

## FLAGSHIPSPECIES

# Lemurs - Ambassadors for Madagascar

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## 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 peculiarities, 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 obviously 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 megafauna-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

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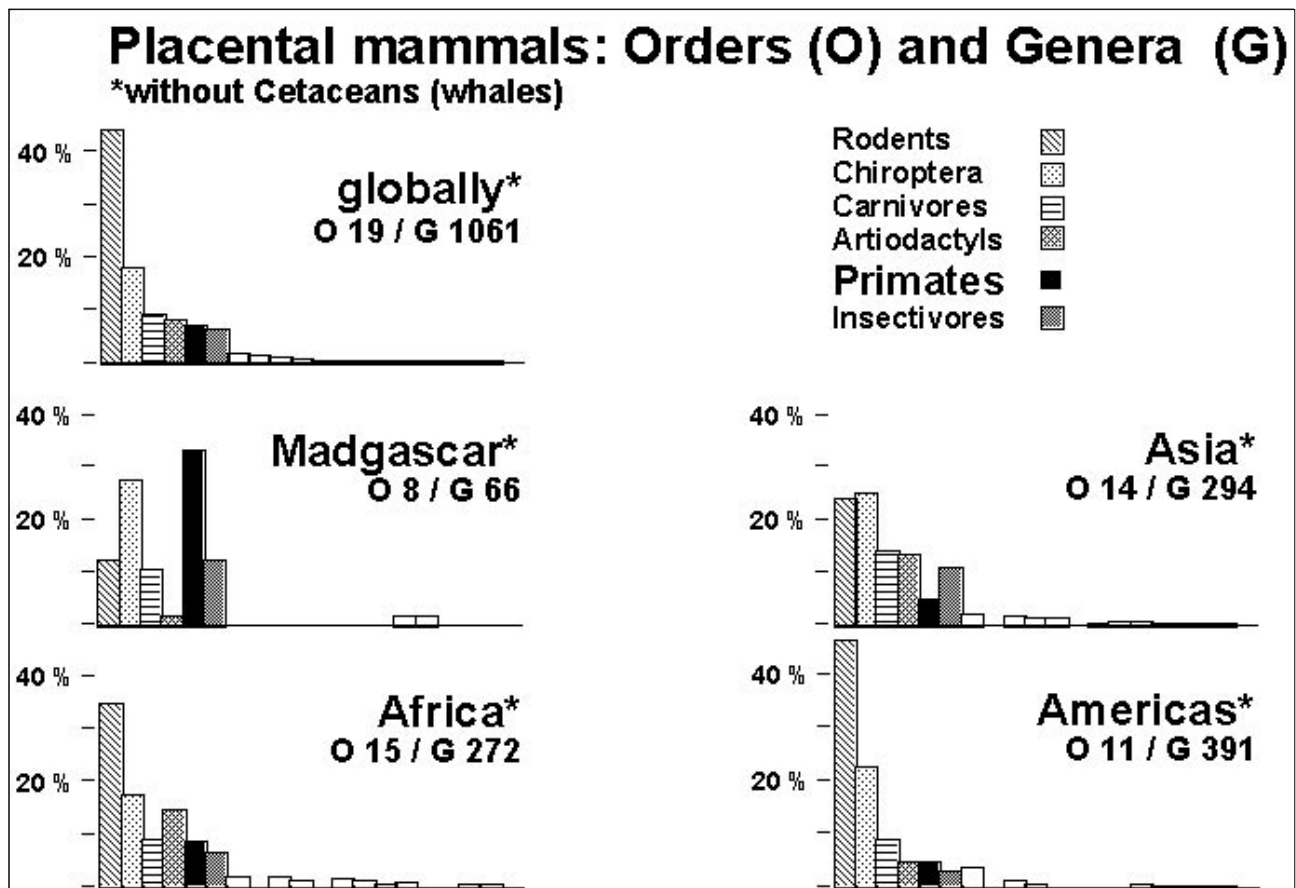


FIGURE 1. Comparative composition of Madagascar's mammal fauna. Only in Madagascar are (non-human) primates the dominant order in number of genera. Based on Nowak (1999).

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.*

## Natural Groups of Primates

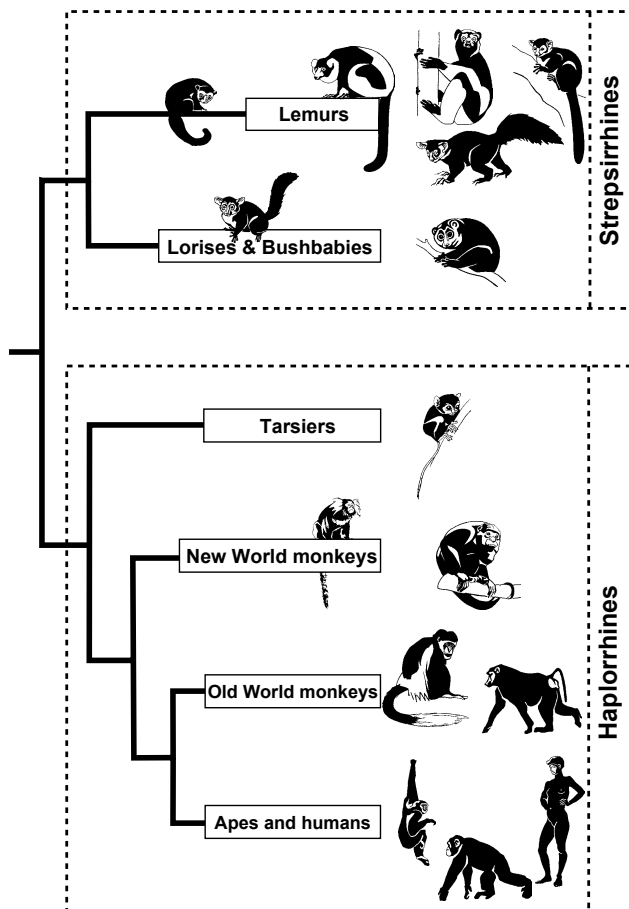


FIGURE 2. Natural groups of primates. The zoological order primates is grouped into strepsirrhine primates with lemurs, lorises and bushbabies on the one hand, and haplorrhine primates with tarsiers, New and Old World Monkeys, apes and humans on the other hand. Drawings by Lucrezia Bieler.

*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 *Vare-*



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

*cia*. 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-

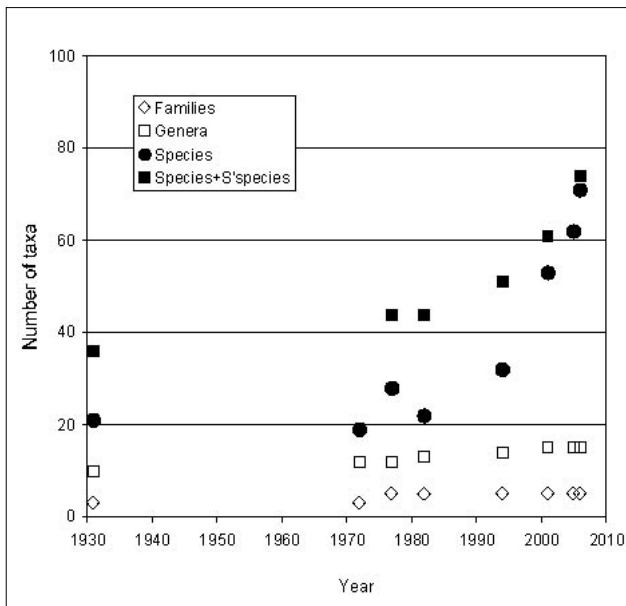


FIGURE 4. Number of lemur taxa from 1931 to 2006. Based on Schwarz (1931), Martin (1972), Petter *et al.* (1977), Tattersall (1982), Mittermeier *et al.* (1994), Groves (2001), Global Mammal Assessment (2005 unpubl.), Mittermeier *et al.* (2006), Andriaholinirina *et al.* (2006), Louis *et al.* (2006).



FIGURE 5. *Lepilemur randrianasoli*. This sportive lemur was formerly 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*) preferring gum (plant exudates), the woolly and sportive lemurs feeding almost completely 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.

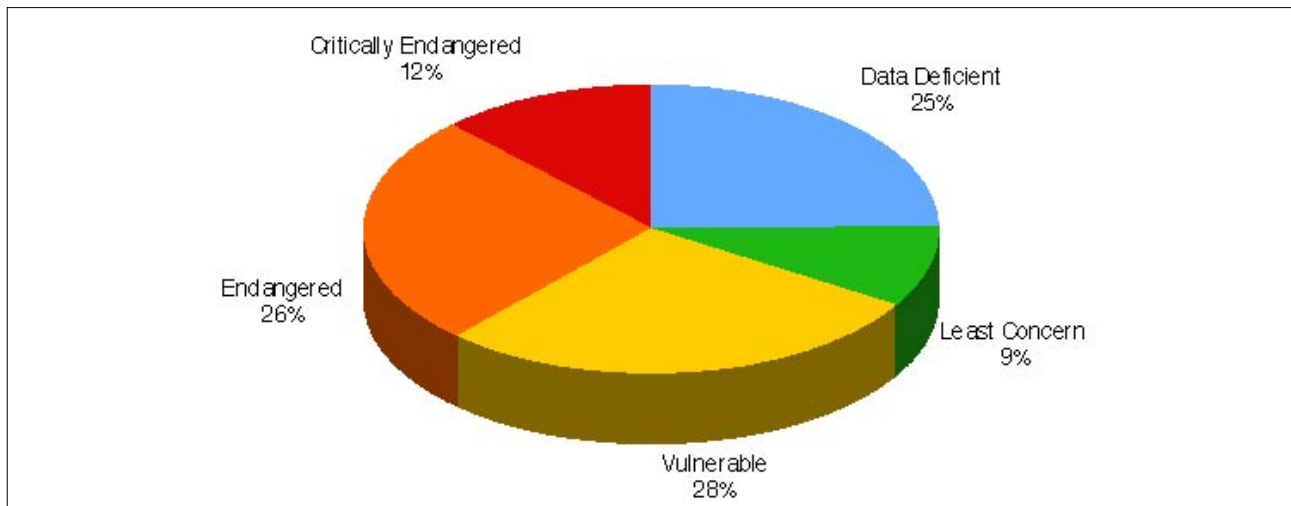


FIGURE 6. Conservation status of 65 lemur species according to IUCN categories (IUCN, 2001). Based on the Global Mammal Assessment workshop 2005 in Antananarivo organized by the International Union for the Conservation of Nature (IUCN) and Conservation International (CI).

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