Short Communication

A major increase in the population of brown lemurs on Mayotte since the decline reported in 1987

Laurent Tarnaud and Bruno Simmen

Abstract The population of the Mayotte brown lemur *Eulemur fulvus fulvus* on the island of Mayotte in the Indian Ocean was reported to have decreased by 50% between 1975 and 1987, from 50,000 to 25,000. From a series of censuses carried out in 1999 and 2000 in the various vegetation types of the island, we estimate that the lemur population now numbers 42,000–72,000. The decline observed in 1987 may have been largely caused by the cyclone that devastated Mayotte in 1984. That the population has recovered must not obscure the fact that loss of forest, increased human pressure associated with further development of infrastructure, and changes in agricultural practices will undoubtedly continue to affect this species on Mayotte.

Keywords Brown lemur, cyclone, *Eulemur fulvus fulvus*, Indian Ocean, Mayotte, primate, population census.

Mayotte (Collectivité départementale de Mayotte, France) is an archipelago of three main islands (Grande Terre, 360 km², Petite Terre, 11 km², and Mtsamboro islet, 3 km²) in the Indian Ocean (Fig. 1). Lemurs occur on Grande Terre, with a few individuals found on Mbouzi islet (Gresse *et al.*, 2002) and possibly on Mtsamboro islet (local inhabitants, pers. comm.). The origin and date of the colonization of Mayotte by this species is not known, but the animals were probably introduced from Madagascar with the early Malagasy migrations, i.e. within the last 1,000 years (Tattersall, 1977a). A subfossil piece of a lemur's jaw found in the archaeological site of Dembeni has been dated to between the ninth and thirteenth centuries (Liszkowski, 1997). If we accept the taxonomic classification of Mittermeier *et al.* (1994), in which the common brown lemur on Mayotte is identified as *Eulemur fulvus fulvus*, i.e. the same subspecies as on Madagascar rather than as *E. f. mayottensis* (Schlegel, 1866) then the subspecies on Mayotte is categorized as Lower Risk: near threatened on the 2000 IUCN Red List (Hilton-Taylor, 2000).

Censuses of the lemur population on Mayotte were carried out by Tattersall in 1974/1975 and 1987, with estimates of total populations of 50,000 and 25,000, respectively (Tattersall 1977b, 1989). The 1987 estimate was based on a more brief survey than that of 1974/1975, but the absence of lemurs in 1987 from habitats in which they had been present in 1974/1975 enabled Tattersall (1989) to provide a relatively reliable population estimate. Tattersall attributed the decline to the destruction

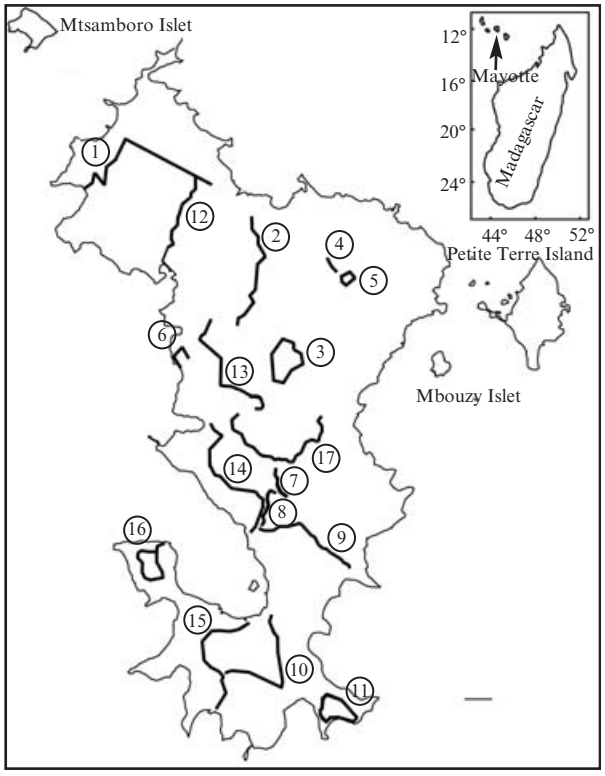

Fig. 1 Mayotte, with the location of the census transects (numbered). Further details of each transect are given in Table 1.

Laurent Tarnaud and **Bruno Simmen**, CNRS FRE 2323, Muséum National d'Histoire Naturelle, 4 avenue du Petit Château 91800, Brunoy, France. E-mail: laurent.tarnaud@free.fr and simmen@ccr.jussieu.fr

Received 0 Month 2000. Revision requested 0 Month 2000. Accepted 0 Month 2001.

of habitat associated with the economic development of Mayotte. The economic and social development of the archipelago has continued since 1987, financed by the French government, with further loss of forests. Although those forests with the highest biological interest acquired the status of natural reserves in the early 1990s, the status of the brown lemur following the last survey in 1987 was unknown.

We made censuses of the brown lemur on Grande Terre in September 1999 and July/August 2000, i.e. immediately before the reproductive season. Seventeen censuses along transects of varying length (2.75–9 km) were made in various habitats (Fig. 1, Table 1). Each transect was walked once, slowly, at various times of the day. Although midday is a resting period during which animals are likely to be less visible, groups displayed signs of activity when an observer was nearby, thus revealing themselves. Once groups were located, either visually or by their vocalizations, individuals were counted during a period lasting on average 10 minutes until a satisfactory estimate of group size was obtained. No attempt was made to differentiate individuals by sex. Groups and individuals were counted along a 25 m wide strip on either side of the transect, but in practice the maximum visibility was often <25 m, and only 15 m in some areas. Population densities were thus calculated using strip widths of $2*25$ and $2*15$ m giving, respectively, minimum and maximum estimates of density.

Table 1 The length of each of the 17 transect censused on Grande Terre, in September 1999 and August 2000, and the number of groups and individuals of the Mayotte brown lemur seen. The locations of the numbered transects are indicated in Fig. 1.

Transect no.	Census sites	Transect length (km)	Number of groups/ individuals
1	Dzoumnyé-Aqua	7.05	9/62
2	Bouyouni-Combani	7.00	4/41
3	Combani	9.00	15/133
4	Mtsapéré I	4.50	12/98
5	Mtsapéré II	2.75	6/44
6	Sohoa	4.00	4/38
7	Bénara I	6.65	4/52
8	Bénara II	3.85	5/39
9	Bandrélé-Mréréni	6.50	1/9
10	Choungi	6.50	5/42
11	Saziley	6.75	4/37
12	Dzoummonyé-Soulou	8.00	2/17
13	Kariani-Coconi	7.65	4/33
14	Poroani-Chiconi	9.00	10/80
15	Mronabeja-Tsimkoura	6.50	1/8
16	Pesqu'île Bouéni	6.40	1/9
17	Tsararano-Coconi	8.70	1/10
	Groups with unknown number of individuals		2/?
	Total	110.8	90/752

Using aerial photographs taken in 1997 by the French National Geographical Institute, the Environment and Forest Service of Mayotte has identified six vegetation types (DAF/SEF, 1999; Table 2) on the island. Remnants of undisturbed natural forest cover 2.8% of the total surface of Grande Terre, located on the slopes of the basaltic massifs scattered throughout the island. 'Anthropogenic forests' (i.e. secondary forests *sensu lato*), including secondary forests, agroforestry, and tree plantations, cover 40.2% of the archipelago. The remaining area consists of fields and mixed pastoral zones (45%), mangroves, urban areas and *padzas* (eroded areas of bare ground). The transects were made in the four main vegetation types, excluding mangroves and urban zones (Table 2), and their positions were mapped to a precision of 1 m using a Global Positioning System and MapInfo software (version 4.5, MapInfo Corporation, France). Estimates of the total population size of the brown lemur were made by extrapolating from the mean density in each vegetation types, taking into account the percentage of the total surface area of the Grande Terre covered by each.

A total of 752 individual lemurs in 88 groups were recorded over a total transect distance of 110.8 km (Table 1). Eleven percent of the lemurs seen were in undisturbed forests, 75% in anthropogenic forests, and the remaining 14% in agricultural fields, where they were generally observed feeding on trees close to forest borders (Table 2). We did not carry out censuses in mangroves as brown lemurs do not live exclusively in this habitat, although it is used as part of the home range by lemurs living in other habitats. Density was highest in undisturbed forests and lowest in agricultural fields (Table 2).

Extrapolating from the censuses, we estimate that the lemur population of Grande Terre numbers between 42,000 and 72,000 individuals (Table 2). As most groups were observed at a distance of <15 m, the number is probably closer to the higher figure. The lemur population has therefore increased to levels comparable to, or even higher than the estimate of 50,000 made by Tattersall (1977) in the first census of the population in 1975. We found that group size was not significantly different between the various habitats, with an average of 8.7 (± 0.2 SEM) individuals (one-way analysis of variance $F_{2,85} = 0.489$, $P < 0.616$), similar to that of 9.1 found by Tattersall (1977a). Taken together these data seem to indicate that the growing pressures exerted by human activities on the environment of Mayotte have not had as dramatic a consequence for the lemurs as Tattersall (1989) suggested. In 1984 Mayotte was devastated by a cyclone, and this may have been responsible for the death of animals, especially juveniles, both directly, and indirectly through its impact on vegetation

Table 2 The vegetation types of Mayotte (DAF/SEF, 1999), their area, and the total number of lemurs seen in each over the 17 transect censuses (see Table 1), with the total area censused, population density, and estimate of total number of lemurs, based on transect widths of 25 and 15 m (see text for details).

Vegetation types[a]	Area on Grande Terre (ha)	Total number of lemurs seen	Area censused (ha), by transect width		Population density (no. ha^{-1}), by transect width[b]		Estimate of total number on Grande Terre, by transect width	
			25 m	15 m	25 m	15 m	25 m	15 m
Undisturbed forests	1,005	255	55.7	33.4	4.6	7.6	4,601	7,668
Anthropogenic forests	14,428	387	175.9	103.6	2.2	3.7	31,740	53,917
Agricultural fields	16,151	110	288.3	173.0	0.4	0.6	6,163	10,272
Eroded areas (padza)	2,507	0	34.1	20.5	0	0	0	0
Mangroves	730	0	0	0	0	0	0	0
Urban zones	1,070	0	0	0	0	0	0	0
Total	35,891	752	554	330.5	1.4	2.3	42,504	71,857

[a]See text for definitions.
[b]Rounded to one decimal place.

(Dittus, 1985; Decker, 1994). *E. fulvus* appears to be a particularly adaptable species that is able to respond rapidly to ecological disasters of this type, a trait also implied by the wide geographic distribution of the various subspecies in Madagascar, and the ability of the species to colonise new environments (B. Simmen, unpub. data).

Although faunal diversity on Mayotte is not high and the percentage of angiosperm plants that are endemic is low (from 3% in dry forest to 14–17% in more humid forests), plant diversity is high relative to the surface of the island (Pascal *et al.*, in press). To protect the remaining biodiversity of the archipelago a prefectoral decree (no. 347/DAF, 07/08/00) was issued in August 2000 to improve the protection of threatened animal species, and six reserves covering a total area of 5,627 ha (Pascal, 1997) have recently been created to preserve the last remnants of forest on Mayotte. However, despite these advances in conservation policies, and recent evidence of a positive perception of the lemur by local human populations (Harpet & Tarnaud, 2000; S. Blanchy, unpub. results), the ongoing intensification of agricultural practices and further development of infrastructure will undoubtedly affect the lemur population. The area of undisturbed forests, the main habitat of the brown lemur and the one in which we found the highest densities, is still decreasing, and secondary forests, which provide a home to the majority of the lemurs of the archipelago, undergo periodic clearances.

There have now been three censuses of the brown lemur of Mayotte, in 1974/1975, 1987 and 1999/2000, i.e. at intervals of about 13 years. Because of the pace of demographic and socioeconomic changes on the island we recommend that more regular monitoring is carried out as part of the development of conservation policies for the archipelago.

Acknowledgements

The research was supported financially by the French Ministry of the Environment (ECOFOR-MNHN convention 2000.18). We are grateful to the Service Environnement et Forêt de la Direction de l'Agriculture et de la Forêt de Mayotte for providing the facilities that enabled us to carry out our research. We also thank C. Harpet for her help during the censuses and A. Hladik for help with the manuscript. We are grateful to A. Cockle and anonymous reviewers who improved the English version of the text and provided constructive remarks.

References

DAF/SEF (1999). Vegetation map of Mayotte In *La Faune Terrestre de Mayotte* (ed. M. Louette), *Annales du Muséum Royal d'Afrique Centrale (Sciences Zoologiques)*, **284,** 1–248.

Decker, B.S. (1994) Effect of habitat disturbance on the behavioural ecology and demography of the Tana River Red Colobus (*C. b. reformitratus*). *International Journal of Primatology*, **15,** 703–737.

Dittus, W.P.J. (1985) The influence of cyclones on the dry evergreen forest of Sri Lanka. *Biotropica*, **17,** 1–14.

Gresse, M., Gandon, B., Tarnaud, L., Simmen, B., Labat, J.-N. & Hladik, C.M. (2002) Conservation et introduction de lémuriens sur l'îlot Mbouzi (Mayotte). *Revue d'Ecologie (Terre et Vie),* **57,** 75–82.

Harpet, C. & Tarnaud, L. (2000) *Eulemur fulvus mayottensis*, un lémurien unique à Mayotte. *Bulletin de l'Association des Naturalistes Historiens et Géographes de Mayotte*, **4,** 38–48.

Hilton-Taylor, C. (compiler) (2000) *2000 IUCN Red List of Threatened Species.* IUCN, Gland, Switzerland & Cambridge, UK.

Liszkowski, H.D. (1997) *Répertoire des sites archéologiques de Mayotte*. SHAM, St Médard en Jalles, France.

Louette, M. (ed.) (1999) La Faune Terrestre de Mayotte. *Annales du Muséum Royal d'Afrique Centrale (Sciences Zoologiques)*, **284,** 1–248.

Mittermeier, R.A., Tattersall, I., Konstant, W.R., Meyers, D.M. & Mast, R.B. (1994) *Lemurs of Madagascar.* Conservation International, Washington D.C., USA.

Pascal, O. (1997). *La végétation naturelle à Mayotte, études quantitatives et qualitatives*. Rapport DAF/SEF, Mayotte.

Pascal, O., Labat, J.-N. & Pignal, M. (in press) Diversité, affinités phytogéographiques et origine présumée de la flore de Mayotte (Archipel des Comores). *Systematics and Geography of Plants*.

Schlegel, H. (1866) Contributions de la faune de Madagascar et des îles avoisinantes. *Nederlands Tijdschrift voor Dierkunde*, **3,** 73–89.

Tattersall, I. (1977a) Ecology and behavior of *Lemur fulvus mayottensis* (Primates, Lemuriformes). *Anthropological Papers of the American Museum of Natural History, New York*, **52,** 195–216.

Tattersall, I. (1977b) The Lemurs of the Comoro Islands. *Oryx*, **13,** 445–448.

Tattersall, I. (1989) The Mayotte lemur: cause for alarm. *Primate Conservation*, **10,** 26–27.

Biographical sketch

Laurent Tarnaud is currently studying the development of the feeding behaviour of juvenile *Eulemur fulvus fulvus* as part of his PhD at the Université René Descartes, Paris. Bruno Simmen carries out research on primate feeding behaviour and interspecific differences in taste perception. He has been involved in field studies in French Guiana and Madagascar, where he compared dietary adaptations of sympatric primate species. Both authors participate in a research program in Mayotte that focuses on interspecific interactions, biodiversity and the perception of the environment by local human populations.