manantely Private Reserve by Steven Goodman in 1990 (Goodman *et al.* 1997). The studies conducted during 2005–2006 represented the first ever surveys of the central and north-eastern parts of Tsitongambarika Forest. Subsequent to these studies, a number of additional species were recorded at Tsitongambarika Forest during birdwatching events at Ivorona (2006–2007) and during participatory monitoring activities with local communities (2007).

During the 2005–2006 studies, 82 bird species were recorded at the four sites visited. An additional three species were recorded during the previous visit to

Manantely Private Reserve (Goodman *et al.* 1997), and a further 12 species were recorded during subsequent visits to Tsitongambarika Forest, bringing to 97 the total number of species recorded to date at Tsitongambarika (Table 14).

These species occupy various habitats, including lakes, agricultural land and fallow land, but the majority depend on humid evergreen forest. Considering the variation in altitude among the study sites (80 to 787 m), the avifauna of Tsitongambarika is characterised by a very high endemism rate: 57 of the 97 species recorded at Tsitongambarika (59%) are found only in Madagascar. Eight species are considered globally threatened (IUCN 2010): Madagascar Grebe *Tachybaptus pelzelinii* (VU), Madagascar Pond Heron *Ardeola idea* (EN), Meller's Duck *Anas melleri* (EN), Brown Mesite *Mesitornis unicolor* (VU), Madagascar Red Owl *Tyto soumagnei* (VU; Plate 10), Short-legged Ground-roller *Brachypteracias leptosomus* (VU), Scaly Ground-roller *Brachypteracias squamiger* (VU), and Red-tailed Newtonia *Newtonia fanovanae* (VU). Several of these records represent expansions of known distribution.



**Plate 10.** Madagascar Red Owl *Tyto soumagnei* (Vulnerable). This bird, the first record in Anosy region, was discovered in Vatofotsy forest near Enato village (ANDRIANDRAOTOMALAZA BRUNO RAVELOSON)

The composition of the avifauna of Tsitongambarika Forest is quite similar to that of Parcel 1 of Andohahela National Park (Jaccard Similarity Index = 0.74). Of the 93 species recorded at Tsitongambarika, 75 are known from Parcel 1 of Andohahela National Park (Hawkins and Goodman 1999). Species so far found only at Tsitongambarika include three globally threatened waterbirds (Madagascar Grebe, Madagascar Pond Heron and Meller's Duck) and one threatened forest bird (Madagascar Red Owl). The difference between the avifauna of the two sites is characterised mainly by the absence of several high-altitude species from the study sites at Tsitongambarika, including Yellow-bellied Asity *Neodrepanis hypoxantha*, Brown Emu-tail *Dromaeocercus brunneus*, Madagascar Yellowbrow *Crossleyia xanthophrys* and Cryptic Warbler *Cryptosylvicola randrianasoloi*. These species are usually found at altitudes above 800 m, and some may be found at Tsitongambarika if the highest altitude sites in this forest are surveyed. Tsitongambarika Forest supports more globally threatened species (eight) than Parcel 1 of Andohahela National Park (five) and is thus a very high priority for conservation.

#### ■ Avifauna of Ivohibe Forest

The forest of Ivohibe was a rich site for birds, with 65 species recorded at altitudes of 87–307 m. Thirty-eight (60%) of these species are endemic to Madagascar, and four are globally threatened or Near

**Table 14.** List of bird species recorded in Tsitongambarika Forest

Species and English name	Distribution	IUCN Status	Site 1 IVHB	Site 2 TGKP	Site 3 IVOR	Site 4 ANDY	Site 5 MANT	TGK Total (87–774m)
<i>Dendrocygna viduata</i> White-faced Whistling-duck	B		1	1	1			1
<i>Anas melleri</i> Meller's Duck	E	EN		1				1
<i>Anas erythrorhyncha</i> Red-billed Duck	B				1*			1*
<i>Tachybaptus pelzelinii</i> Madagascar Grebe	E	VU			1*			1*
<i>Lophotibis cristata</i> Madagascar Crested Ibis	E	NT			1*			1*
<i>Ardeola idae</i> Madagascar Pond-heron	Er	EN			1*			1*
<i>Ardea cinerea</i> Grey Heron	B						1	1
<i>Ardea purpurea</i> Purple Heron	B				1*			1*
<i>Falco newtoni</i> Madagascar Kestrel	Er		1	1	1	1		1
<i>Falco eleonora</i> Eleonora's Falcon	M		1		1			1
<i>Falco peregrinus</i> Peregrine Falcon	B					1		1
<i>Aviceda madagascariensis</i> Madagascar Baza	E			1				1
<i>Macheiramphus alcinus</i> Bat Hawk	B				1			1
<i>Milvus migrans</i> Black Kite	B		1	1				1
<i>Polyboroides radiatus</i> Madagascar Harrier-hawk	E		1				1	1
<i>Accipiter francesiae</i> Frances's Sparrowhawk	Er				1*		1	1
<i>Accipiter madagascariensis</i> Madagascar Sparrowhawk	E	NT	1	1				1
<i>Accipiter henstii</i> Henst's Goshawk	E	NT			1			1
<i>Buteo brachypterus</i> Madagascar Buzzard	E		1	1	1	1	1	1

Table 14 ... continued. List of bird species recorded in Tsitongambarika Forest

Species and English name	Distribution	IUCN Status	Site 1 IVHB	Site 2 TGKP	Site 3 IVOR	Site 4 ANDY	Site 5 MANT	TGK Total (87–774m)
<i>Mesitornis unicolor</i> Brown Mesite	E	VU	1				1	1
<i>Sarothrura insularis</i> Madagascar Flufftail	E		1		1*			1
<i>Canirallus kiolooides</i> Madagascar Wood Rail	E		1		1		1	1
<i>Dryolimnas cuvieri</i> White-throated Rail	Er		1		1	1		1
<i>Gallinula chloropus</i> Common Moorhen	B				1*			1*
<i>Turnix nigricollis</i> Madagascar Buttonquail	Er							1*
<i>Nesoenas picturata</i> Madagascar Turtle-dove	Er		1	1	1	1	1	1
<i>Treron australis</i> Madagascar Green-pigeon	Er		1					1
<i>Alectroenas madagascariensis</i> Madagascar Blue-pigeon	E				1			1
<i>Agapornis canus</i> Grey-headed Lovebird	E							1*
<i>Coracopsis vasa</i> Vasa Parrot	Er		1	1	1			1
<i>Coracopsis nigra</i> Black Parrot	Er		1	1	1	1	1	1
<i>Cuculus rochii</i> Madagascar Cuckoo	E		1	1	1	1		1
<i>Coua reynaudii</i> Red-fronted Coua	E		1	1	1	1	1	1
<i>Coua caerulea</i> Blue Coua	E		1	1	1	1	1	1
<i>Centropus toulou</i> Madagascar Coucal	Er		1	1	1	1	1	1
<i>Tyto soumagnei</i> Madagascar Red Owl	E	VU						1*
<i>Otus rutilus</i> Malagasy Scops-owl	Er		1	1	1		1	1
<i>Ninox supercilialis</i> White-browed Hawk-owl	E				1			1
<i>Asio madagascariensis</i> Madagascar Owl	E		1		1			1
<i>Caprimulgus madagascariensis</i> Madagascar Nightjar	Er		1			1	1	1
<i>Caprimulgus enarratus</i> Collared Nightjar	E		1					1
<i>Zoonavena grandidieri</i> Malagasy Spinetail	Er		1					1
<i>Tachymarpis melba</i> Alpine Swift	B			1				1
<i>Eurystomus glaucurus</i> Broad-billed Roller	B		1	1	1	1		1
<i>Brachypteracias leptosomus</i> Short-legged Ground-roller	E	VU	1		1			1
<i>Brachypteracias squamiger</i> Scaly Ground-roller	E	VU					1	1
<i>Atelornis pittoides</i> Pitta-like Ground-roller	E							1*
<i>Leptosomus discolor</i> Cuckoo-roller	Er		1	1	1	1	1	1
<i>Ceyx madagascariensis</i> Madagascar Pygmy-kingfisher	E			1	1		1	1
<i>Alcedo vintsioides</i> Madagascar Kingfisher	Er		1	1	1			1
<i>Merops superciliosus</i> Madagascar Bee-eater	B		1	1		1		1
<i>Philepitta castanea</i> Velvet Asity	E		1	1	1			1
<i>Neodrepanis coruscans</i> Sunbird Asity	E		1	1	1			1
<i>Calicalicus madagascariensis</i> Red-tailed Vanga	E		1	1	1		1	1
<i>Vanga curvirostris</i> Hook-billed Vanga	E		1	1	1	1	1	1
<i>Xenopirostris polleni</i> Pollen's Vanga	E	NT	1		1			1
<i>Artamella viridis</i> White-headed Vanga	E			1	1			1
<i>Leptopterus chaberti</i> Chabert's Vanga	E		1	1			1	1
<i>Cyanolanius madagascarinus</i> Blue Vanga	Er		1	1	1			1
<i>Schetba rufa</i> Rufous Vanga	E		1	1	1			1
<i>Tylas eduardi</i> Tylas Vanga	E		1		1			1
<i>Hypositta corallirostris</i> Nuthatch Vanga	E				1		1	1
<i>Newtonia amphichroa</i> Dark Newtonia	E			1				1

Table 14 ... continued. List of bird species recorded in Tsitongambarika Forest

Species and English name	Distribution	IUCN Status	Site 1 IVHB	Site 2 TGKP	Site 3 IVOR	Site 4 ANDY	Site 5 MANT	TGK Total (87–774m)
<i>Newtonia brunneicauda</i> Common Newtonia	E		1	1	1		1	1
<i>Newtonia fanovanae</i> Red-tailed Newtonia	E	VU			1			1
<i>Pseudobias wardi</i> Ward's Flycatcher	E							1*
<i>Mystacornis crossleyi</i> Crossley's Babbler	E							1*
<i>Coracina cinerea</i> Ashy Cuckooshrike	Er		1	1	1		1	1
<i>Dicrurus forficatus</i> Crested Drongo	Er		1	1	1	1	1	1
<i>Terpsiphone mutata</i> Madagascar Paradise-flycatcher	Er		1	1	1	1	1	1
<i>Corvus albus</i> Pied Crow	B		<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>		<b>1</b>
<i>Mirafra hova</i> Madagascar Lark	E		<b>1</b>	<b>1</b>				<b>1</b>
<i>Cisticola cherina</i> Madagascar Cisticola	Er		1					1
<i>Hypsipetes madagascariensis</i> Madagascar Black Bulbul	Er		1	1	1	1	1	1
<i>Nesillas typica</i> Madagascar Brush-warbler	Er		1		1		1	1
<i>Oxylabes madagascariensis</i> White-throated Oxylabes	E		1	1	1		1	1
<i>Bernieria madagascariensis</i> Common Tetraka	E		1	1	1		1	1
<i>Bernieria zosterops</i> Spectacled Tetraka	E		1	1	1*		1	1
<i>Bernieria cinereiceps</i> Grey-crowned Tetraka	E	NT		1				1
<i>Randia pseudozosterops</i> Rand's Warbler	E			1	1			1
<i>Neomixis tenella</i> Common Jery	E		1	1	1	1	1	1
<i>Neomixis viridis</i> Green Jery	E				1			1
<i>Neomixis striatigula</i> Stripe-throated Jery	E			1	1			1
<i>Neomixis flavoviridis</i> Wedge-tailed Jery	E	NT			1			1
<i>Zosterops maderaspatanus</i> Madagascar White-eye	Er		1	1	1	1	1	1
<i>Saroglossa aurata</i> Madagascar Starling	E		1					1
<i>Copsychus albospectularis</i> Madagascar Magpie-robin	E		1	1	1	1	1	1
<i>Acridotheres tristis</i> Common Myna	I		1	<b>1</b>				1
<i>Saxicola torquatus</i> Common Stonechat	B		<b>1</b>	<b>1</b>				<b>1</b>
<i>Monticola sharpei</i> Forest Rock-thrush	E			1	1			1
<i>Nectarinia sovimanga</i> Souimanga Sunbird	Er		1	1	1	1	1	1
<i>Nectarinia notata</i> Long-billed Green Sunbird	Er		1	1	1	1	1	1
<i>Ploceus nelicourvi</i> Nelicourvi Weaver	E		1	1	1		1	1
<i>Foudia madagascariensis</i> Madagascar Red Fody	E		<b>1</b>	1	1		1	1
<i>Foudia omisa</i> Forest Fody	E		1	1	1		1	1
<i>Lonchura nana</i> Madagascar Munia	E		1		1			1
<i>Motacilla flaviventris</i> Madagascar Wagtail	E		1	1	1			1
Species richness			63	55	65	24	37	97
E: Endemic to Madagascar			33	31	38	7	21	57
Er: Endemic to the region only (Madagascar and neighbouring islands)			22	16	19	13	15	25
M: Migratory, non-breeding visitor			1	0	1	0	0	1
B: Breeding resident/visitor			6	7	7	4	1	13
I: Introduced			1	1	0	0	0	1
EN: Endangered (IUCN 2010)			0	1	1	0	0	2
VU: Vulnerable (IUCN 2010)			2	0	3	0	2	6
NT: Near Threatened (IUCN 2010)			2	2	4	0	0	6
Notes: IVHB = Ivohibe forest; TGKP = Tsitongambarika pass; IVOR = Ivorona forest; ANDY = Andranany forest; MANT = Manantantely Private Reserve; TGK = Tsitongambarika. * An asterisk indicates species not recorded in main surveys (January 2006) but found since, at one or more of the following sites: Ivorona, Enato, Anka, Ankorabe. Records close to but outside the site are indicated in <b>bold</b> .								



Threatened: *Mesitornis unicolor* (VU), *Brachypteracias leptosomus* (VU), Madagascar Sparrowhawk *Accipiter madagascariensis* (NT) and Pollen's Vanga *Xenopirostris polleni* (NT).

Analysis of the 16 MacKinnon lists compiled during the inventory of Ivohibe shows that the most frequently recorded species were Madagascar Black Bulbul *Hypsipetes madagascariensis*, Madagascar White-eye *Zosterops maderaspatana* and Black Parrot *Coracopsis nigra* (Table 16). These three species are easy to detect and their calls can be heard even from a distance.

A number of species were considered rare, because they were only encountered once during the 10-day visit to Ivohibe, including *Accipiter madagascariensis*, Velvet Asity *Philepitta castanea*, White-throated Oxylobes *Oxylobes madagascariensis*, Blue Vanga *Cyanolanius madagascarinus* and Forest Fody *Foudia omissa*. Other species encountered only once during the visit to Ivohibe Forest were Madagascar Harrier-hawk *Polyboroides radiatus* and Madagascar Starling *Saroglossa aurata*, but these are typically birds of forest edge, scrub and secondary vegetation, rather than forest. Madagascar Long-eared Owl *Asio madagascariensis* and Malagasy Scops-owl *Otus rutilus* were each recorded just once during the two nocturnal visits made to Ivohibe Forest. On the basis of these records, it is not possible to assess the relative abundance of these species. The presence of *Mesitornis unicolor* was confirmed during a reconnaissance visit to Ivohibe Forest, on the basis of the presence of an abandoned nest. Collared Nightjar *Caprimulgus enarratus* was also only recorded during the reconnaissance visit. Therefore, the relative abundance of these two species could not be evaluated.

### ■ Avifauna of Ivorona Forest

Ivorona Forest, at altitudes of 280–774 m, supports at least 68 bird species. Of these, 40 are endemic to Madagascar, including six globally threatened or Near Threatened forest species: Madagascar Crested Ibis *Lophotibis cristata* (NT), *Brachypteracias leptosomus* (VU), *Newtonia fanovanae* (VU), Henst's Goshawk *Accipiter henstii* (NT), Wedge-tailed Jery *Neomixis flavoviridis* (NT) and Pollen's Vanga *Xenopirostris polleni* (NT).

Analysis of the 18 MacKinnon lists compiled during the survey of Ivorona shows that the most frequently recorded species were *Hypsipetes madagascariensis*, *Zosterops maderaspatanus*, *Coracopsis nigra* and Madagascar Paradise Flycatcher *Terpsiphone mutata* (Table 16). These species are all easy to find and their calls can be heard from a distance. Typical forest species considered rare at Ivorona, because they were found only once during the 10-day visit, were: *Accipiter henstii*, Madagascar Wood-rail *Canirallus kioloides*, *Brachypteracias leptosomus*, Forest Rock-thrush *Monticola sharpei*, Green Jery *Neomixis viridis*, Rand's Warbler *Randia pseudozosterops*, Hook-billed Vanga *Vanga curvirostris* and

*Xenopirostris polleni*. Madagascar Kestrel *Falco newtoni* and Madagascar Brush-warbler *Nesillas typica* were also recorded only once each in forest areas, but are both more frequent in forest edge and secondary vegetation.

### ■ Avifauna of Tsitongambarika Pass

Fifty-five species were recorded in the forest around Tsitongambarika Pass at altitudes of 217–774 m. Thirty-one of these are endemic to Madagascar, of which two forest species are globally Near Threatened: *Accipiter madagascariensis* and Grey-crowned Tetraka *Bernieria cinereiceps*. In addition, the globally Endangered *Anas melleri* was found in the Ebakika River, a few kilometres from the edge of the forest. The forest around Tsitongambarika Pass is characterised by the presence of high-altitude species, such as *Bernieria cinereiceps* and Dark Newtonia *Newtonia amphichroa*.

Analysis of the 23 MacKinnon lists compiled during inventory of the forest around Tsitongambarika Pass shows that the most frequently recorded species were *Hypsipetes madagascariensis*, *Zosterops maderaspatanus*, *Coracopsis nigra* and Madagascar Magpie Robin *Copsychus albospectularis* (Table 16). These are all easy to detect and their calls can be heard from a distance. Typical forest species considered rare at Tsitongambarika Pass, because they were found only once during the 10-day visit, were: *Accipiter madagascariensis*, Madagascar Baza *Aviceda madagascariensis*, Madagascar Pygmy-kingfisher *Ceyx madagascariensis*, White-headed Vanga *Artamella viridis* and Stripe-throated Jery *Neomixis striatigula*. Madagascar Buzzard *Buteo brachypterus* and Long-billed Green Sunbird *Nectarinia notata* were both also recorded only once, but these are not typical forest species. They are more common in scrub and agricultural land. Likewise, Malagasy Spinetail *Zonavena grandidieri* was also found only once at Tsitongambarika Pass, but is more often found on rocky cliffs and steep slopes neighbouring the forest.

### ■ Avifauna of Manatantely Private Reserve

Manatantely Private Reserve, at 50–600 m elevation, supports at least 37 bird species, 21 of which are endemic to Madagascar and two of which are globally threatened: *Mesitornis unicolor* (VU) and *Brachypteracias squamiger* (VU). Ornithological inventory of Manatantely Private Reserve is far from complete, and the site deserves further survey.

### ■ Avifauna of Andranary Forest

Twenty-four species were recorded at Andranary Forest at 329–420 m elevation, including seven species endemic to Madagascar. No globally threatened or Near Threatened species have been recorded to date, although this may reflect limited survey effort. Ornithological inventory of Andranary Forest is far from complete, and the site deserves further survey.

Table 15. Relative abundance of bird species at three study sites

IVOHIBE FOREST			TSITONGAMBARIKA PASS			IVORNONA FOREST		
Species	No. lists	Relative abundance	Species	No. lists	Relative abundance	Species	No. lists	Relative abundance
<i>Hypsipetes madagascariensis</i>	15	0.94	<i>Hypsipetes madagascariensis</i>	20	0.87	<i>Hypsipetes madagascariensis</i>	17	0.94
<i>Zosterops maderaspatana</i>	14	0.88	<i>Zosterops maderaspatana</i>	19	0.83	<i>Zosterops maderaspatana</i>	13	0.72
<i>Coracopsis nigra</i>	13	0.81	<i>Coracopsis nigra</i>	16	0.7	<i>Coracopsis nigra</i>	11	0.61
<i>Nectarinia sovimanga</i>	10	0.63	<i>Copsychus albospectularis</i>	11	0.48	<i>Terpsiphone mutata</i>	10	0.56
<i>Coua caerulea</i>	10	0.63	<i>Nectarinia sovimanga</i>	8	0.35	<i>Coracina cinerea</i>	8	0.44
<i>Dicrurus forficatus</i>	6	0.38	<i>Leptosomus discolor</i>	8	0.35	<i>Tylas eduardi</i>	7	0.39
<i>Coua reynaudii</i>	6	0.38	<i>Coua caerulea</i>	8	0.35	<i>Leptosomus discolor</i>	7	0.39
<i>Calicalicus madagascariensis</i>	6	0.38	<i>Terpsiphone mutata</i>	7	0.3	<i>Calicalicus madagascariensis</i>	7	0.39
<i>Nectarinia notata</i>	5	0.31	<i>Dicrurus forficatus</i>	7	0.3	<i>Foudia omissa</i>	6	0.33
<i>Eurystomus glaucurus</i>	5	0.31	<i>Newtonia brunneicauda</i>	6	0.26	<i>Coracopsis vasa</i>	6	0.33
<i>Coracopsis vasa</i>	5	0.31	<i>Foudia omissa</i>	6	0.26	<i>Newtonia brunneicauda</i>	5	0.28
<i>Copsychus albospectularis</i>	5	0.31	<i>Cuculus rochii</i>	6	0.26	<i>Dicrurus forficatus</i>	5	0.28
<i>Nesoenas picturata</i>	4	0.25	<i>Centropus toulou</i>	6	0.26	<i>Cyanolanius madagascarinus</i>	5	0.28
<i>Ploceus neliourvi</i>	4	0.25	<i>Schetba rufa</i>	5	0.22	<i>Copsychus albospectularis</i>	5	0.28
<i>Leptosomus discolor</i>	4	0.25	<i>Philepitta castanea</i>	5	0.22	<i>Bernieria madagascariensis</i>	5	0.28
<i>Coracina cinerea</i>	4	0.25	<i>Cyanolanius madagascarinus</i>	5	0.22	<i>Alectroenas madagascariensis</i>	5	0.28
<i>Bernieria zosterops</i>	3	0.19	<i>Bernieria madagascariensis</i>	5	0.22	<i>Nesoenas picturata</i>	4	0.22
<i>Neomixis tenella</i>	3	0.19	<i>Coua reynaudii</i>	4	0.17	<i>Oxylabes madagascariensis</i>	4	0.22
<i>Vanga curvirostris</i>	2	0.13	<i>Coracopsis vasa</i>	4	0.17	<i>Schetba rufa</i>	3	0.17
<i>Terpsiphone mutata</i>	2	0.13	<i>Calicalicus madagascariensis</i>	4	0.17	<i>Philepitta castanea</i>	3	0.17
<i>Schetba rufa</i>	2	0.13	<i>Nesoenas picturata</i>	3	0.13	<i>Nectarinia sovimanga</i>	3	0.17
<i>Newtonia brunneicauda</i>	2	0.13	<i>Ploceus neliourvi</i>	3	0.13	<i>Buteo brachypterus</i>	3	0.17
<i>Buteo brachypterus</i>	2	0.13	<i>Neomixis tenella</i>	3	0.13	<i>Ploceus neliourvi</i>	2	0.11
<i>Brachypteracias leptosomus</i>	2	0.13	<i>Neodrepanis coruscans</i>	3	0.13	<i>Newtonia fanovanae</i>	2	0.11
<i>Bernieria madagascariensis</i>	2	0.13	<i>Eurystomus glaucurus</i>	3	0.13	<i>Neomixis tenella</i>	2	0.11
<i>Xenopirostris poleni</i>	1	0.06	<i>Coracina cinerea</i>	3	0.13	<i>Nectarinia notata</i>	2	0.11
<i>Saroglossa auratus</i>	1	0.06	<i>Bernieria zosterops</i>	3	0.13	<i>Ispidina madagascariensis</i>	2	0.11
<i>Polyboroides radiatus</i>	1	0.06	<i>Vanga curvirostris</i>	2	0.09	<i>Foudia madagascariensis</i>	2	0.11
<i>Philepitta castanea</i>	1	0.06	<i>Oxylabes madagascariensis</i>	2	0.09	<i>Eurystomus glaucurus</i>	2	0.11
<i>Oxylabes madagascariensis</i>	1	0.06	<i>Newtonia amphichroa</i>	2	0.09	<i>Coua reynaudii</i>	2	0.11
<i>Otus rutilus</i>	1	0.06	<i>Neomixis tenella</i>	2	0.09	<i>Coua caerulea</i>	2	0.11
<i>Foudia omissa</i>	1	0.06	<i>Foudia madagascariensis</i>	2	0.09	<i>Centropus toulou</i>	2	0.11
<i>Cyanolanius madagascarinus</i>	1	0.06	<i>Zoonavena grandidieri</i>	1	0.04	<i>Bernieria zosterops</i>	2	0.11
<i>Asio madagascariensis</i>	1	0.06	<i>Neomixis striatigula</i>	1	0.04	<i>Xenopirostris poleni</i>	1	0.06
<i>Accipiter madagascariensis</i>	1	0.06	<i>Nectarinia notata</i>	1	0.04	<i>Vanga curvirostris</i>	1	0.06
			<i>Monticola sharpei</i>	1	0.04	<i>Randia pseudozosterops</i>	1	0.06
			<i>Leptopterus viridis</i>	1	0.04	<i>Nesillas typica</i>	1	0.06
			<i>Leptopterus chaberti</i>	1	0.04	<i>Neomixis viridis</i>	1	0.06
			<i>Ispidina madagascariensis</i>	1	0.04	<i>Motacilla sharpei</i>	1	0.06
			<i>Buteo brachypterus</i>	1	0.04	<i>Hypositta corallirostris</i>	1	0.06
			<i>Aviceda madagascariensis</i>	1	0.04	<i>Falco newtoni</i>	1	0.06
			<i>Accipiter madagascariensis</i>	1	0.04	<i>Cuculus rochii</i>	1	0.06
						<i>Brachypteracias leptosomus</i>	1	0.06
						<i>Canirallus kioloides</i>	1	0.06
						<i>Falco eleonore</i>	1	0.06
						<i>Accipiter hestii</i>	1	0.06

## Notes:

- (i) The total number of MacKinnon lists compiled per site was 16 at Ivohibe, 23 at Tsitongambarika Pass, and 18 at Ivorona.
- (ii) Data from Andranary are not included because it was only visited for two half-days. Manatantely Private Reserve was not visited.
- (iii) Only species detected during compilation of MacKinnon lists have relative abundance ratings.

## DISCUSSION

### ■ Threats and pressures

#### Boat making

Selective cutting of trees for boat construction is quite common, particularly in areas near the coast or big rivers. The impact of this on the forest is not limited only to trees that are cut. The manufacture of a single boat requires at least 10 trees and shrubs to be cut down around the construction area, and its removal from the forest damages micro-habitats and terrestrial biodiversity. The removal of one boat from the forest takes 10–20 men an entire day. This threat is particularly prevalent in Ivohibe Forest and forest near Tsitongambarika Pass.

#### Selective logging of timber

Selective felling of timber trees for sale to traders is often in direct contravention of regulations governing forest management. The size of the trees selected and the felling technique adopted do not favour natural regeneration. Trees are cut down arbitrarily, without any consideration of optimal diameter. Some trees are cut at the roots, which allows no possibility of regeneration. Sometimes, trees appear to have been cut for no reason and then just left in the forest.

#### Malfunctioning of CoBas

A significant proportion of the forest area of Tsitongambarika has been transferred to CoBas on short-term management transfer agreements. It would appear, however, that CoBa members do not fully understand or, at least, are unable to enforce the forest management system governing transferred forest areas. In the future, this may constitute a serious threat to these forests. The organisations that initiated these management transfers should thus be vigilant, and a monitoring and evaluation programme should be initiated.

An example of malfunction is provided by Ivorona CoBa, Ifarahantsa Commune. The management transfer to Ivorona CoBa was completed in April 2005. However, even during this brief survey, a number of shortcomings were observed. First, the CoBa president issues logging permits and passes to buyers of forest products (square wood, planks, etc.) without other CoBa members, including the treasurer, being aware of these transactions. Second, there is no internal audit of CoBa function. Third, neither CoBa members nor other forest users respect the distinction between the timber harvesting zone (where forest can be exploited) and the conservation zone (which must be protected). During the survey, several people were observed logging or practising shifting cultivation within the conservation zone. Ebony extraction was noted within the conservation zone. According to the president of Ivorona Fokontany, this only started in October 2005 but within three months the whole area was affected.

#### Hunting and poaching

Hunting and poaching of forest species is common in Tsitongambarika. Hunting tracks were encountered within Ivohibe Forest, the forest around Tsitongambarika Pass and Ivorona Forest. The most frequently encountered signs of hunting were traps designed for catching mammals, such as Fossa *Cryptoprocta ferox* and Bushpig *Potamochoerus larvatus*. These are hunted as crop pests. Large-bodied birds, terrestrial and arboreal, are uncommon close to trails owing to local people's proficiency with catapults. Preferred quarry species are: *Polyboroides radiatus*, Madagascar Turtle-dove *Nesoenas picturata*, Madagascar Blue-pigeon *Alectroenas madagascariensis*, Madagascar Green-pigeon *Treron australis* and Blue Coua *Coua caerulea*.

#### Transportation links inside the forest

The presence of a track through the forest, linking localities on the west and east side of the Vohimena range, leads to increased human pressure on the forest ecosystem, particularly disturbance and incidental hunting. People were observed passing along the trail between Mahatalaky village in the east and Ranomafana village in the west at a rate of one person every 10–20 minutes.

### ■ Conservation priorities

The study sites are ranked below in order of bird conservation importance, on the basis of species richness, presence of globally threatened and Near Threatened species, current condition of forest habitat, and opportunities for conservation.

#### 1. Ivorona Forest

Ivorona has the highest species richness and largest number of threatened and Near Threatened species of any site surveyed at Tsitongambarika. Further, this area of lowland forest (below 300 m) is very accessible from Tolagnaro and thus under high pressure. Reorganisation of, and support to, the CoBa are priorities for conservation of biodiversity and sustainable management of natural resources in Ivorona. Development of an ecotourism programme may be one option in the long-term.

#### 2. Ivohibe Forest

With 65 bird species recorded, this site is one of the richest in Tsitongambarika. Difficulty of access is an obstacle to ecotourism because the forest is located on steep slopes. The western part of Ivohibe, which appears intact, could serve as a conservation zone or strict protection area. Support to farming activities, market gardening and cultivation of export crops (vanilla, cloves, etc.) in the Antsotso area might reduce pressures from wood cutting for boat construction.

#### 3. Tsitongambarika Pass

As this site is used as a transport link between villages on either side of the Vohimena range, protection of forest here is a priority to prevent a permanent break

in habitat connectivity along the mountain range. The areas to the north and south of the pass are apparently still covered with intact forest, and could serve as a conservation zone or strict protection area. Support to farming activities, market gardening and cultivation of export crops (vanilla, cloves, etc.) in the Analalava Androtsy, Volobe and Mahatalaky Ambony areas might reduce the need for forest clearance for shifting cultivation.

#### 4. Manantantely Forest

With only 37 recorded species, avifaunal inventory of this area is far from complete. As the site is close to Tolagnaro, there is potential for ecotourism development. There is some existing ecotourism infrastructure, managed by the private sector, but construction of additional tracks across the site would improve accessibility for visitors. Further, the manager should promote the site to regional and national tour operators.

#### 5. Andranary Forest

Conservation is difficult here owing to the proximity to Tolagnaro. Initial indications suggest the avifauna of this forest is depauperate, due to very intense exploitation for planks and beams to meet expanding demands in Tolagnaro. A long-term programme of assisted forest regeneration, using native forest species, is the main priority. Support to farming activities, market gardening and cultivation of export crops (e.g. vanilla and cloves) might reduce pressure on the forest from timber extraction.

#### ■ Avifauna

In total, 97 species have been recorded in Tsitongambarika Forest. The composition of the avifauna is almost the same as that of Andohahela National Park. Owing to its high importance for globally threatened and restricted-range species, Tsitongambarika should be recognised as a very high priority for bird conservation.

#### Crested Coua

Crested Coua *Coua cristata* is represented in southern and eastern Madagascar by at least three subspecies: *C. c. cristata*, *C. c. pyropyga* and *C. c. maxima*. However, the taxonomic position of the third is subject to discussion, because its description by Milon (1950) was based on a single specimen captured near Tolagnaro. Since its description, *C. c. maxima* has never been observed in the wild by biologists.

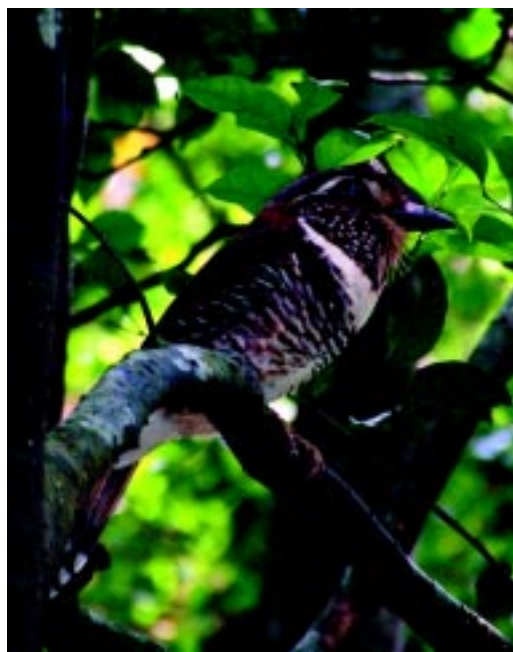
*C. c. cristata* is distributed in the eastern humid evergreen forest, from the massif of Anjanaharibe-Tsaratanana in the north to Manombo Special Reserve in the south (Nicoll and Langrand 1989), while *C. c. pyropyga* occupies the dry forest and spiny forest of the west of Madagascar (Goodman *et al.* 1997). If *C. c. maxima* is a valid subspecies, its distribution is thus likely to be centred on the lowlands of the far south-east of Madagascar, and perhaps Tsitongambarika Forest and/or the littoral forests around Tolagnaro.

However, ornithological studies of littoral forests in the Tolagnaro area have not found *C. cristata* (Watson *et al.* 2004), except at Petriky Forest (Goodman *et al.* 1997). An incidental observation, possibly referring to *C. c. maxima*, was reported in 1988 from lowland forest around Lanirano Lake, 2 km north of Tolagnaro, but subsequent visitors could not find the species (Goodman *et al.* 1997). During these surveys of Tsitongambarika, *C. caerulea* was frequently observed but no evidence of *C. cristata* was obtained. Continued studies in lowland forest in south-east Madagascar, particularly any remnants close to Tolagnaro, are a high priority to ascertain if *C. c. maxima* remains extant.

#### Short-legged Ground-roller

A single Short-legged Ground-roller *Brachypteracias leptosomus* (Plate 11) was observed twice on a slope at 204 m elevation in Ivohibe Forest. This area was visited on the two following days but the bird was not seen again. *B. leptosomus* was also observed in Ivorona Forest: an adult feeding two young was observed in forest near a ridge crest at 537 m elevation (24°48'49.1"S, 46°56'37.8"E). Previously, the known distribution of this species was limited to eastern humid evergreen forest between the massif of Tsaratanana in the north to Andohahela National Park in the south (Langrand 1990, Morris and Hawkins 1998), with an isolated population in montane forest around Daraina (ZICOMA 1999). Records of the species from Tsitongambarika thus constitute a south-easterly extension to the known distribution.

**Plate 11.** Short-legged Ground-roller  
*Brachypteracias leptosomus* (Vulnerable)  
(ANDRIANDRAOTOMALAZA BRUNO RAVELOSON)





### Red-tailed *Newtonia*

Red-tailed *Newtonia* *Newtonia fanovanae* was observed twice in Ivorona Forest, on 5 January 2006, about 300 m south-east of the campsite (24°49'25.0"S, 46°56'56.2"E). *N. fanovanae* is distinguished from Common *Newtonia* *N. brunneicauda* by its characteristic call: a series of five or six notes “pitchi-pitchi-pitchi-pitchi-pitchi” followed, a few seconds later, by five or six notes “sweep-sweep-sweep-sweep-sweep”. As *N. brunneicauda* emits only the series “pitchi-pitchi-pitchi-pitchi-pitchi”, the birds observed were undoubtedly *N. fanovanae*. A male was observed: this is very similar in appearance to a female Red-tailed Vanga *Calicalicus madagascariensis*. However, *N. fanovanae* has a visibly lower tail, a red iris contrasting with a bluish-grey head and forehead, and lacks the pale cream eye ring present in female *C. madagascariensis*. *N. fanovanae* was observed within a mixed flock in the forest canopy, comprising: four *Hypsipetes madagascariensis*, two *Cyanolanius madagascarinus*, one Crested Drongo *Dicrurus forficatus*, two *Terpsiphone mutata*, a pair of *Calicalicus madagascariensis*, one *N. brunneicauda*, one Ashy Cuckooshrike *Coracina cinerea*, three Rufous Vanga *Schetba rufa*, one Tylas Vanga *Tylas eduardi* and about 10 *Zosterops maderaspatanus*. Several more records have followed since the main survey (Dutson 2006, Asity Madagascar pers. comm.; see also Plate 3).

Prior to 1989, *N. fanovanae* was known only from specimens collected in 1931 around Fanovana Forest (Gyldenstolpe 1933). It is limited to eastern humid evergreen forest, within which it seems to have a very restricted distribution (ZICOMA 1999). Prior to this survey of Tsitongambarika, the species was only certainly known from eight localities: Marojejy National Park, Anjanaharibe Sud Special Reserve, Rantabe Maroantsetra Classified Forest, Ambatovaky Special Reserve, Zahamena National Park, Ankeniheny Classified Forest, Vevembe Vondrozo Forest and Andohahela National Park Parcel 1 (Langrand and Sinclair 1994, Randrianasolo 1996, Goodman *et al.* 1997, ZICOMA 1999). The presence of *Newtonia fanovanae* in the forest of Tsitongambarika constitutes a south-easterly extension of the known distribution of this species.

### Bluntschli's Vanga

Bluntschli's Vanga *Hypositta perdita* was described from two young specimens collected by Bluntschli in Eminiminy valley in south-east Madagascar in September 1931 (Peters 1996). The distribution of *H. perdita* could comprise lowland humid evergreen forest in south-east Madagascar, including Eminiminy valley and the nearby Tsitongambarika Forest. Comparison of the two *H. perdita* specimens with specimens of *H. corallirostris* have revealed apparently fundamental differences in foot structure. Since the collection of the type specimens, *H. perdita* has not been recorded. During this survey of Tsitongambarika, only *H. corallirostris* was observed. Further research, including comparison of juvenile *H. corallirostris* (currently undescribed) with the *H. perdita* specimens, may clarify the taxonomic position and/or distribution of the latter.

### ■ Long-term ecological monitoring

Conservation of Tsitongambarika requires a long-term ecological monitoring programme, which is likely to involve both local communities and supporting organisations, such as Asity Madagascar, BirdLife International, Rio Tinto and Rio Tinto QMM. Possible activities and indicators for an ecological monitoring programme for the avifauna of Tsitongambarika are listed in Table 16. The most appropriate season for bird monitoring is between October and December. In addition to ecological monitoring, there is also a need to identify other priority sites for bird conservation within Tsitongambarika Forest. The main gap in survey coverage to date is forest areas at altitudes above 800 m.

## RECOMMENDATIONS

1. Identify additional priority sites by continuing biological inventory work in new areas, including: the far north-west of Ivohibe; the area between Eriampisaky and Maromoky in the east and Ampany Ambahiny in the west; the forest near Farafara, Mahatalaky Commune; and the area around Managotry pass linking Tsitongambarika

**Table 16. Possible activities and indicators for an ecological monitoring programme of the avifauna of Tsitongambarika**

Activities	Quantifiable indicators	Contributors
Censuses by point counts and/or transects along forest tracks at: <ul style="list-style-type: none"> <li>• Tsitongambarika Pass;</li> <li>• Ivorona to Mahatalaky;</li> <li>• Others to be identified.</li> </ul>	Relative abundance of bird species.	Asity Madagascar
Monitoring of human pressure on bird habitats: <ul style="list-style-type: none"> <li>• Annual marking of the forest edge by GPS;</li> <li>• Counting trees that have been cut down;</li> <li>• Recording frequency of hunting and poaching.</li> </ul>	<ul style="list-style-type: none"> <li>• Measurement of forest clearance over time. Number of trees cut (which can be compared to CoBa permits).</li> <li>• Number of hunting and poaching incidents recorded by CoBas.</li> </ul>	Asity Madagascar, trained local community members.

- to Andohahela National Park. Special attention should be given to surveying forest above 800 m elevation, which has not been visited during surveys to date.
2. Initiate an ecological monitoring programme at identified priority sites, focusing on threatened species and those that are good indicators of disturbance. This programme should include measures of bird abundance and of human pressures. Implementation should begin with definition of quantifiable indicators, development of a database, and nomination of a responsible organisation. Analysed results should be published and provided to local communities and organisations working in the area.
  3. Initiate a programme to provide support to local communities for rational and sustainable management of natural resources. This could include creation of new CoBas and/or support to existing CoBas. Activities could include: forest regeneration, small-scale income-generation, training local communities in new or improved farming methods and development of ecotourism.

## Chapter 7: THE ANTS OF THE IVOHIBE REGION OF TSITONGAMBARIKA FOREST

BRIAN L. FISHER

### INTRODUCTION

In December 2006, a survey was conducted of Ivohibe Mountain just east of Antsotso. The survey team consisted of Brian Fisher from California Academy of Sciences (CAS) and four members of the arthropod field team from the Madagascar Biodiversity Center (MBC) in Park Tsimbazaza. MBC is a Malagasy NGO incorporated in 2004, with a central mission to improve and accelerate individual and institutional capacity in biodiversity research in Madagascar, emphasising research on the island's arthropods with an aim to broaden the scope of organisms routinely analysed when mapping biodiversity for conservation purposes. MBC includes training facilities for Malagasy students and provides an environment where practising Malagasy scientists can participate in conservation decision making.

### STUDY SITES

Ants were intensively surveyed at 200 m (100–300 m from forest edge) and 650 m (the summit of Ivohibe) between 2–5 December 2006. The two sites were chosen to represent the largest elevation range of good forest available on the mountain. Specifically, inventories were conducted at the following localities:

1. 55.0 km N Tolagnaro, 24°34.14'S, 47°12.24'E, 200 m, 2–4.xii.2006; collections BLF15448-15553;
2. 55.6 km N Tolagnaro, 24°33.70'S, 47°12.01'E, 650 m, 4.xii.2006, collections BLF15554-15629.

### SURVEY METHODS

Ants were often collected by hand. Areas searched included rotten logs and stumps, in both dead and live branches, in bamboo, on low vegetation, under canopy moss and epiphytes, and under stones.

To capture flying insects, including winged ants (queens and males) we set up four Malaise traps and 25 yellow pan traps at the 200 m site from 2–4 December 2006.

At the 200 m site, invertebrates were extracted from samples of leaf litter (leaf mold, rotten wood) using a modified form of the Winkler extractor. The leaf litter samples were sifted through a wire sieve of 1 cm grid size. Before sifting, the leaf litter was chopped with a machete to disturb ant nests in small twigs and decayed logs. Ants and other invertebrates were extracted from the sifted litter during a 48-hour

period in mini-Winkler sacks. At the 200 m site, we conducted nine trap extractions, with each trap holding eight liters of sifted litter.

Ants on low vegetation and in arboreal habitats were sampled by holding a stretched 60 cm x 60 cm white canvas platform below the undergrowth and beating the trunk of a tree or clump vegetation three times with a stick. The ants dislodged onto the canvas platform were aspirated and placed in ethanol. This process was repeated by one collector for an entire day of collecting.

### RESULTS AND DISCUSSION

Previous arthropod inventories have been conducted at over 225 sites across Madagascar, in all habitats and geological formations. These surveys have included sites in the littoral, lowland and mountain forest in the Tolagnaro (Fort Dauphin) regions.

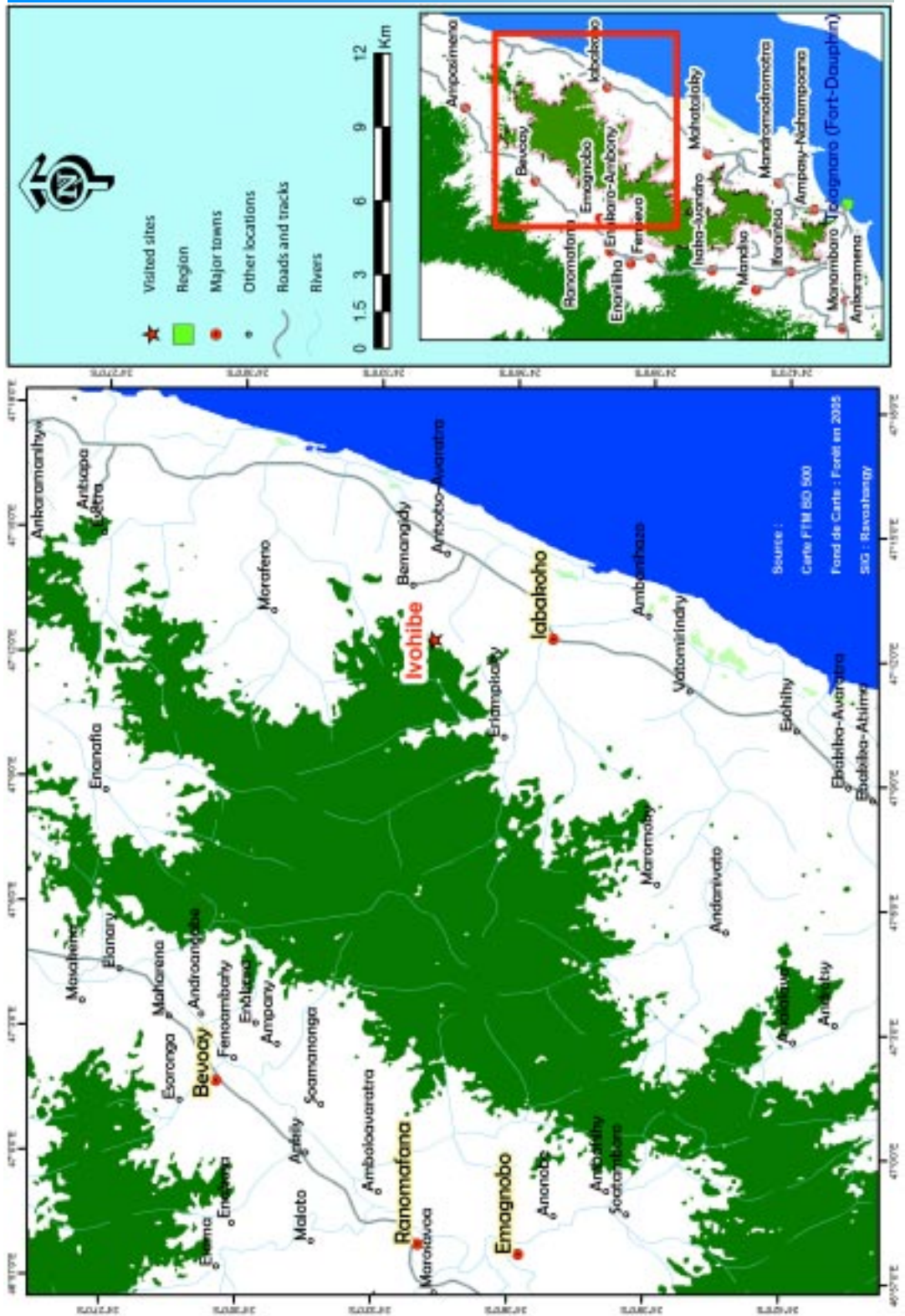
The species collected from 2–5 December, 2006 are presented in Table 17. All specimens from the inventory and images of each species can be found at [www.antweb.org/madagascar.jsp](http://www.antweb.org/madagascar.jsp)

In the four days of field work, 105 species were recorded, with 81 species at 200 m and 40 species at 650 m near the summit. Two species, *Camponotus* MG038 (Plate 12) and *Pheidole* MGs074 are known only from this forest. One other species, *Camponotus* MG080, was discovered for the first time during this



**Plate 12.**  
*Camponotus* MG038,  
a new species of ant  
collected during  
surveys and so far  
known only from  
Ivohibe

### Map 7. Ant survey site



survey, although it has since been found at two other locations.

The fauna is more diverse than similar sites in Andohahela National Park (see AntWeb.org). At Ivohibe, a higher diversity of ants were captured in a shorter amount of time.

The 650 m site includes 23 species not recorded in the lowland site. The shift in species along the elevational gradient makes it important to include both habitats in conservation planning.

Unlike forests such as Lavasoa (Grand Lavasoa, 25.9 km W Tolagnaro, 25°05.26'S, 46°44.94'E), where selective logging has degraded the majority of the forest, Ivohibe is in pristine condition. The forest edge represents the limit of disturbance. Once inside the forest, one quickly encounters mature growth. The resident ant species reflect the pristine nature of this forest. While secondary forests in the region as a whole are invariably inhabited by tramp ants, we did not collect any invasive species in Ivohibe forest.

**Table 17. Ant species collected from Ivohibe**

Species	200 m	650 m	Species	200 m	650 m	Species	200 m	650 m
<i>Anochetus grandidieri</i>	2	0	<i>Crematogaster</i> BBB36	1	0	<i>Pheidole</i> MG121	0	3
<i>Anochetus madagascarensis</i>	7	0	<i>Crematogaster</i> BBB40	1	0	<i>Pheidole</i> MG126	1	6
<i>Camponotus christi</i>	4	0	<i>Crematogaster</i> BBB44	1	0	<i>Pheidole</i> MG151	1	0
<i>Camponotus christi foersteri</i>	1	1	<i>Crematogaster</i> BBB56	1	0	<i>Pheidole</i> MGs011	1	0
<i>Camponotus dufouri</i>	3	0	<i>Crematogaster</i> BBB62	1	0	<i>Pheidole</i> MGs059	1	0
<i>Camponotus edmondi</i>	0	1	<i>Hypoponera</i> MG017	2	0	<b><i>Pheidole</i> MGs074</b>	1	0
<i>Camponotus gibber</i>	0	2	<i>Hypoponera</i> MG025	1	0	<i>Pheidole</i> MGs106	1	0
<i>Camponotus gouldi</i>	3	0	<i>Hypoponera</i> MG033	1	1	<i>Pheidole</i> <i>oswaldi</i>	2	0
<i>Camponotus heteroclitus</i>	0	6	<i>Hypoponera</i> MG038	2	6	<i>Plagiolepis alluaudi</i>	3	1
<i>Camponotus hildebrandti</i>	4	1	<i>Hypoponera</i> MG062	0	1	<i>Plagiolepis madecassa</i>	0	1
<i>Camponotus maculatus</i>	0	1	<i>Hypoponera</i> MG067	2	0	<i>Platythyrea bicuspis</i>	1	0
<i>Camponotus</i> MG024	1	0	<i>Hypoponera</i> MG082	1	0	<i>Prionopelta descarpentriesi</i>	0	1
<b><i>Camponotus</i> MG038</b>	2	1	<i>Hypoponera</i> MG087	1	0	<i>Simopone</i> MG02	1	0
<i>Camponotus</i> MG048	1	0	<i>Monomorium fisheri</i>	0	2	<i>Strumigenys ampyx</i>	0	3
<i>Camponotus</i> MG051	1	0	<i>Monomorium gongromos</i>	2	0	<i>Strumigenys chilo</i>	1	0
<i>Camponotus</i> MG054	4	3	<i>Monomorium hanneli</i>	1	0	<i>Strumigenys origo</i>	1	0
<i>Camponotus</i> MG074	1	0	<i>Monomorium hildebrandti</i>	1	0	<i>Strumigenys sphaera</i>	1	0
<i>Camponotus</i> MG079	2	0	<i>Monomorium</i> MG01	0	2	<i>Technomyrmex madecassus</i>	1	0
<i>Camponotus</i> MG080	0	2	<i>Monomorium micrommaton</i>	1	0	<i>Terataner</i> MG11	9	3
<i>Camponotus</i> MG082	6	0	<i>Monomorium termitobium</i>	1	3	<i>Tetramorium cognatum</i>	0	1
<i>Camponotus</i> MG089	0	5	<i>Mystrum</i> MG01	1	0	<i>Tetramorium electrum</i>	2	1
<i>Camponotus mocquersyi</i>	6	0	<i>Mystrum rogeri</i>	1	1	<i>Tetramorium latreillei</i>	1	0
<i>Camponotus putatus</i>	0	3	<i>Nesomyrmex madecassus</i>	2	0	<i>Tetramorium</i> MG035	2	0
<i>Camponotus robustus</i>	2	0	<i>Nesomyrmex</i> MG07	2	0	<i>Tetramorium</i> MG046	1	0
<i>Carebara</i> MG01	1	0	<i>Nylanderia</i> undetermined	10	6	<i>Tetramorium</i> MG062	0	5
<i>Carebara</i> MG08	1	0	<i>Pachycondyla cambouei</i>	1	0	<i>Tetramorium</i> MG093	1	0
<i>Cataulacus oberthueri</i>	2	0	<i>Pachycondyla</i> JCR05	0	1	<i>Tetramorium</i> MG106	2	0
<i>Cataulacus porcatus</i>	15	1	<i>Pachycondyla perroti</i>	0	1	<i>Tetramorium proximum</i>	1	0
<i>Cataulacus regularis</i>	0	3	<i>Pachycondyla sikorae</i>	1	0	<i>Tetramorium severini</i>	3	0
<i>Cerapachys</i> L_MG10	1	0	<i>Pachycondyla wasmannii</i>	2	0	<i>Tetramorium tosii</i>	3	0
<i>Cerapachys</i> MG10	1	0	<i>Paraparatrechina</i> undetermined	2	0	<i>Tetraponera grandidieri</i>	0	3
<i>Cerapachys</i> P_MG02	1	0	<i>Pheidole</i> MG001	2	4	<i>Tetraponera merita</i>	4	5
<i>Cerapachys</i> P_MG11	0	2	<i>Pheidole</i> MG026	1	0	<i>Tetraponera</i> MG06	1	0
<i>Crematogaster</i> BBB14	0	1	<i>Pheidole</i> MG078	0	1	<i>Tetraponera</i> undetermined	8	4
<i>Crematogaster</i> BBB32	1	0	<i>Pheidole</i> MG091	1	0	<b>Total species</b>	<b>81</b>	<b>40</b>

Note: Species in **bold** are known only from Ivohibe Peak



## Chapter 8: SOCIO-ECONOMIC SURVEY OF THE TSITONGAMBARIKA AREA

MAMINIAINA ANDRIAMAHENITSOA AND MARIE BEATRICE YVONNE RAHASINANDRASANA

### OBJECTIVES

Objectives of the socio-economic research were:

1. Collection and analysis of socio-economic data potentially related to biodiversity;
2. Identification of the importance of biodiversity for local communities;
3. Identification of traditions (e.g. farming and cultural) that impact the Tsitongambarika Forest;
4. Collection of demographic data.

### METHODOLOGY

This survey was conducted in 2005 in four of the 15 communes (municipalities) around Tsitongambarika. The communes surveyed were Mahatalaky, Iabakoho, and Manantenina communes on the eastern side of Tsitongambarika and Ifarantsa Commune on the western side. The methodology was as follows:

1. Consultations: to collect data from existing entities and organisations;
2. Village household surveys: to gather socio-economic data;
3. Qualitative Interviews: to cross-check data collected during household surveys;
4. Meetings with local communities: to assess community involvement in biodiversity conservation and to assess community flexibility to adjust cultural or farming traditions in a future environmental conservation programme
5. Observations (direct and participative): to verify and complete data collected through other methods.

### SOCIAL ORGANISATION

#### ■ Manantenina, Iabakoho and Ifarantsa communes

##### Background

The origin of populations living in these three communes is the same, especially for the coastal populations on the east side of Tsitongambarika I and II. It is said that they are descendants of two Antesaka brothers (the Zafisery) from a tribe in Sandraviny–Vangaindrano in the north. These populations have always lived a part from other ethnic groups and only marry amongst themselves. As a result, the majority of the population in these

communes is essentially Antesaka as in the case of Manambato. However, it is said that the Antanosy settled this region in the past, but later moved to the western part of Tsitongambarika Forest, for example to Ivorona. Two factors prompted the Antesaka to migrate to this region. First, was better ocean fishing (particularly of lobster). Second, was colonial timber harvesting. The Antesaka would leave their homes in the North to come south to Bemangidy to work in the colonial lumber mill. Nowadays, Bemangidy, which was once a large settlement, is nothing more than a small hamlet of four houses, having been abandoned by its previous inhabitants. Since the arrival of the Antesaka, there has been no more significant immigration. The few additional people who come to settle in this region are essentially merchants, constituting barely 1% of the population.

##### Family structure

In villages, houses are built far away from one another because inhabitants are prone to impulsiveness and conflicts. Thus, when a family becomes large it leaves a village to establish another hamlet. At Antsotso, there are up to 10 hamlets of 4–30 houses each, suggesting a desire for independence and self-sufficiency.

In these communities, men, fulfilling their roles as fathers and husbands, are responsible for household income (assisted by their wives). The populations practice traditional marriage, do not approve of polygamy and have 2–8 children per family. In general, girls marry from the age of 15, with boys a little later. Women are respected in the home, participate in family discussions, give their opinions and make relevant decisions.

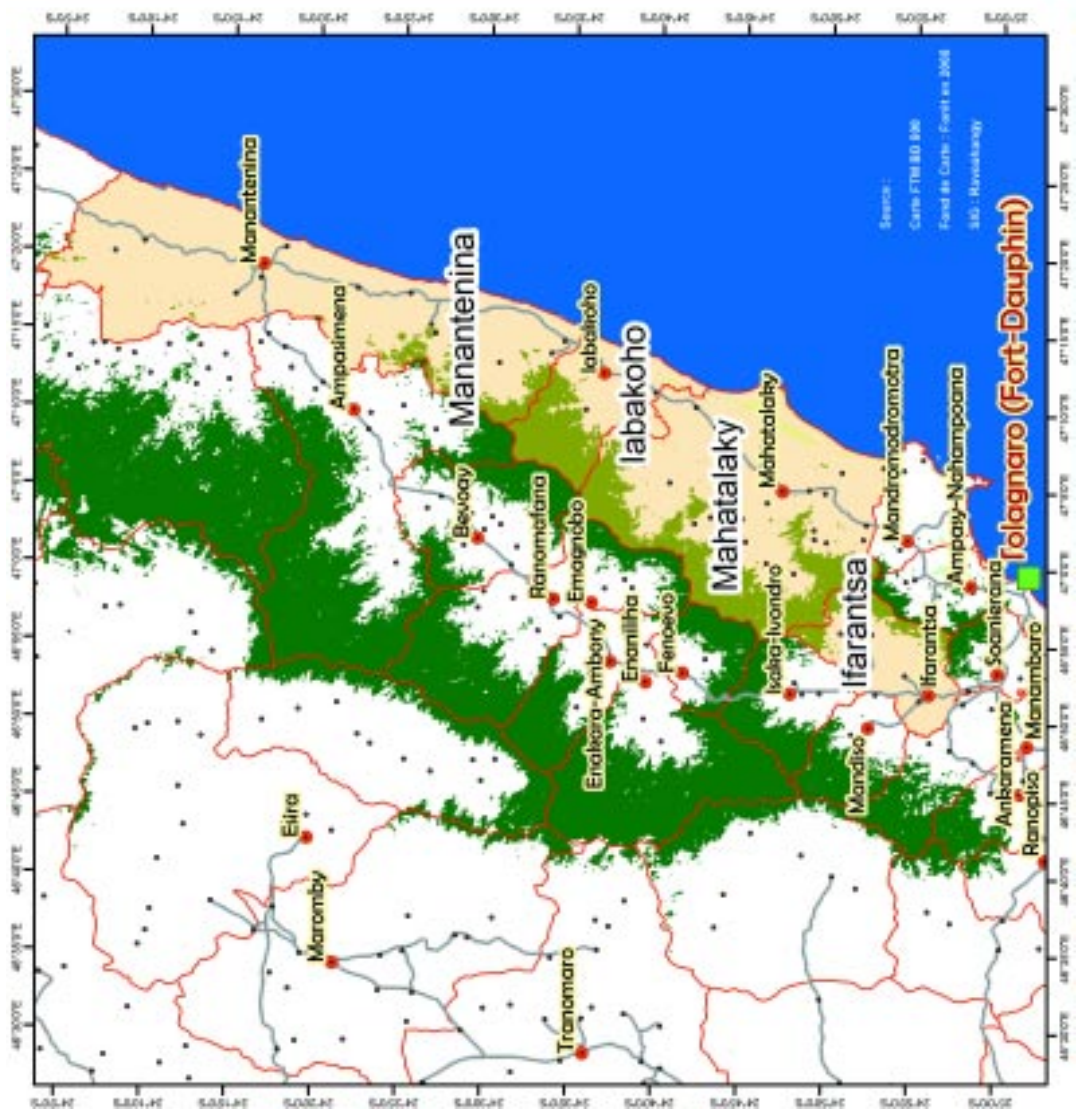
##### Authorities

The villages are managed by legal authorities since the people are all immigrants and thus do not have traditional authorities. The legal authority is the *chef de quartier*, who is the local leader and has close ties to the community. All decisions must pass by this central authority, who governs the communities and solves disputes. Nonetheless, there are other village elders called *lonaky* who hold power inside their own family groups. The situation is the same for religious leaders. There is an exception to this general rule in Iabakoho where the local teachers (with a 9th grade education) are also highly respected, consulted, and are influential in the community.

##### Taboos, beliefs and dina

All villages commonly respect rivers and lakes. It is forbidden (taboo) to urinate and defecate near these

### Map 8. Socio-economic survey sites



waters, probably because these are daily water sources for the population. It is also forbidden to bring recently-cut firewood into the village. It must stay outside the village until it is dry. Some particular species are subject to local beliefs, and these are discussed later. Collective agreements (*dina*) adopted by the community and legal authorities (the mayor and Ministry of Water and Forests) are intended to motivate people to work and to respect their neighbours.

## ■ Mahatalaky Commune

### Background

The main ethnic group in this commune is the Antanosy. Migration within the commune is frequent, particularly to the administrative centre of the commune because of food insecurity in other *fokontany* (the smallest Malagasy administrative unit, often comprised of one or more villages). Intercommunal and interregional migration is not significant, except into South Volobe Fokontany where forest clearing is very intense. The people who have settled on the hillsides of Tsitongambarika come from Manantenina Commune. Since in-migration is practically non-existent, there is not much inter-ethnic co-habitation or interaction and thus there are only Antanosy living in the study sites.

### Marriage

Marriage with close relatives is frequent between the descendants of two brothers or those of a brother and a sister. However, the descendants of two sisters cannot marry. For marriage of the descendants of a brother and sister, a taboo between them must be lifted, by sacrificing a zebu (ox) or a rooster and holding a ceremony known as *Manandra-arim-belo*. After the ceremony, every guest receives a piece of meat called *tahala* and the bride and groom are acknowledged by the community to be married. For marriages between people from two different families, the husband offers zebu to his future wife's parents, the number depending on the agreement between the families.

### Death and burial

If a community member dies, the bad news spreads quickly and far. Families and representatives of other clans come to comfort the family of the dead by bringing money or rice. As a result, there is enough rice and meat to cook for the whole family in a funeral ceremony known as *famaha*. The duration of the *famaha* depends on the wealth of the family. If the family is too poor, the dead relative is buried as quickly as possible but usually the family is obliged to go into debt to hold the *famaha*.

Every clan (whose identity is recognised through a mark on their cows' ears) has a burial place (known as an *amonike* or *kibory*), essentially a small wood with several big stones surrounded by bare land. The dead are buried under these rocks; men and women

separately. These woods are sacred places that it is forbidden to visit (except during an actual burial) or collect firewood. When the burial ground is full, the clan looks for another site.

For a widow or widower, the mourning ritual is strict. The widowed have to wear the same black clothing for a six-month period without washing themselves or their clothes. They also have to stay at their house all day long, except to use the toilet. This period of mourning is called *milobona*. Mourning can have a harmful psychological impact on young individuals, who may suffer from personality change and depression during this period.

## DEMOGRAPHIC SITUATION

Summary demographic data are presented in Table 18. Those aged 0–5 do not yet attend school and remain with their mothers. Those aged 6–10 attend elementary school. They still live with their parents or sometimes with members of their family who live close to their schools. Very few of those aged 11–17 still study. Boys help their fathers and learn their father's profession (fishing, etc.) and girls help their mother in household and agricultural chores. This is the period when the youth are preparing their adult life and begin to be interested in earning money. At the ages of 18–60, people already have their own livelihoods and family. This age group is closely tied to its traditions and is hesitant to adopt new ideas or visions, even if outwardly they profess to be interested. Their conservative tendencies often slow down or even hinder new projects, such as the creation of an association. Those aged over 60 are the leading citizens of the community. Despite their age, they still participate in their family's daily activities: men collect firewood and are in charge of village cleanliness while women carry out household chores, make mats and fishing traps, and assist the men.

## ■ Manantenina Commune

### Fokontany Ankaramany

Ankaramany is located 19 km south of Manantenina along national road 12A and constitutes the northern boundary of Tsitongambarika Forest. It comprises five main villages: Antsapa, Andamasinina, Enakao, Sakorihina and Ankaramany. This fokontany has a public elementary school. More than 70% of households fish as their main livelihood activity. The others are farmers in the plain on the edge of Tsitongambarika. During the official fishing season, these farmers occasionally move to the coast to become fishermen. Their temporary campsites may become permanent, as in the case of Enakao village. There is a fishermen's association in the fokontany. There is not yet a community forest management association (*communauté de base*, commonly known as a CoBa) here, which may explain the scale of forest clearing in this area.

Table 18. Demographic data from four surveyed communes

					Age (years)									
Commune	Fokontany	Site	No. households	Population	0-5		6-10		11-17		18-60		>60	
					Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Manantenina	Ankaramany	N/A	N/A	1,556	171	189	124	137	120	128	315	329	23	20
	Manambato	N/A	N/A	606	68	69	48	53	46	49	124	135	6	8
	Antanitsara	N/A	N/A	1,040	106	81	70	99	88	73	239	258	14	12
Iabakoho	Iabakoho	N/A	N/A	703	71	84	56	63	53	69	137	149	13	8
	Ambanihazo	N/A	N/A	712	62	69	58	71	68	51	135	179	11	8
	Antsofo	N/A	N/A	692	78	84	52	61	53	64	136	147	10	7
	Vatomirindry	N/A	N/A	618	65	69	42	52	51	47	128	149	7	8
Ifarantsa	Ifarantsa	N/A	N/A	1,862	249	250	142	197	108	179	330	361	20	26
	Vatomivarina	N/A	N/A	1,041	115	120	80	103	90	76	209	233	9	6
	Efangerana	N/A	N/A	1,102	155	152	81	107	85	75	194	227	16	10
	Fanjahira	N/A	N/A	1,046	97	88	64	85	83	75	264	253	15	22
	Evonje	N/A	N/A	755	63	99	71	67	70	60	155	147	13	10
	Ivolo	N/A	N/A	1,000	151	95	140	102	60	81	184	155	17	15
	Andanivato	N/A	N/A	918	106	143	78	70	75	78	163	195	7	3
	Ivorona	N/A	N/A	2,137	271	269	168	180	184	176	419	428	29	13
	Ankera	N/A	N/A	923	77	82	59	55	50	60	251	259	16	14
Sub-total				16,711	1,905	1,943	1,333	1,502	1,284	1,341	3,383	3,604	226	190
Total				16,711	3,848		2,835		2,625		6,987		416	
Percentage				100%	23%		17%		16%		41.5%		2.5%	
					Age (years)									
Commune	Fokontany	Site	No. households	Population	0-5		6-17		18-60		>60			
					Male	Female	Male	Female	Male	Female	Male	Female		
Mahatakalay	Anaviavy	N/A	22	104	12	13	16	15	23	25	N/A	N/A		
	Androangabe	N/A	29	133	3	9	25	20	35	41	N/A	N/A		
	Beantafa	N/A	46	243	27	20	38	35	60	63	N/A	N/A		
	Sarondrano	N/A	21	119	12	10	22	21	24	30	N/A	N/A		
	Emanevy	N/A	64	359	45	34	69	61	71	79	N/A	N/A		
	Sahamaro	N/A	52	262	33	33	44	40	56	56	N/A	N/A		
	Tsihalagna	Tsihalagna	24	332	57	49	41	46	60	76	2	1		
		Marovato	15	95	13	14	16	7	16	20	5	4		
		Marofotry	15	76	7	7	16	11	17	17	0	1		
		Tsianoriha	42	180	18	21	27	21	43	44	2	4		
		Ankazomasy	49	210	22	23	26	29	47	53	4	6		
		Andramanàka	40	217	30	26	35	26	48	49	1	2		
		Ambarakotry	32	145	16	15	20	21	35	35	2	1		
		Analalava	80	425	50	50	62	61	100	92	3	7		
		Ankazomasy	16	75	11	8	16	5	17	16	1	1		
		Amboniria	33	172	17	11	41	29	28	39	3	4		
		Mananara I	Mananara I	50	288	31	30	56	56	53	53	5	4	
		Volobe Sud	Analamagnasa	231	1,333	146	170	205	221	246	260	14	71	
			Tanandava	65	339	41	41	51	54	72	68	4	8	
			Fandramanitra	62	356	50	51	59	47	66	77	6	0	
			Andanivato	102	580	57	76	103	104	120	104	9	7	
		Volobe Nord	North Volobe	135	530	50	73	103	103	104	92	4	1	
			Maromoky	80	448	49	54	91	71	88	88	4	3	
			Esinda	40	216	25	26	42	28	47	44	2	2	
			Eforo	17	88	11	8	15	19	18	15	1	1	
		South Ebakika	South Ebakika	89	459	45	45	74	84	98	96	8	9	
	Sub-total				1,451	7,784	878	917	1,313	1,235	1,592	1,632	80	137
Total					1,795		2,548		3,224		217			
Percentage				100%	23%		33%		41%		3%			
Source: Commune statistics for 2004 (Iabokoho and Ifarantsa); survey results (Mahatalaky and Manantenina)														

Source: Commune statistics for 2004 (Iabakoho and Ifarantsa); survey results (Mahatakalay and Manantenina)

### **Fokontany Manambato**

Manambato has two villages, Manambato and Ambalantenina, and is 31 km south of Manantenina, on national road 12A. It has a total population of 606 inhabitants and has a public elementary school and a basic health centre. About 80% of villagers are primarily fishermen but become farmers for part of the year, clearing the forest for cultivation. There is not yet a CoBa in this fokontany.

### **Fokontany Antanitsara**

Antanitsara is 6 km west of Manambato, and is composed of several hamlets, including Antamenaka, Morafeno, Fenoandala, Antanandava, Antanambao, Antanamasy, Ambohimahasoa, Mahasoa, Amboahangy and Tsiangafiafy. It has a public elementary school in the main village, Fenoandala. There is no health centre and thus traditional medicine is well developed. About 90% of the population farm as their main livelihood activity. Agricultural yields are satisfactory because the soil is reasonably fertile. However, there is insufficient irrigation in the lowland rice fields and also flooding during the rainy seasons. There are very few families who do not practice forest clearing in this fokontany. There is no CoBa yet in this fokontany.

### **Iabakoho Commune**

This comprises the fokontany of Iabakoho, Ambanihazao, Antsofso and Vatominindry, with a total population of 2,725. Iabakoho is 60 km north of Tolagnaro (Fort Dauphin) on national road 12A. It is bounded by Manantenina Commune in the north, and Mahatalaky Commune in the south, and is about 15 km long. Every fokontany has at least an elementary school (public or private) but there is a serious lack of school teachers. About 90% of the households practice both fishing and farming and, as in neighbouring communes, forest clearing is practised in Iabakoho. CoBas are being established in the commune, but farmers continue to use traditional agricultural practices.

### **Ifarantsa Commune**

Ifarantsa Commune is 234 km<sup>2</sup> in size and is located on the western side of Tsitongambarika. It is bounded by Isaka Ivondro Commune to the north, Soanierana Commune to the south and Mandiso Commune to the north-west. The total population is 10,784. This commune comprises the fokontany of Ifarantsa, Vatominvarina, Efangera, Ivorona, Fanjahira, Evonje, Andanivato, Ankerana and Ivololo. The commune has a basic health centre (*Centre de santé de base II*, or CSB II) and a middle school (*Collège d'Enseignement Général*, or CEG) at Ifarantsa. There have been public elementary schools in each fokontany since 2005.

Animal husbandry plays an important role in the local economy. Cassava, rice, sweet potato and fruit tree cultivation are also significant. Agricultural practices do clear the forest but less than in other

communes. Some produce is consumed locally and some sold to commercial buyers at the Ifarantsa market. Poor irrigation management, lack of fertiliser and existence of agricultural pests are among the many obstacles to agricultural development in this commune.

An inventory of non-governmental organisations (NGOs) working on rural development in the commune, included CARE International, FAFIFI (Fanentanana, Fambolena, Fiompiana; a Malagasy NGO specialising in rural agriculture and animal husbandry), and ASOS (Action, Santé, Organisation, Secours; a Malagasy NGO specialising in rural public health, water and sanitation). Village associations exist in many fields, including: lychee, chilli, and red peppercorn-producing associations; a women's association; and an association for management of Fanjahira Forest. Forest clearing occurs in the commune but much less so than in other communes. Bushfires have always existed in this commune. There are CoBas at Ifarantsa, Talakifeno, Marovitsika, Ankerana, Ivorona, Androtsy, Maliovoa, Vohibandrika and Andanivato.

In the communes of Manantenina, Iabokoho and Ifarantsa the Education, Health and Communication situation can be summarised as follows:

#### **Education**

All of the fokontany of Manantenina, Iabokoho and Ifarantsa have at least one public elementary school and Ifarantsa has had a public middle school (CEG) since 2005. Parents are proud of sending their children to school even though the classrooms (two classrooms for five classes), teachers, and school furniture and supplies are insufficient. The hamlets are located far from one another, which means that small children have difficulty travelling 3–4 km to schools which are, in rainy seasons, inaccessible because of floods or washed-out bridges.

#### **Health**

Most of the fokontany in Manantenina, Iabokoho and Ifarantsa have or will soon have a basic health centre. The health sector faces the same problems as the education sector such as:

1. Lack of medical staff;
2. Distance from the hamlets to the health centre;
3. Inaccessibility of the road when it rains.

Due to these challenges, people use traditional medicine to treat illnesses.

#### **Communication**

The national road 12A that links Tolagnaro and Manantenina goes through the villages located in the eastern part of Tsitongambarika. Although it is not paved, it is accessible almost year round. To travel between Iabokoho and Manantenina, there are four ferry crossings, which can be problematic if a ferry is broken.



### ■ Mahatalaky Commune

The administrative centre of the commune is comprised of six fokontany: Anaviavy, Androangabe, Beantafa, Sarondrano, Emanevy and Sahamaro. Migration within the commune is frequent, particularly to this centre to avoid the food insecurity situation in the rural areas. In this centre there are public elementary schools and a middle school as in other commune centres. School attendance is high at the elementary level, but decreases at the secondary level as children start to work. The commune has a basic health centre (CSB II), with a doctor, midwife, and small pharmacy with basic medicines. The population uses the health centre especially on market day. Malaria and diarrhoea are prevalent, and the majority of the population has severe dental issues due to lack of calcium in the water and their diet.

Agriculture is the main livelihood activity, followed by animal husbandry, fishing and hunting. Major crops include irrigated and pluvial rice, sweet potato, corn, *bemako* (a type of cultivated tuber, *Dioscorea* sp.), taro root (*saonjo*), sugar cane, banana (cultivated in the forest), fruit trees, and vanilla. Except for coffee and banana cultivation, agriculture uses shifting (slash-and-burn or *tavy*) techniques. Communities say they use this practice because 'the soil is too cold for cultivation and would not produce enough without being burnt'. Ash serves as a fertiliser and basic hand tools are used (spade, machete-like knife, and axe). Animal husbandry includes cattle, pigs, and poultry. Few people fish since this administrative centre is far from the sea, but there is heavy involvement in trading fish and shellfish. Most of the communities hunt occasionally, targeting tenrec species, Collared Brown Lemur (*Eulemur collaris*, known as *varika*), Helmeted Guineafowl (*Numida meleagris*, known as *akanga*), Madagascar Buttonquail (*Turnix nigricollis*, known as *kibobo*) and quails (*Coturnix* sp., known as *trahotrafo*). In Mahatalaky Fokontany, basketwork is an essential source of income for households during the annual five-month period of food insecurity.

### ■ Tsihalagna Fokontany, Mahatalaky Commune

Tsihalagna is close to Tsitongambarika. It comprises four villages of which three were visited during surveys. Among all survey areas, Tsihalagna is the most vulnerable to food insecurity. Local people eat *pape* (a wild forest tuber, *Dioscorea* sp.) during the most severe food insecurity periods. *Pape* is highly poisonous and requires meticulous preparation (peeling, drying for several days, and then immersing in a creek or stream for a week) before it can be consumed.

There is an elementary school in the centre of the fokontany, with one teacher responsible for the three classes (grades 1–3). There were two assistants but these resigned because they did not get their salary on time. Less than 10% of children who should attend school do so. Attendance is low because children are

helping their parents with family livelihood activities and household chores. The nearest basic health centre is in Mahatalaky Commune, a three-hour walk away. Local people treat ailments with medicinal plants, and only go to the health centre when ailments become serious. Malaria and diarrhoea are prevalent. Even births take place in villages, assisted by an experienced elderly woman (often the mother of the woman giving birth).

Shifting agriculture is also prevalent here. Populations cultivate pluvial and irrigated rice, cassava, taro, coffee and banana. Rice production is low, and a given harvest can only feed a family for a week to a month depending on household size. Cassava lasts longer and ensures household survival if it is not stolen, but crop theft is frequent in this area. Cattle, pigs, and poultry are raised. Cattle manure fertilises rice crops, and livestock are only sold in times of need. Basketwork is produced, especially mats for household use, with any surplus sold at the Mahatalaky market. Some people hunt species such as tenrec species, Collared Brown Lemur, Helmeted Guineafowl, Madagascar Buttonquail and Common Quail, within the fokontany's delimited forest reserve.

### ■ Tsianoriha Fokontany, Mahatalaky Commune

Tsianoriha is located near Tsitongambarika and is very similar to Tsihalagna. The majority of the population is concentrated in Tsianoriha village. The standard of living is higher than that of Tsihalagna, due to various economic activities. There is one concrete public elementary school, with one teacher responsible for the three classes (grades 1–3). This is the only fokontany where half of school-age children actually attend. The health situation in Tsianoriha is similar to other places with a prevalence of malaria and diarrhoea. Tsianoriha is not far from the Mahatalaky health centre.

Agriculture, livestock farming and fishing are the main livelihood activities of the community, with salaried work as a secondary activity. Crops are primarily irrigated and pluvial rice, cassava, sweet potato, banana and sugar cane. Agriculture is shifting, either in the valleys/plains or in the hills/forest. Forest is cleared and planted during three years', and then left fallow, while another area is cleared. This agriculture is in a 'local use zone' defined by the World Wide Fund for Nature and the Ministry of Water and Forests during the forestry zoning process with the community. However, the community is dissatisfied with the extent of this area and complains of poverty. Indeed, since the forestry zoning there has been severe food insecurity because the agricultural production in the local use zone was insufficient. Cattle, pigs, and poultry are raised in the fokontany. Subsistence fishing occurs in the Tsianoriha River. Baskets and mats are woven for household use and sold to purchase basic food stuffs. During the yearly period of food insecurity, men may travel long distances to

search for paid work as work as porters, agricultural workers, etc.

### ■ Andramanàka Fokontany, Mahatalaky Commune

Andramanàka is near Tsitongambarika, and is made up of five villages: Ambarokotry, Analalava, Ankazomasy, Amboniria, and Andriamanàka. People tend to settle right next to the forest and carry out many activities related to the forest. This fokontany has a higher standard of living than others, because several NGOs work there (British NGO Azafady, and Malagasy NGOs FAFABI, and ASOS). There is a public elementary school, with three teachers in charge of grades 1–5. There are 10–15 children per class, although only five pupils remain in grade 5. Pupils do not attend school regularly due to the food insecurity situation. They come two or three times and then miss class for a month. Disease prevalence is identical to that of other fokontany. The nearest basic health centre is at Mahatalaky.

As it is near Tsitongambarika, this community has diverse livelihoods, but shifting cultivation is the mainstay. The main crops are irrigated and pluvial rice, cassava, sweet potato, corn, coffee, banana, sugar cane and taro root. Generally, the field burning period (*doro-asa*) is between August and October. As recommended by the CoBa, a 4 m fire break is made (to ensure that the fire stays under control and does not leave the area that is intended for burning) and some members of the community also stand guard to extinguish any fire that leaves the intended area. Intentional fires that go out of control can cause bushfires and burn down the forest (e.g. a one month fire near Andramanàka). Cattle, pigs, and poultry are raised. Baskets are made for household use. Women here work more in the fields than on basket weaving. Some men produce traditional alcohol (*toaka gasy*) to sell in the administrative centre of the commune. This is so profitable that some people have abandoned cassava cultivation. The community tends to settle right on the edge of the forest to facilitate their natural resource extraction activities. People in Analalava hunt wild boar, that destroy crops, Collared Brown Lemur and other edible animals.

### ■ Mananara I Fokontany, Mahatalaky Commune

This is a small fokontany composed of six hamlets. The forest is divided into:

1. Conservation zone (commonly known as *ala faly* though it is not technically, as this term suggests, taboo forest): Eberohy Forest;
2. Commercial timber harvesting zone: Finomandrano Forest;
3. Local use zone: Vohimainty.

There is little flat agricultural land, and the population only has access to the Vohimainty Forest, so natural resource management is rigorous and effective. There

is no school in this fokontany, even though there are many school aged children. The community built a school building, but there is no teacher. The nearest health centre is in the administrative centre of the commune but the community appears healthy, with little malnutrition.

There is no cultivatable plain in this fokontany, given the topography. This local use zone, Vohimainty, is the only area that the community has to cultivate, in addition to the lowland rice fields. Crops include irrigated and pluvial rice, cassava, sweet potato, taro, coffee and sugar cane. Slash-and-burn agriculture is practised but, after forest delimitation by the Ministry of Water and Forests in 2001, certain crops are no longer planted in the local use zone (e.g. banana, sweet potato and taro). Cassava is the only crop cultivated on the lower slopes. Cattle, pigs, and poultry are raised. Cattle are particularly valued for manure to fertilise rice fields. There is a clear difference in the yields of fertilised versus non fertilised rice fields. Baskets are made for household use, but women have to go to Sainte Luce to find *Lepironia articulata* reeds (*mahampy*) for this. Hunting (often of tenrec species) is only practised alongside other activities such as collecting wood.

### ■ Volobe Sud Fokontany, Mahatalaky Commune

Among the visited fokontany, this is the largest and most populated with its four villages. There is a considerable amount of forest clearance. At Analamagnasa, people live in the forest and clear it regardless of demarcation by the Ministry of Water and Forests. These people are not local. The majority are migrant outsiders of the Antesaka (not Antanosy) ethnic group from Manantenina Commune who are breaking local forest management *dina*. These migrants have fled the food insecurity situation in Manantenina. There is a dilapidated public elementary school with two teachers and one assistant. Only a small proportion of children attend school, and thus teachers also teach irregularly, focusing instead on farming. Malnutrition (particularly among children), malaria, diarrhoea and filariasis (testicle swelling in men) are prevalent. There is a basic pharmacy at Analamagnasa.

Shifting agriculture is practised by this community. The main crops are irrigated and rainfed rice, cassava, banana, taro, igname tubers, *bemako* (*Dioscorea* sp.), coffee, greens (Chinese cabbage) and sugar cane. Banana and coffee are traded. Cattle, pigs, and poultry are raised. Often, burning to renew pasture forage grasses causes bushfires. Women spend a lot of time weaving baskets and mats in addition to their main work in the agricultural fields. The production of traditional alcohol is an additional activity for some people. The community members claim that they do not hunt, but it would seem likely that people who live in the hills at the edge and in the forest do hunt to supplement their diet.

### ■ Volobe Nord Fokontany, Mahatalaky Commune

The community in Volobe Nord respects the Ministry of Water and Forests forest demarcation, but extracts wood for building and boat construction without paying fees to the CoBa. The community complains that the suitable land available to them for cultivation has decreased since the demarcation of the local use zone and they request that the Ministry modify the boundaries. Nonetheless, the community has managed to increase agricultural yields in the lowland areas. There is a school in the fokontany, but with similar constraints to other fokontanys. Malaria and diarrhoea are prevalent, with other diseases less so. Access to health care is poor since the nearest health centre is far away and people lack money to visit it. A new health care centre is being planned.

Crop farming is the main livelihood activity in the lowland areas and valleys, the plains, and the forest (in the local use zone). The community farms on land previously used for shifting cultivation and now left fallow (known as *hindy*), and no longer clears new forest areas for cultivation. Main crops are irrigated and pluvial rice, cassava, banana, sugar cane, taro, pineapple and sweet potato. The shifting cultivation system is unlikely to change due to long-standing traditional practices, basic agricultural hand tools and the type of soil. Cattle, pigs, poultry and (by one household) Collared Brown Lemur are raised. Cattle are kept far from villages and are tended to by community members using a rotation system. Weaving mats constitutes a source of income for households even though women must travel far to obtain the necessary *Lepironia articulata* reeds in Ebakika and Vatomirindra. Some people produce traditional alcohol as a secondary activity, generating an average income of 30,000 Ariary per 20 litre jerry can. There is occasional hunting of tenrec species, wild boar, and birds.

### ■ South Ebakika Fokontany, Mahatalaky Commune

South Ebakika and North Ebakika are separated by a river, and traversed by national road 12A linking Tolagnaro to Manantenina. Ebakika Sud is more developed than other fokontanys owing to the existence of roads and local income-generating activities. There is a public elementary school, which the majority of school-age children attend. The fokontany has just received a new classroom building constructed by Rio Tinto/Rio Tinto QMM.

Fishing is the main activity, with a daily lobster catch of 10 kg per day per fisherman in the high season and 1 kg in the low season. Crops farmed in the plains and lowlands include irrigated and pluvial rice, cassava and sweet potato. Cattle, pigs, and poultry are also raised. Only a few households make handicrafts because the community already has substantial income from lobster fishing.

## DISCUSSION

### ■ Social aspects

In summary, the Tsitongambarika area has a subsistence economy. As the human population is growing continuously, there is an imbalance between production and population growth leading to increased poverty. For the Anosy region, the population growth rate is 2.8% per year and the birth rate is 3.7 children per couple (Institut National de la Statistique, 1993). The survey showed that the interval between two births is 13–18 months, women stop giving birth at the ages of 35, girls marry at an average age of 15 and boys at 17, and work generally starts from the age of 15. Migration is almost non-existent in the study area except to Volobe Sud Fokontany, particularly at Analamagnasa.

Education is generally precarious, with only a minority of school-age children attending school, and those irregularly. Those who leave school after grade 5 have forgotten almost all that they learned. The majority of the communities are illiterate, which is an obstacle for any development programme.

The fokontanys visited for this survey each have access to only one health centre or clinic, located at the commune administrative centre. For other more isolated villages, the centre is very distant and people do not travel there unless seriously ill, instead using medicinal plants. Malaria is the main cause of mortality.

### ■ Economic aspects

The primary sector dominates in the region, particularly agricultural production and animal husbandry, and fishing. There is no industry or tourism. No infrastructure exists outside the environs of Tolagnaro. Lobster collecting companies play an important economic role in the region, with collector–delivery man networks in fishing villages. These collectors and delivery men are the intermediaries between export companies and fishermen, with daily deliveries during the open season.

### Agriculture

This is a major activity, but cannot meet the needs of the population. Household rice production cannot cover two months' consumption. Cassava fills this gap, including dried cassava from Ambovombe. Cash crops (such as coffee, vanilla and cloves) also exist. Farmers are also starting to try growing vanilla, with NGO training.

There are two main types of farmland. First, there are the plains surrounding the mountains. On the eastern slope of Tsitongambarika the cultivable plains are not very extensive because they quickly turn into less fertile sandy soils of the coastal plain. However, good uncultivated soil can be found, as at Antanitsara–Manambato. On the western side of Tsitongambarika, the plains are relatively extensive. Second, clearance of forest for shifting cultivation is common, particularly in the east of Tsitongambarika.

From Iabakoho to Ankaramamy (Manantenina Commune), forest clearing has become a tradition. Clearing is still very intense between Antsofso and Antsaha (Ankaramamy Fokontany). Nevertheless, in areas where CoBas have been established, this practice has been reduced. Lands cleared for shifting cultivation are exploitable only for two or three seasons, after which they are left uncultivated for a few years and then the cycle starts again. Shifting cultivation is practised because the plains are no longer sufficiently extensive, yields in currently cultivated fields are decreasing, only simple farming tools are available, and there are lowland areas available for paddy rice cultivation but fertilisers and irrigation are lacking.

Whether on the plains or on the cleared hillsides, farmers cultivate rice, cassava, corn, melons, bananas and pineapple and they use the same simple hand tools to grow their crops. Only in the commune of Ifarantsa do people use ox driven ploughs.

Generally, most production is for subsistence and requires a considerable time investment to protect crops from pests, such as wild boars and birds. Money earned from any quantity sold will be used for household necessities (kerosene for lamps, sugar, etc.). The situation in Ifarantsa is slightly different, because it is much more productive (e.g. up to 23,000 metric tons of cassava can be produced each year).

#### Animal husbandry

This is generally relatively limited in eastern Tsitongambarika I and II, where there are very few cattle. They are not actively used in agricultural production but are raised to be sacrificed for traditional family events (e.g. weddings and funerals). However, on the west side of Tsitongambarika, cattle breeding is rather important and cattle are used for ploughing. For example, at Ifarantsa 30,889 zebu cattle have been catalogued by local authorities.

Every village has pigs, commonly called *lambo*, with every man having a herd of 2–10 animals. The pigs feed only on rubbish and as a result are undernourished and cause village conflict by attacking crops. During this survey, at Melokany, a conflict of this kind was being solved by the mayor's office. Pigs are a particular source of income during the holidays.

Poultry farming is identical to that of pigs; they live in the open and feed on whatever they find. Most families have 2–3 hens, ducks, geese or guinea fowl, with sales of birds providing a small contribution to household needs.

A beekeepers' association has been founded at Sainte Luce by an NGO which has given initial training and equipment. However, continued technical assistance is necessary to foster this new activity. Conversely, in other areas, beekeeping already exists. For example, at Iabakoho it is practised in a traditional manner in Tsitongambarika Forest. Nonetheless, it is a small-scale activity contributing little to livelihoods.

#### Fishing

Fishing, particularly lobster-fishing, is the most important economic activity in the east of Tsitongambarika I and II, and is how the majority of people in the littoral area earn their living. Every village has its own association of fishermen. These associations commonly have management and organisational problems and internal conflicts.

During lobster-fishing seasons, all members of the family actively participate: men go fishing, and women and children make lobster traps and other accessories. Lobster fishing is practised in a traditional way, with a 6–10 m-long boat that accommodates up to seven people. It is very lucrative. In 2005, lobsters were sold at 5,000–10,000 Ariary/kg. In January 2006, a kilogram cost 8,000 Ariary, with prices rising as the end of the season approaching in September. During the open season, a fisherman catches 2–10 kg/day and during the closed season only 1 kg/day. Unfortunately, income from lobster-fishing is poorly managed and so does not have a significant positive impact on fishermen's lives. When lobster season is closed, fishermen thus return to shifting agriculture.

#### Hunting

Hunting is not widely practised except for by children who catch birds. There is however a threat to Collared Brown Lemur that hunters catch and resell.

#### Handicrafts

Unlike those in the west of Tsitongambarika, women in the east are gifted in making handicrafts, particularly baskets, for which potential raw materials abound. Handicrafts thus constitute a significant economic resource, and are the sole source of income during the food insecurity period. This could be a promising sector if it is given a little support at different points along the value chain. Even though trees are abundant and diverse, only unprocessed wood is sold.

## IMPORTANCE OF BIODIVERSITY TO COMMUNITIES

#### ■ Wood

Wood is much used as material in all fields, particularly in building and boat construction, furniture-making, and for firewood. Particular species are used for different purposes. For example, in house building, the pillar may be made of *Asteropeia* sp. (*fagnola*), *Intsia bijuga* (*harandrato*), *Eucalyptus* sp. (*kininina*), *Polycardia* sp. (*taimbarika*), *Calophyllum* sp. (*vitagno*; also used in mortar making) or *Phyllarthron* sp. (*zehana*; a hard wood). *Ravenala madagascariensis* (Traveler's Palm or *ravinala*) is commonly used as a building material. There are three varieties of *R. madagascariensis*: *fotsimamy*, *hiragna* and *horoko*. Apart from the roots, all parts of these can be used:

1. The trunk (*vakaky*) is split along its length and planks obtained from this used for partitions or the floor. These may last 6–10 years;
2. Branches (*falafa*) are also used for making partitions. These last only three years, but are in much demand at market and so constitute an important income source. For instance, a bundle of 100 cost 3,000 Ariary at Ifarantsa in 2005;
3. The leaves (*raty*) are used for the roof of the house and last for seven years. At Ifarantsa, leaves cost 3,000–5,000 Ariary for a bundle of 100 and are a significant income source.

Other tree species used for construction include: *Intsia bijuga*, *Harungana madagascariensis* (*harongoana*), *Phylloxylon xylophylloides* (*sotro*), *Calophyllum* sp. (*vitaony/vitaogny/vintagnol/vintagnon*), *Coffea* sp. (*raotry*), *Eugenia* sp. (*rotsy*), *Faucherea* sp. (*nato*), *Mammea* sp. (*hazignina*), *Polycardia* sp. (*taimbarika*), *Uapaca* sp. (*voampaky*), *Weinmannia* sp. (*lalona*), *amboatavy*, *ankalo*, *tendronkazo*, *teza* and *vahatra*. These are collected every year or two from the forests of Tsitongambarika, Manafiafy, Sainte Luce and surrounding Mahatalaky.

For boat construction, *Harungana madagascariensis*, *Mammea* sp. (*hazignina*), and *Calophyllum* sp. (*vitaony/vitaogny/vintagnol/vintagnon*) are the best and most-used species. A boat made of these woods may last five years. At Iabakoho, one boat costs 120,000 Ariary and takes about one month to build.

The use of a given wood is also linked to traditions and beliefs. People do not build a house with *Faucherea* sp. (*nato*), *hendraendra* or *tombobitsy* because these woods are forbidden. Likewise, it is believed that a husband and wife living in a house made of *Diospyros myriophylla* (*korofoky*) will end up separated.

Axes are the only tools used to cut wood. Even so, now people must go progressively further to find firewood. Generally, firewood from the local area is collected every day or two. Common species include: *Aphloia theiformis* (*fandramana*), *Cynometra cloiselii* (*mapay*), *Harungana madagascariensis* (*arongana*), *Melia azedarach* (*voandelaka*), *Asteropeia* sp. (*fanola*), *Brexia* sp. (*voakarepoka*), *Bronchoneura* sp. (*mafotra*), *Canthium* spp. (*fasikaitra*), *Croton* sp. (*hela*), *Eucalyptus* sp. (*kininina*), *Eugenia* sp. (*rotsy*), *Psidium* sp. (*goavy*), *Tambourissa* spp. (*ambora*), *Thilachium* sp. (*borisaty*), *Voacanga* sp. (*votaka*), *Weinmannia* sp. (*lalona*), *Xylopia* sp. (*fotsivavo*), *azavily*, *hendraendra*, *tsirakaraka* and *voaraozy*, but even precious wood like *Dalbergia* spp. (*magnary*) was observed during surveys.

Regarding charcoal, only producers in Ifarantsa Commune were encountered during the surveys. One sack (30 kg) of charcoal costs 1,100–2,000 Ariary and is sent to Tolagnaro, which currently consumes 11,120 metric tons of firewood and 170,000 sacks of charcoal each year. The main suppliers are the villages along regional road RIP 118 from Evohibandrika to Ranomafana, in the western part of Tsitongambarika.

## ■ Plant fibres

Plant fibres are one of the most used natural resources around Tsitongambarika, and even as far as Tolagnaro. Fibres of *Pandanus* spp. (*vakoa*) and *Lepironia articulata* reeds are used for making mats. As these are frequently used, these plants are heavily depleted in some places. Fibres are also used in place of nails in the building of housing and fences. *Tokampototry*, *vahizaha* and *vahimaramany* are considered best and very hardy.

To make lobster traps, people use the fibres of the liana *Flagellaria indica* (*vahikipy*). These are relatively solid and resist seawater well. They can be used for up



**Plate 13.** Local people collecting *Cyathea* sp. to make flower pots for sale in Tolagnaro (ANDRIAMANDRANTO RAVOAHANGY)



to one month. This species is now very difficult to find and *Ravenala madagascariensis* is more often used, but lobster traps made of *R. madagascariensis* are easily damaged (in 3–5 days at most). *Agalea* sp. (*vahimenty*), *vahiginenina*, *vahihazo*, *vahitogna*, *vahikarabo* and *vahidengo* are used for the ropes on lobster traps.

In addition to fibres, bark of *Grewia* sp. (*valotra*) and *vignoa* is used instead of nails in house building. These species are now very rare.

Apart from some species which grow by water, all of these fibres come from trees of the Tsitongambarika Forest.

## ■ Medicinal plants

As health care centres are often distant from hamlets and villages, it is difficult for people to travel there when sick. Thus, medicinal plants are commonly used, including: *tonga*; *ravim-boahangy*, *fagnalabe* and *famonty* (for stomach ache). *Ravitsipanga* is used for stomach ache in cows and *vahikambo* is used for healing wounds. *Cedrelopsis* sp. (*katrafaha*) is used for stomach ache but its bark is also an additive in the making of local rum.

Most of those plants are found around villages but some are picked in Tsitongambarika Forest. Considering the small quantities needed, it seems likely that use of these plants has no significant negative impact on the forest.

## ■ Water resources

As there are many rivers emerging from the Tsitongambarika mountains, the population of the area has almost no water resource problems. As mentioned earlier, the eastern part of Tsitongambarika could be much more agriculturally

productive if suitable irrigation schemes were developed. Drinking water is fine at all localities visited during the survey, except Ambandrika–Sainte Luce where the quality is poor. In the wet season, when the rate flow is high and continuous, villages are isolated as roads are flooded. However this situation does not usually last long as high topography facilitates drainage.

## THREATS TO BIODIVERSITY

### ■ Forest clearance

Forest clearance is the most serious threat to Tsitongambarika Forest. Reasons for the prevalence of shifting cultivation were discussed earlier. There are two main reasons why it is more prevalent in the eastern part of Tsitongambarika than in the western part:

1. Geology: soil on the eastern side is sandy and so less productive than the fertile plains of the western side. Shifting cultivation on forested land is considered easier, faster, and more productive than other agricultural types on the infertile plains available in the east.
2. Tradition: Shifting cultivation has been practised for several successive generations (especially among the Antesaka ethnic group) in Tsitongambarika. This is a more entrenched habit in the east because this is where seasonal fishermen prevail. Fishermen are the first to clear forest because they return to farming when the lobster season is closed, and have had no time to prepare land for farming during the open season.



**Plate 14.** Forest clearance at Tsitongambarika (ANDRIAMANDRANTO RAVOAHANGY)

Thus, forest clearance is one of the principle threats to the conservation of Tsitongambarika. Three of the main causes are population pressure, sandy and unproductive plains, and relatively fertile land in the forest once it is cleared and burned.

### ■ Bushfires

Bushfires often occur after intentional fires burn out of control. Such fires can be very destructive and are particularly damaging to *Ravenala madagascariensis*, which grows on the forest edge. Around Mahatalaky there are four main reasons for these fires. First, fires used to stimulate regrowth of cattle forage pasture may burn out of control (90% of villages visited use such fires). Second, fires from intentional burning to clear forest or fields for planting burn out of control. Third, young cattle herders light fires to grill cassava, but do not put them out. Last, strong winds may reignite a fire that was not completely extinguished.

### ■ Timber harvesting

This dates back to the colonial period. At that time, a logging company's head office was established at Bemangidy (Antsofso). Elders in the region claimed that there were wild horses in the forest of Tsitongambarika that were scared off, along with other animals, by the noise of the lumber mill. Later, Malagasy companies took over, and there is currently a logging company at Antsapa Andamasinina (Ankaramany Fokontany). According to the person in charge of this sawmill, woodcutters' camps were established about every 30 ha as work progressed.

Nowadays, Ministry of Water and Forest officials and the CoBa demarcate exploitable forests, but illicit exploitation is regular, particularly for ebony and rosewood, and especially around Manambato where there is not yet a CoBa. As Manambato is a fishermen's village, timber trade is most prevalent outside the lobster-fishing season. During the survey, wood seized by authorities was observed at Ankaramany and Antsapa Andamasinina. According to local people, ebony wood 150 x 25 cm would sell for about 6,000 Ariary. The final destination of such timber is reported to be the Indian Ocean islands via Tolagnaro.

### ■ Conversion of wetlands into rice fields

Demographic pressure and low rice yields encourage people to convert wetlands into rice fields, as in Mahatalaky and Mananara I Fokontanys.

### ■ Hunting and collecting forest products

People who go to the forest tend to hunt or capture animals, particularly Collared Brown Lemur which are sold for 3,000–15,000 Ariary/animal. Young animals are sold for domestication, others for meat. Lemur capture was observed during surveys at Soaharena, Antanitsara (Manambato) and Ianakony (Iabakoho). At Ifarantsa, people reported that such hunting ceased when the CoBa was established.

The making of lobster traps with *Ravenala madagascariensis* fibres threatens this tree. Such traps do not last long, and are only made because previous materials have already been depleted. *R. madagascariensis* lobster traps are a good source of income for women who sell them for 200–500 Ariary to fishermen who use 5–10 every four days. A similar situation exists with *Lepironia articulata*, which is now rare in some localities owing to overexploitation for basketwork.

## CONSERVATION OF BIODIVERSITY

Traditional burial woods are sacred places where people cannot collect forest products, and are thus *de facto* conserved by local populations.

People are conscious of degradation of Tsitongambarika Forest, but rely on its exploitation for their survival. They cooperate in conservation in return for support to increase agricultural production through technical training and provision of equipment and materials.

The Tolagnaro office of the Ministry of Water and Forests, in collaboration with various NGOs, made a major effort to develop and implement a Forest Resource Management Project. One achievement is the transfer of management of part of the classified forest of Tsitongambarika to local communities via CoBas. In all fokontany visited during this survey, forest management has already been transferred to CoBas responsible for sustainable natural resources management. The Ministry of Water and Forests demarcated the forest for every fokontany and subdivided it into conservation, exploitation, and local use zones.

CoBas are tasked with ensuring that demarcations and regulations are respected:

1. Conservation zones cannot be used for collection of forest products or for cultivation;
2. Exploitation areas can be used if fees are paid to the CoBa. For example, for the Volobe Nord CoBa, timber for house construction can be harvested for 500 Ariary/tree by CoBa members and 1,000 Ariary/tree by non-members. Timber can be harvested for boat construction for 3,000 Ariary/tree by members and 5,000 Ariary/tree by non-members;
3. Local use zones allow farming by the community if rules decreed by the CoBa *dina* are respected. Offences are punishable by fines. For example, setting fire to the forest is a serious offence punishable by a 10,000 Ariary fine.

Established CoBas are rather weak, perhaps because they are still recent in some areas and therefore not experienced enough, especially in application of *dina*. Besides their nascent capacity to manage the CoBas, some leaders have also shown flagrant abuse of power concerning application of *dina*. For example, some local forest rangers have made threats against people

cutting down trees even when they have appropriate permits, but have not stopped other people (who they know) from illegally cutting timber in protected forests.

On 8 January 2006, the survey team witnessed illegal ebony harvesting in Mamoareny protected forest, part of 71 ha monitored by the Ivorona CoBa (Ifarantsa Commune). The majority of the population of Ivorona continues to take wood from this forest, particularly ebony at Mamoareny, even though a well demarcated forest is allocated to them. Ebony is not exploitable under the *dina* of the Ivorona CoBa. Exploitation is permitted at Ankerà Fokontany, Ifarantsa Commune, under article 20 of the Ankerà CoBa *dina*. However, since the *fokontany* of Ivorona and Ankerà are close to each other and Ankerà is inaccessible by truck, the ebony is sold at the Ivorona market. Since buyers do not care about the origin of the wood, villagers harvest wood in both the Ivorona and Ankerà areas to sell to buyers. If measures are not taken, illegal exploitation of ebony at Ivorona may spin out of control.

The list of offences observed during surveys is a long one and worthy of in-depth investigations. We conclude that, despite the existence of *dina*, the CoBas—themselves signatories of the *dina*—have difficulty meeting their commitments (at least in some localities). CoBas also face serious problems of management and organisation. In surveyed villages, CoBa members complained about a lack of transparency in financial management of CoBas despite *dina* stipulations. This has led to serious unrest and conflicts among members, and may result in dissolution of these CoBas and/or failure to establish new CoBas at other localities.

## CONCLUSIONS

Natural resources are important for local communities. They are aware of environmental degradation, but do not get involved in environmental protection. Biodiversity conservation should function through CoBas. Even though these are well structured associations at community levels they have some management issues, including collusion between members of the community and CoBa leaders to disrespect *dina*. Alternatively, they may strictly follow the *dina* and create enemies in the community leading to intra-village conflict. The management transfers were probably made too soon, since members of these poor communities face serious social and cultural obstacles to effectively implement self-enforcement.

Natural resource exploitation plays a predominant role in local daily life, notably of wood for house and boat construction and firewood, of vegetal fibres for handicrafts and lobster traps, and of medicinal plants. It would be difficult for local people to live without these forest products, and the classified forest of Tsitongambarika is key in providing them.

Tsitongambarika Forest is being degraded by human pressures. Forest clearance for agriculture, particularly by fishermen on the eastern side, is the primary cause. Hunting of animals such as lemurs is another issue. Moreover, even though CoBas are operational, management of Tsitongambarika Forest is far from satisfactory and illegal exploitation of the forest persists.

The three *fokontany* that have the most impact on the forest are Andramanakàna, Volobe Sud and Volobe Nord, since they are located right next to the forest. Other *fokontany* use the forest with less intensity since they are further away. The local population uses the forest for several different reasons:

- The forest is the basis of subsistence for local populations, especially the most isolated ones;
- Low yield for irrigated and rain-fed rice production and other crops leads to increased forest use;
- A growing population cannot obtain its food requirements from existing low crop yields;
- Extreme poverty of the local populations.

The Antanosy ethnic group does not traditionally migrate and thus is not exposed to exchanges and new ideas, which reinforces a reliance on traditional methods.

## RECOMMENDATIONS

### ■ Reduce human pressure

1. Provide education and training in household management to ensure finances (e.g. from lobster-fishing) are wisely managed, thus reducing the need to turn to shifting agriculture during the fishing closed season;
2. Support improved agricultural methods, especially through building or irrigation infrastructure (dams, canals, etc.), to reduce the need for shifting cultivation methods and increase cultivation and yields in the currently underutilised plains;
3. Effectively enforce the law, especially regarding forest exploitation offences.

### ■ Build capacity of community-based organisations

1. Continuously train CoBa members in organisation, negotiation, simplified book-keeping, conflict management, etc;
2. Reinforce trainings with follow-up monitoring visits and assessments;
3. Support CoBas to carry out their mission through qualified coaching, to facilitate learning through practice and adaptive management.

### ■ Promote conservation of biodiversity through communication and education

1. Develop an environmental education programme:
  - (a) For children (as future forest stewards);

- (b) For women (as those who have most influence on families);
- (c) For men (as those who use the forest most intensely);
- 2. Develop and implement awareness programmes about the importance of biodiversity conservation;
- 3. Develop an open communication system (not only one way but with feedback) for exchange of experience among different actors (CoBas, NGOs, etc.)

■ **Link biodiversity conservation programmes with rural development**

- 1. Promote development projects compatible with biodiversity conservation;
- 2. Provide economic incentives (e.g. grants) to communes to adopt biodiversity conservation programmes;
- 3. Meet development needs (e.g. infrastructure);
- 4. Encourage NGOs to actively participate in rural development programmes.

## REFERENCES

- ANDREONE, F., CADLE, J. E., COX, N., GLAW, F., NUSSBAUM, R. A., RAXWORTHY, C. J., STUART, S. N., VALLAN, D. AND VENCES, M. (2005) Species review of amphibian extinction risks in Madagascar: conclusions from the Global Amphibian Assessment. *Conservation Biology* 19: 1790–1802.
- ANDRIAFIDISON, D., ANDRIANAIVOARIVelo, R. A., JENKINS, R. K. B., RAMILIJAOA, O. R., RAZANAHOERA, M., MACKINNON, J. AND RACEY, P. A. (2006) Nectarivory by endemic Malagasy fruit bats in the dry season. *Biotropica* 38: 85–90.
- ANDRIAMASIMANANA, R. (2008) Appui à l'élaboration du schéma d'aménagement de la forêt de Tsitongambarika Taolagnaro par des outils des observations de la terre. Unpublished report to Asity Madagascar.
- ASITY MADAGASCAR (2009) Suivi écologique participatif des forêts de Mahialambo, de Farafara, d'Enato et d'Anka Maromaniry-Tsitongambarika (Fort Dauphin) sud est de Madagascar dans le cadre du projet paiement direct. Unpublished internal report.
- BATES, P. J. J., RATRIMOMANARIVO, F. H., HARRISON, D. AND GOODMAN, S. M. (2006) A review of pipistrelles and serotines (Chiroptera: Vespertilionidae) from Madagascar, including the description of a new species of *Pipistrellus*. *Acta Chiropterologica* 8: 299–234.
- BLANC, C. P. (1985) Priorités en matières de conservation des reptiles et amphibiens à Madagascar. Pp. 117–120 in R. A. Mittermeier, L. H. Rakotovo, V. Randrianasolo, E. J. Sterling & D. Devitre, eds. *Priorités en matière de conservation des espèces à Madagascar*. Gland, Switzerland: International Union for Conservation of Nature and Natural Resources.
- BLOMMERS-SCHLÖSSER, R. M. A. AND BLANC, C. P. (1991) Amphibiens (première partie). *Faune de Madagascar* 75: 1–379.
- BOLLEN, A. AND DONATI, G. (2006) Conservation status of the littoral forest of south-eastern Madagascar: a review. *Oryx* 40: 57–66.
- BOLLEN, A. AND VAN ELSACKER, L. (2002) Feeding ecology of *Pteropus rufus* (Pteropodidae) in the littoral forest of Sainte Luce, SE Madagascar. *Acta Chiropterologica* 4: 33–47.
- BOURGEAT, F. (1972) Sols sur socle ancien à Madagascar. *Mémoires ORSTOM* 57, Paris.
- CREIGHTON, G. K. (1992) Faunal study: Madagascar Minerals Project. Final report: Madagascar Minerals Project. Unpublished report to QIT Fer et Titane.
- CREIGHTON, K. G. (1992) Faunal Study. In: QMM S. A., eds. Ilmenite Project. Social and Environmental Impact Assessment. Supporting Document no 5. Unpublished report by QIT Madagascar Minerals S.A. (QMM S. A.) to the Madagascar National Environment Office.
- DUFILS, J.-M. (2003) Remaining forest cover. Pp. 88–96 in: Goodman, S. M. and Benstead, J. P. *The natural history of Madagascar*. Chicago: The University of Chicago Press.
- DURBIN, J. (2007) New legislation for the protection of Malagasy species. *Lemur News* 11: 4–6.
- DUTSON, G. (2006) Report on birds and bird conservation at Ivorona Forest, Tsitongambarika I. Unpublished report.
- ENTWISTLE, A. C. AND CORP, N. (1997) The status and distribution of the Pemba flying fox *Pteropus voeltzkowi*. *Oryx* 31: 135–142.
- ENTWISTLE, A. C., RACEY, P. A. AND SPEAKMAN, J. R. (1997) Roost selection by the Brown-eared Bat *Plecotus auritus*. *Journal of Zoology* 34: 399–408.
- FEISTNER, A. T. C AND SCHMID, J. (1999) Lemurs of the Réserve Naturelle Intégrale d'Andohahelo, Madagascar. *Fieldiana: Zoology*, new series 94: 269–283.
- GANZHORN, J. U. (1994) Les lémuriens. Pp. 70–72 in Goodman, S. M. and Langrand, O., eds. *Recherches pour le développement: Inventaire biologique de la forêt de Zombitse*. Antananarivo: Centre d'Information et de Documentation Scientifique et Technique.
- GERP [GROUPE D'ETUDE ET DE RECHERCHES SUR LES PRIMATES DE MADAGASCAR] (2003) Rapport final du projet: Relations entre les pressions humaines et le statut de conservation des lémuriens dans les sites d'Ambato et de Maromizaha (région de Moramanga). Unpublished report.
- GLAW, F. AND VENCES, M. (2007) *A field guide to the Amphibians and Reptiles of Madagascar*. Privately published, Cologne, Germany.
- GOODMAN, S. M. (1999) Notes on the bats of the Réserve Intégrale d'Andohahelo and surrounding areas of southeastern Madagascar. *Fieldiana: Zoology* new series 94: 251–257.
- GOODMAN, S. M. (2006) Hunting of Microchiroptera in south-western Madagascar. *Oryx* 40: 225–228.
- GOODMAN, S. M. AND RANIVO, J. (2009) The geographical origin of the type specimens of *Triaenops rufus* and *T. humbloti* (Chiroptera: Hipposideridae) reputed to be from Madagascar and the description of a replacement species name. *Mammalia* 73: 47–55.
- GOODMAN, S. M. AND RASOLONANDRASANA, B., EDS. (1999) Inventaire biologique de la réserve spéciale du pic d'Ivohibe et du couloir forestier qui la relie au Parc national d'Andringitra. *Recherches pour le Développement, Série Sciences Biologiques* 15: 1–180.



- GOODMAN, S. M. AND WILMÉ, L. (2003) Cuculiformes: *Coua* spp., Couas. Pp. 1102–1108: in Goodman, S. M. and Benstead, J. P. *The natural history of Madagascar*. Chicago: The University of Chicago Press.
- GOODMAN, S. M. AND WILMÉ, L., EDS. (2003) Nouveaux résultats d'inventaires biologiques faisant référence à l'altitude dans la région des massifs montagneux de Marojeje et d'Anjanaharibe-Sud. *Recherches pour le Développement, Série Sciences Biologiques* 19: 1–302.
- GOODMAN, S. M., PIGEON, M., HAWKINS, A. W. A. AND SCHULENBERG, T. S. (1997) The birds of south-eastern Madagascar. *Fieldiana: Zoology Field Museum of Natural History, Chicago* 87: 1–132.
- GOODMAN, S. M., ANDRIAFIDISON, D., ANDRIANAIVOARIVELO, R. A., CARDIFF, S. G., IFTICANE, E., JENKINS, R. K. B., KOFOKY, A., MBOHOAHY, T., RAKOTONDRAVONY, D., RANIVO, J., RATRIMOMANARIVO, F. H., RAZAFIMANAHAKA, H. J., RAZAKARIVONY, V. AND RACEY, P. A. (2005a) The distribution and conservation of bats in the dry regions of Madagascar. *Animal Conservation* 8: 153–165.
- GOODMAN, S. M., JENKINS, R. K. B. AND. RATRIMOMANARIVO, F. H. (2005b) A review of the genus *Scotophilus* (Chiroptera: Vespertilionidae) on Madagascar, with the description of a new species. *Zoosystema* 27: 867–882.
- GOODMAN, S. M., CARDIFF, S. G., RANIVO, J., RUSSELL, A. L. AND YODER, A. D. (2006a) A new species of *Emballonura* (Chiroptera: Emballonuridae) from the dry regions of Madagascar. *American Museum Novitates* 3538: 2–21.
- GOODMAN, S. M., RATRIMOMANARIVO, F. H. AND RANDRIANANDRIANINA, F. H. (2006b) A new species of *Scotophilus* (Chiroptera: Vespertilionidae) from western Madagascar. *Acta Chiropterologica* 8: 21–37.
- GOODMAN, S. M., RAKOTONDRAPARANY, F. AND KOFOKY, A. F. (2007) The description of a new species of *Myzopoda* (Myzopodidae: Chiroptera) from western Madagascar. *Mammal Biology* 72: 75–81.
- GRANEK, E. (2002) Conservation of *Pteropus livingstonii* based on roost site habitat characteristics on Anjouan and Moheli, Comoros Islands. *Biological Conservation* 108: 93–100.
- GREEN, G. M. AND SUSSMAN, R. W. (1990) Deforestation history of the eastern rain forest of Madagascar from satellite images. *Science* 248: 212–215.
- HAWKINS, A. F. A. AND GOODMAN, S. M. 1999. Bird Community Variation with Elevation and Habitat in Parcels 1 and 2 of the Réserve Naturelle Intégrale d'Andohahela, Madagascar. *Fieldiana (Zoology)* 94: 175–186.
- HUMBERT, H. (1955) Les territoires phytogéographiques de Madagascar. *Colloques internationaux du Centre National de la Recherche Scientifique, LIX: les divisions écologiques du monde, moyen d'expression, nomenclature, cartographie, Paris, 1954. Année Biologique, série* 3 31: 439–448.
- INSTITUT NATIONAL DE LA STATISTIQUE (1993) *Recensement Général de la Population et de L'Habitat*. INSTAT: Antananarivo.
- IUCN (2010) IUCN Red List of Threatened Species. Version 2010.2. <www.iucnredlist.org>. Downloaded on 07 August 2010.
- JENKINS, R. K. B., ANDRIAFIDISON, D., RAZAFIMANAHAKA, H. J., RABEARIVELO, A., RAZAFINDRAKOTO, N., ANDRIANANDRASANA, R. H., RAZAFIMAHATRATRA, E. AND RACEY, P. A. (2007) Not rare, but threatened: the Madagascar Flying Fox *Pteropus rufus* in a fragmented landscape. *Oryx* 41: 263–271.
- KUNZ, T. H. (1982) Roosting ecology of bats. Pp. 1–52 in Kunz, T. H., ed. *Ecology of Bats*. New York and London: Plenum Press.
- LANGRAND, O. (1990) *Guide to the birds of Madagascar*. New Haven: Yale University Press.
- LANGRAND, O. AND SINCLAIR, J. C. (1994) Additions and supplements to the Madagascar avifauna. *Ostrich* 65: 302–310.
- MACKINNON, J. L., HAWKINS, C. E. AND RACEY, P. A. (2003) Pteropodidae, fruit bats, fanihy, angavo. Pp. 1299–1302 in Goodman, S. M. and Benstead, J. P., eds. *The natural history of Madagascar*. Chicago: University of Chicago Press.
- MILON, P. (1950) Description d'une sous espèce nouvelle d'oiseau de Madagascar. *Bulletin Muséum National d'Histoire Naturelle* (2e série) 22: 65–66.
- MILON, P. (1952) Notes sur le genre *Coua*. *L'Oiseau et la Revue Française d'Ornithologie*, nouvelle série 22: 75–90.
- MITTERMEIER, R. A., TATTERSALL, I., KONSTANT, W. R., NICOLL, M. E. AND LANGRAND, O. (1992) *Lemurs of Madagascar: an action plan for their conservation, 1993–1999*. Gland: IUCN/SSC Primate Specialist Group.
- MITTERMEIER, R. A., LOUIS JR., E. E., RICHARDSON, M., SCHWITZER, C., LANGRAND, O., RYLANDS, A. B., HAWKINS, F., RAJAobelina, S., RATSIMBAZAFY, J., RASOLOARISON, R., ROOS, C., KAPPELER, P. M. AND MACKINNON, J. (2010) *Lemurs of Madagascar*. 3rd edition. Arlington, VA, USA: Conservation International.
- MORRIS, P. AND HAWKINS, A. F. A. (1998) *Birds of Madagascar: a photographic guide*. Robertsbridge, East Sussex, UK: Pica Press.
- NICOLL, M. AND LANGRAND, O. (1989) *Madagascar: revue de la conservation et des aires protégées*. Gland, Switzerland: World Wide Fund for Nature.
- NUSSBAUM, R. A. AND RAXWORTHY, C.J. (1994) The genus *Paragehyra* (Reptilia Sauria: Gekkonidae) in southern Madagascar. *Journal of Zoology* 232:37–59.

- PAULIAN, R., BLANC, C., GUILLAUMET, J.-L., BETSCH, J.-M., GRIVEAUD, P. AND PEYRIÉRAS, A. (1973) Étude des écosystèmes montagnards dans la région malgache. II Les chaînes Anosyennes. Géomorphologie, climatologie et groupements végétaux. (Campagne RCP 225, 1971–1972). *Bulletin Muséum National d'Histoire Naturelle: Écologie générale*, third series, 118: 1–40.
- PETERS, D. S. (1996) *Hypositta perdita* n. sp., eine neue vogelart aus Madagascar. *Senckenbergiana Biologica* 76: 7–14.
- PETERSON, R. L., EGER, J. L. AND MITCHELL, L. (1995) *Chiroptères. Faune de Madagascar*. Paris: Muséum National d'Histoire Naturelle.
- RACEY, P. A., GOODMAN, S. M. AND JENKINS, R. K. B. (2009) The Ecology and Conservation of Malagasy Bats. Pp. 369–404 in Fleming, T.H. & Racey, P.A., eds. *Island bats*. Chicago: The University of Chicago Press.
- RAKOTOARIVÉLO, A. R. AND RANDRIANANDRIANANINA, F. H. (2007) A chiropteran survey of the Lac Kinkony-Mahavavy area in western Madagascar. *African Bat Conservation News* 12: 2–4.
- RAKOTONANDRASANA, E. N. AND GOODMAN, S. M. (2007) Bat inventories of the Madagascar off-shore islands of Nosy Be, Nosy Komba and Ile Sainte-Marie. *African Bat Conservation News* 12: 6–9.
- RAMANAMANJATO, J.-B. (1993) Contribution à l'étude des reptiles et amphibiens de la forêt ombrophile du sud-est de Madagascar. Final DEA dissertation, University of Antananarivo, Madagascar.
- RAMANAMANJATO, J.-B. (2000) Fragmentation effects on reptile and amphibian diversity in the littoral forest of south-eastern Madagascar. In Rheinwald, G., ed. *Isolated vertebrate communities in the tropics*. Proceedings of the 4th International Symposium of the Zoologisches Forschungsinstitut und Museum A. Koenig. *Bonner Zoologische Monographien* 46.
- RAMANAMANJATO, J.-B. (2007) Reptile and Amphibian Communities along the Humidity Gradient and Fragmentation Effects in the Littoral Forests of southeastern Madagascar. Pp. 167–180 in Ganzhorn, J. U., Goodman, S. M. and Vincelette, M., eds. *Biodiversity, ecology and conservation of littoral ecosystems in southeastern Madagascar, Tolagnaro (Fort Dauphin)*. Washington, DC: Smithsonian Institution.
- RAMANAMANJATO, J.-B. AND 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 south-eastern Madagascar. *Animal Conservation* 4: 175–183.
- RAMANAMANJATO, J.-B., MCINTYRE, P. B. AND NUSSBAUM, R. A. (2002) Reptile, amphibian, and lemur diversity of the Malahelo Forest, a biogeographical transition zone in southeastern Madagascar. *Biodiversity and Conservation* 11: 1791–1807.
- RANDRIANASOLO, H. H. (1996) Présence de *Newtonia fanaovanae* dans la forêt de Veveombe Vondrozo et note sur l'avifaune de la région. *Working Group on the Birds in the Madagascar Region Newsletter* 6: 14–18.
- RANIVO, J. (2001) Contribution à l'étude de la biologie et de l'effet de la prédation humaine sur la rousette *Eidolon dupreanum* (Pollen, 1866). Final DEA dissertation, Department of Animal Biology, University of Antananarivo, Madagascar.
- RAVELONAHINA, H. AND RAMAROSANDRATANA, M. (2002) Etude de la forêt de l'extrême sud-est de Madagascar (Région de Fort Dauphin). Cas des forêt d'Ambatotsirongorongo, de Farafara et de Marovony. Unpublished report by QMM and Fauna & Flora International.
- SCHMID, J. AND SMOLKER, R. (1998) Lemurs in the reserve special d'Anjanaharibe-Sud, Madagascar: with reference to elevational variation. *Fieldiana: Zoology new series* 90: 227–238.
- SCHULENBERG, T. S. (2003) Vangidae, Vangas. Pp. 1138–1143 in: S. M. Goodman and Benstead, J. P. *The natural history of Madagascar*. Chicago: The University of Chicago Press.
- STERLING, E. J. AND RAKOTOARISON, N. (1998) Rapid assessment of primate species richness and density on Masoala peninsula, eastern Madagascar. *Folia Primatologica* 69 (suppl. 1).
- STERLING, E. J. AND RAMAROSON, M. G. (1996) Rapid assessment of the primate fauna of the eastern slopes of the Reserve Naturelle Intégrale d'Andringitra: with reference to elevational variation. *Fieldiana: Zoology new series* 85: 293–305.
- SEDGELEY, J. A. AND O'DONNELL, C. F. J. (1999) Roost selection by the long-tailed bat *Chalinolobus tuberculatus* in temperate New Zealand rainforest and its implications for the conservation of bats in managed forests. *Biological Conservation* 88: 261–276.
- ZICOMA (1999) *Les Zones d'Importance pour la Conservation des Oiseaux à Madagascar*. Antananarivo: BirdLife International, Association Nationale pour la Gestion des Aires Protégées and Ministère des Eaux et Forêts.

## Appendix: COMMUNITY INVOLVEMENT IN MANAGEMENT OF TSITONGAMBARIKA FOREST: 2010 UPDATE

ANDRIAMANDRANTO RAVOAHANGY

Tsitongambarika I (19,530 ha) and Tsitongambarika II (29,400 ha) Classified Forests are located, respectively, in the southern and central parts of the Vohimena mountain chain. Between 1997 and 2005, management of these forests was transferred from the Water and Forests Service to the local community. The objective of this transfer was to empower local stakeholders to manage forest resources. In particular, it was expected that, if the local community was allowed to exploit the forest for income in a sustainable manner in carefully defined zones, then they would value the forest and be less tempted to convert forest to cultivation.

At Tsitongambarika I and II, the method adopted for the Transfer of Management was originally Secured Local Management (within the legal framework of the 1997 Forestry Policy in the second phase of the National Environmental Action Plan) and then a simplified version known as the Contractualised Management of Forests, whose legal framework was adopted by Decree 2001-122, February 14, 2001. In 1997, with financial support from USAID (which funded Agents for the Protection of Nature) and the Dutch Government, granted in the context of the WWF Programme – Debt for Nature, WWF established the Forestry Support Framework (within the Water and Forests Service) which aimed to develop Transfer of Management programmes in six sites throughout Madagascar. One of these sites, Tolagnaro, is in Tsitongambarika I Classified Forest. Between 2000 and 2005, working alongside the Forestry Support Framework, WWF implemented a second Transfer of Management programme in Tsitongambarika II Classified Forest. This programme was funded by the European Union and resulted in the creation of 27 Transfers of Management.

Both programmes adopted the same methods, including the following key elements:

- creation of an association (“*Communauté de Base*” in French, or CoBa for short) in each village near or within the protected forest. CoBa members are responsible for implementing development plans and are among beneficiaries of the sale of timber taken from the production zone;
- training of CoBa members in the sustainable use of forest resources;
- training and support for the Water and Forests Service so that it can support Transfer of Management;
- awareness-raising for the local community about the importance of conserving forest.
- development of a forest management plan for areas associated with villages — normally, the plan must include three or four zones: a production zone, where sustainable harvesting of logs for trade would be permitted; a sustainable use zone, where exploitation of forest products would be permitted for local use; a rehabilitation zone, where reforestation should be carried out to meet local needs or for trade; and a conservation zone, where no exploitation would be permitted;
- negotiation of a system for the equitable sharing of benefits obtained in the production zone and the rehabilitation zone;
- delimitation of zones;
- development and implementation of local regulations or *dina* controlling forest resources;
- preparation of terms of reference and contracts;
- implementation of activities described in the management plan through annual work plans;
- introduction of measures to improve livelihood conditions of villagers and in particular the introduction of new farming techniques to provide an alternative to shifting cultivation (“*tavy*”).

In Tsitongambarika III, 12 Transfers of Management to local communities took place in 2010. The steps performed are summarised as follows:

- election of CoBa staff members;
- development of regulations and statutes of each CoBa;
- capacity strengthening of CoBas for forest management.

Physical demarcation of zones will be subject to additional funding.

Transfer of Management was grouped into sectors (depending on location) and, for each sector, two Agents for the Protection of Nature were responsible for overseeing implementation of the above activities, assisted by a technician from the Water and Forests Service.

Until recently, when the New Protected Areas System (SAPM) process suspended all log production in potential areas for conservation identified by the SAPM Decree in October 2004, 10 Transfers of Management in the Vohimena range could be considered functional in terms of profit generated from logs operations according to their sustainable

development plan. It is clear that support to other CoBas is required if other Transfers of Management are to be completed. It is generally agreed that CoBas in existing Transfers of Management will require two or three more years of support before being fully autonomous. This support requires a small team of Agents for the Protection of Nature (probably six for Tsitongambarika I and II), two forest technicians of the Water and Forests Service, and secretarial support.

An evaluation of CoBas in Tsitongambarika I and Tsitongambarika II was carried out in 2008. Only five CoBas among 54 benefited from a renewal of contract for 10 years, namely Ampasy Nahampoana, Anka Maromagniry, Enato, Farafara and Mananara I. Other CoBas need at least a year of restructuring and revitalisation, supported by NGOs such as Asity Madagascar, ASOS, CARE, FAFAFI and WWF.



# TSITONGAMBARIKA FOREST, MADAGASCAR

## Biological and socio-economic surveys, with conservation recommendations

The biodiversity of Madagascar is well known to be exceptionally rich and highly threatened. Lowland humid evergreen forest is one of the most threatened vegetation types, but significant areas can still be found in the far south-east, notably at Tsitongambarika forest.

This book presents the results of a series of biological and socio-economic surveys at Tsitongambarika. These clearly demonstrate the very great importance of this site, and point towards to approaches needed to conserve it.

The work was coordinated by Asity Madagascar, with primary support and sponsorship from Rio Tinto, BirdLife International and Rio Tinto QMM.

