

Short Communication

Decline of *Propithecus diadema edwardsi* and *Varecia variegata variegata* (Primates: Lemuridae) in south-east Madagascar

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Abstract This paper describes the results of field surveys for two Endangered lemurs, Milne-Edward's sifaka *Propithecus diadema edwardsi* and the black and white ruffed lemur *Varecia variegata variegata*, in the unprotected Fandriana-Marolambo forest corridor in south-east Madagascar. Published range maps show *P. d. edwardsi* and *V. v. variegata* present in the corridor, although few surveys have been conducted in this area. A total of 292.9 km of surveys were conducted at eight sites in the corridor but *P. d. edwardsi* and *V. v. variegata* were each located at only one site. Absence of these

species at other sites may be the combined result of altitudinal and anthropogenic effects. Conservation plans for *P. d. edwardsi* and *V. v. variegata* are complicated because gaps in forest cover prevent dispersal of conspecifics from nearby protected areas. Conservation authorities should be cautious in using range maps based on the presumed distribution of lemur species.

Keywords Distribution, lemurs, Madagascar, *Propithecus diadema edwardsi*, *Varecia variegata variegata*.

Lemurs are endemic to Madagascar and are one of the highest global conservation priorities (Lehman, in press). The conservation of lemurs is a serious issue because of the effects of extreme deforestation and hunting pressures (Plate 1). Only an estimated 10% of the original forest cover remains in Madagascar (Green & Sussman, 1990). Deforestation is mainly due to slash-and-burn agriculture and selective logging by local people. Many lemurs are hunted, including in protected areas (Goodman & Raselimanana, 2003). Thus, it is important to provide conservation authorities with up-to-date data on the distribution of lemurs.

Milne-Edward's sifaka *Propithecus diadema edwardsi* and the black and white ruffed lemur *Varecia variegata variegata* are endemic to the humid forests of south-east and eastern Madagascar, respectively. They are both categorized as Endangered on the IUCN Red List (IUCN, 2004). Information on the ecology and behaviour of these lemurs mostly comes from Ranomafana National Park in the south-east (Fig. 1) and Betampona Natural Reserve in the east (Britt *et al.*, 2002; Pochron *et al.*, 2004). Although

these two areas are 432 km apart, range maps show that *V. v. variegata* has a continuous distribution between these protected areas (Mittermeier *et al.*, 1994), and *P. d. edwardsi* a continuous distribution in the Fandriana-Marolambo forest corridor between the Mangoro and Manapatrama Rivers (Fig. 1). The Fandriana-Marolambo forest corridor is one of the largest (c. 250,000 ha) tracts of unprotected forest in south-east Madagascar (Lehman, 2000). However, in preliminary surveys, few sightings were made of these two species in forests near the corridor (Irwin *et al.*, 2005). In this paper we report on the distribution of *P. d. edwardsi* and *V. v. variegata* in this corridor.

The Fandriana-Marolambo forest corridor (Fig. 1) comprises predominantly mid altitude humid forest surrounded by agriculture and impoverished grasslands. This forest type comprises endemic species of *Tambourissa* (Monimiaceae), *Ephippiandra* (Monimiaceae) and *Ocotea* (Lauraceae), and there is also a high diversity of bamboos (Graminaceae) and epiphytes (Lowry *et al.*, 1997). The canopy is continuous and low (c. 10 m in height), and emergent trees reach 25 m.

Surveys were conducted at eight sites in the corridor. Sites 1–2 were located in the northernmost section of the corridor and sites 3–7 in the main body of the corridor (Lehman, 2000). Site 8 was in the Vohibola forest fragment (Lehman *et al.*, in press). A total of 1–6 transects of varying length were established at each site. Transects were marked every 10 m with flagging tape. We walked slowly (0.5–1.0 km h⁻¹) along each transect twice per day at 07.00–11.00 and 14.00–17.00. Surveys were conducted

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Plate 1 Typical lemur habitat at Bezavona (Site 2; Fig. 1) in Fandriana-Marolambo Forest Corridor. Light areas in background are slash-and-burn agriculture on hill slopes (note plume of smoke in top right corner, indicating active deforestation). A lemur snare-trap used by local people is in the foreground.

during 20 October–4 November 1999 at sites 1–2, 15 February–2 April 2000 at sites 3–7, and 1 June–15 July 2003 at site 8.

Hunting and trapping pressures were estimated using data collected during interviews with local people, direct observations of hunting and trapping, and accounts from social scientists working in the survey areas (Lehman, 2000). Interviews ($n = 18$) consisted of asking people to identify lemurs from illustrations in Mittermeier *et al.* (1994), asking for physical descriptions of each species, and requesting information on hunting techniques. Intensities of anthropogenic disturbances (agriculture, selective logging, and hunting) were estimated using a subjective five-point scale: none, low, medium, high and extreme.

A total of 292.9 km of surveys were conducted at the eight sites (Table 1). Three groups of *P. d. edwardsi* were found at the southern end of the Vohibola site (average group size was $3.29 \pm \text{SE } 1.20$ individuals). One group of three individuals of *V. v. variegata* was sighted along a

trail at Mananjara. Forest habitats at most sites had been and were being cleared using slash-and-burn agriculture. Cultivation was mostly of dry-land rice, sugar cane and tobacco. Local people reported that all diurnal lemur species were hunted with traps and/or blow guns. Other than local people near Mananjara, none of the respondents reported seeing or hearing either *P. d. edwardsi* or *V. v. variegata* in the last 1–10 years.

Vohibola is separated from the main corridor by large areas of grassland and cultivation. *P. d. edwardsi* has also been seen in forests 34.7 km south of Vohibola, which is within Ranomafana National Park (Irwin *et al.*, 2005). *P. d. edwardsi* is one of the largest extant lemurs (5.0–6.0 kg), and is a favourite prey item for local people (Lehman & Wright, 2000). The species has a large home range (25–100 ha) and tends to live at low densities (8 individuals km^{-2}) even in protected areas (Wright, 1995). This lemur has a low net reproductive growth rate because of high infant and adult mortalities (Pochron *et al.*, 2004). These life-history characteristics make *P. d. edwardsi* particularly vulnerable to anthropogenic perturbations.

It is unlikely that we missed any groups of *V. v. variegata* in the vicinity of the study sites because of the loud calls given by this species. Other researchers have failed to observe *V. v. variegata* at sites 22 km north of Jangajilo (Rakotondraparany, 1997; Goodman & Shütz, 1999) and at two sites 35 km south of Vohibola (Irwin *et al.*, 2005). This large (3.5–4.0 kg), conspicuous lemur is often hunted by local people because it can be easily located by its calls (Ratsimbazafy, 2002).

Altitude and associated habitat variations have been cited as important determinants of lemur distribution (Goodman & Ganzhorn, 2003). Six of the sites surveyed in the corridor were below the maximum elevation (1,600 m) reported for *P. d. edwardsi* (Goodman & Ganzhorn, 2003). Our sighting of *V. v. variegata* at Mananjara (1,353 m altitude) marks the maximum altitude reported for this species. Of the eight sites surveyed in our study, five were at or below 1,353 m altitude. Thus, altitude and associated habitat effects rather than human perturbations may explain the absence of *P. d. edwardsi* at sites 3 and 4 and of *V. v. variegata* at sites 3–5.

Although the Fandriana-Marolambo forest corridor is currently being assessed as a new National Park by the Government of Madagascar, conservation plans for *P. d. edwardsi* and *V. v. variegata* are complicated by the isolation of their populations. There is a disjunct distribution of forest landscapes between the Fandriana-Marolambo forest corridor and the corridor that contains Ranomafana National Park. Moreover, the Mangoro River is a major dispersal barrier to most lemurs at the northern end of the corridor (Goodman & Ganzhorn, 2003). Dispersal of *V. v. variegata* from the Park into the corridor is unlikely because this species appears to be

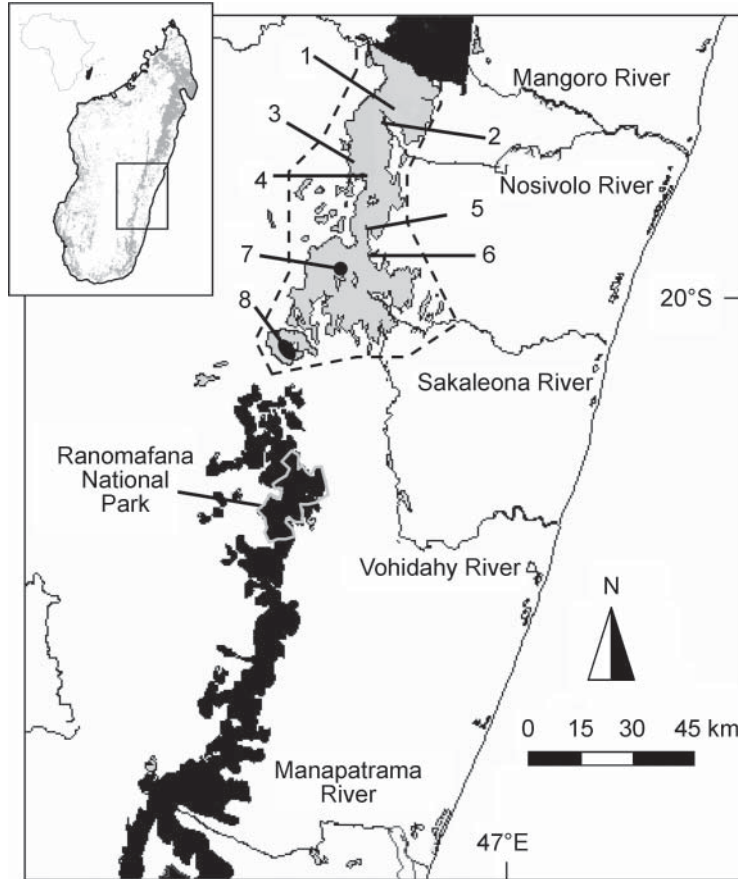


Fig. 1 Location of study sites and distribution of *P. d. edwardsi* and *V. v. variegata* in the Fandriana-Marolambo Forest Corridor (corridor designated with dashed line). Numbers refer to survey sites in the corridor (see Table 1 for descriptions). Black areas indicate sites where *P. d. edwardsi* (site #8) and *V. v. variegata* (site #7) were seen. Gray areas indicate forest habitats where neither species were found. Note that *P. d. edwardsi* is not known to range north of the Mangoro River or south of the Manapatrama River. The inset indicates the position of the main Figure in Madagascar.

unwilling or unable to traverse matrix habitats (Lehman *et al.*, in press). Although *Propithecus* sp. have been seen crossing open areas of up to 400 m between fragments (S.M. Lehman, pers. obs.), it is not known whether they can successfully traverse the extensive open areas from sites south of the corridor. Therefore, re-establishing *P. d. edwardsi* and *V. v. variegata* may require relocation of wild individuals or reintroduction of captive animals

into the corridor, which has only been accomplished, in Betampona Reserve, at great expense and with mixed success for *V. v. variegata* (Britt *et al.*, 2002).

The Red List categorizations of *P. d. edwardsi* and *V. v. variegata* need to be reassessed. They were last assessed in 2000 and forest habitats are becoming increasingly fragmented and lemurs are subject to heavy hunting pressures in the corridor. In addition, unexplored areas

Table 1 Survey effort, lemur sightings, and qualitative evaluation of habitats for eight sites (numbered locations in Fig. 1) in the Fandriana-Marolambo forest corridor of south-east Madagascar.

	Jangajilo	Bezavona	Garonina	Andranofisaka	Korikory	Ranomena	Mananjara	Vohibola
Site Number	1	2	3	4	5	6	7	8
Altitude (m)	1,277	1,223	1,670	1,685	1,555	1,345	1,353	1,311
No. transects	2	3	3	2	1	2	3	6
Transect length (km)	1.5, 2.0	2.0	0.9	0.5, 1.0	1.3	1.2, 4.0	2.0	1.25
Survey distance (km)	15.5	32.0	10.0	10.5	23.9	17.2	33.9	158.7
<i>P. d. edwardsi</i> sighted	No	No	No	No	No	No	No	Yes
<i>V. v. variegata</i> sighted	No	No	No	No	No	No	Yes	No
Conflict & disturbance*								
Agriculture	Extreme	Medium	High	High	Low	High	Medium	Low
Logging	Extreme	High	High	Low	Low	High	High	Medium
Hunting	Extreme	High	High	Low	Low	High	High	Medium

*Low, insignificant impact/occurrence observed; Medium, moderate impact/occurrence observed; High, significant level of impact/occurrence observed; Extreme, extremely high level of impact/occurrence observed.

of the corridor need to be examined for the presence of the two species. These data could then be used to determine ecological and anthropogenic correlates to distribution and density for *P. d. edwardsi* and *V. v. variegata*. Finally, conservation authorities should be wary of range maps based on subjective measures of the distribution of lemur species.

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Biographical sketches

Shawn Lehman has research interests in biogeography and conservation biology. He is the founder of the TREE (Tropical Research in Edge Effects) programme at the University of Toronto, and has worked on mammals for the last 15 years in Canada, USA, Venezuela, Guyana, Suriname and Madagascar.

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