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Southern Range Extensions for the Critically Endangered Black-and-White Ruffed Lemur *Varecia variegata* and Greater Bamboo Lemur *Prolemur simus*

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Abstract: The Vondrozo-Midongy rainforest corridor in south-eastern Madagascar is an example of a habitat corridor between otherwise disconnected protected areas, and is therefore considered important for the conservation of the endemic biodiversity of the island. Through several years of collaboration with local communities surrounding this corridor, WWF-Madagascar learned that members of some of these communities claimed the existence there of the black-and-white ruffed lemur (*Varecia variegata*) and the greater bamboo lemur (*Prolemur simus*), both regarded as Critically Endangered by the IUCN and not known by the scientific community to be present in the corridor. We therefore surveyed six sites in three communes in May 2010 to confirm this information. We made direct observations of *Varecia variegata* at two sites, which represent a southern extension to the known range of the species. We also found the characteristic feeding remains of *Prolemur simus* in the three most southerly sites, observations which also represent a major southern extension of the known range of this species. However, the feeding signs we found were old, at least a year old by our estimations, so we recommend further research to ascertain whether the population still exists there. The corridor is threatened by many anthropogenic pressures, and further reinforcement of the conservation program for the corridor is therefore likely to be necessary to ensure the viability of endangered lemurs in the region, and the role of the corridor in ensuring biological connectivity between the more substantial forests to the south and north.

Key Words: *Varecia variegata*, *Prolemur simus*, *Haplemur aureus*, Vondrozo-Midongy corridor, Madagascar, conservation, local knowledge

Introduction

The island of Madagascar, geographically isolated for around 90 million years (Mittermeier *et al.* 2010), is rich in endemic plants and animals (Goodman and Benstead 2003). Various studies have shown that the maintenance of this biological diversity depends on the conservation not only of disconnected protected areas, but also on the habitat corridors that permit biological exchange between them (Burel and Baudry 1999). The southern rainforest corridor between Vondrozo and the Midongy du Sud National Park is one such corridor that is thought to play an important role in the conservation of biodiversity in Madagascar. Within the framework of the project WWF MG0941.01–*Counting Lemurs—The Biological Corridor Vondrozo-Midongy*, WWF-Madagascar has been collaborating with local communities since 2004 for the conservation of the forest corridor in general, and in

particular of lemurs. Members of some of these local communities claim the existence there of the black-and-white ruffed lemur (*Varecia variegata*) and the greater bamboo lemur (*Prolemur simus*) (WWF unpubl. data; Rakotonirina 2006), both Critically Endangered (IUCN 2010) and not known by the scientific community to be present in the corridor. Although having an overall (but patchy) distribution extending through much of the eastern rainforest belt, *V. variegata* is believed not to occur south of the Mananara River (Irwin *et al.* 2005; Mittermeier *et al.* 2008, 2010). *Prolemur simus* is thought to have suffered a major reduction in its distribution since sub-fossil times, and has never been recorded south of the Manampatrana River (Irwin *et al.* 2005; Wright *et al.* 2008; Mittermeier *et al.* 2010), although recent surveys show that it has in fact been largely overlooked in much of its extant range

(Dolch *et al.* 2008; Ravaloharimanitra *et al.* 2011). Our study therefore aimed to confirm the presence of these two species in the corridor, which, if successful, would add considerably to its perceived conservation value, whilst also surveying for other lemur species and identifying threats to the lemur community and their habitat.

Methods

The Vondrozo-Midongy corridor is in the south-east of Madagascar (Fig. 1), and consists principally of low- and mid-altitude rainforest. Annual rainfall ranges from approximately 1,700 mm in the south of the corridor to 2,350 mm in the north. The climate shows marked seasonality, with the heaviest rains between December and March and a drier season from April or May to October (Repoblikan'i Madagascara 2006).

We surveyed six sites in three communes (Table 1); the sites selected based on information gathered previously by WWF project members from local communities regarding the potential presence of *Varecia variegata* or *Prolemur simus*. The commune of Vohimary was surveyed between 5 and 20 May 2010 by Rajaonson and Ratolojanahary, accompanied by Aimé Victor Tombotiana from Centre ValBio. The Bevata and Maliorano communes were surveyed between 2 and 21 May by Rakotonirina and Missirli.

Following courtesy visits to local authorities, we organized meetings with the local community associations responsible for the management of each survey site prior to undertaking the field research. We used these meetings to undertake rapid participatory research to gather local knowledge concerning the lemurs present in their sites and the distribution of bamboo, and to identify threats to the sites. We used photos of locally occurring lemur species to help us, and participatory mapping techniques (Jones *et al.* 2005) to map local features and landmarks. The results of these community meetings helped us identify areas most likely to support *V. variegata*, *P. simus* or other bamboo lemurs *Hapalemur* spp., and accompanied by local guides we then undertook the site visits. At Vohitrambo we made only a brief one-day visit, but we surveyed the other sites for three or four days each (Table 1), for eight to nine hours per day between 06h and 15h along existing trails and in areas of high bamboo density. We recorded the presence of lemurs through direct sightings whenever possible, but also through vocalizations (for *Eulemur* spp.) and feeding signs (for *P. simus* and *Hapalemur* spp.). The feeding

signs of *P. simus* on large-stemmed bamboos as described by Dolch *et al.* (2004, 2008) and Ravaloharimanitra *et al.* (2011) are highly distinctive, and members of both survey teams had extensive prior experience in distinguishing between feeding remains of this species, *Hapalemur aureus* and *H. griseus* in Ranomafana National Park and elsewhere, which also allowed us to make approximate estimations of the relative age of the feeding signs. Additionally, we recorded signs of threats, including but not limited to habitat destruction, tree or bamboo cutting, artisanal mining, cattle grazing, and evidence of lemur hunting. We carried out nocturnal surveys at two sites, Marovato and Antanimora. Lemur nomenclature follows Mittermeier *et al.* (2010).

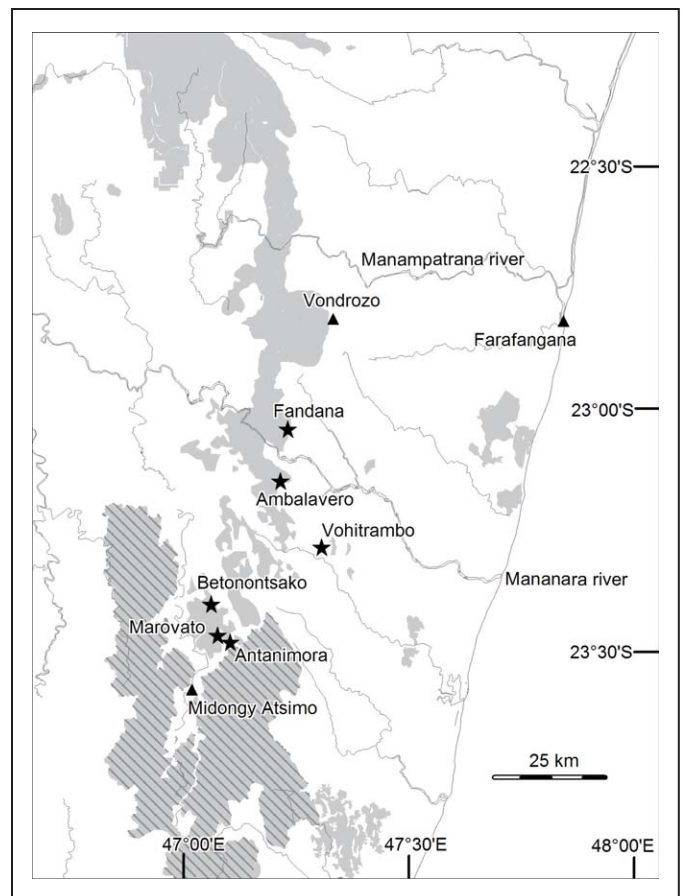


Figure 1. Map showing the location of our survey sites (black stars) and around the Midongy-Vondrozo Corridor, south-eastern Madagascar, approximate forest cover (light grey), rivers (dark grey), and other selected localities (triangles). The Midongy du Sud National Park is indicated by diagonal lines.

Table 1. The sites surveyed during this study in May 2010, including the name of the local community association (COBA) responsible for their management.

Commune	Site	Latitude	Longitude	Altitude (m)	Survey dates	COBA
Vohimary	Fandana	23°03'S	47°13'E	433–513	17–20 May	Fikambanasoa
Vohimary	Ambalavero	23°09'S	47°12'E	512–578	5–8 May	Manakery
Bevata	Vohitrambo	23°17'S	47°18'E	177	21 May	Bevata
Maliorano	Betonontsako	23°24'S	47°03'E	678–771	13–16 May	Mahabe
Maliorano	Marovato	23°28'S	47°04'E	636–788	3–6 May	Marovato
Maliorano	Antanimora	23°29'S	47°06'E	667–810	8–10 May	Ambodisay

Results

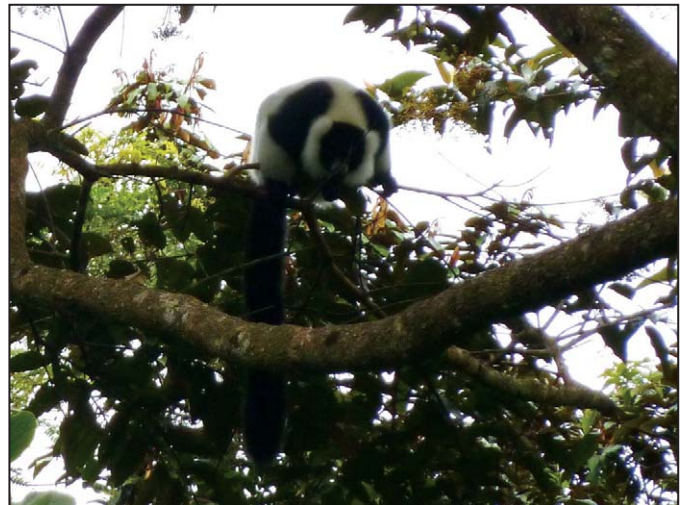
We made direct sightings of *Varecia variegata* at two sites (Figs. 2 and 3), in the Vohimary and Bevata communes. We found old feeding signs of *Prolemur simus* at the three sites in the Maliorano commune (Tables 2 and 3), all on a species of large-stemmed bamboo which we cautiously identified as *Cathariostachys* sp. We also found fresh feeding signs at four sites that we believe to be of *Hapalemur aureus*, but in the absence of direct sightings we refer to them as *Hapalemur* cf. *aureus* in Tables 2 and 3. We were unable to distinguish between the feeding signs of *Hapalemur griseus* and *H. meridionalis* during the survey, neither was our single direct sighting sufficient to separate them, so we have combined our observations of these species in Table 2. We recorded an additional four species by our own direct or indirect observations, and two more, *Lepilemur* sp. and *Daubentonia madagascariensis*, based on local knowledge (Table 2).



Discussion

Varecia variegata

We found *Varecia variegata* at two of the six sites surveyed, Ambalavero and Vohitrambo. Vohitrambo is outside the remaining forest corridor, and the population of *V. variegata* here may not be naturally-occurring; we understand that a few captive individuals of the species were released by local people here around the year 2000 (L. Razafy Fara, unpubl. data). However, the Ambalavero site is in the remaining forest corridor, with no evidence of former release events. Its presence there suggests that the species may be more widely distributed within the corridor. Indeed, local people at the three southern sites surveyed (Antanimora, Marovato and Betonontsako) claimed that *V. variegata* existed in their region several years ago, although they suggested that they passed through their forests rather than being permanent residents (Rakotonirina 2006).



Figures 2 and 3. *Varecia variegata* at the Ambalavero site, May 2010. Photographs by A. Rajaonson.

Table 2. Lemur species recorded in the Vondrozo-Midongy forest corridor, May 2010.

Commune:	Vohimary		Bevata	Maliorano		
Site:	Fandana	Ambalavero	Vohitrambo	Betonontsako	Marovato	Antanimora
<i>Microcebus</i> sp.		*		*	*	Direct
<i>Cheirogaleus</i> sp.				*	Direct	*
<i>Lepilemur</i> sp.					*	
<i>Hapalemur griseus</i> / <i>meridionalis</i> ¹	Feeding signs	Direct	*	Feeding signs	*	Feeding signs
<i>Hapalemur</i> cf. <i>aureus</i> ¹	Feeding signs	Feeding signs		Feeding signs	Feeding signs	
<i>Prolemur simus</i>				Old feeding signs	Old feeding sign	Old feeding sign
<i>Eulemur collaris</i>		Direct		*	Heard	Direct
<i>Varecia variegata</i>		Direct	Direct			
<i>Avahi</i> sp.		*		*	Direct	Direct
<i>Daubentonia madagascariensis</i>						*

¹See text for further explanation

* present according to local knowledge

Both Ambalavero and Vohitrambo are south of the Mananara River, and therefore represent a southern extension to the known range of the species as given in most recent syntheses (Fig. 4; Irwin *et al.* 2005; Wilmé *et al.* 2006; Mittermeier *et al.* 2008, 2010). However, Vasey and Tattersall (2002, illustrated in their Fig. 2) also give a record just south of the Mananara River which appears to have been overlooked by subsequent authors. This observation was made in 1995 close to our observation in Vohitrambo (I. Tattersall, in litt.), suggesting that the species may indeed be naturally-occurring in this area, or perhaps conversely that the release event we refer to above in fact occurred prior to 1995.

Our photos of the animals observed at the Ambalavero site (Figs. 2 and 3) show that the black coloration of the shoulders and upper back is not continuous behind the neck, but is separated by a thick white longitudinal band, a pelage feature considered characteristic of the subspecies *V. variegata variegata* (Mittermeier *et al.* 2010, pp.455 and 464) although apparently also observed within the documented variation of *V. variegata editorum* (Mittermeier *et al.* 2010, pp.458 and 461), which Mittermeier *et al.* (2010) suggest in their distribution maps and English names to be the southern subspecies. However, these authors recognize in their text that the definition and distribution of *Varecia* subspecies is not clear and may require revision. Indeed, Vasey and Tattersall (2002) suggest that the majority (but not all) of records from the south of the species

range are of the *V. v. variegata* coloration, including from the most southerly sites on both sides of the Mananara River, an observation consistent with our observations at Ambalavero. We therefore reiterate the recommendation of Mittermeier *et al.* (2008) that a study of the distribution and taxonomy of *Varecia variegata* should be considered a high conservation priority, and we suggest that such a study includes the newly discovered sites we report here.

Prolemur simus

We found the characteristic feeding remains of *Prolemur simus* in the three most southerly sites surveyed, in the commune of Maliorano. These observations represent a major southern extension of the known range of this species, which was not previously known south of the Manampatrana River (Fig. 5; Irwin *et al.* 2005; Wright *et al.* 2008; Mittermeier *et al.* 2010). The sites are located over 110 km south of the previously-known most southerly sites near Karianga (Wright *et al.* 2008), and approximately 90 km south of the Manampatrana River, near which some potential but unconfirmed sites for the species were reported by Rajaonson *et al.* (2010). This southern range extension follows a recent northern range extension reported by Ravaloharimanitra *et al.* (2011), and illustrates again the advantages of surveying for this species through a combination of gathering local knowledge and searching for feeding signs on large-stemmed bamboos (King

Table 3. Details of observations of *Varecia variegata*, *Prolemur simus* and *Hapalemur cf. aureus*¹ made within the Vondrozo-Midongy forest corridor, May 2010.

Site	Comments	Latitude	Longitude	Altitude (m)
<i>Varecia variegata</i>				
Ambalavero	Heard	23°09'24.3"S	47°12'35.5"E	572
Ambalavero	Heard	23°09'14.2"S	47°12'24.9"E	565
Ambalavero	Two individuals sighted	23°09'14.6"S	47°12'33.7"E	564
Ambalavero	Four individuals sighted	23°09'15.4"S	47°12'32.3"E	531
Vohitrambo	Direct sighting	23°17'21.6"S	47°18'03.3"E	177
<i>Prolemur simus</i>				
Marovato	Old feeding sign	23°28'24.4"S	47°04'01.7"E	699
Antanimora	Old feeding sign	23°29'46.2"S	47°05'48.4"E	810
Betonontsako	Old feeding sign	23°24'34.6"S	47°03'27.6"E	697
Betonontsako	Old feeding sign	23°24'25.7"S	47°03'24.8"E	689
Betonontsako	Old feeding sign	23°24'17.8"S	47°03'30.1"E	700
Betonontsako	Old feeding sign	23°24'40.8"S	47°03'07.7"E	697
<i>Hapalemur cf. aureus</i> ¹				
Ambalavero	Fresh feeding sign	23°09'08.0"S	47°12'22.2"E	546
Ambalavero	Fresh feeding sign	23°09'11.4"S	47°12'40.8"E	526
Fandana	Fresh feeding sign	23°03'01.3"S	47°13'26.3"E	513
Fandana	Fresh feeding sign	23°02'45.7"S	47°13'28.3"E	433
Betonontsako	Fresh feeding sign	23°24'34.6"S	47°03'27.6"E	697
Betonontsako	Fresh feeding sign	23°24'33.2"S	47°03'19.3"E	689
Betonontsako	Fresh feeding sign	23°24'35.1"S	47°03'15.1"E	690
Betonontsako	Fresh feeding sign	23°24'34.8"S	47°03'13.1"E	705
Betonontsako	Fresh feeding sign	23°24'38.6"S	47°03'08.0"E	771
Betonontsako	Fresh feeding sign	23°24'38.7"S	47°03'03.8"E	764

¹See text for further explanation

and Chamberlan 2010; Ravaloharimanitra *et al.* 2011). However, the feeding signs we found were old, at least a year old by our estimations, and at two sites (Marovato and Antanimora) we found only a single feeding sign, compared to four feeding signs at Betonontsako. We therefore recommend further research at this latter site, which supports a high density of giant bamboo, to ascertain whether the population still exists here.

Other species

At four of the survey sites we found fresh feeding signs that we believe to be of *Hapalemur aureus*. Two of us (Rakotonirina and Rajaonson) have extensive experience of differentiating the feeding signs of *H. aureus* and *H. griseus* in the region of Ranomafana National Park, and the signs we found

are identical to those of *H. aureus*. If confirmed, these sites represent a major southern range extension for this species (Irwin *et al.* 2005; Mittermeier *et al.* 2008, 2010); however, in the absence of direct sightings, we cannot be absolutely certain of the presence of *H. aureus* at the sites, so we recommend further research for confirmation. We also found feeding signs at four sites, and one direct sighting, that we attributed to *Hapalemur griseus*. However, based on the species distributions proposed by Mittermeier *et al.* (2010), these records may in fact be of *H. meridionalis* at some of the southern sites. It seems unlikely that these species can be reliably separated from feeding remains, and therefore further research is required to ascertain the distribution of these species in the study area. We recorded a further six species during the surveys (some only to generic level), none of which were

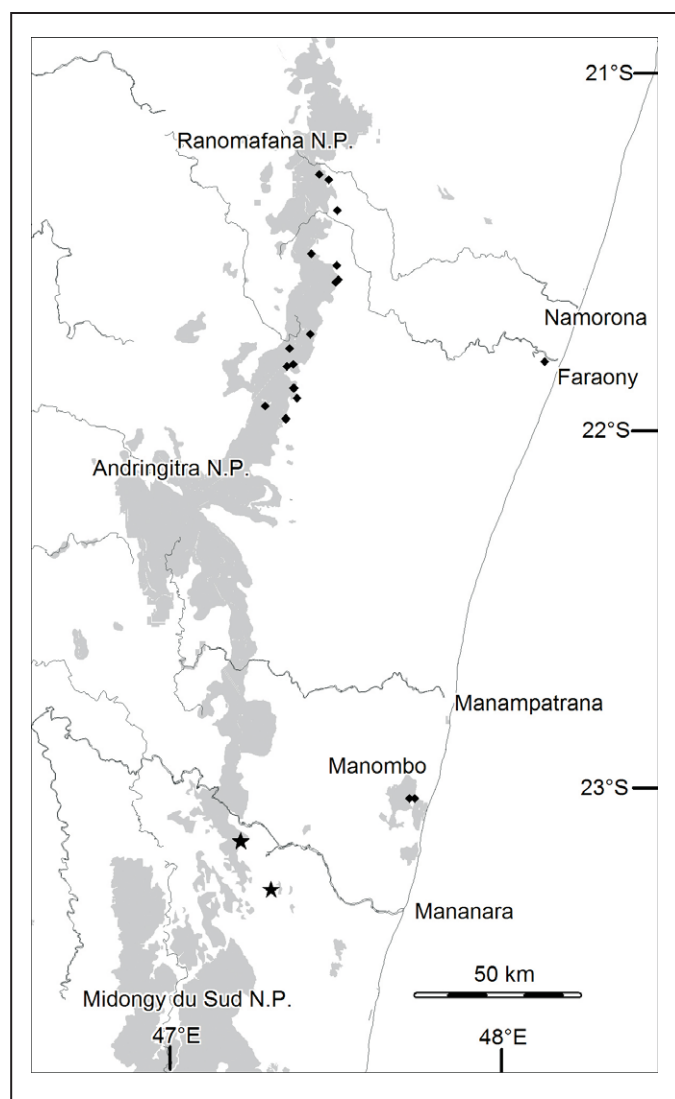


Figure 4. Map showing the *Varecia variegata* sites newly reported here (black stars), sites previously known to support *V. variegata* in south-eastern Madagascar (diamonds), approximate forest cover (light grey), major rivers (dark grey, with names), and other selected localities (named; NP = National Park). Locations of previous *V. variegata* sites are taken primarily from Wilmé *et al.* (2006), with additional sites from Deppe *et al.* (2007), Delmore *et al.* (2009) and Rajaonson *et al.* (2010).

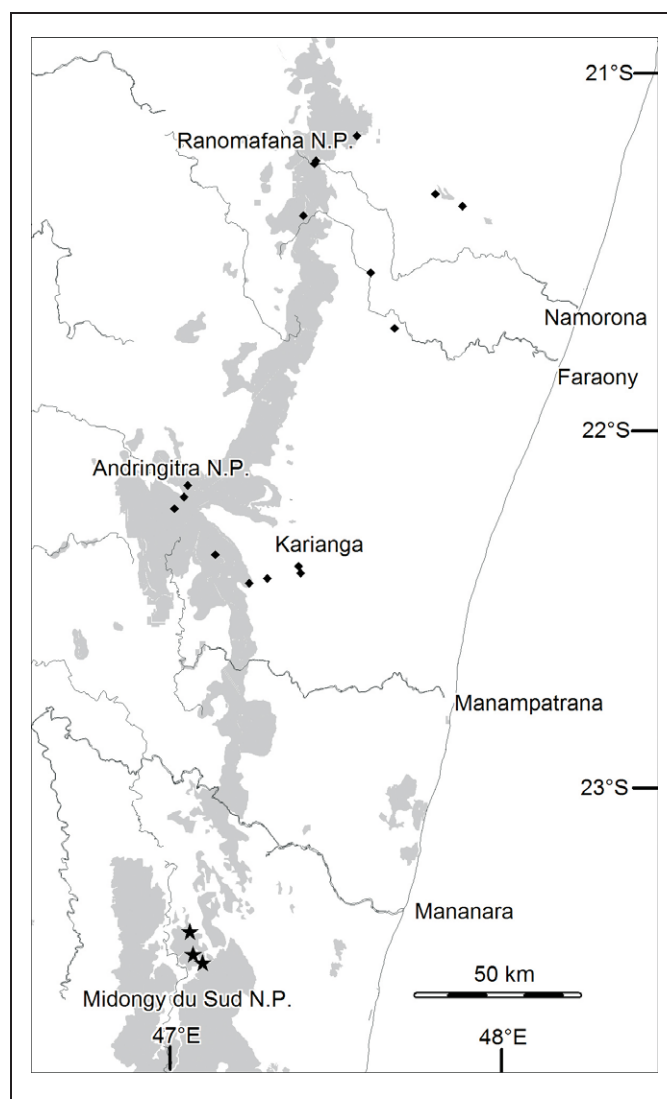


Figure 5. Map showing the *Prolemur simus* sites newly reported here (black stars), sites previously known to support *P. simus* in south-eastern Madagascar (diamonds), approximate forest cover (light grey), major rivers (dark grey, with names), and other selected localities (named; NP = National Park). Locations of previous *P. simus* sites are taken primarily from Wright *et al.* (2008), with additional sites from Meier and Rumpler (1987), Andriaholinirina *et al.* (2003), Delmore *et al.* (2009) and Rajaonson *et al.* (2010).

unexpected based on current knowledge of species distributions as given by Mittermeier *et al.* (2010). The level of local knowledge concerning the presence of lemur species varied greatly between sites, and coupled with the relatively rapid nature of our surveys we almost certainly overlooked some species at each site.

Threats and conservation

Our confirmation of the presence of *Varecia variegata* and *Prolemur simus* in the Vondrozo-Midongy corridor, both listed as Critically Endangered by IUCN (2010), illustrates the high conservation value of the area, and will hopefully stimulate increased awareness at a national and international level of the associated conservation challenges. The corridor is clearly threatened by many anthropogenic pressures. Long-term deforestation has resulted in the corridor currently existing as a very narrow strip of forest which is becoming increasingly fragmented and disturbed. WWF-Madagascar has been working with local populations surrounding the corridor since 2000 in the north, and since 2004 in the south, to ensure biological connectivity in the region. Many local community associations have been created since 2005, with the goal of transferring management responsibility of forest patches from regional government to the local communities themselves (WWF-Madagascar, unpubl. reports). In the Maliorano Commune, the three community associations responsible for the three sites we visited appeared to be well aware of the importance of biodiversity conservation in general, and of lemurs in particular. We found no evidence of lemur hunting in these three sites, which contrasts with the situation we found in the same area in 2006 when lemur hunting was common (Rakotonirina 2006). The cutting of trees for local use in these three sites also appeared to be less frequent than in 2006. However, forest disturbance remains a threat, cattle grazing and cutting of bamboos is still apparent, and local populations remain poor despite the development of various alternative economic opportunities through the WWF program.

At the more northerly survey sites, in the Commune of Vohimary, the forests we visited are generally smaller and more fragmented due to encroaching slash-and-burn agriculture, and the remaining forest areas are highly degraded. Artisanal mining is a principal cause of this degradation, and appears to have become the major source of income for the local populations. In addition, the Ambalavero site is being used as a route for trade in tobacco and locally-produced rum.

Considering these diverse pressures on a corridor already diminished in forest cover, the viability of the remaining lemur populations must surely be questioned. Further work is required to determine distributions, densities and viabilities of these populations, particularly of those species considered Critically Endangered such as *Prolemur simus* and *Varecia variegata*. *Prolemur simus* has a specialized diet dominated by large-stemmed bamboos (Tan 1999; Dolch *et al.* 2008; Ravaloharimanitra *et al.* 2011) and can exist in degraded habitats if bamboo is present and other, as yet undetermined, factors permit (Wright *et al.* 2009; Ravaloharimanitra *et al.*

2011). *Varecia variegata*, however, appears to be very sensitive to habitat loss and fragmentation (Vasey 2003), and recent local extinctions of the species have been recorded elsewhere, thought to have been driven by these factors coupled with hunting pressure (Beaucent and Fayolle 2008). Further reinforcement of the conservation program for the corridor is therefore likely to be necessary to ensure the survival of this and other species in the region, and consequently the role of the corridor in ensuring biological connectivity between the more substantial forests to the south and north.

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