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MADAGASCAR CONSERVATION & DEVELOPMENT

INVESTING FOR A SUSTAINABLE NATURAL ENVIRONMENT FOR FUTURE GENERATIONS OF HUMANS, ANIMALS AND PLANTS OF MADAGASCAR

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MADAGASCAR WILDLIFE CONSERVATION

Jane Goodall Institut Schweiz

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Combining Conservation & Development

Madagascar is a land of contrasts, from the every day humid rainforest on the Masoala Peninsula, to the rough and sharp peaks of the Tsingy de Bemaraha, to the marshes of Lake Tsimanampetsotsa. And its people are equally divers, from Zebu keeper of Morondave, to the fisherman of the Lake Alaotra, to the rice cultivators of the Fianarantsoa. An even more impressive diversity can be found in the rich wildlife with its unique endemic features. Nevertheless, all these peculiarities are under enormous pressure. Human needs for natural resources such as wood for charcoal, bushmeat for protein supply or land for crop cultivations and cattle farming are putting deep, unsustainable impacts on the Malagasy environment.

Conservation and development issues are becoming more and more important. Consequently the idea of a forum for the exchange of experiences and knowledge in the respective fields has arisen. Thanks to the positive feedback and the many contributions from researchers and organisations working in Madagascar, Madagascar Wildlife Conservation (MWC) and the Jane Goodall Institute Switzerland (JGI Switzerland) are able and happy to present the first issue of the new journal MADAGASCAR CONSERVATION & DEVELOPMENT – the MCD journal.

The journal's editorial board is constituted of experts from different disciplines, organizations and universities, which are all involved in conservation or development work in Madagascar.

Thanks to the board members voluntary work and extra hours, the professionalism of the numerous reviewers and the many contributions of the authors, this issue has become reality. The editors are proud to present already a broad variety of contributions ranging from scientific articles about reptile conservation, to the presentation of solar ovens as an alternative to charcoal use, to an essay about the fifteen years of NEAP (National Environmental Action Plan). MCD also presents an interview with three Malagasy women involved in different ways in the CPALI (Conservation trough Poverty Alleviation) Wild Silk Project.

To keep this journal on a high standard for the future issues MCD encourages all young researchers and development workers, especially Malagasy scientists and conservationists, to contribute to this journal. Further, it is crucial that the readers provide feedback and tell their colleagues in conservation and development fields about this journal. This will give the journal a chance to become a viable forum of exchange of knowledge and technologies for Madagascar.

The journal MCD is launched as an open source journal. The limited accessibility of the World Wide Web in Madagascar forces MCD to be also available as printed edition. To cover layout, printing and distribution costs MCD hopes to place in future (more) advertisements and announcements in the journal from the private sector. Sponsorships and funds will be very welcome and necessary. The journal will be distributed to universities, libraries, publishers and other suitable organisations, and of course any individuals interested in the field.

The Founder Editors
Patrick Waeber (MWC), Dani Hänni (JGI Switzerland)

FOREWORD BY JOELISOA RATSIRARSON

A warm Welcome to the MCD-Journal

Madagascar is considered as one of world's highest priority in biodiversity conservation. This is linked not only with the high degree of diversity and endemism but also the ongoing threats of the natural communities. However, efforts have been underway at different levels in Madagascar with the new vision *Madagascar Naturally* and the proposed five year plan *Madagascar Action Plan (MAP)*, to protect and valorise the unique and rich biological diversity, in collaboration with all stakeholders, including the International communities.

The new Protected Areas System of Madagascar represent an important benchmark in an overall plan for conservation and sustainable development, first unveiled by Excellency President Marc Ravalomanana at the World Parks Congress in Durban, South Africa in 2003. The President committed to increase the total size of protected areas to 10 % of the country's territory, from 1.7 million hectares to 6 million hectares, in a five-year period to ensure the conservation of these unique biodiversity. One of the key aims of the new Protected Areas System of Madagascar is to strengthen the integration of Conservation and Development for sustainable management of resources. In addition, the involvement and empowerment of stakeholders, including local communities, traditional leaders, private sectors, government or non government organizations, play an important role in this new system of protected areas. The Ministry of Environment, Water and Forests, has targeted about one million hectares of protected areas to be classified each year, to reach this objective of six millions hectares over five years. The first one million hectares of this system of protected areas has been classified in 2005, and the classification of the next one million hectares for 2006 is going to the right direction. In addition to the declaration of the President of Madagascar in Durban, recently during the General Assembly of the United Nations in New York in September 2005, the President of Madagascar has also announced to allocate 8 % of the cancelled external debt of Madagascar, to support biodiversity conservation and environmental management, for sustainable financing of all efforts in Madagascar

Conserving the natural communities is critical not only to biodiversity, but also to the people who rely on the resources for their livelihoods. Conservation does not mean full protection, and exclude human being. We all need to understand that conservation includes sustainable management, protection and preservation. The importance of zoning would play an important role in this undertaking. One would need to consider a zoned area that could be harvested with control, another one for ecotourism, another zone for protection and so on. To live in a safe and healthy environment does not only mean protecting species in their natural habitat, but also enhancing the life quality of each citizen. Therefore it is very important that we all work together to achieve this goal and that conservation efforts go hand in hand with development.

I welcome this new journal MADAGASCAR CONSERVATION & DEVELOPMENT as it deals largely and exclusively with Conservation and/or Development in Madagascar. Biodiversity Conservation would not go alone without Development and vice versa. I encourage Malagasy researchers, students, decision makers to contribute to this journal as this new journal aims to provide a forum for exchange of information and experiences, about all aspects of conservation and development work in Madagascar. It will also play an important role as an early warning for interested people to threats to nature and culture as they arise. Therefore, this new journal arrives at the right time, as it will provide a kit for both, conservation and development practitioners in Madagascar. I wish a long life to the MADAGASCAR CONSERVATION & DEVELOPMENT new journal, and warm congratulations to its Editorial Board. Sincerely Yours,
Joelisoa Ratsirarson, Ph.D.

Secretary General of the Ministry of Environment, Water and Forests, Madagascar

FOREWORD BY JANE GOODALL

Sharing the information with locals

It is rare for a journal to provide information not only about research and conservation of wildlife and wildlife habitats, but also about human development. The editors are to be congratulated, since my own experience in Africa makes it clear that long-term conservation can never be successful unless local people are taken into consideration. It is essential to raise the standard of living and education of the very poor, whilst ensuring that any development that results is environmentally sustainable. This journal thus provides a unique forum for the exchange of ideas and sharing of information between research, conservation and humanitarian organizations. There is no shortage of NGO´s in Madagascar, but many are working in isolation, unaware of others with similar concerns and projects: yet my experience suggests that when such organizations agree to cooperate, their effectiveness often increases dramatically. Madagascar, despite the damage inflicted on its island environment, is still stunningly beautiful with a rich diversity of flora and fauna. But unless everyone works together to save what is left and restore some crucially important habitats, whilst gaining the goodwill of the local people, many species will become extinct during this century. Thus I hope that, over the years, this journal will grow, both in scope and in its ability to reach ever more interest groups.
Jane Goodall Ph.D., DBE

Founder of the Jane Goodall Institute and UN Messenger of Peace.
www.janegoodall.org

FLAGSHIPSPECIES

Lemurs - Ambassadors for Madagascar

Urs Thalmann [I, II]

Anthropological Institute
University Zurich-Irchel
Winterthurerstrasse 190
CH–8057 Zurich, Switzerland
Phone: +41 44 6354192
Fax: +41-44-635 68 04
E-mail: uthal@aim.unizh.ch

ABSTRACT

In this short article on lemurs I give a concise introduction for non-specialists to these conspicuous and unique animals on the island of Madagascar.

INTRODUCTION

Madagascar has long been known for its exquisite wildlife. It has been identified as a Megadiversity country and "Hottest Hotspot" for biodiversity conservation (Meyers *et al.* 2000 Mittermeier *et al.* 2005) due to the combination of extraordinary high diversity and extreme degree of threat. Lemurs, a natural group of primates endemic to Madagascar, are possibly the most conspicuous and most widely known wildlife of Madagascar. In this article, written for a non-specialist audience, I try to situate these mammals in a wider context to shed light on (i) their biological position and diversity, (ii) some biological pecularities, and (iii) the important role they may play for Malagasy conservation and development.

MADAGASCAR: A MEGADIVERSITY COUNTRY

Madagascar is located almost entirely within the tropics. This geographic location with its typical wind regime (trade winds, monsoon. Donque 1975), combined with a north-south mountain chain reaching heights up to 2000 m and more allows for year long orographic precipitation on the eastern side, and prolonged dry periods with a distinct rainy season in the wide western lowlands. Combined with the long geological isolation from large continental landmasses but occasional non-synchronized colonisation events by mammals this provides the coarse scenario for the evolution of Madagascar's mammal wildlife (Goodman and Beanstead 2003, for a comprehensive overview). Due to this particular combination (geographic position, relief, geology, long isolation, occasional colonization) the fauna of Madagascar (biodiversity in general) evolved tremendous endemism.

MADAGASCAR'S MAMMAL COMPOSITION

On a high systematic level, eight placental mammal orders are present on Madagascar (without cetaceans), whereas 15 are present in continental Africa, 15 in Asia, and 11 in the Americas out of 19 orders globally (Figure 1). The composition is, however, very special. There are on average less genera per animal order in Madagascar (8.1 genera/order) than on other continents. One order of Malagasy mammals, Bibymalagasia, is entirely restricted to Madagascar and went extinct only relative recently (MacPhee 1994) along with artiodactyle pygmy hippos and other large vertebrates (Burney 2004). Within Malagasy mammals, the mammal order primates clearly stands out with the endemic lemurs. The lemurs are the most diverse mammal group on the generic level, and Madagascar is the only place where primates genera are the dominant group overall. On a global scale primates rank 5th behind rodents, bats, carnivores, and even-toed hoofed mammals.

MADAGASCAR: A HOTSPOT FOR CONSERVATION

A biodiversity hotspot is a region that contains at least 0.5 % (or 1,500) of the world's 300,000 plant species as endemics and has lost 70 % or more of its primary vegetation. Madagascar harbours around 12,000 plant species of which about 9,700 or 3.2 % of the world's plant species are endemic. An enormous 90 % of the primary vegetation has been lost (Myers *et al.* 2000). This qualifies Madagascar obviousely as a biodiversity hotspot. Additionally, the consideration of five key factors, endemics and endemic species/area ratios for both plants and vertebrates and habitat loss ranks Madagascar in all figures among the top ten hotspots, along with the Philippines and Sundaland. Hence these regions are also called "hottest hotspots" (Myers *et al.* 2000). How did Madagascar achieve this position? Madagascar was one of the last great habitable land masses settled by humans. According to the comprehensive review by Burney *et al*. (2004), multiple points of evidence date the earliest presence of humans at ca. 350 yr BC. A decline in megafauna at around 230-410 AD is followed by large increases in charcoal particles in sediments signalling increased human impact on the landscape. When Madagascar was discovered by Europeans in 1500, almost all of the Malagasy megafaua-pygmy hippos, elephant birds, giant tortoises, large lemurs-had already disappeared. This was the result of the synergistic combination of human impact, nonlinear natural responses and environmental change, population fragmentation, and local extirpation (Burney *et al.* 2004). Today, the same negative synergies of resource overutilization, fire-mediated vegetation change, and biological invasion combined with an enormously growing

I ANTHROPOLOGICAL INSTITUTE, UNIVERSITY ZÜRICH-IRCHEL, SWITZERLAND

II JANE GOODALL INSTITUTE SWITZERLAND

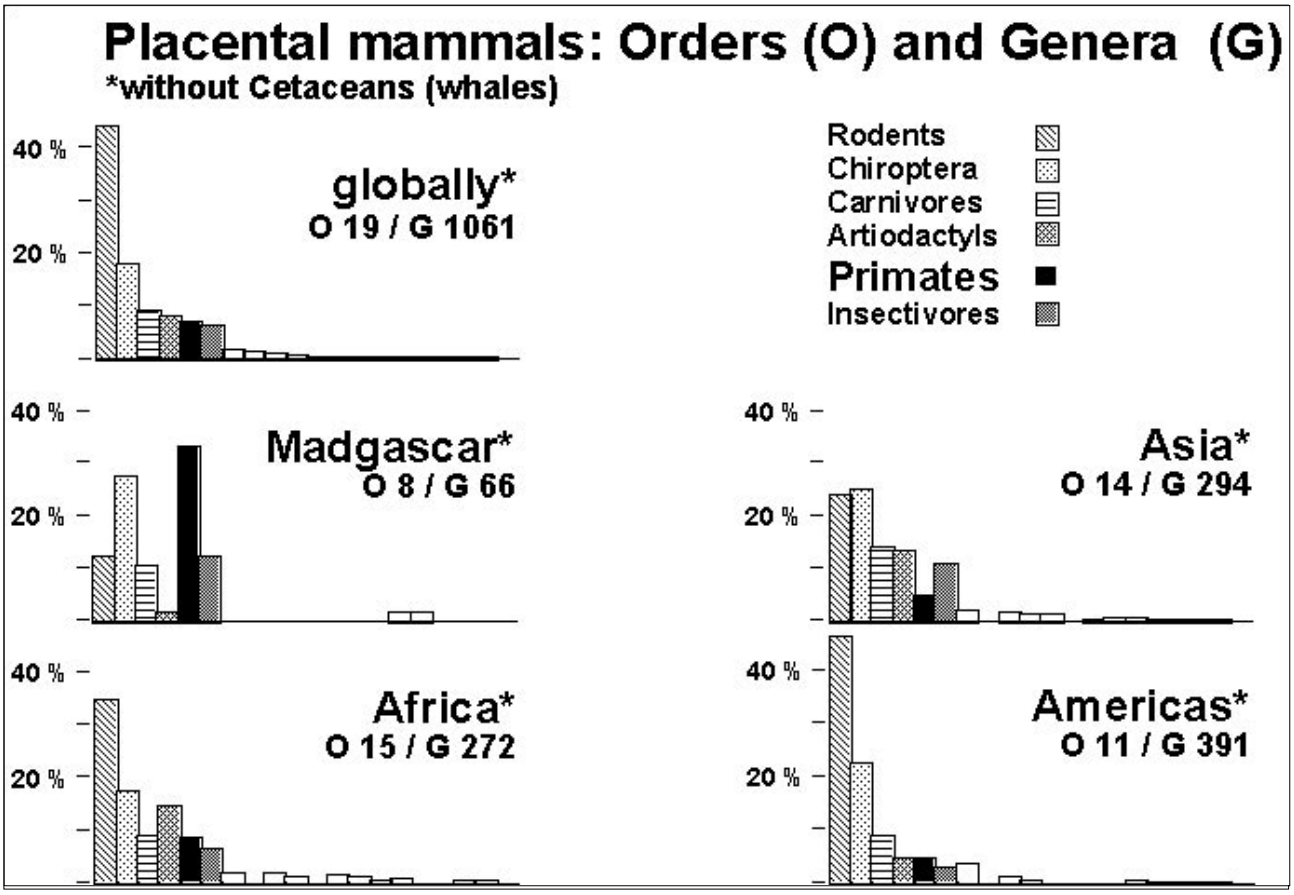

FIGURE 1. Comparative composition of Madagascar's mammal fauna. Only in Madagascar are (non-human) primates the dominant order in number of genera. Based on Nowak (1999).

population continue, pulling smaller lemur species and a host of other organisms into the extinction vortex.

WHAT ARE LEMURS?

Lemurs (Lemuriformes) are one of the six natural groups of primates and occur only in Madagascar (Figure 2). On the nearby Comoros they have been introduced from Madagascar (Pastorini *et al.* 2003). The Afro-Asian Loriformes (lorises and bushbabies) are the closest relatives. Together these primates constitute the strepsirrhine group that encompasses primates with a "wet" nose and other common characteristics. The name refers to the morphology of the nose with an outer rhinarium and a midline cleft, as for example in cats and dogs. Conversely, Southeast Asian tarsiers, New World Monkeys, Afro-Asian Old World Monkeys, apes and humans are considered as a group apart, the haplorrhines. There are several characteristics that distinguish strepsirrhines and haplorrhines as well as the different groups. The eye of most lemurs, the lorises and galagos, for example, have a reflective layer in the eye as have many other mammals. This reflecting layer facilitates finding them at night. This layer is not developed in haplorrhine primates. Strepsirrhine and haplorrhine primates are distinguished by many other morphological, physiological and anatomical characters. These are not presented here but can be found in text books on primatology (*e.g.*, Fleagle 1999).

Today, 15 lemur genera representing 5 zoological families still survive, whereas at least 8 genera representing 3 families have disappeared in pre-historic time. A major role has been attributed to the arrival of human settlers on the island as trigger for the extinction of these lemurs (Burney *et al.* 2004). Large, diurnal lemurs were especially prone to extinction. Today, the largest surviving diurnal lemurs reach a body mass of approximately 7.5 kg (eastern Propithecus and Indri). All extinct diurnal lemur genera had a higher body mass, the largest may have reached a body mass of 150-200 kg (Figure 3).

HOW MANY LEMUR SPECIES EXIST?

The number of lemur species has dramatically increased over the past 15 years (Figure 4). Whereas Mittermeier *et al.* (1994) counted 32 species in the first edition of their lemur guide, this number has more than doubled. My current compilation reaches 71 species (based on Mittermeier *et al.* 2006, Andriaholinirina *et al.*, 2006, Louis *et al.* 2006), and further descriptions of new species are immanent. This development has several, mutually not exclusive, reasons: i) discovery and characterization of new species, ii) resurrection of synonyms, and iii) the application of new species concepts.

i) Since the beginning of the new millenium, 15 new lemur species have been described. Most of them were formerly lumped with closely resembling species and/or not recognized as distinct species (*Avahi spp.*, *Cheirogaleus spp.*, *Lepilemur spp*. Figure 5), *Microcebus spp.*, *Mirza zaza*). ii) Accompanying such research efforts, nine old names have been resurrected from synonymy based on new information from the field and museum work (*e.g. Cheirogaleus spp.*, *Microcebus spp.*), including two subspecies of the diurnal *Varecia variegata* (*V. v. editorum* and *V.*

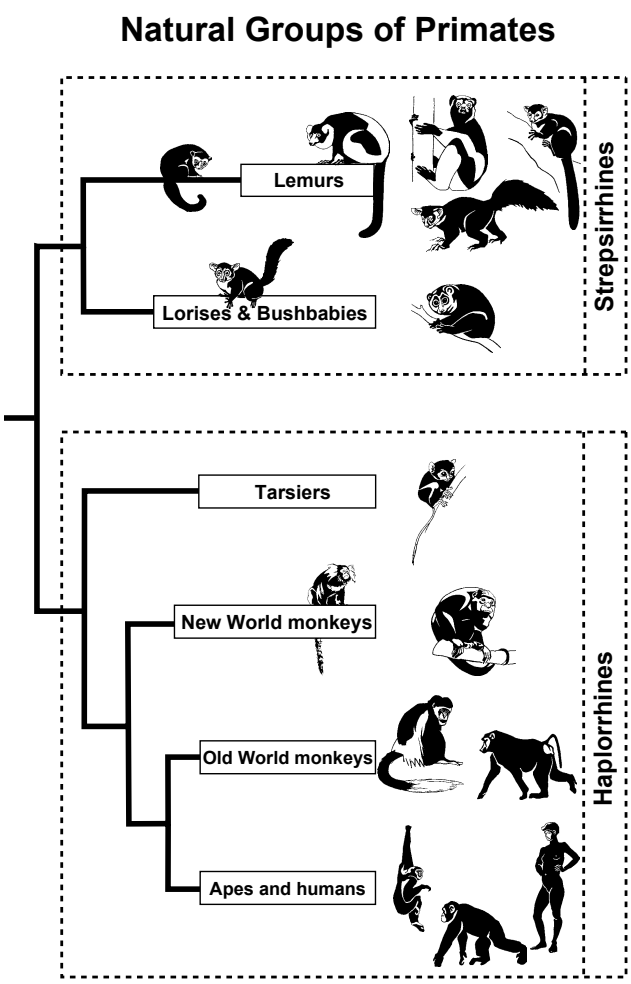

FIGURE 2. Natural groups of primates. The zoological order primates is grouped into strepsirrhine primates with lemurs, lorises and bushbabies on the one hand, and haplorrhine primates with tarsiers, New and Old World Monkeys, apes and humans on the other hand. Drawings by Lucrezia Bieler.

FIGURE 3. A ringtailed lemur in comparison with an extinct lemur of the genus Megaladapis in Apenheul Zoo, the Netherlands. Photo: Jenny Pastorini.

v. subcincta). iii) Most influential was the application of a different species concept, the Phylogenetic Species Concept from Cracraft (1983). This led to the recognition of many former subspecies as species (for a detailed review see Thalmann, in press).

PARTICULARITIES IN LEMURS

Lemurs are not only endemic to Madagascar they also show interesting characteristics which are very particular amongst primates and even among mammals. This makes lemurs scientifically especially interesting for comparative studies with other primates in other regions.

Unfortunately, only the smaller lemurs survived into our days, but once the lemur radiation covered a body mass range from 30 g (*Microcebus berthae*) to 150-200 kg (*Archaeoindris*). With 30 g *Microcebus berthae*, Madame Berthe's mouse lemur is the smallest primate world wide. Some of the smaller lemurs belonging to the family Cheirogaleidae are able to reduce their metabolism and enter torpor or hibernation. *Cheirogaleus medius*, the fat-tailed dwarf lemur for example, spends several months during the austral winter to overcome the dry period in the dry portions of Madagascar where it occurs.

Most of today's surviving lemur species are nocturnal, in line with their usually small body size. In general, nocturnal primates are smaller than diurnal primates (Martin 1990). However, some diurnal species remain such as the *Indri*, *Propithecus* and *Varecia*. A third activity pattern - cathemerality - is present in many species of the genus *Eulemur* (*e.g.*, *Eulemur mongoz*). These lemurs have activity peaks distributed over the entire daily 24 hr cycle, modified according to season (Curtis *et al.* 2006).

Particularly interesting is the social organization of some lemurs. On average, they live in smaller groups than monkeys. In many species, females are dominant over males, which is unusual among primates. Also, an unusually high portion of the surviving lemurs live in pairs with their offspring. Indeed, based on investigations of nocturnal lemurs it has been shown that the ancestral social organization in primates was not a kind of harem. It was most likely either a dispersed multifemale/multimale organization or they were organized in dispersed pairs (Müller and Thalmann 2000). Lemurs are usually seasonal breeders with seasonal birthpeaks. Offspring are carried from birth by their mothers in many species with singletons. Other species – mostly nocturnal smaller lemurs – have litter sizes of up to 4 and build nests for their offsprings. The nocturnal sportive lemurs usually cache their single offsprings while adults are foraging. The diurnal Varecia is an exception among diurnal lemurs and cathemeral lemurs because they usually have more than one offspring and leave them in nests until they can follow their mother.

Lemurs cover a wide range of dietary regimes from primarily folivores to frugivores and omnivores. Some are highly special-

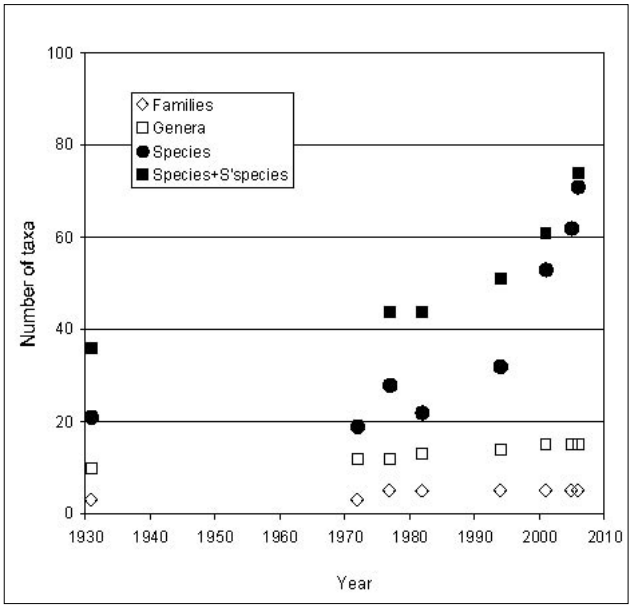

FIGURE 4. Number of lemur taxa from 1931 to 2006. Based on Schwarz (1931), Martin (1972), Petter *et al.* (1977), Tattersall (1982), Mittermeier *et al.* (1994), Groves (2001), Global Mammal Assessment (2005 unpubl.), Mittermeier *et al*. (2006), Andriaholinirina *et al*. (2006), Louis *et al*. (2006).

FIGURE 5. *Lepilemur randrianasoli*. This sportive lemur was fomerly thought to be *L. edwardsi*, then attributed to *L. ruficaudatus*, and has recently been identified as new species based on genetic studies (Andriaholinirina *et al.*, 2006).

ized, others exhibit a broader adaptable regime. Specialists are for example fork-marked lemurs (*Phaner furcifer*) prefering gum (plant exudates), the woolly and sportive lemurs feeding almost completly on leaves and buds, and gentle or bamboo lemurs feeding on different parts of bamboo depending on the species. Especially notable among the gentle lemurs is the Alaotran gentle lemur. This lemur lives only around Lake Alaotra in the reed and Papyrus region. This habitat makes this lemur unique among primates world-wide but also makes it one of the most threatened, because reed beds around Lake Alaotra are still decreasing due to human activities.

Today's surviving lemurs are still widely distributed in Madagascar where suitable habitat remains and specific ecological requirements are met. Lemurs live almost exclusively in different kinds of forests, evergreen rainforests, dry deciduous western forests and southern spiny bush vegetation. Some species survive in secondary vegetation and in plantations. However, most of the forests are considerably threatened and fragmented, and with them many lemur species suffer from environmental pressure. The Global Mammal Assessment workshop for Madagascar organized by the International Union for the Conservation of Nature (IUCN) and Conservation International (CI) revealed that two third of all species are threatened (Figure 6) according to IUCN categories (IUCN, 2001). Twelve percent (8 species) were classified in the Critically Endangered category, the highest threat category, and 28 % (17 species) in the Endangered category. On a world wide scale, four of these lemurs (Greater bamboo lemur, White-collared lemur, Silky sifaka, Perrier's sifaka) rank in the top 25 most endangered primates (Mittermeier *et al.* 2005).

THE ROLE OF LEMURS

Despite the fact that a third of all lemurs, including the largest species reaching up to 200 kg, have already disappeared, the remaining lemurs are still the most diverse mammal group of Madagascar. Biologically they constitute an integral and important part of Madagascar's natural heritage and remaining ecosystems. As a primate group endemic to Madagascar they constitute a unique part of the world's natural heritage and a unique part of humankind's natural history. Being mostly forest dwelling animals they may serve as ambassadors for the forests of Madagascar and the whole wildlife in these forests all over the island where it remains. Lemur conservation equals forest conservation. Unique as lemurs are biologically, diverse, fluffy and sympathetic, they may serve as flagship species for the whole island. With regionally occurring endemic species they may even serve as flagships for different regions within Madagascar (e.g. the Alaotran gentle lemur. Durbin 1999). In addition, lemurs are ideally suited for many kinds of different research and favoured subjects by researchers from the North. This attractiveness can also help to find funds for research by Malagasy students. Acquired skills in natural sciences and research are transferable to other domains of daily importance, and should not be considered purely academic. Indeed, a rapidly growing community of Malagasy students and researchers are integrated in smaller and larger projects together with partners from the North. However, lemurs should not be seen merely as utilities for the development of Malagasy society. Lemurs are part of the aesthetics that nature has, and cannot be valued in simple monetary terms. As unique as lemurs are, most of Madagascar's wildlife is. However, the aesthetic of scorpions, snakes, insects – as unique as they are too – is more difficult to explain and these animals are less attractive for most humans. Protecting and conserving lemurs will help to protect a plethora of other species as collateral effect. Because lemur conservation is forest conservation, the protection of lemurs also helps to grant important services by forests, such as reduced erosion, clear and sustainable water proliferation – a better life for humans.

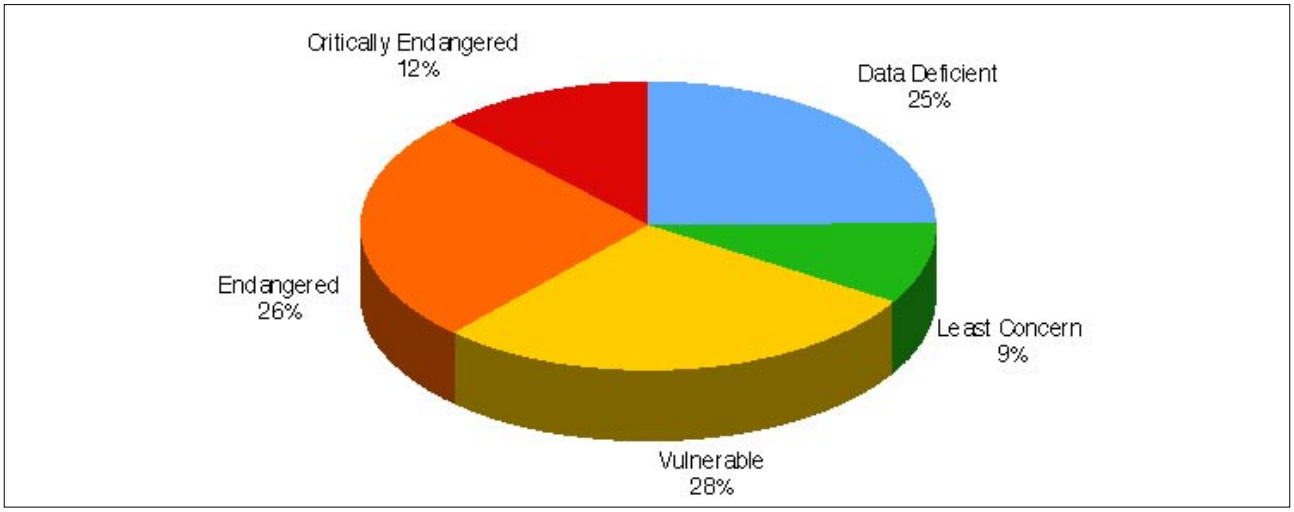

FIGURE 6. Conservation status of 65 lemur species according to IUCN categories (IUCN, 2001). Based on the Global Mammal Assessment workshop 2005 in Antananarivo organized by the International Union for the Conservation of Nature (IUCN) and Conservation International (CI).

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SHORT COMMUNICATION

The Alaotra gentle lemur: Population estimation and subsequent implications

Fidimalala B. Ralainasolo, Patrick O. Waeber, Jonah Ratsimbazafy, Joanna Durbin and Richard Lewis

Correspondence:
Jonah Ratsimbazafy
Durrell Wildlife Conservation Trust – Madagascar
B.P. 8511, Madagascar
Tel +261 20 2235748
E-mail: jonah.ratsimbazafy@durell.org

ABSTRACT

Durrell Wildlife Conservation Trust (DWCT) has conducted since 1994 several census' on the population of the Alaotran gentle lemur to observe the development of the population in time and space.

ALAOTRA GENTLE LEMUR AND ITS THREATS

The Alaotra gentle lemur or Bandro (*Hapalemur griseus alaotrensis*) (Figure 1) is confined to the papyrus and reed beds of the Lake Alaotra (see Figure 2). This type of vegetation is most found in the southern parts of the lake. The population of the Alaotra lemur is suffering severe anthropogenic threats: The major pressures derive from habitat destruction mainly through fires. Slash and burn culture is mostly used to convert marshy habitat into rice paddies and to gain better access to fish ponds. Since the beginnings of the 1980's, there has been a significant reduction in rain precipitation which prolongs the dry season and therefore leads to a desiccation of substantial parts of the marshes. This enhances and further propagates the slash and burn culture. Another direct population pressure is the hunting of the lemurs mainly for protein supply.

POPULATION CENSUS

Since 1994 Durrell Wildlife Conservation Trust is conducting several census' to estimate the population development in time and space. In total there have been 8 census' until now. Since 2001 the census has been conducted on a regular year-round base always during the rainy season in the months February to March. In 1994 the population was estimated at 11,000 animals (Mutschler and Feistner 1995). Only five years later the population had already diminished by 50% (Mutschler *et al.* 2000). In 2003 the population reached its lowest level with 2,480 individuals (Ralainasolo 2004). If the decline of the population will continue with the measured 16% *per annum* under the same anthropogenic pressures, the species might disappear within the next 40 years (Ralainasolo 2004). For all census', four main key sites have been chosen: Anororo and Andilana Sud in the western part of the lake and Andreba and Ambodivoara on its Eastside. This was for two reasons: the four sites are bordering directly the marshes and are easily accessible. Furthermore, they cover more than 85% of the whole Alaotra marshes. The estimations were based on Mutschler's *et al*. technique of encounters of lemur individuals per time spent on the trail. Since 2004 the distance sampling as a new method has been applied in addition to allow comparisons between the methods to reach a more appropriate estimation.

FIGURE 1. Alaotra gentle lemur or Bandro (*Hapalemur griseus alaotrensis*)

In 2005 the census was difficult, due to special conditions: Heavy rainfalls caused a very high water level of the lake as found only back in the early 1970's. Consequently, huge areas of natural lemur habitat have been inundated and are not useable for the lemurs. This also allowed the observers to visit former remote regions in the marshes. Furthermore, due to the special situation the observers were often on the same height as the canopy where the animals were to be found. Additionally, intense habitat destructions through fires at the end of 2004 have reduced the existing habitat for more than 47% (Andrianandrasana, unpublished data). Hence, the animals were to be found in a relatively high number and density.

CONCLUSIONS

In conclusion we can say there are three major aspects to address for the future to save the Alaotra lemur from extinction: First, the fires must be reduced to zero because fire is the most devastating pressure to the habitat. Second, poaching must be stopped. (Informal sources said that only in one of the four key sites more than 800 animals have been killed in 2004). Third, the four key sites must be reconnected again, so that the different subpopulations may have the possibilities of migration and gene exchange. For all this, a main responsibility must be given to

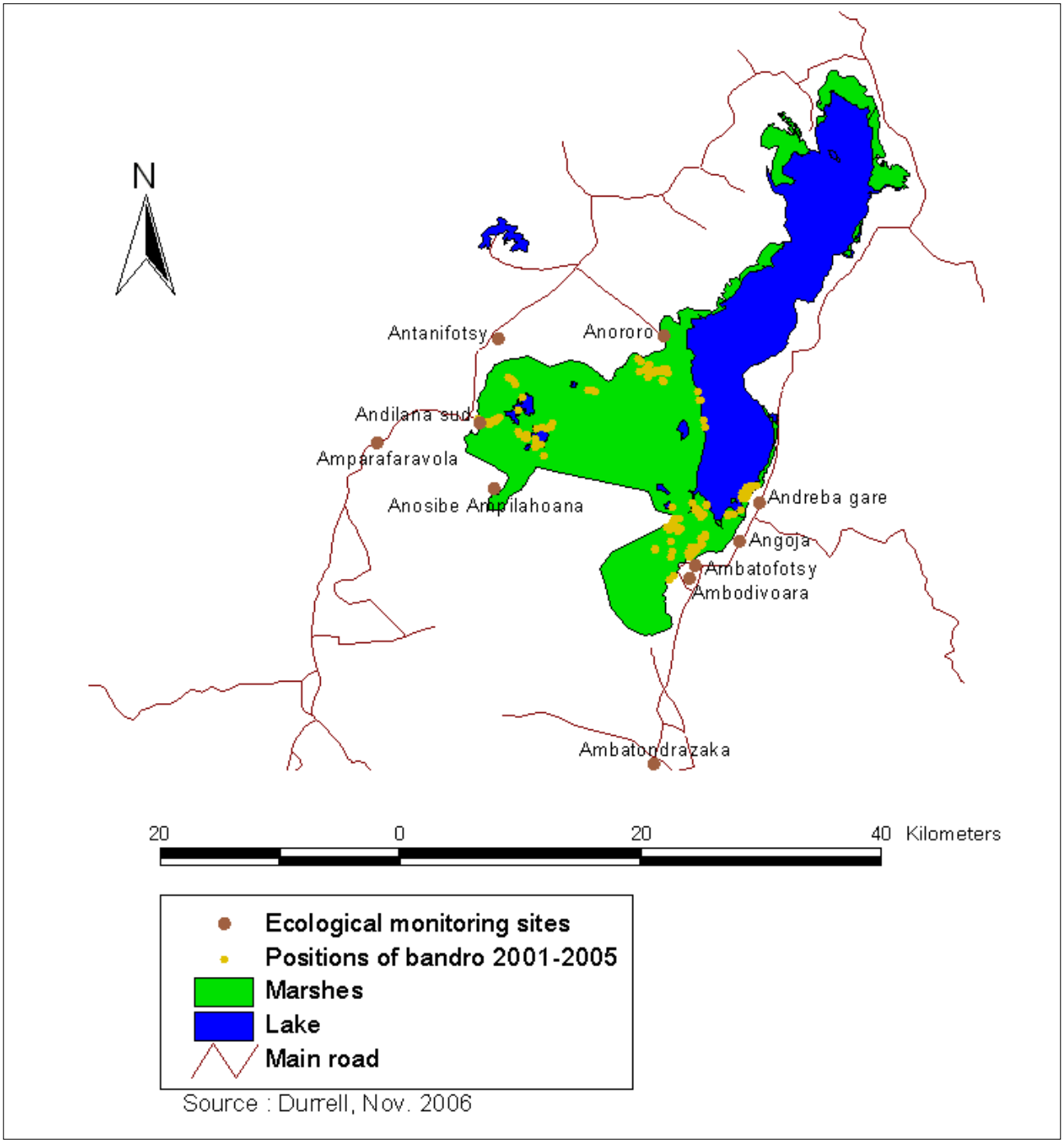

FIGURE 2. Bandro distribution map

the villagers, especially in view of implementing the Ramsar Convention by setting up protection areas at the key sites.

ACKNOWLEDGEMENTS

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EDUCATION

Comic Strips as Environmental Educative Tools for the Alaotra Region

Claudette P. Maminirina[I], Pascal Girod[II] and Patrick O. Waeber[I]

Correspondence:
Patrick O. Waeber
Madagascar Wildlife Conservation
Anthropological Institute and Museum, University of Zurich
CH-8057 Zurich
Switzerland
E-mail: madagascar@mwc-info.net

ABSTRACT

The Alaotra Gentle Lemur (*Hapalemur griseus alaotrensis*) is one of the most endangered lemurs of Madagascar. The wild population struggles for survival in the rapidly disappearing papyrus marshes fringing Lake Alaotra, northeastern Madagascar. The current estimated population size of the Alaotra lemurs is about 3,000 individuals. The largest subpopulations left are found in the marshes around the four villages of Andreba, Ambodivoara, Andilana Sud and Anororo. These sites constitute the main focus of Madagascar Wildlife Conservation's (MWC) environmental education project. In a test phase lasting from November 2006 -February 2007, eight primary school classes will implement a series of educative comic strips dealing with the complexity of the Alaotra lake and marshy ecosystem. The aim of this teaching method is to raise the awareness of the schoolchildren about the importance and significance of their natural environment.

INTRODUCTION

THE WETLAND'S VALUES The wetlands of the Lake Alaotra are known for their complex ecosystems including the reed and papyrus beds which are home to a rich animal community including 72 species of birds and the Alaotra Gentle Lemur (*Hapalemur griseus alaotrensis*), also known as the "Bandro", a species of lemur endemic to the region. The marshes surrounding the lake have several substantial functions and are of fundamental importance for the fauna inhabiting them and for the human population of the basin (Pidgeon 1996). The vegetation serves as a refuge and safe breeding ground for fish and also acts as a natural filter reducing pollution of the lake by breaking down chemicals used in rice production. Furthermore, the marshes store humidity during the dry season benefiting the adjacent rice fields and in turn prevent flooding during annual periods of high rainfall.

ENDANGERED BANDRO The increasing human activity around Lake Alaotra has resulted in a severe loss and fragmentation of natural habitats. Combined with pressures from hunting and fishing, these activities are threatening the survival of many local animal species. The endemic Alaotra Grebe (*Tachybaptus rufolavatus*) and Madagascar Pochard (*Aythya innotata*) might already have gone extinct (Pidgeon 1996) and the Alaotra Gentle Lemur is struggling for survival. While in 1990 11,000 individuals were counted (Mutschler and Feistner 1995), today only 2,500 - 3,500 remain, mostly in isolated subpopulations. If the population continues to decline at this pace, the Bandro will be extinct in less than 40 years (Ralainasolo 2004).

AIMS OF THE PROJECT To promote a public sensitiv ity for the importance of an intact and healthy habitat for certain species, MWC will implement an environmental education programme in the primary schools (EPP) of the region. In order to make learning more interactive and exciting and teaching easier, MWC has chosen to use comic strips as environmental educative tools. A comic book about the importance and peculiarities of lemurs has been tried and tested in other parts of Madagascar (Vaucoulon 1990). However, to cope with the specialities of the Alaotra region, Madagascar Wildlife Conservation aims to develop and publish a comic with the regional characteristics.

There are several long-term goals for this project. First, to widen the horizon and the knowledge of the school children and future adults on the complexity of the natural and agro-cultural environment of the Alaotra region. Second, to help these young people to appreciate their own environment and to encourage them to share what they learn with their respective communities. Third, to point out the links between people's activities and the natural resources of their region. And finally, to become actively responsible for the specialities of their living space and resources and to enable them to protect, to improve and to conserve the productivity of their land.

BACKGROUND

THE REGION OF ALAOTRA Lake Alaotra is the largest lake in Madagascar and is surrounded by a vast wetland area consisting of marshes and rice fields (Nicoll and Langrand 1989). Due to the high productivity of these wetlands, the Alaotra basin is known as the "Grenier de Madagascar" (Granary of Madagascar), producing one third of the annual rice harvest of the country (Pidgeon 1996). Moreover, Lake Alaotra provides the highest amount of sweet water fish in Madagascar: In 2004 2,400 tonnes and in 2005 2,700 tonnes of fish were caught for export to other Malagasy regions, mainly to the capital Antananarivo (Randriamanolosoa Jean, Centre de Surveillences des pêches Ambatondrazaka, pers. com.). 50 years ago, about 100,000

I Madagascar Wildlife Conservation, Madagascar

II Madagascar Wildlife Conservation Switzerland

people lived in this region (Trappe 1987). By 2004, 673,493 people had settled in the region (Démographie 2004).

THE MARSHES UNDER PRESSURE In the last 50 years, the marshes have suffered from an extensive destruction due to the increasing use of these natural resources by humans. For example, large areas have been burnt and transformed into new rice fields. Additionally, the papyrus and reed beds provide the traditional material for the construction of the typical Sihanaka houses, as well as for the weaving products. Lake Alaotra is bordered on two sides by hill chains, which today have been completely deforested for the gain of agricultural and pasture land. Unprotected by the forest, the soil of the hills is washed away during the rainy season and the mud is transported by the rivers towards the marshes, where rice fields are destroyed and irrigation systems silted up (Bakoariniaina *et al.* 2006). The sediments that are not retained by the destroyed papyrus and reed beds are carried into the lake, covering its bed with a thick layer of mud and resulting in an increased water level (Moreau 1987, Pidgeon 1996). The shoreline has also been recorded to advance continually (more than three meters between 1915 and 1974 (Moreau 1987), leading to a decrease in the open water surface of the lake. Within the past 30 years, the lake has lost about five km^2 of its size (Bakoariniaina *et al.* 2006).

EDUCATIONAL SYSTEM IN THE ALAOTRA REGION The Alaotra-Mangoro region (see Figure 1) is divided into five sub-regions or districts: Ambatondrazaka, Amparafaravola, Andilamena, Moramanga and Anosibe An'ala. In 2004, children in the age group of 6-14 years old represented 27 % (or 300,389 people) of the population of the Alaotra-Mangoro region. 18 % of these children were not formally educated due to lack of schools (Education 2004). Furthermore, there is no school obligation, hence it is up to the parents to send their children to school or not.

The Alaotra region is represented by the two districts Ambatondrazaka and Amparafaravola, which cover a surface of 13,463 km^2 (Population 2004). Each district has 20 townships containing several villages. The number of establishments for both districts is similar, with an average of 12 primary schools per township. The internal structure of primary schools is presented in Table 1.

In the Alaotra primary schools, there are on average 44 pupils per class and teacher. It is noted that there is a large imbalance for public schools with 47 pupils per teacher and private schools with 32 pupils per teacher. Furthermore, where the number of teachers in public schools is very low and therefore the number of pupils even exceeds the mentioned average, the chief of the administrative and educational zone (Chef ZAP: Zone Administrative et Pédagogique) and the pupil's parents association recruit additional teachers (often not professionals) and finance their small wages. Such associations make regular school attendance for the children more feasible.

For every school there are five levels of classes starting at level eleven and finishing with level seven. One school year lasts nine months from September to June. Pupils are examined every two months on all the taught courses. The school programme, which is administered by the Ministry of Education, embraces up to eleven subjects, such as French, Arithmetic, Malagasy, Recitation, Music, Drawing, Writing, Sport and during the last two years also Geography, General Knowledge and History. This highlights that, until now, there has been no environmental education program at the level of primary school in this region.

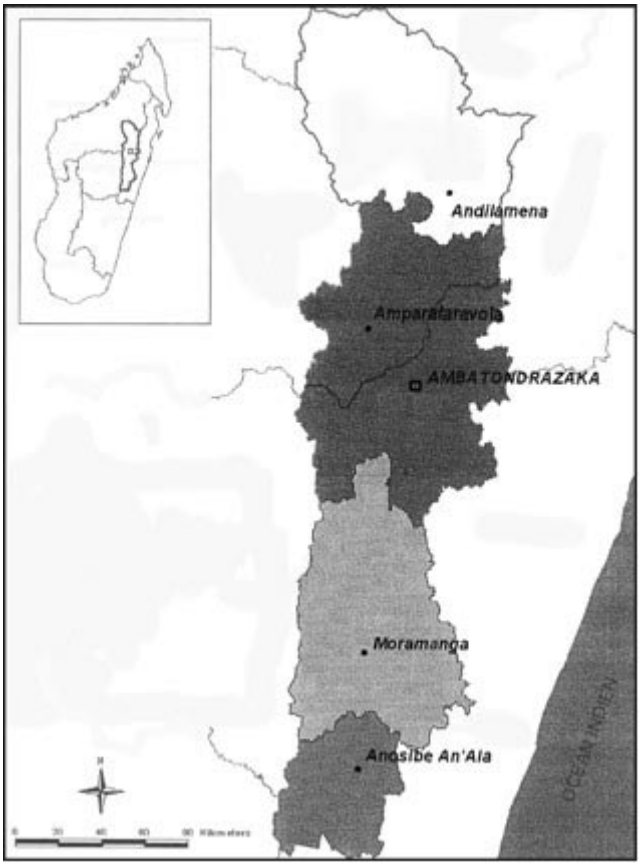

FIGURE 1. The 5 districts of the Alaotra-Mangoro region. Adapted from: FTM, Monographies des Districts 2004 (with kind permission of UGI Région Alaotra-Mangoro)

THE COMIC BOOK APPROACH The comic developed by MWC is divided into eight different thematic episodes (see Table 2) such as hunting, lemurs as pets, the importance of an intact marshy habitat, or the consequence of fires. An episode consists of 12-24 pictures, is written in Malagasy and has its own theme and conservation message. The titles of the episodes already contain the central message. The main characters in the comic strip will be an Alaotra Gentle Lemur called Malala (Malagasy, meaning 'sweet'), a Kingfisher called Haja (Malagasy, meaning 'respect') and a Mellers duck called Solofo (Malagasy, meaning 'generation') as representatives of the wildlife. The villagers' point of view will be represented by two girls (Felana and Lalao) and two boys (Fidy and Tefy).

Using these characters (see Figure 2) has several advantages. First, it is possible to show that both humans and wildlife have their own important uses, and hence often compete, for the same resources (*e.g.*, papyrus stems: humans use them as basketry material, wildlife use them as food). Second, depending on the theme and/or cultural situation, it is more appropriate to have girls than boys or *vice versa* playing a scene (*e.g.*, it is mostly boys that go fishing). The same method and approach is valuable for the wildlife. For example a Kingfisher can represent an expert of fishes whereas a Gentle lemur knows certainly more about papyrus and reed grass. Furthermore, by having the Alaotra lemur or the Mellers duck as main characters, the peculiarity of the fauna can be directly demonstrated and discussed.

Every school child will receive their own personal black and white copy of the comic containing all episodes. They can

TABLE 1. Showing numbers on the Alaotra districts, schools, enrolled school children and teachers (from CISCO, Monographie des Districts, zones de planification 2004 (school year 2003-2004). In *Plan Régional de développement Alaotra-Mangoro*).

DISTRICTS	NUMBER OF ESTABLISHMENTS		Enrolled school children		NUMBER OF TEACHERS	
	Public	Private	Public	Private	Public	Private
Ambatondrazaka	212	35	40,738	7,560	794	196
Amparafaravola	216	39	40,393	5,262	926	202
Alaotra region	428	74	81,131	12,822	1,720	398

TABLE 2. The first column represents the title of an episode (=main message); the second column shows the discussed theme and the third column gives possible additional educative material for the teachers.

TITLE OF AN EPISODE	DISCUSSED THEME IN AN EPISODE	SUPPLEMENTARY MATERIAL FOR TEACHERS
Everyone needs the reed and papyrus beds	Bandro Biology	Locomotion of Lemurs Marsh Plants (Reed; Papyrus)
There is no possibility to hide in the rice paddies	Bandros are at home in the marshes	Rice cultivation methods Importance of the region as 'grenier de Madagascar'
Problems in finding a life partner	Habitat fragmentation	Social structure of the Bandro, migration Biology of reed and papyrus Fire and the regeneration process of reed
Without marshes no more fish	Reed and papyrus is an important breeding ground for fishes to maintain the fish stock of the lake	Fish species of Alaotra Alien Fish species and consequences Biology: from egg to fish The need for a Fishing-restriction in November
Bandros are not pets	Bandros cannot survive in captivity without the appropriate food	Differences between domestic, useful and wild animals
The Bandros are protected by Malagasy law	We should not hunt Bandros	Natural enemies of the Bandro Why are species protected
We plant trees	Sand is fatal for the lake and for the rice paddies	The role of forests in a landscape Consequences of degradation and erosion for agricultural output
Bandros only exists at Lake Alaotra	Tourists are coming from far away to see the Bandro	Lemurs of Madagascar Endemic species to Alaotra

colour it (if pencils are available) and they can take it home and show it to other people.

The episodes are interesting and often humorous but also concise and they transmit only one central message. This message is stated as the title of each episode. The more clearly this central message is directed to the children, the more memorable and long-lasting it will be.

By using dialog of the characters together (*e.g.*, the animal characters are also able to 'speak'), the real and daily life problems can be addressed in a manner that allows children to understand it.

As the comic's girls and boys show different characteristics, real children can identify with their respective counterparts in the comic strips. To further facilitate and deepen the identification between the readers and the characters in the comic, the comic-children are aged between six and eleven years and the stories are written and presented close to reality or real-life situations that children may encounter.

MATERIAL FOR THE TEACHERS In the issues, problems such as destruction of habitat or hunting are introduced and possible reasons for such activities are discussed. However, direct solutions to problems or specific alternatives are not presented. For deeper understanding of the very complex theme, the teachers will receive supplementary educative material for creating the lessons to accompany each issue.

An issue is the starting point for a class discussion or a class activity (*e.g.*, a theatre play or a boat trip in the marshes). It can also function as a promoter of a more elaborate theme such as "lemurs and endemism", or the natural function of a tropical rainforest.

METHODOLOGY

Prior to the comic strip going into production, the storyboards will be checked by Malagasy conservationists and students for regional cultural consistency. It should be a comic designed especially for the Alaotra region and therefore only typical and specific cultural elements from this region should be presented. In a follow up stage, the books as well as the copies for the children will be produced and printed in Madagascar. MWC will distribute paperbacks of the comic strips to the teachers.

In a test phase the comic will be introduced to eight classes (452 children, see Table 3) in four selected villages (Andreba, Ambodivoara, Andilana Sud and Anororo). Beforehand the eight teachers of these classes will be trained in Ambatondrazaka by a Conservation Instructor of the "Parc Ivoloina" (Madagascar Fauna Group), MWC and the CISCO (Circonscription Scolaire, the school authorities) on topics such as Malagasy biodiversity,

TABLE 3. The 8 test-classes presented by village. CE = 9th, CM = 8th level; (chosen in the school year 2005-2006); the age of the pupils varies for the CE level from 9-11 years and for the CM level from 10-12 years.

VILLAGE	TEACHER	SCHOOL LEVEL	NUMBER OF PUPILS
Andreba	Mme Razanamihamina	CE	35
	Mme Razanarivo Meltine	CE	35
Ambodivoara	Mlle Ranantenainasoa Louisette	CE	43
	Mr Randriamiarizaka Tolinirina Media	CE	43
Andilana Sud	Mme Rabeby	CE	73
	Mme Razafimanarivo Marie Augustine	CM	27
Anororo	Mlle Rasoanandriana Jaqueline	CE	102
	Mme Rakotoarimanana Anjarasoa	CE	94
TOTAL			452

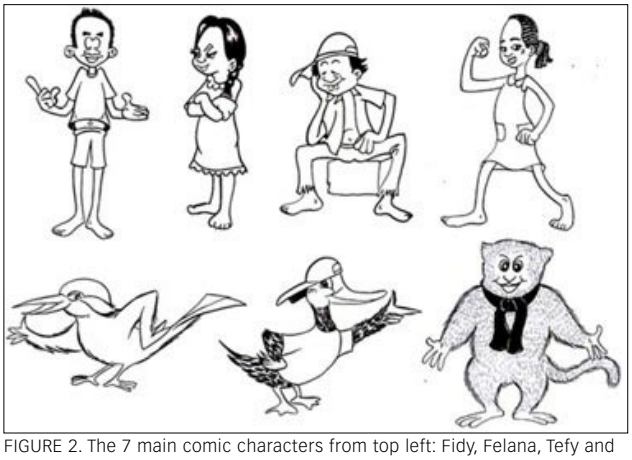

FIGURE 2. The 7 main comic characters from top left: Fidy, Felana, Tefy and Lalao, representing the villagers and from bottom left: Haja, Solofo and Malala, representing the wildlife.

fundamental environmental problems and other related subjects. They also will be informed in detail about the comic and provided with supporting educational material. At the beginning of the 2006-2007 school year, MWC were provide these schools with comic paperbacks. After a four months test phase, MWC will use a questionnaire to evaluate the influence of the environmental education programme on the understanding of the environmental complexities of the lake and marsh system by the test pupils as compared to the control classes (from other villages than of the test classes). MWC aims to have the environmental education implemented in all EPPs of the Alaotra region by 2016.

ACKNOWLEDGEMENTS

First of all, MWC thanks the CISCO of Amparafaravola and Ambatondrazaka and the CIREF (the regional division of the Ministry of Water & Forests) for their collaboration and interest in the comic project. MWC is glad to work with the "Parc Ivoloina" (Madagascar Fauna Group, MFG) in the training of the teachers and would like to thank Karen Freeman (MFG) and Andrea Katz (Lemur Center, Duke University) for their support on this article. MWC is gratefully to Susanne Hagen for her critical comments and to Joleen Timko (University of British Columbia) for her helpful comments and proofreading on the latest version of the article.

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BIODIVERSITE DANS LA DARAINA

Aspects de la Conservation des Reptiles et des Amphibiens dans la Région de Daraina

Hery A. Rakotondravony

Département de Biologie Animale, Faculté des Sciences, Université d'Antananarivo, BP 906 et Ecology Training Program, WWF, BP 738 Antsakaviro, Antananarivo (101).
E-mail: etp@wwf.mg

ABSTRACT

This paper deals with conservation aspects of amphibians and reptiles in the Daraina region, north eastern part of Madagascar, where herpetological surveys undertaken between October 2002 and March 2003 and between October 2003 and March 2004 lead to the discovery of 36 amphibians and 74 reptiles. Thirteen taxa among them are currently known only within the Daraina forest areas, and 20 are listed in the CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) Appendices II and I. These high herpetofaunal species diversity and endemism demonstrate the value of this site in terms of terrestrial vertebrate conservation in Madagascar, and the need of an urgent conservation strategy to protect these natural resources.

INTRODUCTION

L'importance des écosystèmes forestiers naturels malgaches dans le maintien de la biodiversité terrestre n'est plus à démontrer, considérant le niveau de diversité et du taux d'endémicité très importants à Madagascar (cf. Goodman and Benstead 2005). Mais en raison du taux de déforestation très élevé dans ce pays, ces habitats naturels sont parmi les plus menacés au monde. Actuellement, six pour cent des forêts naturels malgaches sont inclus dans le réseau national d'aires protégées (Du Puy and Moat 2003); et d'autres sites méritent également d'être conservés notamment en raison des menaces précitées. Mais à l'égard des limitations auxquelles fait face l'Etat Malgache dans la réalisation et le renforcement des politiques de législations forestières, il est évident que l'insertion d'un site parmi le réseau national d'aires protégées devrait suivre certaines logiques de priorités. Un des critères favorisant l'attribution de statuts légaux de protection pour ce site serait le niveau de diversité et d'endémisme qui est significativement important au moins pour un groupe d'organismes donné. Ce document essaie de démontrer l'importance de la région de Daraina en terme de conservation en abritant des niveaux importants de diversité et d'endémisme en reptiles et amphibiens.

MÉTHODOLOGIE

RÉGION D'ÉTUDES La ville de Daraina (S 13° 12'; E 049° 39') se situe dans la province d'Antsiranana, environ à mi-chemin entre Ambilobe et Vohémar. La région communément appelée «région de Daraina» se trouve à l'extrême Nord-Est de Madagascar, et est délimitée naturellement par les fleuves Loky au nord et Manambato au sud (Figure 1). L'altitude varie de 0 à 1,170 m. La température moyenne annuelle serait de 26°C et la pluviométrie annuelle serait de 1,280 mm (Rakotondravony données nonpubl.).

Les écosystèmes forestiers naturels de cette région se présentent sous forme de fragments et blocs de forêts en mosaïques dans une échelle microgéographique de 44 km^2. Elle se situe dans un carrefour bioclimatique important (Cornet 1974); et avec ses structures pédologiques très complexes (Besairie 1965), elle possède différents types de formations végétales. Ces dernières varient à partir de forêts caducifoliées en dessous de 350 m d'altitude aux forêts humides semi-sempervirentes à plus de 700 m, avec diverses formations de transition dans les étages altitudinaux intermédiaires.

La région de Daraina a été identifiée par Conservation International (1995) comme une des priorités en matières de conservation à Madagascar, surtout en raison de l'existence d'une espèce de primate qui y est endémique (Indridae). L'arrêté ministériel nº 5862/05-MINENVEF du 31 mai 2005 portant création de la Station Forestière à Usage Multiple de Loky-Manambato (70'837 ha) a conduit à l'inclusion de la majeure partie des plus grands blocs forestiers de la région parmi le réseau national d'aires protégées malgaches. La nouvelle aire protégée comprend les sept blocs forestiers les plus importants de la région de Daraina en terme de superficie, Ambohitsitondroina, Ampondrabe, Antsahabe, Antsaharaingy, Bekaraoka, Binara, Bobankora et la forêt littorale de Sahaka.

COLLECTE DES DONNÉES Des séries d'inventaires d'amphibiens et de reptiles ont été conduites dans certains blocs et fragments forestiers de la région de Daraina entre octobre 2002 et mars 2003, et entre octobre 2003 et mars 2004 (tableau 1). Ces mois correspondent aux saisons chaudes et pluvieuses d'activités maximales des amphibiens et des reptiles, favorables à leurs recensements. L'équipe a été composée de l'auteur et d'un assistant de terrain. Trois principales méthodes ont été utilisées: 1) observation directe le long d'itinéraires échantillons; 2) fouille systématique des lieux de refuges et 3) piégeage par trous-pièges («pitfall») avec barrière plastique. Des descriptions de ces techniques sont données dans Raxworthy *et al.* (1998) et Raselimanana *et al.* (2000).

RÉSULTATS ET DISCUSSION

RICHESSE SPÉCIFIQUE Un total de 110 taxons herpétologiques a été recensé dans douze massifs forestiers de la

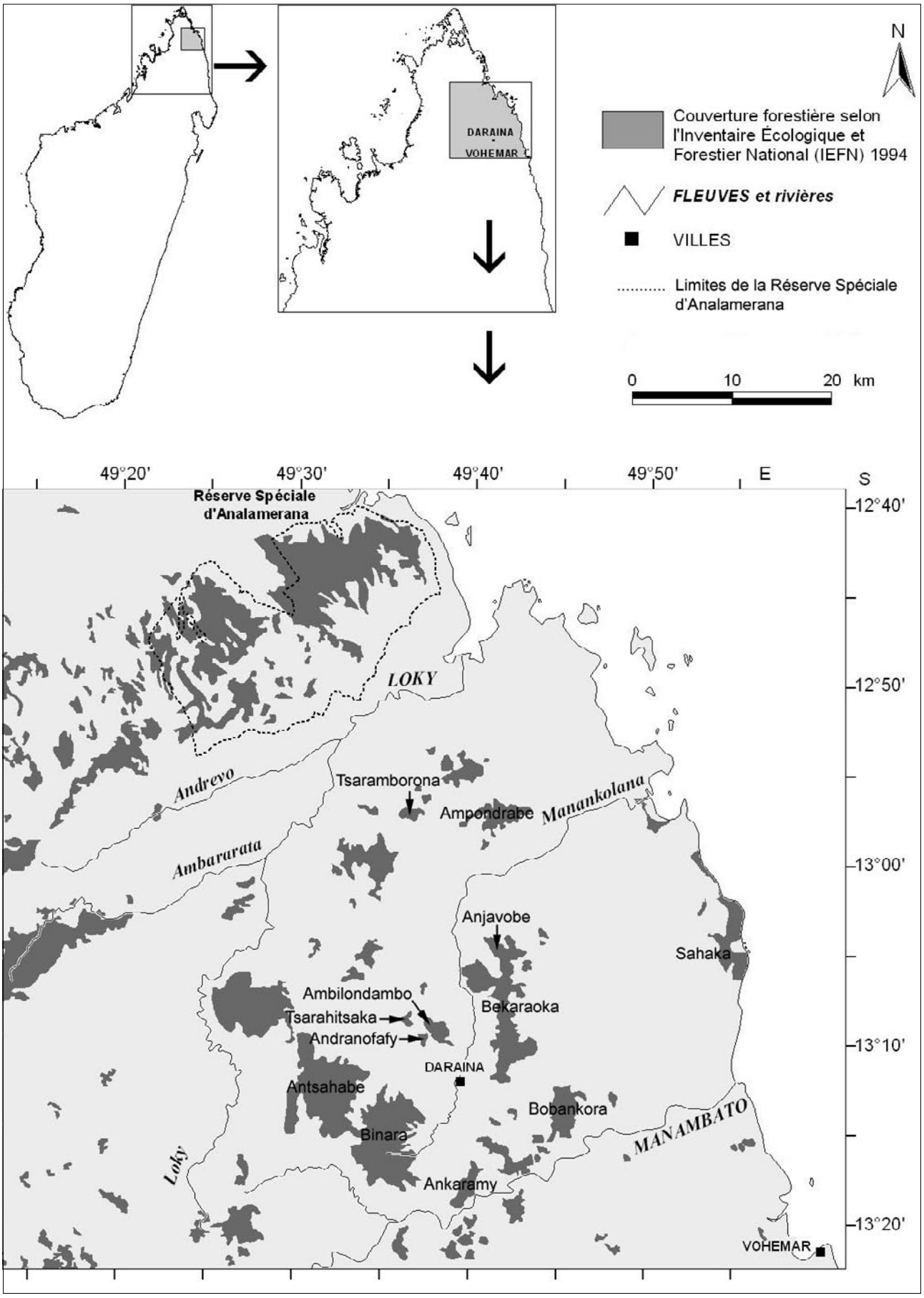

FIGURE 1. Carte montrant les différents blocs et fragments forestiers de la région de Daraina, d'après l'Inventaire Ecologique Forestier National (IEFN), 1994. Cette carte montre que le fragment forestier d'Anjavobe était rattaché au massif de Bekaraoka il y a quelques années mais lors de nos travaux sur le terrain, Anjavobe est actuellement isolé de ce massif. Au nord de la région se trouve la Réserve Spéciales d'Analamerana.

TABLEAU 1. Noms, coordonnées géographiques, superficie, altitude, dates d'inventaire et richesses spécifiques en amphibiens et reptiles des massifs forestiers de Daraina concernés par cette étude.

SITES (SUPERFICIE [ha]; PRESSIONS ANTHROPIQUES[1])	LATITUDE	LONGITUDE	ALTITUDE (M)	DATE D'INVENTAIRE	REPTILES	AMPHIBIENS
Ambilondambo (319; BD, CSB, PZ)	S 13°09,7′	E 049°38,7′	250–540	20–28 jan. 2003	28	7
Ampasibe (67; CSB, PZ)	S 13° 09,9′	E 049°37,8	230–410	01–07 mar. 2004	21	5
Ampondrabe (1231; BD, PZ)	S 12°58,4′	E 049°42,2′	80–580	10 nov.–23 nov. 2003	31	7
Anjavobe (560; BD, PZ, CSB)	S 13°04,0′	E 049°41,4′	90–420	26 nov.–02 déc. 2002	22	5
Ankaramy (472; CSB, PZ, OR)	S 13°17,0′	E 049°40,8′	160–360	29 nov.–05 déc. 2003	25	9
Antsahabe (3404; CSB, PZ)	S 13°12,6′	E 049°33,8′	350–500	16–23 oct. 2003	39	17
	S 13°12,6′	E 049°33,5′	450–950	23–30 oct. 2003		
Bekaraoka (4150; BD, OR, CSB, PZ)	S 13°09,9′	E 049°43,0′	180–330	04–11 déc. 2003	37	11
	S 13°11,7′	E 049°42,6′	170–310	06–13 fév. 2003		
	S 13°10,6′	E 049°42,0′	150–340	07–14 déc. 2003		
	S 13°06,3′	E 049°42,7′	110–360	18–25 nov. 2002		
Binara (4143; CSB, BD, PZ)	S 13°15,7′	E 049°36,4′	610–1070	24–31 oct. 2002	53	25
	S 13°15,2′	E 049°35,5′	710–1170	31 oct.–07 nov. 2002		
	S 13°14,4′	E 049°34,8′	710–1100	07–14 nov. 2002		
	S 13°14,3′	E 049°37,5′	210–550	16–24 oct. 2002 et 15–21 fév. 2004		
Bobankora (1121; BD, PZ, CSB)	S 13°13,4′	E 049°45,6′	350–610	20–27 fév. 2003	40	13
	S 13°13,6′	E 049°45,1′	140–350	13–20 fév. 2003		
	S 13°12,7′	E 049°46,3′	90–350	28 fév–07 mar. 2003		
Sahaka (2678; CSB, BD, PZ)	S 13°04,7′	E 049°54,1′	10–50	23–28 fév. 2004	21	5
Tsarahitsaka (47; CSB, PZ, BD)	S 13°08,9′	E 049°37,4′	230–430	28 jan.–04 fév. 2003	25	6
Tsaramborona (216; CSB, PZ, BD)	S 12°57,4′	E 049°36,8′	150–450	04–10 nov. 2003	21	0

[1] BD = coupe de bois durs, CSB = culture sur brûlis, OR = orpaillage, PZ = pâturage de zébus.

région de Daraina. La liste complète de ces taxons est accessible via l'auteur. La faune herpétologique de ces forêts est caractérisée par le nombre élevé en espèces reptiliennes, une des signes de l'aridité prononcée dans la région. Les amphibiens représentaient 32.7 % (36 espèces) de cette faune, tandis que les 74 espèces restantes (67.3 %) étaient des reptiles. Ce niveau de diversité herpétologique élevé témoigne l'importance de la place tenue par cette région en terme de conservation de la diversité des vertébrés terrestres malgache. Apparemment, peu nombreux sont les sites de la Grande Île ayant des richesses spécifiques en reptiles et amphibiens plus élevées que Daraina. Par exemple, la Réserve Spéciale (RS) de Manongarivo et le Parc National (PN) de la Montagne d'Ambre abritent respectivement 86 et 70 espèces (Rakotomalala 2002; Raxworthy and Nussbaum 1994); tandis que Nosy Be et les îles voisines en abritent 81 (Andreone *et al.* 2003). Raxworthy *et al.*(1998) mentionnent 93 espèces pour la RS d'Anjanaharibe-Sud. Dans l'état des connaissances actuelles, le seul site qui possède une diversité herpétologique avoisinant celle de Daraina serait le PN de Marojejy (113 espèces, Raselimanana *et al.* 2000). Néanmoins, ces comparaisons devraient être traitées avec réserves puisque les efforts déployés dans chacun de ces sites ont été très inégaux, malgré les analogies sur les plans méthodologiques lors des inventaires.

ESPÈCES D'AMPHIBIENS ET DE REPTILES MENACÉES DANS LA RÉGION DE DARAINA La région abrite plusieurs espèces inscrites aux Annexes de la CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) dont deux en Annexe I (*Acrantophis madagascariensis et Sanzinia madagascariensis*, Boidae, Reptilia) et 20 en Annexe II (Amphibia- Mantellidae - Mantella spp.: deux espèces; Reptilia – Chamaeleonidae - Brookesia spp.: quatre espèces, Calumma spp.: deux espèces et Furcifer spp.: quatre espèces; Gekkonidae - Phelsuma spp.: quatre espèces et Uroplatus spp.: quatre espèces). Elles constituent 20 % des espèces d'amphibiens et de reptiles recensées lors de cette étude, ce qui est une proportion non négligeable. Toutefois, aucune collecte de ces espèces à des fins commerciaux n'a été signalée lors des travaux effectués dans la région. La principale menace pour ces espèces est la destruction de leurs habitats naturels par les pressions anthropiques (voir Tableau 1). Il est ainsi évident que la gestion durable de ces espèces dans cette région se situerait dans l'application d'une meilleure gestion de leurs habitats naturels qui sont primordialement les forêts primaires.

IMPORTANCE DE LA DIVERSITÉ DES MILIEUX NATURELS SUR LES RICHESSES SPÉCIFIQUES Nombreux auteurs ont souligné l'importance des grands blocs forestiers dans le maintien de la diversité biologique aussi bien à Madagascar qu'ailleurs. Cependant, une analyse des communautés d'amphibiens et de reptiles des massifs forestiers de la région a montré que la superficie y jouerait un rôle «secondaire» dans la distribution des richesses spécifiques; le facteur le plus important semble être la diversité des habitats naturels engendrés par l'altitude (Rakotondravony, données nonpubl.). En outre, les études effectuées dans cette région mettent en évidence l'existence d'une zonation altitudinale des communautés d'amphibiens et de reptiles dans la région, ce qui signifie l'existence de changements de compositions des communau-

tés d'amphibiens et de reptiles le long du gradient altitudinal. Ce fait joue un rôle important, en y engendrant des niveaux de diversités plus élevés pour les massifs montagneux les plus importants.

IDENTIFICATIONS DES MASSIFS FORESTIERS PRIORITAIRES EN MATIÈRES DE CONSERVATIONS La diversité régionale de Daraina semble être bien représentée dans les massifs forestiers de Binara, d'Antsahabe et de Bobankora. Il est à souligner que ce sont ces trois massifs qui possèdent la diversité d'habitats naturels les plus importants dans la région, en raison de l'oscillation altitudinale plus élevée que l'on y rencontre. Ensemble, les massifs forestiers d'Antsahabe, de Binara et de Bobankora arrivent à conserver 94.4 % des espèces d'amphibiens et 86.5 % des espèces de reptiles forestiers de la région de Daraina (Rakotondravony, données nonpubl.). A première vue, ces massifs de superficies importantes sont les prioritaires en matières de conservation de reptiles et d'amphibiens dans la région de Daraina. Cependant, certaines espèces d'amphibiens et de reptiles n'ont pas été enregistrées dans l'ensemble formé par les trois massifs forestiers les plus diversifiés en reptiles et en amphibiens. Il s'agit de trois espèces d'amphibiens et de 10 espèces de reptiles. La présence de ces espèces semble indiquer l'importance des autres massifs forestiers de moindre superficie dans le maintien de la diversité biologique dans la région.

ESPÈCES SUGGÉRÉES ENDÉMIQUES À LA RÉGION DE DARAINA Les forêts de Daraina possèdent une proportion significative de son herpétofaune qui pourrait y être endémique. Il s'agit de 13 espèces dont l'identification n'a pas pu être établie avec certitude et qui pourraient constituer des formes nouvelles pour la science. Elles constituent 12 % environ de l'herpétofaune de la région de Daraina, un taux qui n'est pas le moindre à l'instar de ceux observés dans d'autres sites de Madagascar: 12 % environ pour le PN du Marojejy (Raselimanana *et al.* 2000) et 13 % pour le PN d'Andringitra (Raxworthy and Nussbaum 1996).

CONCLUSION

Les niveaux de la diversité et d'endémisme importants (rivalisant ceux des autres sites malgaches protégés) confirment l'importance de la région de Daraina dans le maintien de la biodiversité. Ces faits témoignent également que les forêts de la région de Daraina tiennent une place importante parmi le réseau national d'aires protégées de Madagascar. Néanmoins, 20 % des espèces herpétofauniques recensées lors des études sur le terrain sont inscrites aux Annexes I et II de la CITES. La gestion durable de ces ressources naturelles réside dans l'application d'une meilleure gestion de l'ensemble des écosystèmes forestiers dans cette région.

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FIGURE 2. Destruction des forêts naturelles dans le massif de Binara, au sud-ouest de Daraina.

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BUSHMEAT

Communautés locales et gibiers dans la région de Daraina, extrême Nord-Est de Madagascar

Hery A. Rakotondravony

Département de Biologie Animale, Faculté des Sciences, Université d'Antananarivo, BP 906 et Ecology Training Program, WWF, BP 738 Antsakaviro, Antananarivo (101).
E-mail: etp@wwf.mg

ABSTRACT

Wild meats take part in the daily protein sources for many Malagasy rural communities. Many animal species are affected by hunting, which is practiced during almost all seasons in Madagascar. In the Daraina region, animal groups hunted by local people are mainly mammals, birds, fishes, and reptiles. As the natural habitats within this region are actually highly perturbated by human activities, and as this region shows a high population growth, hunting may constitute a severe threat for many species. Sustainable management of these later depends on local population awareness regarding the threats of intensive hunting on animals as well as on the natural ecosystems.

INTRODUCTION

Presque partout en milieu rural à Madagascar, les sources de protéines journalières sont généralement limitées, et sont surtout d'origines végétales. Selon la qualité du sol, le régime climatique et la tradition, ces dernières varient d'une région à une autre, à partir du riz – base de l'alimentation des malgaches – jusqu'à divers rudiments alimentaires (ex. beignets dont la base varie également d'une région à une autre). Pour la majeure partie des malgaches, les protéines animales sont actuellement difficilement accessibles. Signes de richesses et la plupart du temps vendues à des prix hors de la portée des communautés rurales, les viandes de zébus et celles d'autres ovins ne se consomment généralement que pendant les périodes festives.

Pour ces différentes raisons, les viandes sauvages tiennent des places plus ou moins importantes dans l'alimentation des malgaches. Les espèces concernées ainsi que leurs quantités varient d'une région à une autre. Pour les régions marécageuses, fluviatiles ou littorales, les animaux chassés incluent les poissons, les oiseaux, les tortues d'eau douce ou marines, etc. Dans les régions forestières il s'agit d'autres groupes d'animaux tels que les oiseaux, les lémuriens, les sangliers et dans certains cas des reptiles (voir Goodman and Benstead 2003) et les ressources cynégétiques forestières peuvent constituer jusqu'à 27-28 % des produits extraites dans les forêts (60 % environ pour les bois de construction; Rabesahala Horning 2003). Le but de ce document est de donner une liste d'animaux sauvages potentiellement chassés dans la région de Daraina et de donner de brefs aperçus sur les conséquences éventuelles des chasses sur leurs populations.

LA RÉGION DE DARAINA

La région de Daraina est comprise entre les fleuves Loky au Sud et Manambato au Nord, dans l'extrême Nord-Est de Madagascar. Le relief, l'existence des reliques forestières et du lac Sahaka (à l'est de la région) conduisent à l'existence de différents types d'habitats où se trouvent une diversité biologique importante. Jusqu'à une période très récente, aucun des habitats forestiers de la région n'était pas protégé et leurs exploitations s'étaient effectuées de manières traditionnelles: cultures sur brûlis, collectes de bois durs et exploitations aurifères artisanales, chasses et pêches.

Sur le littoral est de Daraina se trouve la Réserve de Chasse du lac Sahaka (120 ha) qui a été établie le 13 février 1969 par l'arrêté 0711 MAAER / FIN. Son but était de protéger la faune tributaire de ce lac. La chasse est en principe interdite dans cette réserve; mais au-delà de laquelle, dans la zone appelée Réserve Cynégétique (730 ha), les chasses sont permises, selon l'arrêté ci-dessus, de mai en septembre. Les chasseurs devraient obtenir des permis de collectes délivrés par le Service des Eaux et Forêts de Vohémar, d'Antalaha ou d'Antsiranana, puis les présenter auprès des chefs d'administrations locales et y payer les droits de chasse (Safford 2000).

La population de la région de Daraina est actuellement composée de 30,000 personnes environ. A part les flux migratoires importants des années 80 et 90 relatifs à la découverte de gisements aurifères dans la région, la croissance démographique actuelle reste stationnaire mais importante, environ 4 à 5 % par an entre 1998 et 2003 selon les données de bases de l'Institut National de la Statistique de Madagascar. Ces populations sont d'origines différentes, mais les ethnies présentes dans la région (par ordre d'importance en nombre) sont les Sakalava Anjoaty, les Tsimihety, les Betsimisaraka, les Sakalava Makoa, les Merina et les Antemoro. Ces ethnies possèdent leurs propres traditions (*i.e.* tabou) à l'égard de la consommation d'animaux sauvages. Il existe, néanmoins, des espèces dont la consommation n'est pas en général considérée comme tabou, et sont chassées d'une manière plus ou moins importante.

ESPÈCES ANIMALES CONCERNÉES PAR LA CHASSE ET LA PÊCHE DANS LA RÉGION DE DARAINA

Nombreuses espèces animales sont chassées par les communautés locales dans la région de Daraina. La chasse à certaines espèces discutées ici (surtout les oiseaux aquatiques) n'était

pas observée dans la région; et leur inclusion dans cette discussion est essentiellement basée sur le fait qu'elles sont chassées dans d'autres régions de Madagascar. Mais à l'égard de la différence des us et coutumes observée presque partout dans l'île, on ne peut pas fermement rapporter ici qu'ils sont ou ne sont pas activement chassés dans la région.

MAMMIFÈRES Dans l'ensemble la région de Daraina, l'espèce la plus prisée en tant que gibier est le tenrec (*Tenrec ecaudatus*, Tenrecidae; figure 1). Cette espèce abonde aussi bien dans les savanes boisées qu'en milieux forestiers. Les populations locales chassent tous les individus qu'ils jugent (de par leurs tailles) subadultes ou adultes, mâles ou femelles, excepté les femelles gravides et les juvéniles. La chasse commence dès la sortie de l'espèce de l'hibernation, à partir de la mi-novembre. Malgré cela, les chasses intensives semblent actuellement ne pas avoir affecter la population de cette espèce dans cette région.

Les Mégachiroptères (fanihy en malgache) sont parmi les animaux fortement chassés à Madagascar (MacKinnon et al. 2003). L'espèce *Pteropus rufus* (Pteropodidae) est représentée par une population importante dans la forêt d'Analabe-Sahaka, sur le littoral est de la région (Safford 2000; obs. pers.). Safford (2000) a estimé cette population entre 1000 à 1500 individus. Les gens du village d'Añaborano, un des villages les plus proches de la lisière de cette forêt, en majorité Sakalava, affirment ne pas consommer de fanihy. Néanmoins, des immigrants observant différentes traditions pourraient constituer une menace pour cette espèce dans la région. En plus, Safford (2000) suspecte des cas probables de consommations de cette espèce du côté d'Ankalotany; et certains hôtels du Nord et du Nord-Ouest de Madagascar mettent généralement les fanihy parmi leurs menus. Par conséquent, la population de Pteropus rufus d'Analabe-Sahaka pourrait être concernée par la chasse bien qu'elle ne semble pas être gravement menacée dans les temps actuels.

Le sanglier Potamocherus larvatus (Suidae) est le gibier le plus important en terme de masse corporelle dans cette région et semble également être abondante. Les jeunes gens chassent souvent cette espèce pour la raison qu'elle pourrait engendrer des dégâts importants aux cultures (saisonnières) de riz. Aucune période n'est pas spécialement consacrée pour traquer «l'espèce nuisible». La majeure partie des locaux de la région n'en mange pas la viande; et dans le cas où un individu serait capturé, la viande est souvent donnée aux chiens, quelquefois vendue sur le marché local à bas prix (environ la moitié de celui de la viande de zébus). Les gens qui les consomment appartiennent généralement à d'autres ethnies (surtout les Betsimisaraka et les Merina). L'importance apparente de la taille de la population de cette espèce dans la région de Daraina suggère qu'elle ne semble pas être affectée par la chasse actuellement.

Randrianarisoa *et al*. (1999) ont fait mentionner quatre espèces de lémuriens qui sont chassées dans la région de Daraina: *Eulemur coronatus*, *E. fulvus sanfordi* (Lemuridae); *Lepilemur* sp. (Megaladapidae) et *Propithecus tattersalli* (Indridae). La consommation de cette dernière est tabou pour les Sakalava. Cependant, cela ne la met pas totalement à l'abri puisque, par exemple selon M. Théodore (chef quartier d'Ambatoharanana, comm. pers.), dans les années 1990 pendant lesquelles les exploitations aurifères étaient les plus importantes dans la région de Daraina, presque toutes les espèces de lémuriens ont été chassées. Par ailleurs, ce groupe

FIGURE 1. Tenrec ecaudatus (Tenrecidae), une des espèces la plus chassée dans la région de Daraina.

est largement chassé presque dans l'ensemble de la région Nord de Madagascar (voir Goodman and Benstead 2003). Dans quelques massifs forestiers, *Propithecus tattersalli* (Indridae) et *Lepilemur spp.* (Megaladapidae), se familiarisent facilement à la présence humaine (obs. pers.). Ce type de comportement constituerait un risque important pour ces espèces vis-à-vis de la chasse; mais pourrait également signaler que cette pratique serait plus ou moins limitée dans cette région. En outre, compte tenu de la régression de la couverture forestière dans la région, cette pratique aggraverait la situation de ce groupe d'animal par rapport à sa conservation.

OISEAUX Les tabous et restrictions alimentaires à l'égard de la faune aviaire semblent moins vigoureux à Madagascar; et les malgaches mangent nombreuses espèces d'oiseaux de différentes tailles (cf. Ekstrom 2003, Goodman and Wilmé 2003, Young 2003). Presque toutes les espèces sont susceptibles d'être chassées, exceptées (en général) les Falconiformes, les Strigiformes et les martins-pêcheurs (Alcedinidae). La région de Daraina n'échappe pas à cette situation. En milieu forestier, l'espèce la plus chassée est *Lophotibis cristata* (Threskiornithidae), apparemment en raison de sa taille plus importante. Cette espèce a été observée assez fréquemment dans les forêts de Daraina. Les informateurs locaux du côté d'Ankijabe affirment avoir chassé cette espèce pour de nombreuses fois. En dehors de cette espèce en milieu forestier, les autres ne sont chassées vraisemblablement que d'une façon très occasionnelle. Mais dans la région du lac Sahaka, nombreuses espèces d'oiseaux aquatiques existent et sont également susceptibles d'être chassées : *Phalarocorax africanus* (Phalacrocoracidae); *Anhinga rufa* (Anhingidae); nombreuses Ardeidae (*Ardea sp.*, *Bubulcus sp*., Egretta sp., etc.) et Rallidae (ex. Anas sp.).

REPTILES Quatre espèces sont connues consommées par les gens de la région de Daraina: Acrantophis madagascariensis (Boidae); Pelusios castanoides (Pelomedusidae) et Eretmochelys imbricata et Chelonia mydas (Cheloniidae) (Safford 2000; obs. pers.). Dans la région de Daraina, le boa terrestre A. madagascariensis a été surtout observé dans les savanes boisées ou les forêts dégradées. Les ethnies originaires des zones côtières de Madagascar (Sakalava, Tsimihety, Betsimisaraka et Antemoro) ne consomment pas cette espèce. Actuellement, la chasse semble encore ne pas affecter sa population dans la

région. La raison serait que les Merina, seuls consommateurs de cette espèce dans la région, semblent les chasser de manière très occasionnelle. *C. mydas* et *E. imbricata*, des tortues marines, ont été rapportées nidifiant mais fortement chassées dans certains endroits du littoral est de Daraina (Safford 2000). Concernant *P. castanoides*, bien qu'aucune chasse n'est enregistrée dans la région de Daraina (Safford 2000), cette espèce est consommée dans la région d'Analamerana, environ à 65 km au nord de la région de Daraina (H.A. Rakotondravony non-publiées). Elle figure par conséquent parmi les espèces qui peuvent potentiellement être des gibiers. Pour *Crocodylus niloticus* (Crocodylidae), cette espèce n'est pas généralement consommée dans le Nord de Madagascar, et aucune chasse à cette espèce n'était observée ni rapportée dans la région de Daraina.

POISSONS Safford (2000) a signalé sept espèces de poissons récoltés par les pêcheurs dans le lac Sahaka en août 1999: deux espèces allogènes du genre *Oreochromis* (Cichlidae); et cinq espèces indigènes: *Eleotris sp*. (Eleotridae); *Glossogobius sp.* (Gobiidae); *Mugilidae sp*.; *Anguilla sp*. (Anguillidae) et *Megalops cyprinoides* (Megalopidae). Cet auteur a fait rapporter également que ces Cichlidae (non-endémiques malgaches) représentaient 90% de ces récoltes. Lors de nos séjours (février 2004) dans la région du lac Sahaka, ces Cichlidae composaient apparemment 100 % des poissons attrapés par les pêcheurs. La pêche constituait l'activité la plus importante aux alentours du lac bien que cette période était loin de celles autorisées pour pêcher dans la région de Sahaka. Cette activité hors des saisons propices semble affecter les structures des communautés de poissons dans ce lac où les biomasses des espèces endémiques sont déjà largement dominées par les espèces allogènes.

AUTRE TYPE DE CHASSE ET SON IMPACT La collecte de miel (produit par *Apis spp*., Apidae) constitue une des activités forestières les plus importantes pour les populations de la région de Daraina, surtout pour celles vivant près des lisières forestières. Les miels sont généralement collectés de façon aléatoire, i.e. les collecteurs ignorent si les miels sont prêts ou non à être récoltés; et ils n'hésitent pas d'abattre de gros arbres pour en collecter 1,5 à 3 litres de miel (si la récolte est bonne). Quelques cas d'abattages de gros arbres pour les miels étaient observés dans la région, notamment dans les forêts de Binara, de Bobankora, d'Ampondrabe, d'Andranotsimaty et d'Ambilondambo.

CONCLUSION

Comme presque partout dans les régions rurales de Madagascar, les animaux sauvages constituent la principale source de protéines animales dans la région de Daraina. Le prélèvement des produits animaux peut affecter aussi bien des espèces particulières que l'ensemble de l'habitat où les produits sont récoltés. Toutefois, sans l'évaluation de la démographie des espèces concernées, il serait encore actuellement difficile de confirmer si les prélèvements affectent ou non ces espèces. Cependant, la croissance démographique importante dans la région suggère des pressions anthropiques de plus en plus importantes. La seule façon de gérer de manière durable ces potentialités naturelles réside dans la sensibilisation des communautés locales faces aux menaces que constituent la pratique intensive de la chasse aussi bien sur les animaux que sur l'ensemble des écosystèmes naturels, et dans la définition et l'application de législations forestières bien définies pour les écosystèmes de la région de Daraina.

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SOLAR COOKING IN MADAGASCAR

Solar Cooker Project of ADES

Heinz Vetter

Technikumstrasse 62, CH-8401 Winterthur
Switzerland
Telephone: +41 52 2134477
E-mail: heinz.vetter@cores.ch

ABSTRACT

The article describes the contribution of the ADES (Association pour le Développement de l'Énergie Solaire Suisse-Madagascar) Solar Cooker Project in the south of Madagascar: fighting the ongoing deforestation, preserving the environment and fighting poverty. It explains advantages and disadvantages of solar cooking and the challenges to change traditional cooking habits. It shows the achievements of the project after five years of existence and the future goals and long term perspectives of ADES in the field of cooking methods and in the field of electricity in rural areas by using renewable energies.

WHAT IT IS ABOUT

COOKING WITH SOLAR COOKERS INSTEAD OF WOOD: For centuries the population of Madagascar has been cooking their food with wood, which requires vast amounts of firewood in the form of charcoal. A Madagascan family uses about 100kg of charcoal on a monthly basis, amounting to 1/6 of an average monthly salary. Madagascar has, especially in the south of the country, close to ideal conditions for the use of solar energy.

The solar cookers are an important contribution towards halting the deforestation process and thereby preserve the environment. At the same time they help in fighting poverty. 500 solar cookers save 5,500 tons of wood a year, which translates into 1,000 hectares of woodland in the south of Madagascar. There is no CO_2 emission, which is the main agent responsible for climate change. The population will become less dependent on wood and charcoal. Besides environmental reasons there are also economical and practical reasons to favour the solar cooker. Families spend a lot less money on wood and charcoal. There is a pay back on the investment after only 6 months of using the solar cooker. Furthermore cooking with the solar cooker is hygienic, there is no smoke to affect health and therefore reduces life expectancy. Housewifes report they have more time for other work as the fire doesn't need to be tended. Also, the solar cooker is less dangerous for children than it is with cooking on the open fire.

Nevertheless there are also some disadvantages of the solar cooker. It cannot be used to cook breakfast and meals in the evening when there is no sun. In the box type solar cooker the cooking time takes about 50–100% longer than on the open fire since it is low temperature cooking. On the other hand the meals cannot be overcooked.

WHAT IS A SOLAR COOKER (BOX TYPE SOLAR COOKER)?: The box type solar cooker is an easily built, insulated box (Figure 1). Due to incident solar radiation temperatures up to 150 °C can be generated in the box which is sufficient to cook almost all meals: rice, manioc, mais, potatoes, vegetables, meat and fish. Also bread and cakes can be baked and medical tools or water can be sterilised. There are also other kinds of solar cookers, like the parabolic solar cooker or the solar dryer to dry vegetable, fruit, leaves and fishes.

THE CONSTRUCTION, PRODUCTION AND SALES OF SOLAR COOKERS IN TULÉAR AND EJEDA: Local craftsmen produce the box type solar cooker in the ADES workshop in Tuléar and since April 2006 also in Ejeda in the South of Madagascar. ADES (Association pour le Développement de l'Énergie Solaire Suisse-Madagascar) is a Non-Governmental Organization (NGO) and a non-profit organization, producing solar cookers in Madagascar and encouraging the use of renewable energy. ADES sells the solar cookers to the population and can offer a fair price due to donations. Teaching the population to use the solar cooker is an important part of ADES work. Demonstrations on how to use the solar cooker regularly take place.

HOW IT ALL HAPPENED: Regula Ochsner, the initiator of the solar cooker project, worked for a women's program in Tuléar in the south of Madagascar between 1972 and 1975 for the Swiss development aid agency (now called DEZA). In 1998 she revisited Madagascar and was shocked when she noticed that entire forests had been cut down leading to the loss of diverse and unique animals and plants. She realized that within a short time the country would lose its livelihood if the deforestation continued at this rate. As the main part of the chopped wood was being used as firewood or charcoal to prepare the food, Regula Ochsner began looking for alternative cooking solutions. Her search lead her to the solar cooker, a technology that was already known. In 2001 local production of solar cookers by Malagasy carpenters began under a tent. Also distribution and sales started. ADES was founded. In 2003 the own carpentry workshop began its operation in Tuléar and in 2006 in Ejeda, located 250km in the south of Tuléar.

DEVELOPMENT OF THE PROJECT: Since its start in 2001 the project has developed positively. ADES works closely with various cooperation partners like Soltec, WWF, Tany Meva, ANGAP, Bel Avenir in Tuléar, association des femmes of Ankoronga, ESSVA school of Antsirabe as well as governmental

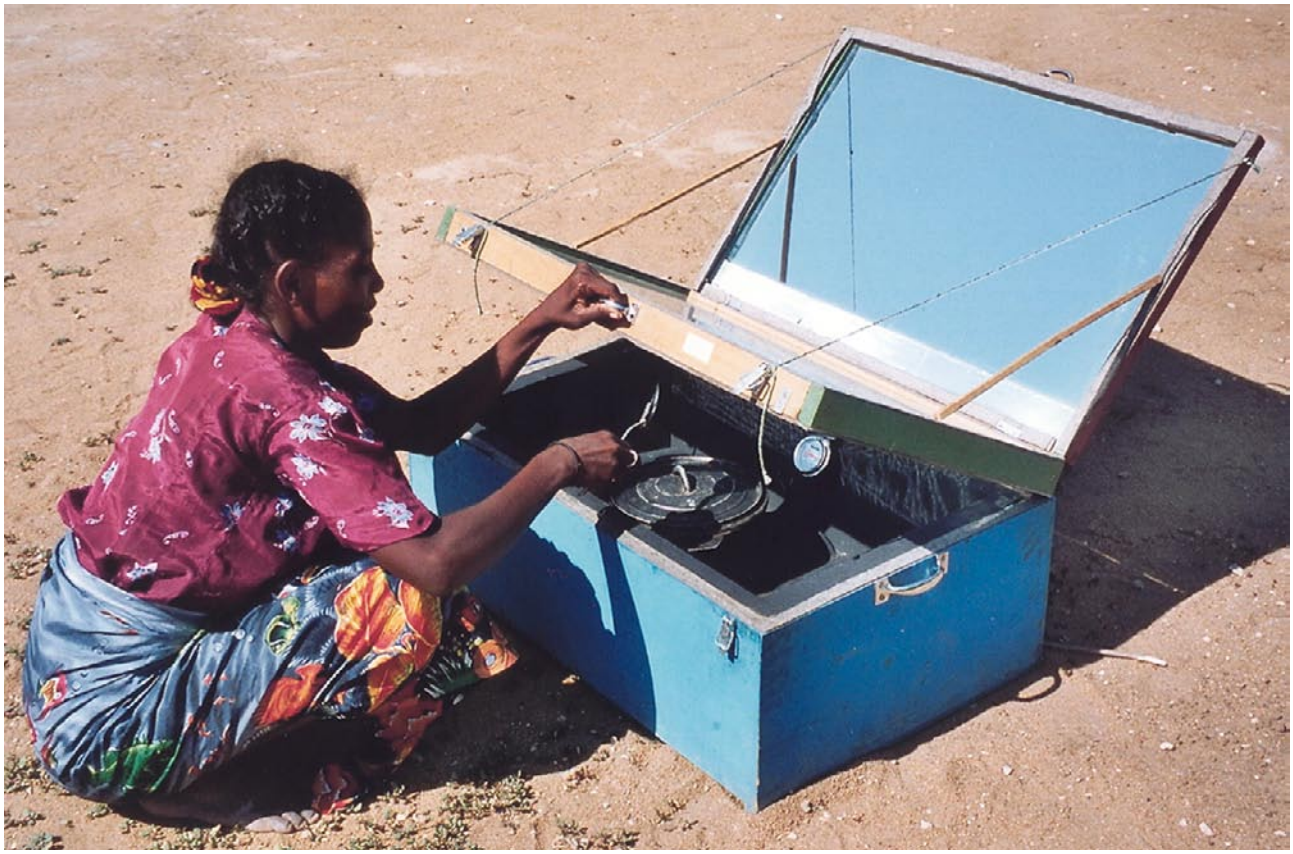


FIGURE 1. Cooking with the solar cooker

organizations on the state and the province level. ADES has developed into a small non-profit enterprise. Currently ADES provides a work place for 13 employees in Tuléar and Ejeda in the South of Madagascar. By the end of 2005 1,300 solar cookers had been sold at a fair price to the population. A survey of the usage of the solar cookers conducted by two German students in 2004 showed that 75% of the solar cookers were used regularly. These are very positive signs but nevertheless there is still a long way to go until solar cooking becomes more widespread.

LONG TERM PERSPECTIVES AND THE FUTURE DIRECTION OF ADES

SOLAR COOKING: ADES has the vision that within 20–40 years a large part of the population in the south of Madagascar is predominantly using solar cookers to prepare their food. In this region we encounter a very rich environment that is worth preserving. Due to the favourable conditions of 350 sunny days per year the South is ideal for using solar energy. ADES therefore focuses its activities on the south of Madagascar, the Province of Tuléar, which is four times as big as Switzerland.

In order to cover the whole south ADES is planning to build various regional and local centres for solar cooking within the next 8 to 10 years. Two regional centres are planned in Morondava (about 300 km north of Tuléar) and in Fort Dauphin (ca. 350 km south-east of Tuléar). The regional centres will be based on the same concept as the centre in Tuléar. For each regional centre the construction of 2–3 local centres is planned in order to reduce the level of transportation on the poor roads. The solar cookers will be introduced to the surrounding villages via the regional and local centres. Each centre consists of a carpentry workshop for the production of the solar cookers and a sales and demonstration office. The realization of these projects will very much depend on the financing. Up to the present time the financing of two centres (investment and yearly operation) is possible through the fundraising activities of ADES in Switzerland. For further centres other financial sources have to be found.

In general the interest of people for solar cooking is big, but it needs a lot of work to convince the people to apply this new way of cooking like a daily routine. Since solar cooking means a completely new cooking method and therefore a change in cooking habits and attitudes. Changing attitudes and habits is not easy, as we know by our own experience: Are we in the western countries willing to reduce individual car traffic to reduce the CO_2 emission? The biggest challenge is convincing the people and slowly implementing the new method of cooking. In order to enforce and support this process ADES has planned many different efforts in the near future: Radio, TV and press advertising; education programmes in the usage of the solar cooker for the population in both the countryside as well as in the cities; educational films for children that will be shown in cinemas, raising children's awareness in schools for environmental questions and solar cooking as a method to preserve the environment; cooperation with partners like WWF, women associations etc.

ADES continuously cooperates with partners that are involved with other similar projects. One of them, for example, is Soltec in Antananarivo, a German-Malagasy NGO, which produces the parabolic type solar cooker. This type is also part of the ADES product programme. ADES does not produce it but sells the Soltec parabolic type solar cooker in the south as a

reseller. In this way cooperation between different organizations that are working in the same field can be reached.

IMPROVED TRADITIONAL COOKING: ADES is often reminded that the solar cooker cannot be used in the early morning and in the evening when there is no sun. Since a lot of people in Madagascar eat warm rice for breakfast this is a strong argument. In order to cope with these needs ADES now completes its product programme with an improved traditional cooking device that saves up to 40% of the charcoal. Professor Daniel Ramampiherika, a member of the ADES board in Tuléar, had the idea and the concept. The production of this new device has just started a few weeks ago. It is a low tech product and all components can be produced in Madagascar. It will be promoted together with the solar cooker. ADES considers the solar cooker and the improved traditional cooking device as an ideal combination to fight the ongoing deforestation and the poverty by saving a lot of money for charcoal and wood. The improved cooking device can be used in the early morning and in the evening and the solar cooker during the day.

FAVOURABLE CONDITIONS FOR FIGHTING AGAINST DEFORESTATION: Although the need for means to protect the environment is enormous and very urgent – some people say it is a race against time – the experience tells us that it will develop step by step, "slowly slowly" or "mora mora" as the people in Madagascar say. But the time for these various initiatives seems to be right as the conciousness of many people of Madagascar to protect the environment is increasing. The country and the population also want to increase gentle tourism and have realized that the preciousness of Madagascar's habitat and nature are an attraction for tourists. Should this all be destroyed it would mean the end of tourism. Governmental circles as well as the World Bank Group have come to realize the importance of regulating and reducing deforestation and are actively supporting several aid projects.

BRINGING ELECTRICITY TO RURAL AREAS BY USING RENEWABLE ENERGIES: It is one of the goals of the government of Madagascar to bring electricity to rural areas to support rural development and to fight poverty. In rural areas only 4% of the population does have electricity. The government very much favours the application of renewable energies, in the high planes hydroenergy and in the south solar and wind energy. Encouraging the use of renewable energies is also an ADES goal. ADES has become a partner of the provincial government in Tuléar in order to encourage renewable energy, mainly solar energy, in the province of Tuléar. Concrete projects have been worked out and are currently being discussed with organizations that may provide financial support. The further development of ADES in this field very much depends on the projects that can be realized.

In the past five years the ADES project has developed very positively, step by step. This will also be the philosophy for the years to come – a continous, but careful development of the activities, as well as the funding and organization.

ADES homepage: www.adesolaire.org

Translation to English by: Michael Spiess, Albisstrasse 37, CH-8038 Zurich, Telephone: +41 78 8137901

SODIS

Establishing Solar Water Disinfection as a water treatment method at household level

Regula Meierhofer

Swiss Fed. Institute of Aquatic Science and Technology (EAWAG)
Dept. of Water and Sanitation in Developing Countries (SANDEC)
Ueberlandstrasse 133
CH-8600 Duebendorf
Switzerland
E-mail: regula.meierhofer@eawag.ch

ABSTRACT

1.1 billion People worldwide do not have access to safe drinking water and therefore are exposed to a high risk for diarrhoeal diseases. As a consequence, about 6,000 children die each day of dehydration due to diarrhoea. Adequate water treatment methods and safe storage of drinking water, combined with hygiene promotion, are required to prevent the population without access to safe drinking water from illness and death.

Solar water disinfection (SODIS) is a new water treatment to be applied at household level with a great potential to reduce diarrhoea incidence of users. The method is very simple and the only resources required for its application are transparent PET plastic bottles (or glass bottles) and sufficient sunlight: microbiologically contaminated water is filled into the bottles and exposed to the full sunlight for 6 hours. During solar exposure, the diarrhoea causing pathogens are killed by the UV-A radiation of the sunlight.

At present, SODIS is used by about 2 Million users in more than 20 countries of the South. Diarrhoea incidence of users significantly has been reduced by 30 to 70 %. A careful and long-term community education process that involves creating awareness on the importance of treating drinking water and initiates behaviour change is required to establish the sustainable practice of SODIS at community level.

In Madagascar, more than 160 children younger than 5 years die each day from malaria, diarrhoea and acute respiratory illnesses. The application of household water treatment methods such as SODIS significantly could contribute to improve their health.

THE NEED FOR WATER TREATMENT

Water in sufficient quantity and good quality is essential for live. However, at the beginning of the year 2000 one sixth of the world's population, 1.1 billion people is without access to improved water supply and many more are without access to safe water (Unicef, 2000). The water quality in improved water supply systems often suffers from unreliable operation and lack of maintenance, or the water is subject to secondary contamination during collection, transport and storage.

The lack of access to good quality drinking water leads to a high risk for waterborne diseases such as diarrhoea, cholera, typhoid fever, hepatitis A, amoebic and bacillary dysentery and other diarrhoeal diseases. Each year 4 billion cases of diarrhoea cause 2.2 million deaths, mostly among children under the age of five (WHO, 2000). This is equivalent to one child dying every 15 seconds, or 20 jumbo jets crashing every day.

The public health condition in developing countries can abruptly change to the dramatic circumstances of spreading epidemics. Cholera for example remains a danger for such an epidemic outbreak. It is endemic in 80 countries and still a concern to all regions of the world. The number of deaths caused by cholera has declined over the last decades due to the application of simple and adequate curative treatment methods (oral rehydration therapy). Adequate water treatment methods and avoidance of secondary contamination of drinking water, combined with hygiene promotion, are required to prevent the population without access to safe drinking water from illness and death.

The simple act of washing hands with soap and water can reduce diarrhoeal disease transmission by one third (Unicef, 2000) (Figure 1). Promotion of household centred water treatment methods should therefore always be combined with hygiene training. Three key hygiene behaviours are of greatest likely benefit:

– Hand washing with soap (or ash or other aid)
– safe disposal of faeces
– safe water handling and storage (Unicef, 2000).

Thus, incorporating water treatment, safe water storage and health education into a single program is more likely to have a positive long lasting effect on public health.

FROM CENTRALISED SYSTEMS TO A HOUSE-HOLD CENTERED APPROACH

Much effort has been placed in the past by governments in developing countries on the installation of sophisticated water treatment plants and public water supply systems especially in urban areas, while the rural population often has remained neglected.

The conventional water treatment plants and distribution systems however often fail to produce and distribute water safe for consumption. The lack of trained operators, reliable supply of chemicals and spare parts, as well as financial constraints, often hinders a reliable operation and maintenance of the system. Water shortages lead to interruptions in the supply and leaky distribution systems worsen the situation. In addition, the rapid population growth in urban areas puts an excessive stress on the existing water and sanitation infrastructures and creates enormous problems in the planning and construction of new infrastructure.

FIGURE 1. Washing hands with soap and water can reduce diarrhoea incidence by 30%

Inhabitants of many urban centres in developing countries as well as the rural population therefore only have access to water of dubious quality. The treatment of water to be safe for consumption therewith often remains under the responsibility of the individual household (Mintz *et al*. 2001).

The following water treatment methods for the application at household level generally are recommended (WHO, 1997) to reduce feacal contamination of drinking water:

WATER STORAGE at household level is a simple method to improve the water quality. Plain sedimentation however can only partly remove turbidity and faecal coliforms – the common indicator used to quantify the degree of feacal pollution. Therefore, water storage is only used as pretreatment for surface waters.

BOILING OF WATER is the safest water treatment method, it kills all the microorganisms present in contaminated water. Water should be brought to a rolling boil for one minute at sea level, adding one minute for every additional 1,000 meters in altitude. The main disadvantage of boiling water is the large amount of energy required, which makes it relatively expensive and unaffordable for the poorest section of the population in developing countries. During decades development organisations have invested their efforts and resources to disseminate the information on the importance of boiling drinking water to communities without access to safe drinking water. To a large degree these efforts have not reached the targets or completely failed to achieve the intended behaviour change. This is not surprising, if we keep in mind that the cost for additional energy to boil the water often reaches 20 to 30 % of the total household budget of poor families. Even if awareness for the importance of treating drinking water is there – who can afford to boil it?

WATER PASTEURISATION achieves the same effect as boiling at temperatures of only 70 °C – 75 °C, but requires a longer exposure time of approximately 10 Minutes. Also pasteurisation requires much energy.

WATER FILTRATION by simple household filters, such as ceramic candle filters, stone and sand filters, will remove a high fraction of solid matter, but may not remove all the microorganisms. Commercially produced filters are relatively costly, and filters made of locally available material are generally of limited treatment efficiency with regard to microbiological water quality improvement.

WATER DISINFECTION WITH CHLORINE is used to kill microorganisms (bacteria and viruses), but it's efficiency to inactivate pathogenic parasites (e.g. *Giardia*, *Cryptosporidium* and helminth eggs) depends on different factors (e.g. free Cl, pH, temperature, contact time). Water treated with chlorine is protected against recontamination. This type of treatment requires the supply of chlorine either in liquid or powder form. Skilled application is necessary as chlorine is a hazardous and corrosive substance. Water treated by chlorine has a taste which many users do not appreciate.

SOLAR WATER DISINFECTION (SODIS) is a simple water treatment method using solar radiation (UV-A light and temperature) to destroy pathogenic bacteria, viruses as well as *Cryptosporidium* spp. and *Giardia* spp. present in the water. A great advantage of SODIS is that it uses locally available resources such as transparent PET-plastic bottles (or glass bottles) and sunlight. Therefore SODIS can be replicated with very low cost.

HOW DOES SODIS WORK?

Contaminated water is filled into transparent plastic bottles, preferably PET-bottles, and exposed to the full sunlight for 6 hours. During the exposition, the sunlight destroys the pathogenic bacteria, viruses as well as *Cryptosporidium* spp. and *Giardia* spp (Wegelin *et al*. 1994; Mendez-Hermida *et al*. 2005; McGuigan *et al*. 2006). The destruction of parasites is caused by the UV-A radiation of the sunlight. Laboratory tests as well as field research in Bolivia and Nepal have shown that the water is also disinfected if SODIS is applied in cooler climatic areas and if the water temperature in the bottle remains below 40 °C. However, a synergy of UV-A radiation and temperature occurs if the water temperature raises above 50° C, then the disinfection process only requires a third of the solar radiation intensity. After one hour of solar exposition at 50 °C, the water is safe for consumption (Wegelin *et al*. 1994). SODIS is highly efficient to improve the microbiological water quality at household level, but it cannot always guarantee a 100 % reduction rate of pathogens as the SODIS efficiency depends on climatic conditions and the user's handling practices.

Factors to be considered during the application of SODIS:

CLIMATIC CONDITIONS: The effect of SODIS is depend ent on the availability of sufficient sunlight. The solar radiation intensity required of 2500 Wh/m² is well reached within 6 hours of solar exposure on a sunny or partially cloudy day in countries between latitude 35 °N and 35 °S. During days of partial rainfall, strong clouds or fog, the bottles have to be exposed for 2 consecutive days to disinfect the water. During days of continuous rainfall, boiled water or stored SODIS water should be consumed (Wegelin *et al*. 1994).

Pathogen	Illness	Reduction through SODIS ** at water temperatures of 40°C and solar exposure of 6 hours
Bakteria		
E.coli	Indikator for Water Quality & Enteritis	3-4 log (99.9 -99.99%)
Vibrio cholera	Cholera	3-4 log
Salmonella spp.	Thyphoid	3-4 log
Shigella spp.	Dysentery	3-4 log
Viruses		
Rotavirus	Diarrhoea, Dysentery	3-4 log
Polio Virus	Polio	inactivated, results not yet published
Hepatitis Virus	Hepatitis	Reduction of cases of SODIS users
Protozoa		
Giardia spp	Giardiasis	3-4 log (Infectivity of Cysts)
Cryptosporidium spp.	Cryptosporidiasis	2-3 log (Infectivity of Cysts)

FIGURE 2. The following pathogens are destroyed by SODIS (Wegelin 1994, Sommer 1997, McGuigan 1998, Kehoe 2004, Méndez-Hermida 2005, Lonnen 2005, McGuigan 2006)

TURBIDITY: SODIS requires relatively clear water with a turbidity of less than 30 NTU (Nephelometric Turbidity Units) to be effective (Wegelin *et al*. 1994). A simple test is available to check if water is clear enough for the application of SODIS: Place the open bottle upright onto the SODIS Logo or the headline of a newspaper. Look through the mouth of the bottle through the bottles toward the Logo or the newspaper. The water is clear enough for the SODIS application if you still can read the headline of the newspaper (Figure 3A and 3B).

If the water is too turbid for the application of SODIS, the water needs to be treated before it can be filled into the bottles:
Methods to remove turbidity:
– let the bottles stand for a while until the particles settle to the ground
– filter the water through a folded cloth
– use alum or the crushed seed of *Moringa olifeira* for flocculation and sedimentation

BOTTLES: SODIS requires transparent containers, which transmit UV-A-light. Most suitable are plastic bottles made from PET, but also glass bottles can be used if they have a lid that can be closed again. Users in developing countries prefer to use PET-bottles because they are cheaper than glass, they can be carried around more easily and they do not break easily. Old and scratched plastic bottles should be replaced after about 6 to 12 months of regular daily use for SODIS as the mechanical scratches and photo-oxidation of the material reduce its transmission of UV-light. The depth of the container should not exceed 10 cm as at this depth, and at a turbidity level of 26 NTU, the UV-A radiation is reduced to 50%. This means, that the volume of bottles to be used for SODIS should not exceed 2 litres.

OXYGEN: SODIS is more efficient in water containing high levels of oxygen: In water sunlight produces highly reactive forms of oxygen (oxygen free radicals and hydrogen peroxides) which react with the microorganisms' cell components. Aeration of the water can be achieved by shaking the 3/4 filled bottles for about 20 seconds before they are filled completely (Reed, 1997).

THE HEALTH EFFECT IN COMMUNITIES USING SODIS

The effect of consuming SODIS treated water on the health was first examined in Kenya in the 90ies. The study examined Kenyan children under 5 years and found a 16 %-24 % of diarrhoea reduction among Maasai children below 5 and a 86% reduction of cholera cases during an outbreak (Conroy *et al*. 1996, 99, 01). During the years 2000 to 2003 the Swiss Tropical Institute in collaboration with EAWAG conducted an epidemiological study to assess the health impact of SODIS on more than 200 children below 5 in Bolivia. The study showed that SODIS reduced the diarrhoea incidence by more than 35% (Hobbins, 2003). Further health evaluation studies were conducted in the two cities Rajoa and Chinot in Pakistan 2002, where diarrhoea incidence was reduced from 26 % to 13 % in Rajoa and from 39 % to 19 % in Chiniot and in Uzbekistan in 2003, where children <5 showed a reduction of diarrhoea incidence by 53 %. In the control group the occurrence of diarrhoea illnesses increased. Also in Nepal, East Lombok and Assam, India, the diarrhoea incidence was reduced by 50 to 70 % (unpublished project reports).

GLOBAL PROMOTION OF SODIS

EAWAG/SANDEC initiated the promotion and dissemination of SODIS in 1995 with seven pilot projects in Latin America, Africa and Asia. Following the positive results in the pilot projects, the SODIS promotion and dissemination process has been initiated at national level in more than 20 developing countries. "Fundación SODIS" in Latin America and the SOLAQUA Foundation in Asia

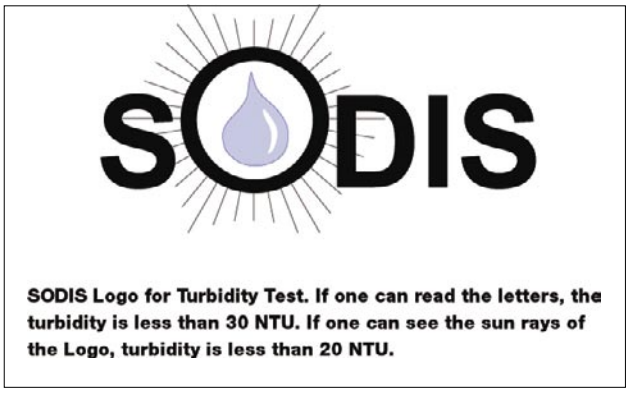
FIGURE 3A. A simple test can be applied to test the turbidity of water

and Africa support the SODIS dissemination process through information campaigns, training and advising of government institutions, networking activities as well as awareness building and training of users at grassroots level. As a result of these activities about 2 Million people presently use SODIS for the treatment of their drinking water.

In Madagascar, only about 3 out of 10 people have access to improved water supply and sanitation, even less have access to safe drinking water. As a consequence, more than 160 children die each day in Madagascar before their fifth birthday from malaria, diarrhoea and acute respiratory illnesses (Unicef, country reports). The promotion and dissemination of household water treatment methods such as for example SODIS significantly could contribute to improve the health of the local population, particularly of children below 5 years.

The socio-cultural acceptance of SODIS was evaluated during the pilot projects as well as during project implementation in Nicaragua and Bolivia. The assessments showed that the sustainable uptake of the method depends on the promotion approach and lies between 40 % and 80 % of the people trained.

At international level, SODIS is in the process of reaching global recognition. On the World Water Day on 22 March 2001 WHO recommended SODIS as one of the measures to reduce health hazards related to drinking water. SODIS is a member of WHO's 2003 established international network for the promotion of household water treatment and safe storage (http://www.who.int/household_water/en/). In recognition of these achievements, SODIS received the special price of the Energy Globe Award 2004, a most prestigious environmental price www.energyglobe.at.



SODIS Logo for Turbidity Test. If one can read the letters, the turbidity is less than 30 NTU. If one can see the sun rays of the Logo, turbidity is less than 20 NTU.

FIGURE 3B SODIS Logo for turbidity.

DISSEMINATION OF SODIS AT GRASSROOTS LEVEL

Before a SODIS project in a specific area is planned and implemented, a needs assessment should be conducted to get the critical information on the environmental conditions in a specific area and insight into current behaviour practices of the local population. The assessment will provide information about the characteristics of the population, health status of the community, diarrhoea incidence, the water sources, water consumption and treatment practices, healthy habits and unhygienic behaviours.

The needs assessment does provide the basic information for the decision whether a SODIS project makes sense and should be implemented or not. A SODIS project should not be implemented if:

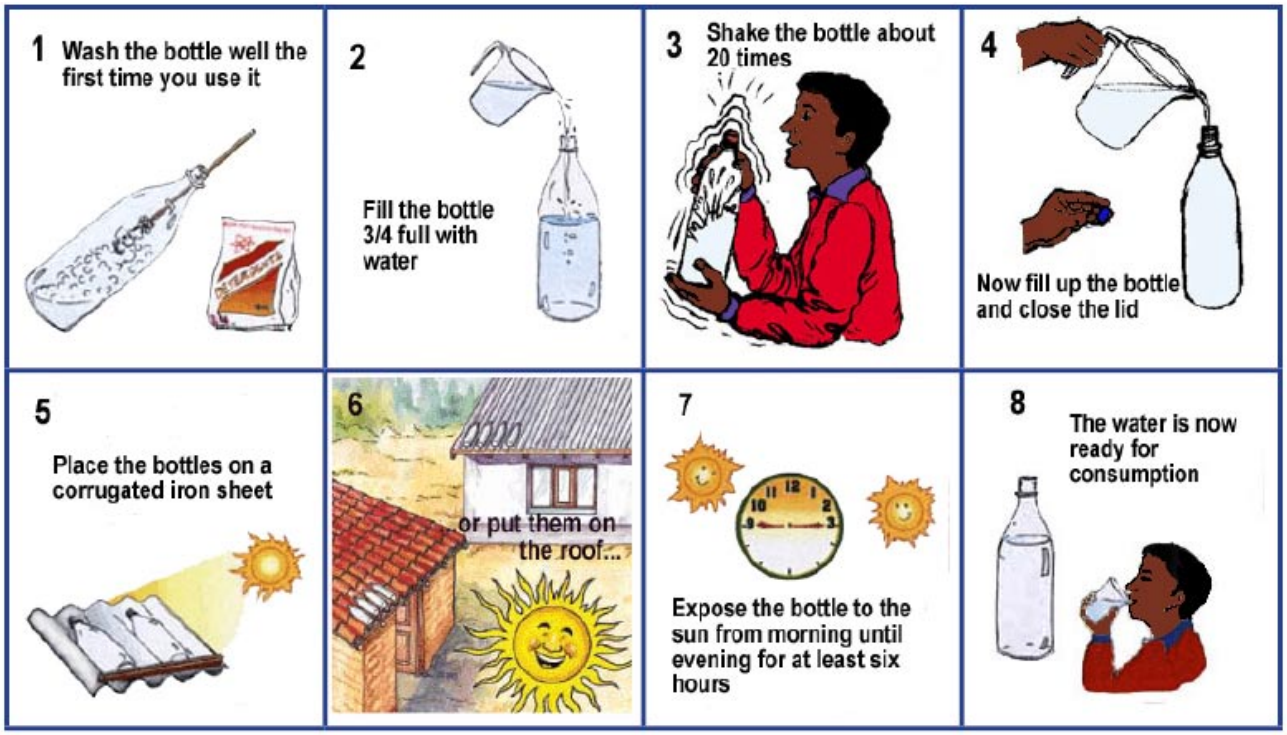


FIGURE 4. Steps required for the application of SODIS

– people consume clean drinking water
– people do not suffer from diarrhoeal diseases
– people successfully use another method for the disinfection of drinking water
– climatic conditions do not favour the application of SODIS
– PET bottles are not available and a supply scheme cannot be established

A SODIS education project will highly benefit the health of people if they consume microbiologically contaminated water, suffer from a high diarrhoea incidence and if PET-bottles are available locally.

A very careful community education approach is required in order to establish SODIS at grassroots level. It is not easy to create an understanding among illiterate people on the relation between the consumption of contaminated drinking water, hygiene practices and the effect of invisible pathogens on human health. The awareness on the importance of treating water before the consumption and adequate hygiene practices such as washing hand with soap however needs to be established before people will use a water treatment method such as SODIS. Such processes for changing habits and establishing new behaviours require much time and intensive coaching from community workers.

Experiences made during the implementation of SODIS activities at the field level revealed the importance of the following points:

– Isolated information events do not establish SODIS practice in the community. Long-term education processes are required which involve participatory tools for hygiene education and careful coaching through community workers at community gatherings. Regular household visits (once a month during 6 to 12 months) are an important factor for achieving behaviour change.

– The trust and strong relation between the field staff and the community is a key aspect for the success of the project. The adoption of SODIS in the community is enhanced if field staff has a close relation with the people. Also, it is very effective to spread and promote the method at grass roots level through local leaders, for example health promoters, teachers or other locally respected persons.

– The field staff has to personally use SODIS, and therewith demonstrate the confidence in SODIS.

– SODIS is a simple method, but it needs careful training. Trainers must be experienced in the application of SODIS. if the treatment procedures are not followed correctly, the users fail to produce water safe for consumption.

– Good quality SODIS training and promotion material plays a significant role in the implementation process.

– Demonstrations of the effectiveness of SODIS at the field level do reduce scepticism: To demonstrate the effect of SODIS by performing water quality tests of raw water and SODIS treated water in front of the community can be a good tool to overcome doubts.

– A good approach is to integrate SODIS into already existing projects working in the field of community health & hygiene education.

– The local availability of the material needed is crucial for the sustainability of the SODIS application. If no plastic bottles are available locally, a supply scheme needs to be established for the purchase and transport of used plastic bottles from the city to the villages.

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FIGURE 5. SODIS reduces the diarrhoea incidence of users, especially of children below 5 years.

FIGURE 6. A relation of trust between community worker and users is important for establishing behaviour change.

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EDITORIAL NOTE

SWISS RED CROSS FEDERATION AWARD FOR SODIS

Zurich, June 24, 2006

For the first time in its 140 years old history, the Swiss Red Cross (SRC) has awarded a price (25,000 CHF) for special humanitarian commitment. This price has been awarded to the SODIS project directed by Martin Wegelin, EAWAG/SANDEC. The SODIS project receives with this price additional publicity which is needed for the further promotion of this simple but effective water disinfection method used at household level.

A NEW RESEARCH PROJECT IN CENTRAL MENABE

Scientific Bases for a Participatory Forest Landscape Management

Clémence Dirac[I], Lanto Andriambelo[II] and Jean-Pierre Sorg[III]

Correspondence:
Clémence Dirac
GFD, CHN 75.3
Universitätsstrasse 22
CH-8092 Zurich
Switzerland
E-mail:clemence.dirac@env.ethz.ch

ABSTRACT

In Madagascar – a biodiversity hotspot of international importance – the villagers depend on the forest first for its soil as a reserve of arable land as well as a shelter and a pasture for the herds, and second for the production of timber, charcoal and other forest products. Most of the currently proposed conservation management systems for forests do not take into consideration villagers' needs, in Madagascar too; indeed degradation and deforestation have continuously occurred in places where the forest is under great pressure.

In targeting the improvement of the livelihood of local populations and the maintenance of "multifunctionality", especially the ecological value of the forest, the present project aims at developing scientific criteria for a sustainable management of forest landscapes in western Madagascar at a regional scale. A detailed inventory of resources and a specific understanding of stakeholder requirements and strategies will allow drawing an accurate picture of the human-forest interface. A participatory approach paves the way for realistic management criteria that are really adequate to the ecological and social situations. The management criteria will provide a tool for further discussions on landscape management in central Menabe.

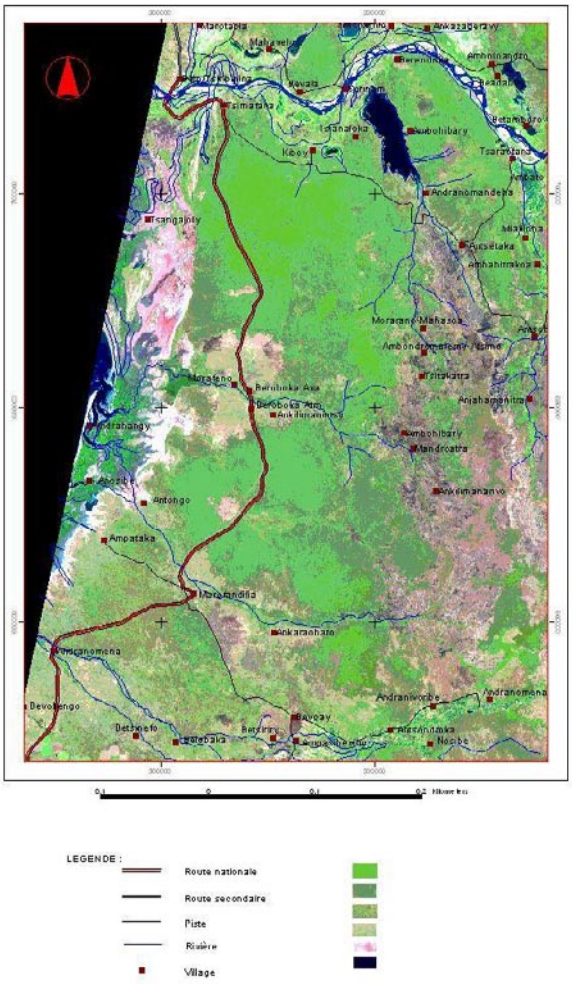
INTRODUCTION

PROJECT'S RELEVANCE AND CHANCES Local populations use the forest in two ways: directly, to collect products and indirectly, for forest services. Forest conservation programmes that close forest to the public have often had negative impacts on the neighbouring populations (Ghimire 1994), because they change villagers' access to food (Kunarattanapruk *et al.* 1995). The consequences of such conservation programs on the indigenous populations are hard to measure (FAO 2003). Moreover, traditional systems of forest management, which advocate an extensive utilization of resources, threaten the preservation of natural ecosystems when demographic pressure increases (Schneider and Sorg 2000). As villagers are not only dependent on the forest, but also well placed to intervene effectively in forest management (Schneeberger 2005), biodiversity conservation would need to be ensured by a sustainable participative landscape management that accords with villagers' access and property rights.

In Madagascar – an internationally important hotspot for biodiversity (Myers *et al.* 2000) – the forests make up part of the village territories and furnish local populations with wood and non-wood products, as well as services. Forest soils constitute a reserve of pasture and cultivable land for livestock and shifting agriculture. The right of exploitation for the villagers is only allowed in forests that are not subjected to protection regulations or where no concession is allocated. All forests are state property. Former rather authoritarian Malagasy policies aimed at protecting natural resources totally excluding communities from natural resources management. These policies failed and, since 1995, environmental policies have been set up that move towards a participative management of natural resources (GELOSE: *gestion locale sécurisée*), and which aim at sustainability (Rakotovao *et al.* 1997). Although forest management has partially been transferred to the villages (Raoliarivelo 2001) and communal rights of usage duly recognised, the transfer of competencies to local organisations hamper (Randrianasolo 2000) as the normative speech of the state does usually not agree with local village rules (Ranjatson 2004).

In Madagascar, as in other developing countries, demographic pressure is increasing (Kistler 1999) and young people are obliged to move to forested areas to find new land that they can cultivate for a living. The region of Central Menabe (see Map 1 and 2), along the west coast of Madagascar, receives flows of immigrants, which increases the pressure on forest (Lebigre *et al.* 1997). It seems that villagers' exploitation of forest products and soil is uncontrolled and unmanaged and that loggers enter the forests in this zone largely illegally. Even though the number of village fires destroying forests to create spaces suitable for cultivation is decreasing, former clearing has drastically reduced the once large forests in the area (Genini 1996). If the deforestation in the dry region of Central Menabe continues at the present rate, the forest will disappear and no longer be capable of ensuring the different services it provides (amongst others the maintenance of biodiversity and a CO_2 sink) (Sorg *et al.* 2003). Nor will it be able to provide the numerous resources for the local populations (nutri-

I ETH Zürich GFD, CHN 75.3, Universitätstrasse 22, CH-8092 Zürich.
II Lanto Andriambelo, ESSA, Département Eaux et Forêts, B.P. 3044, Antananarivo 101, Madagascar.
III ETH Zürich, GFD, CHN 75.2, Universitätstrasse 22, CH-8092 Zürich.



MAP 1. The research site is located on the west coast of Madagascar. Source: wildmadagascar.org

tion, source of energy, building material, medicine, etc.), or retain the soil. In order to conserve the biodiversity of the dry forest of Central Menabe, a new protected area is in the process of being set up. Zoning activity is in progress, which aims to define zones according to their use. Largely speaking, the forest landscape will be divided into a) zones to be protected, and b) zones to be exploited by villagers and other stakeholders. It seems, however, that local populations will have only limited exploitation rights (Raharinjanahary 2004). It is therefore urgent to intervene in the region of Central Menabe with a view to ensuring the sustainability of all forest functions and to filling the needs of a range of stakeholders. These are the goals of a project, carried out by the Swiss Federal Institute of Technology, Zurich, Switzerland (EPFZ) and the "Ecole Supérieure des Sciences Agronomiques", Antananarivo, Madagascar (ESSA), which has been launched in this region. The project aims to provide scientific criteria, developed together with the local populations, for a sustainable management that can be inserted into future regional zoning.

The study can make use of a range of very favourable starting conditions. First, the broad and deep knowledge of the studied zone provides a very good and detailed description of the situation, which gives the project a sound basis from which to start. The zone of Central Menabe and the dry forest of Kirindy in particular (a forest used as a research site in this zone) have been subjects of a number of multidisciplinary scientific studies over the past 25 years (Ganzhorn and Sorg 1996, Goodman and Benstead 2003). A

MAP 2 The research site is located on the west coast of Madagascar (zoom). Source: wildmadagascar.org

wealth of knowledge concerning forest (Prelaz and Rakotonirina 1982, Covi 1990), fauna (Ganzhorn *et al.* 1996, Schülke 2005) and land-use issues (Favre 1989, Raonintsoa 1996, Paupert-Razafiarisera 2005) exists for the Kirindy region. This is an extremely rare situation for a Madagascan dry forest landscape (Dufils 2003).

Second, the project should be of great interest to every actor in Central Menabe, because deforestation concerns everyone:

1. Villagers depend on the forest mainly for grazing cattle, numerous non-wood forest products (NWFP) and for timber.

2. Energy and construction wood correspond to both current and future demand, also for people of the town Morondava.

3. The level of international interest and involvement in biodiversity issues is high. Environmental organizations are present and want to protect the forest.

4. Development organizations engaged in the region have established good relations with the villagers and have wide knowledge about their ways of life and their demands on forest products and soil.

This situation should facilitate the project's implementation and development.

Third, the limited number of actors of this forest landscape should simplify the task of determining management criteria that satisfy all actors' needs and demands; villages are small, Morondava, Belo and Mahabo are the only towns in the vicinity, there are only few environmental and development organizations to liaise with, tourism is not yet an important factor and some loggers have already been stopped.

OBJECTIVES, ABSTRACT OF METHODOLOGY AND RESEARCH SITE

The main objective of the project is to set up scientific bases for a sustainable multifunctional and participatory management of a forest landscape in Central Menabe.

Taking into account participatory management and forest "multifunctionality", the project combines two of the United Nations' Millennium Development Goals: livelihood development (*e.g.*, the use of forest resources by local populations) and nature conservation (emphasizing the role of these forests as hotspots of biodiversity). As the conservation of dry tropical forests has become urgent (Bellefontaine *et al.* 1997, Sanchez-Azofeifa *et al.* 2005) and as combating poverty is a major aim also in the domain of forestry (Dürr 2002), the project brings together a number of internationally important issues. The specific objectives are to:

1. Assess the role of forest products and local knowledge about forest and tree management in the livelihood strategies (human-forest interface).

2. Determine production potential and regeneration capacity of the most important forest products that underpin livelihoods.

3. Deduce potentialities and constraints for sustainable management of a landscape with a major forest component.

The project is based on a consultative and an active participatory approach that integrates scientific and indigenous knowledge. Starting from present day local knowledge on land-use, it aims to provide, at a landscape level, scientific management bases respecting forest biodiversity. In particular, the project aims to improve strategies in the market chains of forest products, integrate agriculture (agroforestry) and livestock in forestry and establish the potentialities in biodiversity conservation of payments or compensations for ecological services.

The Central Menabe region is characterised by a landscape of primary and secondary dry forest, savannahs and surfaces cultivated with maize, groundnut and cassava. Villages are small (around 500 inhabitants) and most of villagers live in precarious economic circumstances. Due to the scarcity of agricultural products during dry seasons villagers depend heavily on the forest, especially during these periods.

As the project is being carried out in an area representative for the dry forest zone, it is likely that research results can be applied to other regions of Menabe in future.

ORGANISATION OF THE PROJECT

The project is based at the EPFZ (Group for Forestry and Development). The Swiss Center for International Agriculture (ZIL) of Zurich has assured funding for the project from November 2005 until October 2008. Two PhD students, one from Madagascar and one from Switzerland, are doing the research. Tasks are shared according to the background and experience of each. The Malagasy forest engineer works mainly on forestry aspects (*sensu stricto*) and landscape issues, while the work of the Swiss biologist focuses mostly on NWFPs and multifunctional issues. Academically, the Malagasy PhD thesis is supervised by the ESSA and the Swiss one by the EPFL (Swiss Federal Institute of Technology, Lausanne, Switzerland). With a view to ensuring the transdisciplinarity of this predominantly ecological research, the PhD theses are reinforced with two socio-economic DEA (*Diplôme d'études approfondies*) and two Master theses on social issues.

The project is supported by local and international partners. The CFPF (Centre de Formation Professionnelle Forestière, Morondava, Madagascar) and the CNRE (*Centre National de Recherche sur l'Environnement*, Antananarivo, Madagascar) support ecological issues, whereas the CIFOR (Center for International Forestry Research, Bogor, Indonesia) and the SAHA Menabe (Organization for rural development on the western coast of Madagascar, Intercooperation, Morondava, Madagascar) supports mainly the social issues of the project.

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REPORT ON A FEASIBILITY STUDY

Indigenous silk moth farming as a means to support Ranomafana National Park

Tsiresy Razafimanantosoa[I], Olga R. Ravoahangimalala[I], Catherine L. Craig[II]

Correspondence:
Catherine L. Craig
221 Lincoln Road
Lincoln, MA 01773
Telephone: +31 781 2599184
E-mail: ccraig@cpali.org

ABSTRACT

We envisage a world where the rural poor can derive a livelihood from protecting forests instead of cutting them down; where development planners understand that habitat health is the keystone for human health and survival, and where conservation biologists understand that long-term solutions to biodiversity loss must be built around social programs which enable local people to thrive. Our vision, however, can only be achieved when scientists express the role of biodiversity conservation in economic terms (Baird and Dearden 2003), and development planners understand environmental complexity and its role in poverty alleviation. Our long-term goal is to develop a generalized approach to biodiversity conservation that will enable scientists and development professionals to identify, plan and initiate sustainable, small-scale businesses in ecologically important areas. This paper reports on a recent study to expand current production of wild silk and explore new types of silk as one economic means of biodiversity protection in Madagascar.

Madagascar is one of the most important centers of world biodiversity and 90% of its species are forest dwelling. Nevertheless, 80% of the population are subsistence farmers (Kistler and Spack 2003), and the predominant agricultural practice is "tavy" or slash and burn. Less than 10% of the original forest remains. Development and conservation communities can effectively prevent deforestation only when they counter the macroeconomic forces that drive people to clear land. Small-scale farmers cut down forests because national and international policies, market conditions or local institutions do not provide them with reasonable alternatives (Tomich *et al.* 2005). Furthermore, even when alternatives are made available, results are difficult to achieve in a short time. At least some actions need to be implemented pro-actively, in sites that are currently healthy but near areas of potential population growth.

We have been working for the past year to develop an approach to identify high value export products (*i.e.* products whose value is likely to be least vulnerable to macroeconomic shock; Castellano and San 2005), that can be found in areas of high biodiversity and conservation importance. One such product may be wild silk. Wild silk can be sustainably harvested in remote areas and easily transported to commercial centers. To determine if wild silk is a potential means of income generation for people living in areas of Madagascar where silk has not been traditionally produced, we gathered three types of information:

1. The diversity of silk producing larvae in the Eastern Forest Corridor and specifically in Ranomafana
2. The physical properties of larval silk and their estimated commercial value
3. How to apply our data in order to select sites where wild silk production could have a maximum economic and conservation effect

We emphasize that the work reported here is preliminary and that we are working to expand our database for silkworm larvae and potential projects sites. All of these data will be posted on the website for *Conservation through Poverty Alleviation* (www.cpali.org) as we progress. Elsewhere we report the life-history biology of the species found to date and analyze the economic resources that will need to be generated by local communities to engage in silk production for commercial markets (Craig and Weber, in prep.).

1.THE DIVERSITY OF SILK PRODUCING LARVAE IN RANOMAFANA

COLLECTION APPROACH Initially, we set up black lights and white lights in multiple sites to census adult silk moths at night. We found that many of the moth species in which we were interested were not attracted to the lights. Furthermore, this approach could not give us information on the types of plants on which the females laid eggs and on which larvae fed. Therefore, we began to collect larvae with the assistance of the Ranomafana community.

Turning to the community for assistance was effective for several reasons. First, the collecting program proved a valuable tool for educating the local population about our program and greatly increased our visibility in Ranomafana. Second, the local people were better at finding the silkworms then we were, and covered a broader area than our team could search.

I Department of Animal Biology, Faculty of Science, BP 906, University of Antananarivo, Anatananarivo 101, Madagascar

II Conservation through Poverty Alleviation, International, 221 Lincoln Road, Lincoln, MA 01773 and
Museum of Comparative Zoology, Harvard University, Cambridge, MA 02138

TABLE 1. Summary of larvae collecting program. Due to disparity in sample size, statistical analyses are not appropriate. Nevertheless, many more local residents collected larvae when an equal value of rice was offered instead of money

MONEY (5CM ABOUT 5000 FMG)		LARVAE (2CM=CUP OF RICE)	RICE	
Number of payments	96		Number of payments	31
Number of days	39		Number of days	4
Number of larvae	441		Number of larvae	106
Average payment of larvae	3,315 FMG (0.33 US$)		Average payment of larvae	3 cups of rice
Uses of US$ Food Supplies Recreation	 68% 16% 16%		Uses of US$ Food	 100%

Third, we only accepted the target larvae of the silkworms when they were delivered together with a sample of their plant and with locality data. This allowed us to track where the villagers searched, what the larvae were eating, and for whom in the community wild silk production might be an economic benefit. The community soon learned the types of larvae we were interested in, and brought us only those. Fourth, our collecting program allowed us to conduct informal surveys to determine 1) what methods were most effective when we wanted to communicate information about our program, 2) if villagers knew what silk was, and 3) the impact of the reward on family support.

We learned that most villagers did not know what silkworms were and only a few knew that silk could be used to produce textiles. The notices posted in Malagasy at the National Park Headquarters in Ranomafana and at the Mayor's office to advertise the program had little effect to recruit participants. Instead, most individuals found out about the program by word of mouth and starting with the villages where CPALI team members lived.

Members of the community collected larvae outside the park. In exchange for larvae we offered money or an equal-value volume of rice (Table 1). We found that many more people participated in the program when rice was exchanged for larvae. This may be simply because as the program became known to more people, or it may be that rice was more highly valued than money. In addition, rice rewards ensured that payments were used to support local families and not recreational purposes. Finally, because members of the community were only allowed to collect larvae outside of Ranomafana National Park, we learned that wild silk production could be one way to add value to the border forests that protect the park.

LARVAL DIVERSITY The diversity of silk moths found at the edge of the Ranomafana National Park was high. We found over 28 morphologically distinguishable, larval species from the family Lasiocampidae and in particular, the subfamily Gonometinae (see Figure 1 for examples). The Gonometinae species are currently used for wild silk production in Madagascar, and in most cases the silk is spun by *Borocera madagascariensis* or *B. cajani* (Lajonquiere 1972, Peigler 2004). Although we were unable to link all of the larvae with positive identifications of the adults we were able to divide the larvae into three groups, the "madagascariensis complex", the "cajani complex" and the "social complex". Table 2 is a preliminary list of species based on comparisons between photographs of the wings of adults that emerged from our cocoons, and photographs of adult specimens in the Muséum National d'Histoire Naturelle, Paris. These data need to be verified through molecular and morphological analyses and the adults need to be linked with the diverse larvae illustrated in Figure 1.

TABLE 2. Preliminary list of silk moths found in border forests at Ranomafana. All identifications need molecular and morphological confirmation.

GONOMETINAE	NOTODONTIDAE
Borocera attenuata	*Anaphe aurea*
B. madagscariensis	*Hypsoides befotakana*
B. cajani	
B. cajani castenea	SATURNIIDAE
B. cajani f. gigas	*Antherina suraka*
B. nigracornis	*Argema mittrei*
B. mimus	*Maltagorea fusicolor*
Eutropa punctillata	*M. auricolor*
Phoenecladocera merina	*Bunaea aslauga*
Ochanella hova	
Acosmetoptera raharizoninai	
Malacostala spp	
Napta serratilinea	
Apatelopteryx spp	
Phoenicladocera graveaudi	

FIGURE 1. Larval diversity. We found a bewildering array of larval phenotypes, some of which are illustrated above, and have grouped them into three classes based on the distribution of spines and the emergent adults. We are currently working to develop a database of all our larvae, that will include development stages, egg photographs and natural history and that will be posted on our website. We hope to use a format similar to the ACG project (http://janzen.sas.upenn.edu/).

In addition to the diverse Gonometinae species we found in Ranomafana, we also found two species of silk moths from the family Saturniidae (Griveaud 1961), and one species of social moth from the family Thaumetopoeidae (*Anaphe aurea*, *Thaumetopoeidae*, *Notodontoidea*) that may be valuable for silk production (Kiriakoff 1969). None of these have been used for silk textiles in Madagascar although silks produced by Saturniidae species are used throughout Asia and silk produced by the colonial silkworms, *Anaphe* spp., is used for textiles in Africa (Peigler 1993, Gowdey 1953).

2.THE PHYSICAL PROPERTIES AND COMMERCIAL VALUE OF COCOONS AND SILK PRODUCED BY NATIVE MOTHS

Three, easily measured properties of silk and cocoons affect their commercial value: cocoon weight, the number of layers of the cocoon and fiber porosity. We observed that cocoons spun by the silk moths we reared were made up of 1-4 layers of silk. In the case of the Gonometinae, the outer layer is a paper-like husk and there are one or more soft, inner layers. In contrast, the cocoons produced by Saturniidae were always two layers and each layer was similar in weight and spun from the same silk.

Figure 3 is a plot of cocoon weight versus the number of layers. Notably, cocoon weights are highly variable even if the number of layers spun is not. The high variability in the data could be the result of two factors. Cocoon weight and layer number may reflect the type of plant on which the larvae fed. Alternatively, the variation observed might reflect different species of silkworm that we have not yet identified. For example, we know that the Malagasy silk moth *Borocera cajani* is made up of multiple eco-races (if not species, (Lajonquiere 1972)) and feeds on multiple plant foods (unpublished data).

In Madagascar, cocoons are sold by weight. Cocoons produced by *Borocera madagascariensis* in the Malagasy highlands are 2-4 times as heavy as cocoons produced by *Borocera* species in Ranomafana (Figure 2). Therefore, these data may indicate that the cocoons produced by *Borocera* spp. in the Ranomafana area are too lightweight to be of great commercial value unless 1) many individuals can be raised/found or 2) unless cocoons produced by multiple species are combined. Our preliminary data also suggest that cocoons produced by silk worms reared on guava (introduced plant species, *Psidium guajava,* Myrtaceae) are heavier than cocoons produced by *Borocera* spp. reared on other plants. Therefore, it may be that if *Borocera* larvae are reared on guava, cocoons produced in the Ranomafana region will be more commercially competitive. The cocoons produced by the saturniid moth *Argema mittrei* are approximately equal in weight to cocoons produced by *B. mada-*

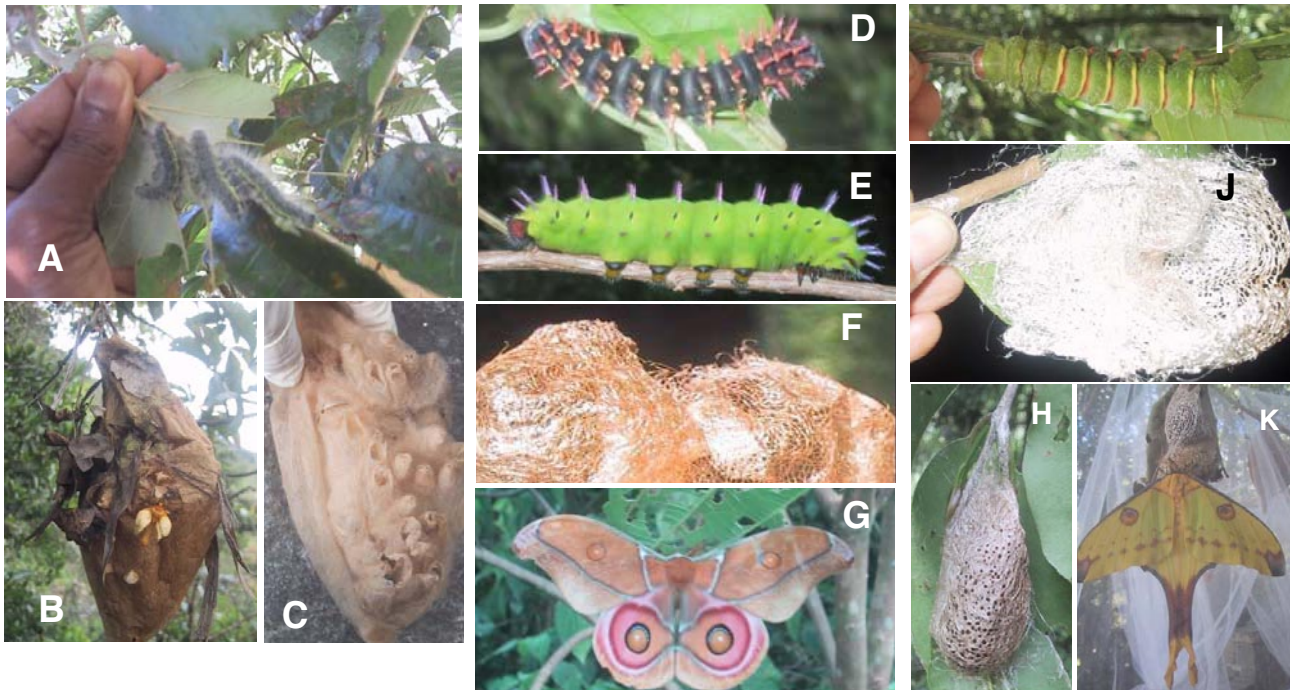

FIGURE 2. Potential producers of new types of silk could result in new income for Madagascar. A, B, C: Colonial silk moth *Anaphe aurea* (used for silk production in Kenya), A. larvae, B. female emerging from group cocoon, C. silk cells inside of cocoon; D, E, F, G: *Antherina suraka* (a similar silk, produced in Indonesia by the *Circula* moth has high value on the Japanese market), D. black morph larvae, E. green morph larvae, F. double, bronze colored cocoon, G. adult female; H,I,J.K: *A. mittrei* (similar to *Circula* and likely to have high value on Japanese market) H. cocoon (≈ 5cm length), I. larvae, J. double cocoon, K. recently emerged adult female.

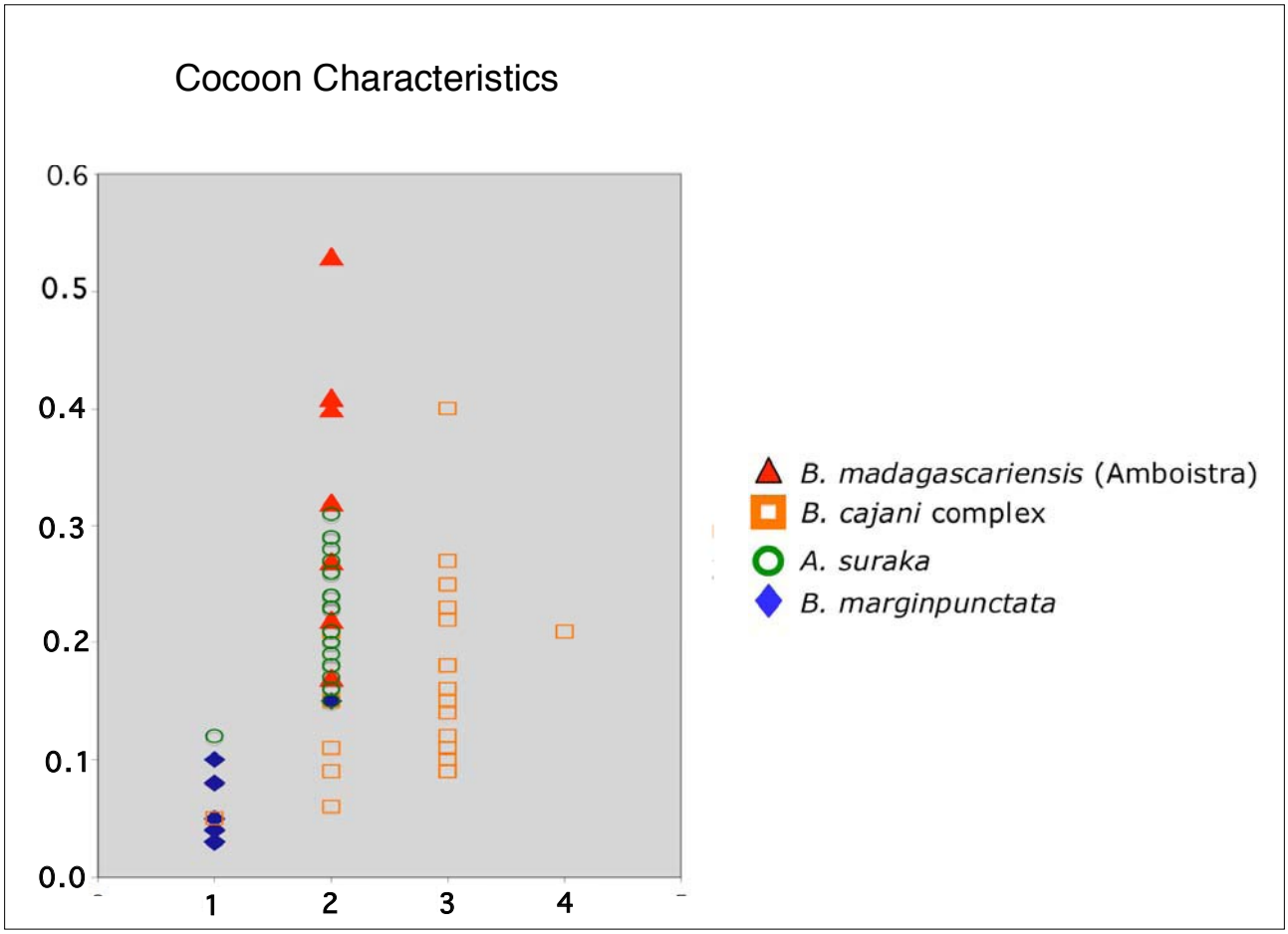

FIGURE 3. Cocoon characteristics vary within and between species. The variation in the amount of silk and number of layers of the cocoons reflect the food or different species in the reported complexes. The data show that experiments to determine the conditions under which maximum silk per cocoon is produced are needed for optimal silk production.

TABLE 3. Value of cocoons and processed silk between 2003-2005 (pers. com., F. Checcucci, Ny Tanintsika; F. Kuroda, Royal Silk Project, H. Akai, Japanese Society for Wild Silk Moth).

MOTH SPECIES	COCOONS/KG	COCOON VALUE	SPUN SILK VALUE	
Bombyx mori Bombycidae (Domesticated or farmed)	1,000	3-6 $/kg	25 $/ kg (reeled)	Central Silk Board, Indian Silk, Dec. 2005, 60.
B. madagascariensis Lasiocampidae (collected in Amboistra)	3,000	2-3 $/kg	40 $/kg	Checcucci, pers. com.
B. cajani Lasiocampidae (collected in Ranomafana)	6,250	2-3 $/kg	40 $/kg	Based on *B. madagascariensis*
Antheraea pernyi (Chinese tusser, reeled) Saturniidae			30 $/kg	Central Silk Board, Indian Silk, Dec. 2005, 60.
Antheraea yamamai (Japanese tusser) Saturniidae			23 $/kg	Central Silk Board, Indian Silk, Dec. 2005, 60.
Anaphe aurea Notodontidae (Ranomafana)	500	2-3 $/kg?	≈40 $/kg	H. Akai, Japanese Society for Wild Silkmoths, pers.com.
Cricula trifenestrata Saturniidae (Indonesia)	3,000		225 $/kg	Kuroda, RSP, pers. com.
A. suraka (Ranomafana)	3,000		≈ 225 $/kg	Based on *Cricula trifenestrata*
A. mittrei (Ranomafana)	1,666		≈ 225 $/kg	Based on *Cricula trifenestrata*

gascariensis from the highlands. Although cocoons produced by *Antherina suraka* weigh half as much, as *A. mittrei, A. suraka* are easier to rear and more common. *A. mittrei* silk fibers, like *A. mittrei cocoons*, are porous.

Over all, the volume of silk produced by the colonial species is much lower per individual than that produced by non-colonial species. However, the colonial nests are relatively large and easy to collect. If nests are abundant, there may be a cost/benefit to collecting and processing the larger, colonial nests in contrast to individual cocoons produced by other species. If *Anaphe* silks are collected in future, it will be important to collect them only after the adults have emerged. Adult emergence begins in February but is not completed until the end of April. Therefore, nest collection should not begin before the middle of May.

The value of silk (Table 3) fluctuates throughout the year with moth seasonality. In Madagascar, silk produced by the domesticated silk moth, *Bombyx mori*, currently brings a higher value than wild silk, despite the fact that the demand for wild silk is unmet. Silk textiles are not spun from the colonial nests produced by *Anaphe,* although one silk shawl made from silk produced by *Hypsoides,* a colonial species of silkworm (from a different moth family, the Notodontidae), was found in a shop in Antananarivo. The cost was not differentiated from the cost of silk produced by *Borocera* species.

Silkworms in the family Saturniidae are used to produce silk textiles in India and Indonesia. Saturniid silk is considered by some experts to be superior to the silk produced by both *Borocera* and the domesticated silkworm, *Bombyx mori*, because it is porous, dyes easily, and is lightweight (Akai 2000). J-R. Estime (pers. com., Business and Market Expansion, BAMEX, Madagascar) estimates that farmers can be convinced to adopt new practices only if they yield higher income by at least a factor of 10. The silk produced by *Argema mittrei* is potentially such a product (Table 3).

Silk produced by *Anaphe* spp. are currently used to produce textiles in West Africa (H. Akai, pers. com.) but not in Madagascar, despite the fact that *Anaphe aurea* is common and widespread (Kiriakoff 1969). *Anaphe* moths are social and spin a group cocoon in which they undergo metamorphosis (Fig. 2a-c). The group cocoon contains 3-6 grams of silk, which can be collected, cleaned, carded and spun.

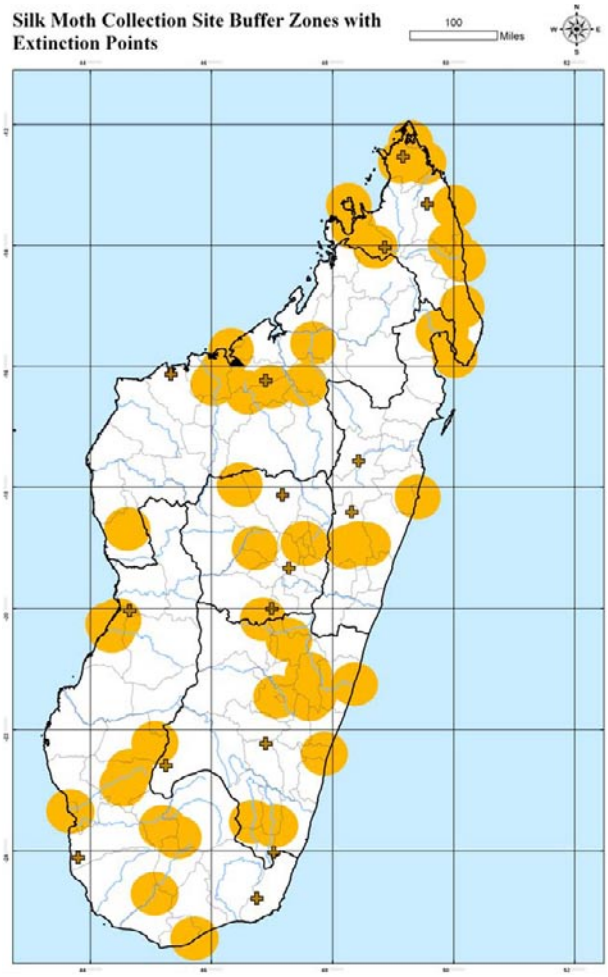

FIGURE 4. Imminent extinction points overlap with some silk moth collection sites. Light brown discs represent 25 mile buffer zones around silk moths collection sites and cross sites of imminent extinction. These data suggest 5 specific localities where wild silk production might be an effective tool for conservation and poverty alleviation.

3.SITE SELECTION FOR MAXIMUM ECONOMIC AND CONSERVATION EFFECT

We have taken a GIS-mapping approach to identify those sites where silk production could have its greatest positive impact on maintaining the forests and the local fauna (Figure 4). In particular, we collected data on collection localities for *Borocera madagascariensis, Borocera cajani, A. suraka* and *A. mittrei* from the Muséum National d'Histoire Naturelle, Paris and plotted them on a map of imminent extinctions for mammals, birds, amphibians and plants in Madagascar (Ricketts *et al.* 2005). Fifteen such sites are located in Madagascar. Five extinction sites are found within the 25-mile buffer zone surrounding silk collection sites. It may be that these areas serve as potential sites where wild silk production could contribute to forest recovery and hence vertebrate conservation. The animals found in these sites are: 1) the Forest Rock Thrush (*Monticola erythronotus*, Turdinae) found in Montagne d'Ambre National Park and Special Reserve, 2) the Madagascar Giant Tree Frog (*Platypelis alticola*, Microhylidae) found in the Tsaratanana Strict Nature Reserve and adjacent areas, 3) the Greater Big-Footed Mouse (*Macrotarsomys ingens*, Muridae) found in Ankarafantsika, 4) theWhite-tipped Tufted-Tail Rat (*Eliurus penicillatus*, Nesomyidae) found in the Ampitambe Forest and 5) the frog, (*Aglyptodactylus laticeps*, Mantellidae) found in the Menabe Forest.

CONCLUSION

The production of wild silk textiles is a traditional industry in Madagascar. In the past, silk cloth was produced probably using silk moths primarily in the genus *Borocera.* Due to over-harvesting of pupae and the destruction of native forests, wild silk production in those early sites has largely disappeared. We have found new sites and new types of silk that could be produced in Madagascar to benefit the rural poor. Furthermore, we found at least 5 potential silk producing areas that would support the maintenance and restoration of forests that protect birds, primates and amphibians threatened with imminent extinction.

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MCD INTERVIEW

Three women engaged in the CPALI Wild Silk Project

Eugénie RAHARISAO
Tsiresy Maminiaina RAZAFIMANANTSOA
Nirina Berina NATOLINA

Correspondence:
Madagscar Wildlife Conservation/Journal MCD
Anthropological Institute and Museum, University of Zurich
Winterthurerstrasse 190
CH-8057 Zurich
Switzerland
E-mail: info@journalmcd.net

INTERVIEW AVEC EUGÉNIE RAHARISOA, COORDINATRICE NATIONALE DE NY TANINTSIKA

Qui êtes-vous, quelle est votre fonction dans ce projet et depuis quand participer-vous?

Je m'appelle Eugénie RAHARISOA. Je suis Coordinatrice Nationale de NY TANINTSIKA, une ONG malagasy créée en 2002 avec l'appui de l'ONG Ecossaise Feedback Madagascar. J'ai travaillé au sein de Feedback Madagascar en tant qu'Assistante de projet de 1998 au 2002. Feedback Madagascar est intervenue dans le domaine de la soie depuis 1997. C'est à travers cette ONG que j'ai commencé à apprendre le milieu de la soie.

Avec NY TANINTSIKA, nous avons lancé nos interventions dans le Région de l'Amoron'i Mania, en 2002, juste après la crise politique. Au début, les interventions concernaient uniquement la relance des activités de sériciculture sur la soie d'élevage ou *bombyx mori*, lesquelles comprennent le renforcement de la culture des mûriers, la formation et encadrement en élevage des vers à soie *bombyx mori*. Pourtant, les femmes de la zone d'interventions ont comme activité traditionnelle le tissage de soie sauvage pour faire des linceuls. C'est pourquoi que nous avons renforcé les techniques de tissage et de teinture, l'introduction des matériels de filature et de tissage améliorés et la recherche des débouchés.

La Region de l'Amoron'i Mania abrite la plus grande forêt de tapia à Madagascar. Dans les zones où nous travaillons, les communes d'Ambohimahazo et d'Anjoma Ankona, il y a des forêts de tapia, la plante nourricière principale des vers à soie sauvage, mais il n'y a pas eu de peuplements des vers à soie sauvage. C'est pour ces différentes raisons qu'on a implanté le projet de conservation des forêts de tapia et la reproduction de landibe; lequel est lié avec la relance de la filière soie dans la région.

NY TANINTSIKA travaille dans plusieurs communes de la province de Fianarantsoa. On a d'autres projets de développement rural. Je suis chargée d'appuyer le coordonnateur local de ces différents projets, la recherche de financement. Mais concernant le projet «soie», je suis l'initiateur, chargée de l'élaboration et de la coordination de la mise en œuvre, le renforcement organisationnel des associations des tiserandes, la recherche de débouchés et surtout la recherche de financement du projet.

Quel sont les changements dans votre vie depuis que vous avez commencé à travailler dans ce projet?

J'ai effectuée mes études supérieures en Sciences Economiques. J'ai rêvé de travailler dans des établissements financiers, alors que j'ai commencé de travailler dans un projet de recherche sur l'économie rurale à Madagascar. C'est à partir de ce moment là que j'ai eu la préférence d'intervenir dans le milieu rural. Depuis que j'ai commencé à travailler dans ce projet, j'ai constaté que j'ai beaucoup eu de changement au niveau relationnel avec le public, je ne suis plus fermée au niveau de communication, j'arrive plus facilement à convaincre les gens à adopter certaines attitudes ou certaines activités de développement afin de changer leur vie et leur comportement. Après mes études supérieures, je n'ai reçu aucune formation en management ou gestion de projet, mais c'est par la pratique que j'ai tiré mes leçons. Comme j'ai travaillé au sein de la société, je connais les véritables problèmes.

Je peux dire, que sur le plan financier, certaines tisserandes gagnent plus que moi. Certaines ont construit des maisons, acheté des zébus, du terrain. Mais c'est ma satisfaction car

Eugenié RAHARISAO

c'est un indicateur de réussite du projet. Par contre, je devrai encore travailler beaucoup, car il faut qu'on aie ces indicateurs de réussites au niveau de tous les bénéficiaires et cibles.

Pour les villages et les alentours du projet, que pensez-vous a changé par ce projet?

Dans le projet, il y a deux volets différents, donc deux cibles: les villageois concernés par la gestion des ressources naturelles dans la forêt de tapia et les transformateurs de la soie sauvage, une des ressources de la forêt de tapia. Comme on a commencé par différentes périodes, les changements au niveau des bénéficiaires ont beaucoup plus d'écart.

On peut dire qu'on a déjà eu des résultats palpables au niveau des transformateurs. Le revenu issu de la soie devient au premier rang pour les différentes sources de revenu du ménage. Aujour'hui c'est la soie qui paie les autres services, alors que auparavant c'était le riz qui a eu le premier rang. Le tissage est une activité féminine dans la région et les femmes participent à la décision de l'affectation du revenu du ménage actuellement.

Par ailleurs, la transformation de la soie concernait uniquement la confection des linceuls avant le projet. Actuellement, les femmes cibles le marché de habillement et de décoration en confectionnant des écharpes, des nappes, des couvres lits et de rideaux en soie. Les villages deviennent de plus en plus connus, car certains tours opérateurs exploitent des circuits touristiques qui passent dans différents villages en montrant la filière dans son ensemble; c'est-à-dire la forêt de tapia, le repeuplement des vers à soie sauvage et la transformation (la filature et le tissage).

Quant à la conservation de la forêt de tapia, les activités ont été commencée récemment et la sensibilisation est encore à renforcer. Pourtant, les villageois ont commencé à comprendre l'importance de la protection. La forêt de tapia abrite beaucoup de ressources qui pourront procurer de revenu pour eux, à part de la soie; entre autres les champignons, les plantes médicinales, les plantes tinctoriales. Pour ce volet, c'est surtout le changement de comportement et d'attitudes qu'on a constaté au niveau des villageois, et surtout au niveau des autorités locales. On constate une grande participation et des plans ont été dressés pour les actions à prendre. Le reboisement en tapia devient une pratique pour les communes d'interventions et elles incluent cette activité dans leur plan communal de développement respectif.

INTERVIEW AVEC TSIRESY MAMINIAINA RAZAFIMANANTSOA, ÉTUDIANTE

Qui êtes-vous, quelle est votre fonction dans ce projet et depuis quand participer-vous?

Je suis Tsiresy Maminiaina RAZAFIMANANTSOA, étudiante préparant le Diplôme d'Etude Approfondie à l'Université d'Antananarivo: Option Biologie, Ecologie et Conservation Animale. J'ai travaillé avec CPALI en tant qu'assistante de Docteur Catherine Craig à Ranomafana pendant à peu près 7 mois et en tant que premier responsable lorsque Docteur Catherine Craig a été absente.

On a étudié les vers à soie sauvages en les élevant, mais on a aussi effectué des suivis sur le terrain de leur milieu naturel. On a fait tout ceci dans le but d'obtenir des cocons (en quantité et en qualité). Les cocons ont été destinés pour les femmes tisserandes du village. Le village a une association locale de femmes qui ont suivi des formations sur le tissage.

J'ai pris soins des larves et des cocons ainsi que des papillons origine des soies au Centre Valbio à Ranomafana. Mais on n'a pas pu atteindre ce but car notre étude a été encore basée sur la recherche, et aucune étude n'a été faite auparavant sur les vers à soie sauvage à Ranomafana. En outre notre permis de recherche a été expiré le mois de juin 2005.

Quel sont les changements dans votre vie depuis que vous avez commencé à travailler dans ce projet?

D'abord, j'ai commencé à aimer les vers à soie sauvages. Puis, ce projet me fait comprendre à quel point la population locale peut tirer profit de la biodiversité en la conservant car les animaux préfèrent les habitats à la lisière de la forêt. Ainsi leur élevage est possible.

Enfin, la réalisation du projet m'a permis de communiquer avec autrui, d'échanger des expériences avec les personnes concernées (Filière à soie)

Pour les villages et les alentours du projet, que pensez-vous a changé par ce projet?

Bien qu'il s'agit de recherche, le projet leur a permis de connaître les animaux ainsi que leur écologie et leur importance économique. Car il a été difficile de trouver les animaux dans leur milieu naturel pour nous, nous avons mobilisé les gens à chercher des larves et des cocons en leur donnant du riz en échange. On leur a aussi posés certaines questions sur leur

Tsiresy Maminiaina RAZAFIMANANTSOA

Tsiresy Maminiaina RAZAFIMANANTSOA

connaissance des vers à soie sauvage. Puis on leur a dit le but du projet et leur avantage si la recherche est un succès. Le projet a changé leur regard envers la filière à soie. Les villageois de Ranomafana n'avait aucune idée sur le tissage des cocons alors qu'ils les possèdent en énorme quantité. Maintenant les villageois ont fait recours à la filière à soie.

INTERVIEW AVEC NIRINA BERINA NATOLINA, COLLECTEUR DE SOIES

Qui êtes-vous, quelle est votre fonction dans ce projet et depuis quand participer-vous?

Je m'appelle Nirina Berina NATOLINA. J'ai 19 ans et j'habite à Ambatolahy. Je suis Betsileo du Savindrona. J'ai un enfant, mais je ne suis pas mariée. Pendant deux mois j'ai été collecteur de soies (insectes) qu'on a vendu à Catherine Craig, la fondateur du projet CPALI, ou qu'on à échangé contre du riz.

Quel sont les changements dans votre vie depuis que vous avez commencé à travailler dans ce projet?

Avant la naissance du projet dans notre village, j'ai de la difficulté de trouver de quoi nourrir mon enfant, de quoi acheter du riz et du pétrole, de quoi acheter les habits de mon enfant, mais durant que je travaillait dans le projet, tout ça a beaucoup changé. Intellectuellement, j'ai appris l'importance de la biodiversité tel que les insects de la soie. C'est dans le projet aussi que j'ai appris que les soies peuvent être utiles pour la fabrication de tissus.

Pour les villages et les alentours du projet, que pensez-vous a changé par ce projet?

Je ne sais pas beaucoup, parce que le projet n'a pas duré très longtemps, alors, il n'y avait que la collection de soies, puis la vente ou l'échange avec du riz. Mais je peux dire que le projet a crée du travail surtout pour les jeunes femmes dans notre village et a réduit le nombre des prostitués. Malheureusement le projet s'arrête déjà. Ce que les villageois anticipent maintenant c'est le retour de Catherine Craig pour continuer le projet. Et pour que les produits de soies locales soient utilisés par l'association des femmes producteurs de tissus à soies de Ranomafana au lieu de chercher ces materiaux tres loin de Ranomafana. Au niveau intellectuel, je pense que beaucoup de villageois ont maintenant beaucoup de savoir sur les soies.

Nirina Berina NATOLINA et son enfant devant le laboratoire d'analyse de soies à Ranomafana

PRESERVING MADAGASCAR'S NATURAL HERITAGE

The Importance of Keeping the Island's Vertebrate Fossils in the Public Domain

David W. Krause[I], Patrick M. O'Connor[II], Armand H. Rasoamiaramanana[III], Gregory A. Buckley[IV], David Burney[V], Matthew T. Carrano[VI], Prithijit S. Chatrath[VII], John J. Flynn[VIII], Catherine A. Forster[I], Laurie R. Godfrey[IX], William L. Jungers[I], Raymond R. Rogers[X], Karen E. Samonds[XI], Elwyn L. Simons[VII], Andre R. Wyss[XII]

Correspondence:
David W. Krause
Telephone: +31 631 4443117
Fax: +31 631 4443947
E-mail: David.Krause@stonybrook.edu

INTRODUCTION

The origin of Madagascar's highly endemic vertebrate fauna remains one of the great unsolved mysteries of natural history. From what landmasses did the basal stocks of this unique and imbalanced fauna come? When and how did the ancestral populations arrive on the island? How rapidly did they diversify, and why? The most direct means of addressing these questions, and other enigmas concerning the evolutionary and biogeographic history of Madagascar's vertebrate fauna, is through discovery of fossils from a sequence of well-dated geological horizons. Many fossils relevant to these queries have been discovered by paleontologists in recent years…but many more are being lost to commercial enterprises, both foreign and domestic, that have little or no regard for the scientific significance of fossils. The objectives of this essay are to 1) provide an overview of Madagascar's vertebrate fossil record and its importance, 2) raise awareness concerning the illegal collection, exportation, and sale of vertebrate fossils, and 3) stress the importance of keeping vertebrate fossils from the island in the public domain. In light of these issues, we underscore the necessity for development of adequate repositories and support infrastructure in Madagascar to safeguard and display the country's vertebrate fossil collections; doing so would ensure the preservation and appreciation of Madagascar's rich natural heritage for future generations of scientists and Malagasy citizens alike.

MADAGASCAR'S TERRESTRIAL AND FRESHWATER VERTEBRATE FOSSILS

Numerous Pleistocene (1.8 million years ago [Ma] to 11,500 years ago) and Holocene (11,500 years ago until today) cave sites and swamp deposits scattered across Madagascar have yielded the bones of extinct vertebrates that lived before and during human colonization of the island, which began roughly 2,300 years ago. In recent years, paleontologists from a number of foreign institutions (*e.g.*, Duke University, Field Museum, Fordham University, Stony Brook University, University of Massachusetts – Amherst), in collaboration with scientists from the University of Antananarivo, have unearthed the bones of giant tortoises, elephant birds, pygmy hippopotamuses, many extinct species of lemurs, and a variety of other interesting creatures. Although some of these bones are as old as 26,000 years (Late Pleistocene), others have been dated to as recent as 500 years, some 1,800 years after human occupation of the island. The Holocene fossil record also reveals that the geographical distributions of several extant species of lemurs (*e.g.*, bamboo lemurs and indris) were much broader in the recent past.

In contrast, the pre-Pleistocene Cenozoic (65.5-1.8 Ma) fossil record of Malagasy terrestrial and freshwater vertebrates is virtually non-existent, in large part because terrestrial sediments from this interval are rare or extremely difficult to access. The Mesozoic Era, however, has yielded an abundance of vertebrate fossils, from all three of its periods: Triassic (251.0-199.6 Ma), Jurassic (199.6-145.5 Ma), and Cretaceous (145.5-65.5 Ma). Following upon work conducted by various French, Japanese, and Malagasy expeditions that began in 1895, Stony Brook University and the University of Antananarivo have conducted joint paleontological field research in Upper Cretaceous sediments (one horizon at ~70 million years old and another slightly older) of the Mahajanga Basin since 1993. This work has resulted in a plethora of well preserved and remarkably complete specimens that have shed considerable new light on the evolution of Cretaceous vertebrates from across the southern supercontinent Gondwana, and from Madagascar

I Department of Anatomical Sciences, Stony Brook University, Stony Brook, New York 11794, U.S.A.
II Department of Biomedical Sciences, Ohio University, Athens, Ohio 45701, U.S.A.
III Département de Paléontologie, Université d'Antananarivo, Antananarivo (101), Madagascar
IV Evelyn T. Stone University College, Roosevelt University, Chicago, Illinois 60605, U.S.A.
V Department of Conservation, National Tropical Botanical Garden, Kalaheo, Hawaii 96741, U.S.A.
VI Department of Paleobiology, Smithsonian Institution, P.O. Box 37012, NHB E-105, MRC-121, Washington, DC 20013, U.S.A.
VII Department of Biological Anthropology and Anatomy and Primate Center, Duke University, Durham, NC 27705, U.S.A.
VIII Division of Paleontology, American Museum of Natural History, Central Part West at 79th Street, New York, New York 10024, U.S.A.
IX Department of Anthropology, University of Massachusetts, Amherst, Massachusetts 01003, U.S.A.
X Geology Department, Macalester College, St. Paul, Minnesota 55105, U.S.A.
XI Redpath Museum, McGill University, 859 Sherbrooke St. W., Montreal, Quebec H3A 2K6, Canada
XII Department of Earth Science, University of California – Santa Barbara, Santa Barbara, California 93106, U.S.A.

in particular. The Late Cretaceous Malagasy vertebrate fauna now includes fishes, frogs, turtles, lizards, snakes, crocodiles, non-avian dinosaurs, birds, and mammals. The records of frogs, lizards, birds, and mammals are particularly significant in that they are the first-known, pre-Late Pleistocene occurrences from the island.

Paleontologists from the Field Museum, American Museum of Natural History, University of California at Santa Barbara, and University of Antananarivo have also begun to dramatically improve knowledge of Jurassic and Triassic Malagasy vertebrates. A small collection of fossils of probable Early Jurassic age from a site in the central Morondava Basin includes diverse bony and cartilaginous fishes, non-mammalian synapsids ("mammal-like reptiles"), and various other reptiles (including sauropod and theropod dinosaurs, the oldest members of both groups from the island). Middle Jurassic nonmarine vertebrates from Madagascar were previously known only from fragmentary remains recovered before the end of the 19th century but recent expeditions to these deposits have yielded an impressive assemblage from the southern part of the Mahajanga Basin. At least 13 vertebrate groups are now known from this fauna including fishes, amphibians, reptiles (noteworthy being pterosaurs, theropods, and the earliest known ornithischian dinosaur from Madagascar), and the earliest known tribosphenic mammal, *Ambondro mahabo*, which has generated debates about the origins of "advanced" (holotherian) mammals. Similarly, recent exploration in Middle to Late Triassic strata of the Morondava Basin has revealed a high diversity of vertebrate fossils, complementing discoveries of various fishes, amphibians, and reptiles made largely by earlier French expeditions. This assemblage contains rhynchosaurs, sphenodontians, a dicynodont, a diverse array of basal cynodonts, and an archosauromorph.

Finally, Permian (299 – 251 Ma) vertebrate faunas of Madagascar, largely collected by French expeditions to the Isalo region in the 20th century, include atherstoniid fishes, primitive amphibians, a host of cotylosaurian and eosuchian reptiles, and, with the exception of a complete dicynodont skull, fragmentary remains of therapsids.

Figure 1 provides just one example of the extraordinary fossils recently recovered from Madagascar and Figure 2 presents a summary of terrestrial and freshwater fossil vertebrates known from the island – more complete summaries are provided by Burney *et al.* (2004 – Pleistocene and Holocene), Krause (2003 – Cretaceous), and Flynn and Wyss (2003 – Jurassic and Triassic).

WHY ARE MADAGASCAR'S VERTEBRATE FOSSILS SO IMPORTANT?

Fossils provide the only direct chronicle of the rich vertebrate fauna that once existed on Madagascar. They reveal an evolutionary past that scarcely could have been predicted on the basis of the modern fauna alone. For example, without the fossil record, we would not have evidence that gorilla-sized lemurs, diminutive hippopotamuses, and the heaviest bird of all time inhabited the island only a few hundred years ago or that the Cretaceous vertebrate fauna had closer ties to those on the Indian subcontinent and South America than to that on the closer landmass of Africa.

The Late Cretaceous fossil record from Madagascar is pro-viding the highest quality information on the anatomy and

FIGURE 1. An exact replica of the skeleton of the theropod dinosaur *Majungatholus atopus* from the Late Cretaceous of Madagascar (above), based on a composite of specimens, and the excavation site from which one of the specimens was recovered (below).

relationships of major groups of Gondwanan vertebrate animals. The Jurassic of Madagascar has yielded the earliest known record of tribosphenic mammals, a discovery that has played a strong role in shaping views of early mammalian evolution. For some parts of the fossil record, we already know that Madagascar provides unparalleled insight into ancient animal life because these time intervals are poorly represented elsewhere in the world. For example, at the beginning of the Triassic, a diverse array of archaic vertebrate animals populated the globe. By the end of the period, dinosaurs and mammals had appeared but the record of what transpired in between has been sparse on all continents, and is only now beginning to be revealed by discoveries from Madagascar. The Malagasy fossil record also yields profound insight into the biogeographic origins of the extant fauna of Madagascar, both recent and long past extinction patterns (including lessons to be learned concerning maintenance of the modern biodiversity), and the timing, sequence, and environmental and biotic effects of Gondwanan fragmentation.

Despite the views into Madagascar's past provided by these discoveries, it is only a start. Even in the most intensively sampled field areas, it is clear that we have only glimpses of the full diversity of vertebrate animals that once lived on Madagascar. Furthermore, even in these well-studied areas, many species are still represented by only fragmentary or isolated specimens; additional materials must be recovered to learn more about how these animals lived and died, how they

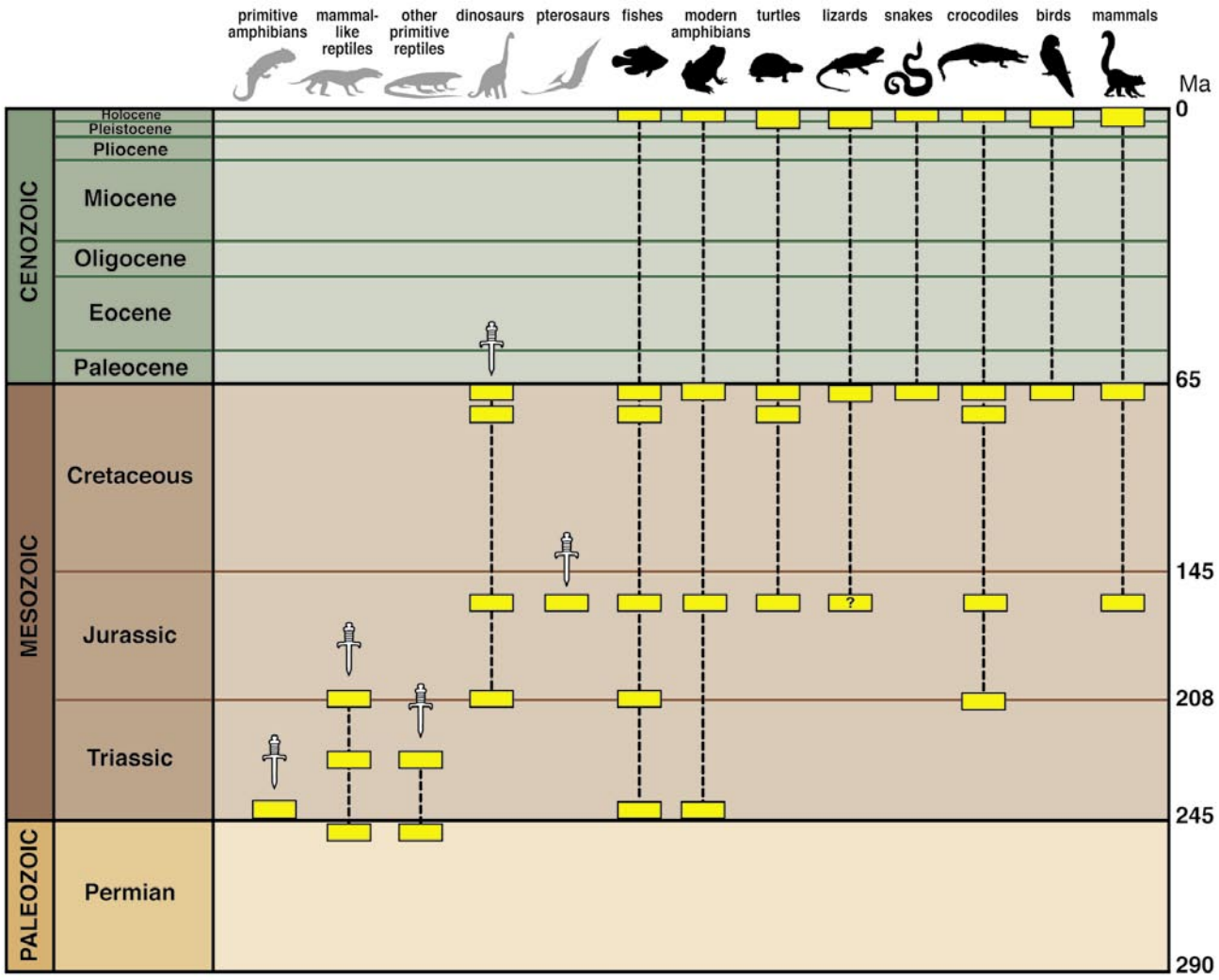

FIGURE 2. Temporal distribution of occurrences (yellow boxes) of terrestrial and freshwater fossil vertebrate groups known from Madagascar. Daggers and gray silhouettes indicate extinct groups.

are related to animals in other parts of the world, and what novel data they reveal concerning broader questions of plate tectonics, biodiversity, and conservation.

THE ILLEGAL COLLECTION AND EXPORTATION OF MALAGASY VERTEBRATE FOSSILS

Vertebrate fossils collected by trained researchers and technicians are exhumed with extreme care and documentation. Prior to excavation, the sites are carefully mapped and their stratigraphy and sedimentology thoroughly documented. During excavation, the position and orientation of individual bones are duly noted. Rock samples are collected to reveal aspects of depositional history, taphonomy, and paleoecology, and to accurately date the sediments. All scientifically significant fossil specimens in an area are collected, not only those of high-profile taxa (*e.g.*, dinosaurs, primates) or just those parts most valued by private/commercial collectors (*e.g.*, jaws, teeth, skulls, articulated skeletons). Most importantly, all fossils collected on scientific expeditions are maintained in the public domain by accessioning them permanently into museum collections, with all documentation available to current and future researchers.

In order to legally collect vertebrate fossils in, and remove them from, Madagascar, collection and exportation permits must be obtained from the Ministry of Energy and Mines (see Code Minier 2000). Furthermore, current "*accords de collaboration*" between foreign and Malagasy scientific institutions stipulate that the fossils collected as part of these joint expeditions can be exported for preparation and study but that, upon completion of study, all holotype specimens and one-half of the remaining specimens must be returned to Madagascar. The other half of the specimens are reposited in accredited foreign public museums so that they can be made available to all scientists and, where appropriate, displayed for the worldwide public. As such, all legally collected fossils remain in the public domain, both in and outside of Madagascar. Unfortunately, however, scientifically and educationally priceless fossils are increasingly being pillaged and removed from the public domain by unscrupulous foreign and domestic commercial enterprises. Typically, such fossils find their way into the collections of private owners, and, in turn, important aspects of the natural heritage of Madagascar, and the world, are lost to scientific research and are forever unavailable for the education of current and future generations of the interested public.

Contributors to this article have witnessed multiple cases in which scientifically significant fossils have been destroyed through the poor excavation techniques commonly associated

with non-scientific collecting. The specimens were not thoroughly consolidated and were carelessly removed from the ground with large picks. We have also observed tell-tale signs of "head-hunting," the practice of removing only the parts of skeletons that will get a high price. Information obtained from local residents indicates that the perpetrators are foreign entities who do not possess accords de collaboration, nor collecting or export permits, and are thus working illegally. Fossils are carelessly removed without regard for critically important location and geological data and then are sold, thereby disassociating them from their geological context and nullifying or markedly diminishing their scientific value. In some cases, rather than collect the fossils themselves, foreign commercial fossil dealers recruit residents living in fossil-rich areas to collect specimens, bring them to pre-arranged meeting places, and sell them, for the equivalent of pennies (providing a small increment of much-needed money to the desperately poor). These fossils are similarly poorly and improperly taken from the ground. Such activity has even resulted in the destruction of fossils, or parts of fossils, while in the process of being legally collected by scientific teams. Whether collected by them or purchased from local residents, the fossil dealers privately sell the fossils abroad, acquiring major ill-gotten profits, while removing the fossils from the public domain.

Many vertebrate fossils are sold in artisans' markets throughout Madagascar, but this practice is particularly rampant in the capital Antananarivo, especially at one site near the Ivato International Airport. Tourists have the opportunity to purchase a range of fossils, among the most common being dinosaur bones from the Jurassic of the Morondava and Mahajanga basins. The bones come in various forms: some consist of complete, or nearly complete, isolated elements, usually vertebrae and teeth; others are bones, usually large sauropod vertebrae, that have been hollowed out and polished to make ashtrays; and yet others are polished into spheres (up to 4 inches in diameter!) to make a game of solitaire utilizing 37 spheres placed on a hardwood board or the traditional Malagasy game "Fanarona", which requires 35 spheres. In some cases, we have been approached, in Antananarivo, in our field camps, and elsewhere, to purchase fossils, both already exhumed (and therefore lacking contextual data) and in situ. Many other fossils from Madagascar are exported and frequently sold on the internet (*e.g.*, www.ebay.com, www.mcculloughfossils.com, www.cornishcrispa.com), in auction houses (*e.g.*, Bonhams and Butterfields Los Angeles Gallery), at gem and mineral shows (*e.g.*, Tucson Gem and Mineral Show), and in rock shops (*e.g.*, Paleoguy's Rock Shop). Indeed, it takes little effort to find illegally collected and exported specimens of vertebrate fossils from Madagascar for sale. Brief searches conducted recently on the internet revealed several examples of not only isolated bones, teeth, and coprolites but also a nearly complete and well-preserved skeleton of a dinosaur. One seller advertised coasters made from sectioned Malagasy dinosaur bone. Elephant bird eggs, in varying states of completeness, are also commonly available. It is impossible to know how many scientifically valuable specimens have been lost due to these various activities, and to predict how many more will be lost in the future.

The rationale provided by commercial enterprises for buying and selling fossils is exemplified by a statement on one of the websites operated by fossil dealers ("Two Guys Fossils": http://www.twoguysfossils.com/), who provide four reasons: 1) "A fossil is a piece of history that, in many cases, will become a family heirloom;" 2) "As a straightforward investment opportunity, fossils outperform many other options;" 3) "A fossil is a low-maintenance investment;" and 4) "Fossils are functional pieces of art." It is crucial to note that none of these reasons involve science or education; fossils are regarded solely as personal investments and/or as objects of art. No value is placed on retaining the geological context of specimens or in keeping such specimens in the public domain, where scientists can study them or where the public can appreciate them. Also lacking is any acknowledgment of the importance of these specimens to the natural heritage of our planet and their country of origin.

PRESERVING MADAGASCAR'S FOSSILS FOR EVERYONE

Madagascar's vertebrate fossil resources – currently being lost to illegal but largely unchecked commercial exploitation – must be preserved and protected. It is imperative that they remain in the public domain. If fossils are simply regarded as curios and "objets d'art," that is all they will ever be – commodities regarded only as mysterious or pretty. But there is much more to fossils. Fossils were once parts of living animals and thus yield crucial information about past life on this planet, how extinct animals lived, died, and evolved, and how they interacted with each other and their environment. Data derived from vertebrate fossils are crucial for revealing phylogenetic and biogeographic relationships to other animals on the planet; these data in turn can be used to test hypotheses about the origins of the modern Malagasy fauna and about the timing and effects of Gondwanan fragmentation. They already underscore the need for conservation in that they demonstrate that the geographic distributions of many extant taxa have shrunk drastically since human colonization of the island.

These aspects of Earth history are important for science and fascinating to people of all ages and all cultures, but can only be revealed or independently tested if fossils are excavated with extreme care, if data on their geological context are collected, if they are carefully removed from the rock by skilled and experienced technicians, if they are studied by trained scientists, and if the information derived from them is published in widely accessible scientific or popular books, magazines, or journals. Only if fossils are curated and housed in a public institution (such as a museum or university) can there be reasonable assurance that they will be available to future generations of researchers, educators, students, and the general public. These specimens become all the more significant as new discoveries are made and new techniques for studying them are developed.

Each and every fossil has a story to tell, and these stories from Madagascar's history will be forever lost if the island's fossils are torn from the ground in haste, sold into private collections, and left unstudied. Perhaps most disheartening is the fact that the Malagasy people will lose their opportunity to learn about these fascinating tales themselves if their unique fossil heritage is sold to the highest bidder. The value of fossils as sources of scientific information to unravel the mysteries of past life far outweighs any monetary value that is artificially, illegally, and inappropriately placed upon them by unscrupulous fossil dealers. Madagascar's fossils do not belong on mantelpieces and coffee tables in private homes and offices of the

world's wealthy to be enjoyed by a few. They instead must be protected in publicly-accessible institutions, in Madagascar and elsewhere.

The woeful state of facilities for storage and display of fossil specimens in Madagascar itself also needs to be addressed. Public research institutions such as the University of Antananarivo are in dire need of a state-of-the-art collections facility to safely store and maintain vertebrate fossils. Correspondingly, Madagascar would be well served if a national museum was built to display the educationally most significant fossils that have already been collected, and those to be collected in the future. Only then can the rich natural heritage of this unique island be fully appreciated by its own citizens, as well as foreign visitors.

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CHILDREN AND CONSERVATION

Roots & Shoots: A model for active environmental protection

Patrick O. Waeber

Jane Goodall Institute Switzerland
Germaniastrasse 51
CH-8006 Zurich
Switzerland
E-mail: pawaeber@janegoodall.ch

SUMMARY

Madagascar is facing severe environmental problems. One approach to engage possible future stakeholders and to raise awareness for environmental concerns is the Roots & Shoots program. On the following the program and its philosophy are presented.

MADAGASCAR – THE DEMOGRAPHIC SITUATION

Madagascar has a current population of about 18 million people living across the more than 587,000 km^2 big islands. Madagascar is among the top ten countries in the world concerning birth rate (>3%, world average: 1.15%). More than 8 million Malagasy are under 15 years old. Thus, a bit less than 50% of the whole population are children.

In the meantime, the environment on this island is facing fast changes it cannot cope with. Those comprise soil erosion resulting from deforestation and overgrazing through cattle, desertification, contamination of surface water with raw sewage and other organic wastes. Hence, the living conditions for a majority of the Malagasy population is changing to the worse and surviving has become a daily challenge.

The future for millions of people is not at all bright. Always the weakest in a community are the first to suffer negative impacts of environmental changes: children and old people.

THE ROOTS & SHOOTS PROGRAM

Roots & Shoots (R&S) program engages children and young people through community service and service learning. The children are organized in groups of 2 up to 40 or more children with for example a teacher or an adult person taking over the lead and responsibility for the group. Roots & Shoots groups show care and concern in three different areas: the human community (social environment), the animals (wild and domestic) and the natural environment. The main goal of R&S is to raise the children's awareness as well as the public's one for these areas by doing small projects with their groups. The importance thereby is that the children get the possibility to plan and implement their actions by their own. The group leaders are there to coordinate and support the children's activities.

THREE KEYNOTES ARE THE CORE OF R&S: *Knowledge*: The more children know about their community or environment, the better they can judge what needs to be done. The more children know and understand the higher is the chance to develop *Compassion*: The concern and a desire to make a difference energize young people to tackle problems around them. This has as a logical consequence the third keynote – *Action*: Action is the result of a group's learning and planning. These three steps are crucial for a success and serves as starting point for the R&S program. Furthermore, the knowledge-compassion-action-pathway is to be achieved in all the mentioned areas of R&S activity.

Roots & Shoots has been founded in 1991 by Dr. Jane Goodall in Tanzania and embraces today 96 countries with more than 100,000 children worldwide. An R&S group can work by its own or use the network and have a steady exchange of ideas and actions with a group from another region or even another country. This gives the children the possibility to learn and know more about other regions and cultures. Furthermore, this is an important reason to enhance children's motivation to participate in such a program.

ROOTS & SHOOTS MADAGASCAR

In October 2005 Roots & Shoots Madagascar has been founded with Todinaina Ralasondraibe as the Coordinator of R&S Madagascar. Until now he has founded 6 groups: one at the Malagasy East Coast, two in Antananarivo and three in the Alaotra Region. The best way to engage as many children as possible is to involve primary and secondary schools into the R&S program. The goals of Roots & Shoots Madagascar are to build a network of groups in each of the 6 provinces of Madagascar to cover all the 5 geographic regions with the respective and diverse habitats. The long-term goal in Madagascar is to engage the students at the university level, because they are the most closely future stakeholders.

On the following, an example of action is presented: The group 'Domoina' (composed of children from the 3rd-5th secondary school level) learns about lemurs as a Malagasy heritage and peculiarity. They make draws of the lemurs, which they have visited and seen in the Tsimbazaza Zoo in Antananarivo. These draws are exposed in their school. Further, the R&S members will present in their respective classes what they have learned about lemurs: the importance of the lemurs, the threats which most of the lemurs faces, and possible solutions to preserve the lemurs for the future.

ROOTS & SHOOTS – AN ACTION-PLAN FOR THE LONG-TERM SCALE

Together, the Roots & Shoots philosophy can be a way to engage as many children and young people as possible across the whole islands of Madagascar taking action for their environment and their future. Only if children of today learn about the importance of their environment, the men and women of tomorrow can handle it with care. Therefore, Roots & Shoots is not only a way to take action for the short-term, but it is an action-plan with sustainable potential on a long-term scale.

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MADAGASCAR MOVING TOWARDS SUSTAINABLE DEVELOPMENT

The preparation of the National Environmental Action Plan (NEAP): Was it a false start?

Jean-Roger Mercier[1]

ABSTRACT

In the late 80's, the World Bank got interested in environmental matters, to the point that a tsunami of a new process (National Environmental Action Plans –NEAPs) swept across the African continent. At that time, Madagascar was still under the rule of Didier Ratsiraka, an iron rule which had started in 1975. A place where biodiversity assets are unique and fascinating, one of the best and hottest hotspots of conservation around the world; but also a place where environmental mismanagement has created severe erosion and water quality problems. What to do when the daily life of the average Malagasy is spent surviving for the very sector sustaining the country's battling economy? Some of the solutions proposed at the time materialized during the 15 years period since the 1990 adoption by the Malagasy government of the NEAP's findings and recommendations. Some of the original intentions, however, never were transformed into significant large-scale progress in environmental management. In 2006, Madagascar is still plagued with very serious poverty and environmental degradation problems. Can the lessons learned from the original design and the 15 years of application of the NEAP be useful to help the Malagasy nation move towards more sustainable and equitable development? If the answer is yes, what should the ways and means be?

ONCE UPON A TIME

I was privileged to participate in the preparation of the NEAP for Madagascar in the mid-80's.

After many efforts to help Sub-Saharan Africa (and notably the Malagasy government) develop the local infrastructure, especially in the transport, water and energy sectors, the World Bank got interested in environmental matters through an assistance to the preparation of National Environmental Action Plans. When the process was launched, very few experts had set out for such an ambiguous plan and even the basic methodology was to be invented. Partial approaches to environmental planning had been tried and tested (in particular National Conservation Strategies), but as far as the overall NEAP approach was concerned, it is fair to say that the design was done in parallel with the preparation of the first NEAPs. Madagascar and Rwanda were, for reasons that have to do with some strong personalities, the early dominance of international groups like the WorldWide Fund for nature (WWF), the World Conservation Union (IUCN) and Conservation International and also to the unique and fascinating biodiversity assets of the two countries. These countries indeed came first on the radar screen of the World Bank, and the preparation of these two NEAPs garnered strong support from the international community.

ROLLING UP THE SLEEVES

The donor-funded team had strong initial views on what needed to be done to reverse the catastrophic environmental degradation of the times. François Falloux, a land tenure and agricultural specialist at the World Bank, called me up when he built his team to help with the Madagascar NEAP. I was fortunate to bring experience with Environmental Impact Assessment to the table, plus a few short and longer stays in Madagascar. I thus joined a team of several experts in biodiversity, forestry and other "green" topics. Our enthusiasm was probably in direct proportion of our political ignorance of the depth of internal struggles within the Malagasy society and our equally naive perception of the ease to transform additional financial support, which seemed to be ready to flow towards Madagascar, into improved environmental protection.

The basic objective of the Madagascar NEAP was to "curb the environmental degradation spiral by reconciling population with their environment". The NEAP was designed as a 15-year plan, which was to be in majority funded from external sources, and more marginally by the Malagasy Government. The mission was huge and we were collectively doomed, as a FOFIFA[2] researcher colleague put so well, to having to help our Malagasy counterparts "choose between the ox and the lemur". While the original team was essentially composed of international experts, we rapidly co-opted several Malagasy experts and anchored our contacts with the Malagasy Government which was involved at the highest level, the then-Prime Minister Victor Ramahatra bringing an incredibly pertinent vision to this NEAP preparation. Cooperation with the international NGOs was a given, with WWF having a particularly strong and competent involvement from the onset.

Our first order of business was to define the NEAP's scope. We cast the net very widely and did not limit ourselves to conservation, though conservation was both the reason why Madagascar was so famous and courted internationally and the biggest motivation behind the preparation of the NEAP. However, we built seven components into the preparation of the NEAP, which were to correspond to programs to be implemented over a period of 15 years:

Protecting and managing the national heritage of biodiversity, with a special emphasis on parks, reserves and gazetted natural forests, in conjunction with the sustainable development of their surrounding areas; Improving the living conditions of the population. This would be done in rural areas by improving the protection and management of natural resources. Particular attention would be paid to watershed protection, reforestation, and agro forestry. In urban areas, this would involve improving water supply and sanitation, waste management and pollution control in general; Promoting environmental education, training, and communication; Developing mapping and remote sensing tools to meet the demand for natural resources and land management; Developing environmental research on terrestrial, coastal and marine ecosystems; and Establishing mechanisms for managing and monitoring the environment, one of which was unfortunately dropped prematurely.

The reader will notice that there are only six components! As a matter of fact, one of the original components was unfortunately dropped prematurely. A major internal battle was indeed lost when the component on "preventive and mitigation measures against natural disasters" was taken off the NEAP scope. The rationale for excluding the topic was that it was (i) not truly within environmental purview and (ii) that there were no cost-effective technical solutions to this issue. In other words, let's do nothing to make buildings more and better resistant to hurricanes, earthquakes and landslides. It was very disappointing. But other than that, the NEAP preparation continued over the remaining six components and, by 1989, the work was sufficiently advanced that the NEAP report could be published and widely disseminated.

WHAT HAPPENED AFTER THE NEAP?

The NEAP was translated into a policy document "La Charte de l'Environnement" which was formally adopted as a law (Law 90-033, December 21, 1990). The NEAP was essentially the proposal of a new environmental management framework and a long list of activities to be further refined and implemented for the 1990-2005 period.

Originally, the Government and the donors wanted the NEAP to be implemented in three five-year packages. Because life happens and mathematics are only for nerds, the reality has been that the packaging of the externally funded activities was in two 7/8-year projects: Environmental Project I and II (EP I and EP II).

EP I was initiated in 1991 in the face of a limited conservation baseline with the support of a broad coalition of bilateral donors (Germany, France, Switzerland, USA), international agencies (WB-IDA[3], UNDP[4], UNESCO[5]) and NGOs (Conservation International, WWF, Wildlife Conservation Society). Activities in this phase aimed at nurturing policy and regulatory reform and creating the basic institutional framework for protected area management and for ecologically compatible development[6]. EP II, initiated in 1997, expanded the field coverage of conservation activities, while further strengthening institutional capacities, and developing the policy framework to improve conditions for sustainability.

What have the first two externally-funded projects achieved? Measured against the key performance indicators, EP II largely met or exceeded the planned targets and brought significant accomplishments in both (i) increasing the sustainable use of natural resources in target areas; and (ii) establishing conditions for mainstreaming sustainable environmental and natural resources management at the national level. There were several areas, however, particularly in regard to the second objective, where EP II achievements remained short of targets.

BOX 1. Madagascar at the time of the PNAE implementation

Madagascar was still under the rule of Didier Ratsiraka, an iron rule which had started in 1975. Ratsiraka's domination of the national political scene would only end in 2000. What the first decade of this long reign had brought to the island was nothing short of isolation, poverty, a police regime and very little development prospects for a poor and increasingly desperate population.

While the 2004 population is estimated at 17.2 million, it was only about 10 million in 1989, an average growth rate of 2.6 % per annum. Income per capita was low, estimated at US$ 240, and it has barely increased in 2004 (US$ 300), at best a little over half of the per capita income in Sub-Saharan Africa, itself the poorest continent worldwide. Life expectancy at birth was under 50 years. In 2002, it is 55 years, by contrast with economic indicators, well above Sub-Saharan Africa's average of 46. Agriculture was making up about 30% of Madagascar's Gross Domestic Product. In 2004, the GDP is US$ 4.4 billion, and agriculture's share is 28.9%.

CAN WE CALL IT A SUCCESS?

In respect to its first objective – increasing the sustainable use of natural resources (*e.g.*, soil, forests, biodiversity) in the target areas – EP II achievements were satisfactory as described hereafter.

Concerning forest and land management, EP II substantially contributed to reducing the deforestation. The NASA satellite imagery and the decadal deforestation map constructed by Conservation International show that deforestation rate in protected areas is four times lower than outside the parks. Importantly, an ongoing multivariate analysis of the data suggests that the relationship between the parks effect and decreased deforestation is causal, and cannot be explained just by the placement of parks in less accessible or agriculturally less attractive areas. EP II interventions also contributed to controlling the incidence of unsustainable slash-and-burn tavy agriculture in the target areas. Tavy incidence decreased by 72 % during the first 4 years of the project. Following EP II mix of interventions promoting conservation agriculture and soil management, soil erosion diminished from the prevailing 8 tons per hectare to 1.6 ton per hectare annually, a substantial 80 % decrease while the agricultural productivity remained stable or increased. This reduction is particularly valuable given that the target areas were areas selected because of their high population, high soil vulnerability and sizeable agricultural sector.

Conservation agriculture lead to improved soil fertility as measured over a three-year period (1997-2000). Particularly significant was the increase of soil fertility on soils applying direct sowing with (zero tilling) with permanent or seasonal soil cover. In these soils, the activity and content in soil fauna increased, soil humus content improved, soil compaction diminished and soil structure improved. The thickness of top soils increased from 10-15 cm to 20-25 cm. A soil analysis of basic nutrients showed that organic matter content increased by 45 %, nitrogen by 440 %, phosphorus by 600 % and potassium by 218 %.

Improved soil fertility contributed to improved yields for green beans, soybean, maize, and rain-fed rice which showed a yield increase of 99 %, 170 %, 201 %, and 188 %, respectively when compared to typical yields under traditional farming methods.

The improved use of forest resources in the target areas reduced degradation of sensitive ecosystems and decelerated the loss of biodiversity. Measured through a biodiversity index, the loss of biodiversity diminished from a level of 1.66 % to a level of 0.62 % during EP II. The expansion of the protected areas based on tourism that EP II catalyzed strengthened the sustainable, non-consumptive uses of biodiversity resources and demonstrated potential to generate new revenues while meeting global conservation objectives.

THE POLICY REFORM DID NOT PROGRESS AS WELL

In respect to its second objective – establishing conditions for mainstreaming sustainable environmental and natural resources management at the national level (*e.g.*, through improved local practices, national policy reform, environmental management, environmental education) – EP II achievements were also satisfactory.

Awareness of government authorities, local communities, and civic society about environmental protection and biodiversity conservation is high. The target communities in different areas, *e.g.* Fianarantsoa, Sakatia, Montagne d'Ambre, have perceptibly changed their approach to environment and use of natural resources away from unsustainable practices towards seeking more livelihoods that are more sustainable and derive greater value from the natural assets, such as improved agriculture, handicraft work and ecotourism.

Policy reform to mainstream environmental considerations into economic sectors with greatest impacts on the environment has advanced substantially in mining, fisheries, aquaculture and industry sectors. Under EP II, the government approved and implemented key new policies, including policy on protected areas (POAP), policy on integrated marine and coastal zone management, national biodiversity management policy, national environmental education policy and environmental policy for road and infrastructure sector.

The policy reform, however, progressed less than planned. Several policies – tourism development policy, intellectual property protection policy, urban development policy and pesticide use policy were drafted, however not adopted or implemented by the government. The forestry policy, which was developed and adopted during EP II preparation as a condition of EP II effectiveness, was not adequately implemented. Incomplete progress of the policy reform was a significant shortcoming of EP II.

EP II supported the strengthening of environmental management at various levels through capacity building and support to the regional environmental management offices; creation of regional environmental cells which act as an interlocutor between the government, donors and local communities; transfer of natural resource management to local communities; and transfer of management and budget decisions to the local environmental authorities and the resident staff of protected areas. Importantly for the further mainstreaming of environmental management into national development, EP II supported adoption of advanced environmental impact assessment (EIA) legislation and improvements to the EIA system. Finally, to streamline institutional arrangements, under EP II assistance, the two ministries which previously oversaw different aspects of environmental management – the Ministry of the Environment and the Ministry of Water and Forest Resources – merged into a single institution which enabled better coordination of their activities, and reinforcement of the network of their regional and local offices.

Environmental education during EP II implementation became integrated in primary and secondary schools and in the curriculum of graduate programs. Staff of agencies working in areas related to the environment received training on environmental management. Environmental considerations have been integrated into the extension services provided through NGOs and Government of Madagascar staff.

BOX 2. World Bank's Self-Ex-Post-Evaluation of what went right and wrong in the implementation of the NEAP

How does the World Bank self-evaluate the impacts of the two Environmental programs?

Major achievements of the NEAP up until to date include: (i) the enactment of enabling legislation for the protection of country's natural resources and the promotion of proper environmental management; (ii) the set-up of environmental institutions (such as the park service ANGAP[7]) for the implementation of environmental activities and programs; (iii) the development and implementation of community-based approaches for natural resources management; (iv) the emerging evidence of positive field-level impacts in terms of reduced deforestation rates; and (v) the establishment of a platform for sustained donor support and coordination for the environment in Madagascar.

At the same time, as indicated in the Bank's Rural and Environment Sector Review (2003), there are numerous areas where the NEAP could improve its track record. The application of policies and regulations remains a challenge due to weak institutional capacity and serious governance problems, particularly in the forestry sector. Resources under the NEAP have been disproportionately invested in parallel structures at the central level, while too little has been invested to strengthen institutional capacity on the ground. Lack of rigorous priority setting has also led to a situation in which NEAP tends to drift somewhere between conservation and rural development, sometimes seeking to fill gaps that other programs such as the Plan d'Action pour le Développement Rural (Rural Development Action Plan) now seeks to fill.

Consequently, there is the notion that the operational programs of the NEAP have spread themselves too thinly, thereby contributing to the widespread feeling that more could have been achieved than actually has been. The challenge for mainstreaming of the environmental agenda is reflected in: (i) the relatively modest budget allocations for the sector; (ii) the existing limited knowledge and awareness of the Malagasy population concerning environmental issues; and (iii) the slow development of market mechanisms for the valuation of environmental services.

WHERE IS MADAGASCAR IN 2006?

Madagascar is still not doing well in 2006. Economic and social indicators are putting the country and its people among the poorest and the worst off around the globe. The island, even geographically, is not anywhere near any of the phenomenal growth centers. South Africa, the only real economic engine

of the sub-region, is struggling with its own political and social problems. There is, however, a fresh wind of hope in Madagascar, with a dedicated and enterprising government, a strong aspiration of the young generation and, generally speaking, a big appetite for catching up with the rest of the world, a world where geographic handicaps are increasingly lessened by the cheapness of information and knowledge transfers through the Internet.

At the national level in Madagascar, the Government has just put out a great proposal to develop a 2020 vision for the country that emphasizes on inclusive development and on halting environmental degradation to sustain growth with a high stock of natural resources.

WHAT IS IN THE BOOKS?

A new project (not surprisingly called EP III) is under implementation. The objectives of EP III are to achieve the mainstreaming of environment into macroeconomic management and sector programs as well as putting into place sustainable financing mechanisms for the environment.

The project is consistent with the main goal of the CAS aimed at assisting Madagascar in accelerating poverty reduction. Following the close linkage between poverty and environmental degradation, the CAS recognizes that "Madagascar's unique biodiversity resources offer interesting revenue generating potential, which, if realized, could contribute to the reduction of poverty as well as the conservation of these resources". To unleash potential in this arena, there is a need to set access to biodiversity resources on a more rational and transparent footing as well as to develop revenue generating sources from non-extractive forest products and environmental services, of which eco-tourism, hydrological services, carbon storage and non-timber forest products are the most promising.

Where would a NEAP continuation fit in? Given the political situation of 2002 and with the unavoidable delays in processing large credits and grants to Madagascar, the preparation of EP III only started in July 2003. It is estimated that Madagascar lost about 12 million ha of forest between 1960 and 2000, effectively reducing forest cover by 50 percent in just 40 years. Following the launch of the National Environment Action Plan in the late 1980s, deforestation rates have since declined from over 400,000 ha/year in 1975-1985 to around 100,000-200,000 ha/year during the 1990s. Based on satellite imagery, it is estimated that the total area of natural forest in Madagascar declined from 9.4 million ha in 1993 to 8.5 million ha in 2000, reflecting a national average rate of deforestation of about 0.86 percent per year (World Bank, 2003[8]).

There is clearly an urgent unfinished agenda of extending several of the NEAP success stories beyond the pilot stage into full-scale development.

The following key performance indicators have been identified for EP III: Increased proportion of terrestrial, marine and forest ecosystems under conservation and sustainable management: (i) 6 million ha of natural forests; and (ii) 100,000 ha of coastal zone and marine resources; Increased areas of ecosystems included in the national protected areas system managed by ANGAP: from 1,468,111 ha in year 1 to 2,253,848 ha in year 5; Improved protected areas management efficiency index (from 41% to 70%); Rate of degradation of forest and wetland resources is less than half the 1993-2000 degradation rate; Operationalization of the Malagasy Foundation for Protected Areas and Biodiversity and establishment of an endowment under the Trust Fund to be managed by the Foundation; Harmonization of sector specific legislation, environmental legal framework and international conventions through 15 strategic EIAs. Improved voice of communes in PA management through operational CROs (*Comités Régionaux d'Orientation*) in 27 protected areas and 80% of CROs complying with their rights and obligations as defined in Protected Areas (PA) management plans.

WHAT, IF ANYTHING, DID THE NEAP BRING TO A MORE SUSTAINABLE DEVELOPMENT IN MADAGASCAR?

Conceptually, one of the obvious limitations of the preparation of the Madagascar NEAP was, actually, the vacuum that preexisted Harlem Gro Brundlant's invention of «sustainable development» as a concept and as a potential operational approach. In the late 80's, the world was getting ready for the Rio conference, not dreaming that it would be such a political success, and international donors like the World Bank had just started their Copernican revolution of trying to mainstream environment into international development assistance. But "poverty is the worst form of pollution"[9] was still in everyone's mind in Madagascar and other poor countries. It is true that the link between environmental management and poverty reduction, at the operational level, had not been done before the end of the 20th century and it is yet to be firmly anchored. After all, these are two extreme political and philosophical currents converging for the first time now, as I write this: the defenders of the ecology and wildlife, who set the stage for the environmental agenda, on the one hand, and the socially-conscious on the other hand, who primarily see poverty as a multi-dimensional notion in which access to environmental resources is but one of the many facets of the poverty status and tragedy. Hopefully, articles like this one can make a modest contribution towards getting these two groups around the same table.

In spite of these shortcomings, the NEAP implementation was a great real-life experiment in improved environmental management at a pilot stage. Beyond dry and sometimes unrealistic research trials, the externally-funded projects (EP I and EP II) have showed that deforestation could be slowed down, soil fertility restored and improved, erosion diminished, through a series of technical activities. It demonstrated the feasibility of such activities and helped establish the costs of doing so, a foundation upon which engineers, economists and policy makers can build for other projects and programs, in Madagascar and elsewhere. In passing, these two projects also demonstrated the feasibility, relevance and value of actual donor coordination and cooperation for better and stronger impact.

A very encouraging sign for environmentalists is the inclusion of environmental management in the recently proposed "*Vision pour Madagascar et ses régions*" published by the Présidence de la République. It lists environmental management as the last of the four basic objectives of the Poverty Reduction Strategy Paper (PRSP). It also puts regions and cities right and center of the improved and increased environmental management and economic growth efforts for the country between now and 2020. How to help the Malagasy Government achieve their laudable and ambitious goals?

A MODEST PROPOSAL

A broad consultative conference (which does not have to get participants to travel to Antananarivo, but could use all the modern tools like videoconferencing) could call upon all interested in the sustainable future of Madagascar. That conference could be an honest and transparent stock-taking exercise of what has really worked in environmental management and what has not. The background would be the Madagascar 2020 vision being developed in-country, but participants would mainly focus on the multidimensional sustainable development aspects (at least, social, environmental and economic) of this vision. It could also constitute a great opportunity to integrate lessons learned from other initiatives in future interventions (*e.g.*, regional and land-use planning) in Madagascar as well as to pave the way for more and better Public-Private Partnerships.

What might the conference achieve? If anything, more ownership by the Malagasy people of the stakes and objectives of sustainable development of one of the most touching and interesting nation on this planet.

Examples of issues which could be discussed at this conference include: How to scale up the pilot efforts of EP I and EP II and make them sustainable and significant nationally? How to reach out to the rural population and the urban poor to share the environmental management message with them? How to integrate environment in the energy sector? Ditto in regional, and more generally, decentralized development in Madagascar? How to bring more transparency and inclusion in environmental management? How to mainstream environmental education? How to go beyond so far the limited implementation of the good environmental laws?

The road out of poverty is long and windy for Madagascar, but appropriate environmental management can be implemented for everyone's benefit and help make poverty reduction efforts more sustainable.

FOOTNOTES

1 The author is deeply grateful to his beloved wife and social scientist Hedwige Jullien-Mercier for turning his initial blurp into a publishable article. Thanks should also go to Viviane Ralimanga, former colleague and now with UNDP in Antananarivo for inspiring many of the reflections presented here. The author expresses himself on a personal basis and takes full responsibility for the opinions presented in this article as well as for the possible mistakes and misinterpretations of facts.

2 A Malagasy acronym meaning "National Center for Applied Research on Rural Development", a Center created in 1974.

3 International Development Agency: it is the «soft credit» part of the World Bank Group. A credit by IDA will typically be interest free and have a repayment period of 50 years with a 10-year grace period.

4 United Nations Development Program

5 United Nations Education, Science and Culture Organization

6 improved fuel wood management utilization practices as well as communication and extension activities aimed inducing local populations to discontinue ecologically harmful slash-and burn practices; development and establishment of alternative energy sources (other than rural electrification) to reduce pressure on forest resources and lower greenhouse gas emissions.

7 Agence Nationale de Gestion des Aires Protégées, National Agency for Protected Area Management.

8 Accessible at http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2004/04/23/000012009_20040423101043/Rendered/PDF/273530MG.pdf

9 The slogan of many developing countries representatives at the 1972 World Conference on Environment and Development in Stockholm (Sweden).

TALK

Lost World: The Past, Present and Future of Biodiversity in Madagascar

Philip Benham[1] and Jonah Ratsimbazafy[2]

[1]Shell Canada Limited
[2]Durrell Wildlife Conservation Trust

7:30-9:00 PM
Friday, February 17 th, 2006
Room B108, Mount Royal College, Calgary

Madagascar is essentially a "Lost World" where evolution has proceeded in isolation for about 135 million years. The 300 km wide Mozambique Channel, separating the country from continental Africa, provides a fairly effective barrier to colonization. As a result, Madagascar has one the highest rates of endemism in the world. About 90 % of Madagascar's plants and over 95 % of its many bizarre mammals, reptiles and amphibians are unique to the island. Due to the vagaries of fossil preservation and historical documentation much of the ancient and more recent past is lost to us. Much of the Tertiary rock record is absent, thus information on a critical period in the development of the country's mammalian fauna is missing. Little work has been done to understand the intriguing geological history of Madagascar, but it is geology that is the tie to Madagascar's heritage.

One source of Alfred Wegener's theories of plate tectonics was the restricted distribution of fossils of primitive seed plant Glossoptera in landmasses (including Madagascar) that could be reassembled in what would be called Gondwanaland. An earlier Malagasy continental connection with Pangaea and a late separation from India perhaps about 80 Ma complicate the picture. Even now Madagascar retains strong floral and faunal ties with India. These connections can be unraveled by examining the fossil record (ancestral lemurs and the lineage of giant birds known as ratites), the modern distributions of plants and animals (such as freshwater crayfish, earthworms and leeches) and genetics. Despite Madagascar's geographic isolation, the formidable stretch of water in the Mozambique Channel did not completely prevent occasional colonization. For example, the molecular clock, calibrated through changes in DNA extracted from subfossil and 50 species of extant lemurs points to a single colonization event by their common ancestor in the early Tertiary (approximately 60 Ma). Similar colonization events have been postulated for rodents, spiny tenrecs, plated lizards and the more recent carnivores (including the mongoose, cat-like fossa and the fox-like Malagasy civet) who arrived perhaps 20-30 Ma. On the other hand, chameleons, of which over 50 species thrive on the island, seem to demonstrate multiple oceanic dispersals from Madagascar to various destinations bordering the Indian Ocean. Presumably its slow metabolism allowed it to survive ocean crossings. While the oldest chameleon fossils date back to the Miocene (18 Ma) in Kenya, the genetic evidence points to a Malagasy origin.

Madagascar was one of the last major landmasses to be colonized by man (about 2,000 years ago, only Hawaii and New Zealand were colonized later). As a result, Madagascar provides a good laboratory for observing the impact of man on wildlife. The results are sobering. Since the island's colonization, the *Aepyornis* (one of the largest birds that ever lived), 17 species of giant lemurs, three species of pygmy hippopotami, giant tortoises and many other species went extinct by about 400 AD. Growth of the human population has lead to conversion of 90 % of the primary vegetation to farmland or cattle pastures. Much of this farmland is lost to erosion as the soils of Madagascar bleed red into the ocean. Today the pressures are greater than ever on the remaining natural habitats. Even reserves and parks are not immune to local hunting, gathering plants for food, weaving materials, firewood and construction. It is not as simple as banning and enforcing the protection of the reserve areas. Most people on this tenth poorest nation in the world are at bare subsistence level, seasonally starve and may have minimal access to alternate fuels with which to cook their food.

The authors' talk outlined the current situation at Manombo Special Reserve where a small parcel of forested land supports a population of black and white ruffed lemurs (*Varecia variegata variegata*). Periodically, local villagers have required forest resources. In the past, lemurs and other mammals were hunted. Earthwatch expeditions, lead by the second author, have provided an opportunity for the local community to see the value that the international community places on their particular reserve but more importantly a form of employment where subsistence was the only previous option. Further activities by other charitable organizations will lead to the construction of a new school, medical and dental assistance, more productive farming practices and opportunities to produce crafts to be sold in local markets or further apart. Manombo is Madagascar in microcosm. The unique ecosystem cannot be protected without helping local communities and more importantly providing them the means to help themselves without destroying their natural heritage. While prospects for Madagascar's flora and fauna are challenging, Manombo and several other small communities around the country demonstrate that there is still hope.

In 2003, new President Marc Ravalomanana announced his intention to triple the protected areas of Madagascar. Additionally announced global financial support in the form of a $50 million trust fund will last long in a country where the average daily wage is $1 USD.

BIOGRAPHY

Philip Benham is an exploration geologist for Shell Canada Limited's Newfoundland Offshore Team. The inspiration for this talk is an Earthwatch Expedition to Madagascar funded by Shell to allow their employees to be more aware of issues pertaining to biodiversity and sustainable development. Co-author Dr Jonah Ratsimbazafy is Scientific Coordinator for the Durrell Wildlife Conservation Trust. His first love is paleontology but he now focuses on the more urgent task of protecting natural regions within his Malagasy homeland and providing means for local communities to help themselves without negatively impacting the remaining islands of diversity.

INFORMATION

This event is jointly presented by the Alberta Palaeontological Society, Mount Royal College and the CSPG Palaeontology Division. For information or to present a talk in the future please contact CSPG Paleo Division Chair Philip Benham at 403-691-3343 or programs@albertapaleo.org. Visit the APS website for confirmation of event times and upcoming speakers: http://www.albertapaleo.org/

EUROPEAN ASSOCIATION OF ZOOS AND AQUARIA

Arovako i Madagasikara – Conserve Madagascar

EAZA and the Campaign on the web: www.eaza.net

INTRODUCTION

In 2000 the European Association of Zoos and Aquaria (EAZA), started with an important activity: the organization of annual conservation campaigns. These campaigns aim to increase the cooperation between EAZA and important conservation organizations. Conservation organizations have been involved in financing parts of the different campaigns but have also helped in their preparation and running. Additionally, other conservation organizations were funded with money that was collected during the EAZA campaigns. In 2006/2007 the EAZA chose Madagascar as the 'target' for their campaign.

THE EAZA 2006/2007 MADAGASCAR CAMPAIGN TARGETS

Raise public awareness of one of the most important reservoirs of natural history on the planet. Promoting the high degree of biodiversity through the unique fauna and flora found on Madagascar.

Promote ecotourism to Madagascar. For many biodiversity rich countries, responsible ecotourism can be a viable way to bolster their economy, whilst ensuring that the unique habitats and wildlife that visitors come to view are afforded greater protection by being recognized as an asset.

Raise funds for specific conservation projects throughout the island. The fundraising target for the Madagascar Campaign has been set at €500,000.

Highlight ways in which the public can make positive contributions to conservation through activities in their daily lives. If world conservation goals are to be achieved, sustainable use and recycling are messages that are particularly prevalent in the developed world, which uses a far greater share of the world's resources than the biodiversity rich developing world.

Alert EAZA collections to the diversity of Madagascar wildlife – it's not just lemurs! Promoting the responsible sourcing and keeping of conservation dependent species currently held in small numbers, or not at all, in EAZA collections. Spreading information regarding threatened Malagasy species will then hopefully influence future collection planning decisions at EAZA institutions.

Promote the concept of «twinning» between EAZA members and National Parks as well as protected reserves. Whilst the EAZA Madagascar Campaign will run for one year, long-term interest in the island will hopefully be stimulated. ANGAP (*Association Nationale pour la Gestion des Aires Protégées*), the government body established in 1990 to administer the protected areas of the island, hopes to link to zoos which wish to support protected areas.

TEN GOOD REASONS TO GET INVOLVED

1. Madagascar is a biodiversity 'hotspot' and the fourth largest island in the world with a unique fauna and flora. Madagascar has the highest combined levels of species richness and endemism of any place on the planet. It ranks in the top five 'hotspots' of the world. 3.2% of the world's plants species are only found on Madagascar. 2.8% of all global vertebrates are endemic to the island. When considering the approximately 117 described mammal species, 90% are endemic, and if bats are excluded this rises to 100%.

2. Most EAZA members have Malagasy species, be it a lemur, bird, reptile or invertebrate, and therefore this campaign is very inclusive. Additionally, many aquaria house Malagasy fish, both freshwater and marine. Many zoos will also have Malagasy plants on their sites, allowing botanical stories to be incorporated into campaign materials.

3. Lemurs are an instantly recognizable group that visitors love. Although the fauna of Madagascar is generally small-bodied, lemurs are high-profile species, with a great deal of public goodwill associated with them. Lemurs will act as an informal flagship for the campaign, galvanizing their popularity, whilst bringing attention to the lesser known, yet equally fascinating and unique species found on the island. Therefore this single island can be used as a focus for multi-taxa conservation awareness.

4. The movie 'Madagascar' has given the island higher profile and made it popular amongst all age groups. Dreamworks, the Steven Spielberg film company, has made an animated film entitled Madagascar. It was a very popular film throughout 2005 and a sequel will be released in 2008. This popularity ensures that recognition of the island is appreciably higher in Europe than prior to the film release, and this is likely to be beneficial to the campaign.

5. In situ conservation on Madagascar needs our help. Much of the fauna of Madagascar is threatened, with 90% depending on the dwindling forest cover for their survival, and is therefore a conservation priority. Out of the 332 Malagasy species described on the IUCN Red List 46.4% are listed as critically endangered, endangered or vulnerable. Much of the flora of the island is also uniquely – illegal trade in Orchids and hardwoods are a threat to its continued survival.

6. Madagascar has many different habitats. The diversity of habitats found on the island includes rainforests, dry deciduous forests, bush, xerophytic and spiny forests, seasonal humid forests and anthropogenic grasslands. It is this striking diversity and varied topography that has led to Madagascar being termed the '8th Continent'.

7. Madagascar is an island! The majority of extinctions that have taken place in the past 500 years have occurred on islands (72% of all recorded extinctions) – Madagascar can be used to draw attention to this issue. So far EAZA campaigns have not addressed an island ecosystem, yet these are amongst the most conservation dependant areas of the world.

8. Madagascar is a culturally fascinating place as well as biodiversity hotspot. Madagascar is culturally rich, with unique traditions, music and dance. Madagascar is associated with myth, legend and mystery (the Rohk of Sinbads travels is likely to have been based on the extinct Malagasy elephant bird, and historically pirates of the 17th and 18th centuries routinely based their Indian Ocean raids from Madagascar).

9. The government of Madagascar endorses this campaign. The government of Madagascar, led by President Marc Ravalomanana, supports the aims of the EAZA Madagascar Campaign.

10. «This is not just Madagascar's biodiversity, it is the world's biodiversity». These were the words of President Marc Ravalomanana at the World Parks Congress in Durban in 2003. This is an opportunity for us to get involved to make a real difference in Madagascar, for its biodiversity and its people.
Let's help in saving our biodiversity. Arovako i Madagasikara!

MADAGASCAR CAMPAIGN CORE GROUP The Madagascar Campaign Core Group, chaired by Lesley Dickie and Alex Rübel, has developed and prepared the Madagascar Campaign and will oversee its successful running throughout the campaign period and, if necessary, afterwards.

CORE GROUP MEMBERS Lesley Dickie (ZSL) lesley.dickie@zsl.org; Alex Rübel (Zoo Zürich) alex.ruebel@zoo.ch; Roger Graf (Zoo Zürich) roger.graf@zoo.ch; Martin Bauert (Zoo Zürich) martin.bauert@zoo.ch; Quentin Bloxam (Durrell) quentin.bloxam@durrell.org; Corinne Bos (EAZA Executive Office) corinne.bos@eaza.net

A WORD OF THE PRESIDENT

Madagascar is a magnificent country and we are very proud of it, of its animals, plants, landscapes and people. We know how unique and special they are, not only to us in Madagascar but to the whole world. We wish to conserve our precious biodiversity. For this reason, my government has been drafting and implementing plans to greatly increase the number of protected areas for conservation across the island in a process that has come to be known as the «Durban Vision».

However, we face many challenges. Through conservation we need to create a sustainable future for the environment and humans alike and successfully balancing the needs of people and biodiversity is a major challenge in countries with high biodiversities. We hope our community-based approach to conservation across the island will bring great dividends to both people and wildlife. Many international conservation groups work in Madagascar in habitat protection projects, community projects, training projects and more. We are especially encouraged by the efforts of so many different groups assisting us in our task of ensuring a future for biodiversity in our country. Working in conjunction with government authorities and our universities we are also particularly pleased with the emergence of a new generation of Malagasy scientists and conservationists. We know that many European zoos already have projects in Madagascar and have committed much time, effort and funds to help us in achieving our goals.

As President of Madagascar I am delighted that the European Association of Zoos and Aquaria (EAZA) has chosen Madagascar for its conservation campaign. This public show of support for Madagascar, its people and its biodiversity by zoos of Europe, and their visiting public, will be deeply appreciated throughout Madagascar, thank you. We welcome the emphasis put on the concept of «twinning», where local communities in protected areas establish long-term relationships with European zoos.

We hope that this EAZA Madagascar Campaign 2006/2007 will be an ongoing one, increasing the European zoo interest in our country. We look forward to many years of fruitful cooperation.
Marc Ravalomanana, President of the Republic of Madagascar

AROVAKO I MADAGASIKARA! BY JOHN CLEESE

Madagascar is a jewel! This island, and in particular the lemurs, has been a fascination of mine ever since I was fortunate enough to travel there while making a documentary about lemurs in Madagascar, each time seeing something new and exciting. The beautiful country, outstanding scenery, unique animals and plants, and the welcoming people, make Madagascar one of the great treasures of the world.

However, I am fully aware of the countless challenges that Madagascar faces and so whenever possible I actively support conservation initiatives on the island. I hope I have done my bit to help, and I am delighted to be able to do so. Last year I was particularly touched when a recently discovered species of lemur was named after me; *Avahi cleesei*. Fame at last!

I also support the work of responsible zoos, zoos that are using their facilities to improve the survival chances of threatened species in the wild through conservation breeding, fundraising, *in situ* projects and many more activities. These zoos also work with local people, ensuring those people a stake in the future of their wildlife. So, it should be no surprise that a project combining Madagascar and responsible zoos would be a cause to which I could lend my efforts.

The EAZA Madagascar Campaign will bring this extraordinary island to millions of visitors throughout the EAZA network, stimulating, we hope, a positive surge of energy and interest that will generate funds for the vital projects featured.

The EAZA Madagascar Campaign has my full support, it has the full support of the President of Madagascar, and it's hoping for yours. I ask you to join the campaign. It fully supports the work of the government of Madagascar and we should all do our best to assist them in their great endeavour, the 'Durban Vision'. The EAZA Madagascar Campaign will do its bit to help... but only if as many institutions as possible participate.
So, Arovako i Madagasikara, Conserve Madagascar!
John Cleese, Patron EAZA Madagascar Campaign 2006/2007

Society, Natural Resources & Development in Madagascar, Recent Contributions by the Research Community

Friday 30th and Saturday 31st March 2007

An International Symposium hosted by the Sainsbury Research Unit and the School of Development Studies, University of East Anglia, Norwich, UK.

Papers are invited for the Symposium 'Society, Natural Resources & Development in Madagascar, Recent Contributions by the Research Community', a multidisciplinary event being held at the University of East Anglia.

The meeting will have three sessions each of which begin with an invited plenary speaker.

Symposium Sessions

A) Malagasy Culture, Society and Origins
Chair : Professor John Mack

B) Ecology and Biology of Malagasy Endemics
Chair : Dr John McDonagh

C) Conservation and Development
Chair : Dr Angus Carpenter.

The Overseas Development Group ODG DEV The School of Development Studies

UEA NORWICH

Sainsbury Research Unit for the Arts of Africa, Oceania & the Americas

Society, Natural Resources & Development in Madagascar
Recent Contributions by the Research Community

Instructions for Submission of Abstracts :

Papers are welcomed from all academic disciplines and will be selected by the Conference Committee on their merits and relevance to the symposium themes.

Abstracts of 300-500 words should be submitted electronically or in hard copy before the 31st January 2007. Presentations should be 20 minutes in length, 5 minutes will be available for questions after each paper. Publishing options are currently being investigated, authors should state on their abstract if they would like their paper to be considered for inclusion in special issue of a journal or another publication arising from the symposium.

The working language of the conference will be English, however papers in French are very welcome.

Space will be available for the display of academic posters, abstracts should be submitted in the same way as for oral papers.

Places for this symposium are limited therefore early registration is strongly encouraged.

Deadlines :

- Deadline for booking place on symposium and for the dinner – 7pm Wednesday 31st January 2007 –bookings may be accepted after this date but as places are limited early booking is strongly advised.
- Deadline for submission of Abstracts – 7pm Wednesday 31st January 2007 (authors of accepted abstracts will be informed on Friday 16th February 2007).

Costs and further information:

The Symposium fee is £35, this includes refreshments and lunch on both days and a delegate pack. This symposium has not received any financial assistance, the fee is to cover the basic running costs associated with the event. Only prepaid bookings can be accepted, booking and payment must be received by the 31st January 2007.

Symposium Fee - £35.00 Optional Conference Dinner - £20.00

All Payment must be by cheque or money order (£STG) made payable to 'University of East Anglia' Booking Forms are available electronically from the conference organiser or in hard copy on request. Detailed information on transport and accommodation options as well as facilities at the event are included with the application pack which is available online or by contacting the organiser:

http://www.uea.ac.uk/art/sru/symposia.htm and
http://www1.uea.ac.uk/cm/home/schools/ssf/dev/events

Contact :

The Conference organiser is Barry Ferguson who should be the first point of contact for any queries concerning the symposium :

Postal Address : Barry Ferguson(PGR), School of Development Studies, University of East Anglia, Norwich, NR4 7TJ, UK.

Email : madagascarsymposium2007@googlemail.com **Tel** : + 44 (0) 7780 600 751

Symposium committee: Professor John Mack (Chair), Dr John McDonagh & Dr Angus Carpenter.

Image by Eric Matson

ERIC MATSON

Eric's love affair with Madagascar began in the most romantic way imaginable, he was cruise director on the square rigged sailing vessel "Eye of the Wind" when she slipped quietly into Nosy Be in late 1998 after crossing the Indian ocean on the way to Africa. So much so that he chose to leave the ship in Capetown and return to Madagascar rather than sail on to England. Since then Eric has travelled widely across the Rainbow Island, including in 2000 and 2005 as Adventure Associates (Australia) tour leader.

The tropics had always been so strongly attractive to me, especially the natural coastal ecosystems with their astounding diversity and the often mountainous and misty interiors which provide such compelling contrasts in texture and life. And then came Madagascar; nowhere on the planet is there so much rare and delightful life that's so easy to see, nowhere are there more diverse and beautiful people, and nowhere are there more compelling issues for both.' E.M.

Eric currently works with the Climate Change team at the Australian Institute of Marine Science looking specifically at historical climate records frozen in the skeletons of very old and very massive corals living on the Great Barrier Reef.

Apart from extended sailing voyages with eco-tourist groups throughout the Pacific and Indian Oceans, Eric has worked at the University of Adelaide, the University of South Australia and the University of the South Pacific (Fiji) in various scientific, training and counselling roles. He lives in Townsville with his wife and son and in spare moments crafts furniture from old wood found at demolition sites.

Chameleons *(Furcifer minor).* Image by Eric Matson

IMPRESSUM

Madagascar Conservation and Development is the journal of Madagascar Wildlife Conservation (MWC) and the Jane Goodall Institute (JGI Switzerland). It is owned by these two institutions and is produced in these institutions own responsibility.

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