

## ARTICLE

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# Taboo adherence and presence of Perrier's sifaka (*Propithecus perrieri*) in Andrafiamera forest

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## ABSTRACT

Habitat loss and poaching are among the most serious threats to the fragile and unique biodiversity of Madagascar. In the past, traditional taboos (*fady*), commonly associated with folk stories, have had a buffering effect on several lemur species. Here, we examine the status of hunting taboos with reference to the conservation of the critically endangered Perrier's sifaka (*Propithecus perrieri*). We also provide an update on *P. perrieri*'s presence in the protected area of Andrafiamera in the face of ongoing habitat fragmentation and poaching. The Andrafiamera forest represents one of the key refuges for this species, which has a very limited and fragmented range in northern Madagascar. We report the results of a 2016 presence/absence survey in Andrafiamera and from interviews on Perrier's sifaka taboo adherence, conducted in 2012 across the whole species range. Our results confirm the presence of Perrier's sifakas in Andrafiamera and that in 2012, across the species' range, the hunting taboo was observed by most (>95%) interviewees who answered (N = 23). Forest clearing and a decrease of taboo adherence may intensify the pressure on the already small and fragile population of *P. perrieri*. A deeper knowledge of the human-wildlife interconnections, as well as regular monitoring of this rare species' distribution, may be crucial for the success of its conservation.

## RÉSUMÉ

La perte de l'habitat et le braconnage sont parmi les menaces les plus graves pour la fragile biodiversité de Madagascar. Les tabous traditionnels (*fady*), communément associés à des contes et mythes, ont eu historiquement un effet de préservation sur la plupart des espèces de lémurien. Le propitèque de Perrier (*Propithecus perrieri*) est une espèce de lémurien en danger critique d'extinction. Il a l'une des distributions les plus restreintes parmi les propitèques. Quelques témoignages anecdotiques relevés dans la littérature suggèrent qu'un tabou protégerait cette espèce de la chasse. La forêt protégée d'Andrafiamera représente à ce

jour l'un des principaux refuges pour cette espèce mais la population de ce propitèque n'y a pas été évaluée régulièrement depuis 2013. Cette étude apporte une mise à jour de la présence de *P. perrieri* dans la forêt d'Andrafiamera et évalue l'importance des tabous pour la conservation de cette espèce, sous la forme de résultats émanants d'une brève étude sur le terrain menée à Andrafiamera en 2016. Les données d'entretiens succincts sur l'adhésion aux tabous liés à la chasse de *P. perrieri* menés en 2012 sur l'aire de distribution de l'espèce incluant l'aire protégée d'Andrafiamera-Andavakoera, la Réserve Spéciale d'Analamerana et le Parc National de l'Ankarana sont également présentées. Les résultats confirment la présence de *P. perrieri* dans trois des sept sites visités de la forêt d'Andrafiamera considérée comme étant l'une des zones les plus importantes pour sa conservation. Les résultats montrent également que, sur l'ensemble de l'aire de distribution du propitèque de Perrier, le tabou de chasse est observé par la plupart (> 95%) des répondants (N = 23), une valeur élevée en comparaison avec d'autres zones de Madagascar abritant des populations du genre *Propithecus*. Un conte traditionnel associé au tabou de *P. perrieri* est présenté et rappelle d'autres récits du folklore malgache. Le répertoire des récits concernant les différentes espèces de propitèques semble avoir des éléments stéréotypés et la permanence du récit peut augmenter la probabilité de respect du tabou. Le déboisement et la diminution de l'adhésion aux tabous peuvent intensifier la pression sur la population de *P. perrieri* qui est déjà modeste et fragile. Une connaissance plus approfondie des interconnexions homme-faune ainsi qu'une surveillance régulière de cette espèce menacée peuvent être cruciales pour le succès de sa conservation.

## INTRODUCTION

Slash-and-burn agriculture, hard-wood logging, poaching and mining activities represent serious threats to Madagascar's unique biodiversity (Styger et al. 2007, Dunham et al. 2008, Golden 2009, Schuurman and Lowry II 2009, Allnutt et al. 2013, Borgerson 2015).

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Although our knowledge of lemur biology and distribution has increased in past decades (e.g., Mittermeier et al. 2015), the persistence of human-driven threats makes it necessary to regularly re-evaluate human-wildlife interactions on a local scale and to monitor populations of species threatened with extinction (Plumptre and Cox 2006).

In Madagascar, poaching is driven by both socio-economic and cultural trends (Jenkins et al. 2011, Golden et al. 2014, Golden and Comaroff 2015a,b, Borgerson et al. 2016, Rizzolo et al. 2016) such as the erosion of traditional taboos (*fady*) passed down from the ancestors. Traditionally, taboos have played a crucial role in community interactions and attitudes towards wildlife (Jones et al. 2008). With the exception of a common but not globally spread harmful *fady* towards the aye-aye (*Daubentonia madagascariensis*, Shaw 1896, Ruud 1960, Simons and Meyers 2001), all lemur taboos reported in the literature provide positive conservation outcomes (Jones et al. 2008). The origins of these taboos are in most cases memorialized by a rich repertoire of orally transmitted traditional stories. Origin stories may link mankind or specific tribes to lemur origin, kinship, and altruistic actions towards humans, like in the case of indriids (Ferrand 1893, Decary 1950, Ruud 1960, Thalmann et al. 1993, Harpet 2011a,b). Additional data on taboo spread and cultural forms are necessary for a better understanding of people living closest to biodiversity-rich areas on which conservation depends.

Perrier's sifaka (*Propithecus perrieri*, Lavauden 1931) is a diurnal lemur. It is listed on Appendix I of CITES and has been considered Critically Endangered by the IUCN Red List since 1996 (IUCN 2014) and one of the 25 most endangered primate species (Salmona et al. 2017a). Perrier's sifaka population size ranges from ca. 1,000 to ca. 2,600 individuals (Banks et al. 2007, Banks 2013, Salmona et al. 2017a) and shows low levels of genetic diversity (Salmona et al. 2015, 2017b, Bailey et al. 2016), with an estimated effective population size ( $N_e$ ) of about 230 individuals, according to field surveys by Banks et al. (2007) and 50–100 individuals estimated from genetic data (Salmona et al. 2015, 2017b). *Propithecus perrieri* occurs in dry deciduous forests on limestone karst and semi-evergreen transitional forests on sandstone soils in the extreme north of Madagascar, around 50 km to the south of Antsiranana (Salmona et al. 2017a). It has one of the most restricted distribution ranges among sifakas. Its range includes the Analamerana Special Reserve, the Andrafiomena-Andavakoera Protected Area, and possibly the eastern part of the Ankarana National Park, with the Andrafiomena mountains forming its southern limit (Banks et al. 2015).

In Andrafiomena, the presence of Perrier's sifaka was first documented in 1988 as rare (Meyers and Ratsirarson 1989). It was re-assessed in 2005 (Ranaivoarisoa et al. 2006) and in 2012, when a total of 17 groups was found (Salmona et al. 2013). In 2007, Matthew Banks habituated five groups in the forest of Anjahankely. In 2008, 18 individuals were equipped with radio collars (Banks 2013). The groups were followed until 2011 (M. Banks, pers. comm.). The absence of regular surveys since 2013 appears to have favoured the rise of threats such as habitat loss, land conversion, fire, and poaching (Banks et al. 2015).

In the last decade, researchers failed to find Perrier's sifakas in the Ankarana National Park (Banks et al. 2007, Rasoloharijaona et al. 2005, Salmona et al. 2013, Gilles and Reuter 2014) and in Andavakoera (Zaonarivelo et al. 2007, Salmona et al. 2013). Andrafiomena and the western forest of Analamerana can be considered

crucial refuges for the species. Considering the restricted species range and the persistence of threats, an update on the presence in Andrafiomena was regarded as essential. In this paper, we therefore report the results of a quick survey of the Andrafiomena forest conducted in 2016 aimed at assessing the presence/absence of sifakas, and we integrate them with bibliographic as well as unpublished data from previous surveys. In addition, as Perrier's sifaka has been reported to be protected by a hunting taboo (Lavauden 1931, Meyers and Ratsirarson 1989, Mayor and Lehman 1999, Harpet 2011b, Banks 2013), we report results of the first interviews attempting to examine taboo adherence in the Perrier's sifaka region.

## METHODS

**SURVEY AREA.** All site visits were conducted in the Andrafiomena Protected Area (Figure 1), located at E049° 19', S12° 55', within the Région de Diana, District d'Antsiranana II, Commune Rurale d'Anivorano-Nord, Fokontany d'Andrafiabe. Andrafiomena-Andavakoera is an 85,000 ha Protected Area (IUCN category V) created only in October 2008 (Buřivalová 2011), and is managed by the Association Fanamby since 2006. Undisturbed and disturbed dry deciduous and transitional forests are interspersed with grasslands (Buřivalová 2011, Banks 2013). The fragments of dry forests are frequently surrounded and/or connected by riparian corridors or fragments of smaller size, extended riparian forests are present as well (Moat and Smith 2007, Salmona et al. 2015). The 2016 informal conversations were conducted in the village of Anjahankely (E049° 18' 49", S12° 54' 31"), located within Andrafiomena (Figure 1). The village consists of approximately 25 wooden houses belonging to the Antankarana (or Antakarana) ethnic group (92 inhabitants in 2011, Buřivalová 2011).

**SURVEY METHODS.** Seven sites were visited to detect the presence of Perrier's sifakas. Surveys were carried out daily by AA, RR, and two local guides (from the guide association of Anjahankely), from 31 May to 7 June 2016 from 0630h to 1700h. The visited forest fragments were selected based on the guides' suggestions. We visited Anjahankely, Beangivy, Dilanandrovo, Andohan'i Barabanjabe, Andohan'Ampantsona, Ambatombazaha and Andohan'Ambilobe (Figure 1). The forest of Anjahankely was visited several times (6 out of 8 days), as the habitat status ap-

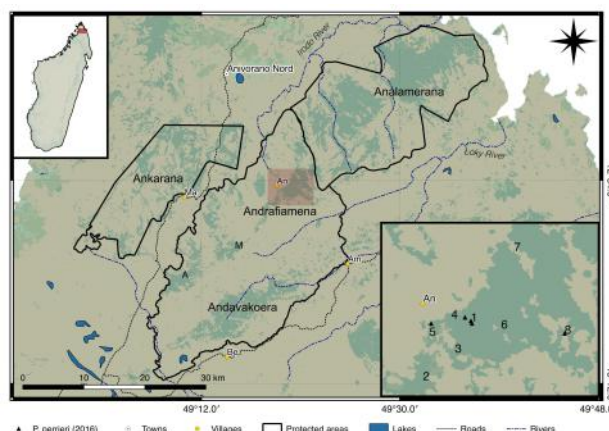


Figure 1. Sites visited during the 2016 survey. Perrier's sifaka was directly observed only in Anjahankely, Andohan'Ambilobe, and Ambatombazaha forests. (M = Mahanoro, AM = Ambohibe; 1–8 = sites visited in Andrafiomena Forest as follow 1 = Anjahankely, 2 = Beangivy, 3 = Dilanandrovo, 4 = Andohan'i Barabanjabe, 5 = Andohan'Ambilobe, 6 = Andohan'Ampantsona, 7 = Ambatombazaha Nord, 8 = Ambatombazaha Sud)

peared better than in other sites and we aimed to find and determine the size of groups followed by Banks until 2011 (Banks 2013). All the other sites were visited only once (1/2–1 day). We carried out presence/absence site visits, and no quantitative survey or distance sampling technique was used. We walked along existing trails. Recorded data included sifaka group size, geographic location, and a quick assessment of the forest type (dry deciduous, transitional semi-humid, humid, and humid riverside forest).

Playbacks were performed to acoustically detect sifakas and their presence was always confirmed visually. We used the integrated speakers of a Marantz recorder PMD660, and played the 'Zzuss-Tsk' and the 'lost' calls of diademed sifaka (*Propithecus diadema*), recorded by AA in Maromizaha forest, eastern Madagascar in 2014. These call types are generally used by eastern sifakas and *P. perrieri*, with, among others, cohesive functions (Macedonia and Stanger 1994, Garbutt 2007, Patel and Owren 2012). Although our targets were sifakas, we additionally recorded the presence of other lemur species, which were detected visually or acoustically, without the use of playbacks.

**SURVEY GEOGRAPHIC DATA.** The GPS data was recorded from the global positioning of a Canon EOS 6D camera. Geolocated sites and sifaka sightings were projected on the Forest Cover layer (Conservation International, Harper et al. 2007) using QGIS 2.18. We additionally represented the Protected Areas (Rebioma SAPM 2010, <http://www.rebioma.net>), roads (<http://www.mapcruzin.com>), lakes and rivers (<http://www.diva-gis.org/datadown>) layers.

**ETHICAL STATEMENT.** All interviews and conversations were conducted in Malagasy by native and/or non-native speakers. We obtained verbal consent to conduct the interviews and to record the discussions from all the participants. Participants could stop the interview at any time. Participation was not paid nor incentivized in any other way. Interviews, conversations as well as the other research described in this manuscript adhered to the current laws of Madagascar, Portugal, France, and Germany and complied with the International Primatological Society Guidelines for the Use of Nonhuman Primates in Research (<https://www.asp.org/welfare/socialhousingpolicystatement.cfm>) and the MCD guidelines for ethical research conduct in Madagascar (Wilmé et al. 2016). The authorization to conduct this research was granted by the Ministry of Ecology, Environment and Forests of Madagascar.

**INTERVIEWS.** We analysed the results of 34 structured interviews conducted between May and September 2012 in the region encompassing Andrafiamena-Andavakoera Protected Area (17 interviews), Analamerana Special Reserve (14 interviews), and Ankarana National Park (3 interviews). Participants included ER, FJ, JS. Interview subjects included 31 men (18–65 years old) and 3 women (36–76 years old). Most of them were farmers apart from five reserve officers, one sapphire panner, and one unemployed individual. The five-minute interviews used a prepared questionnaire of 50 questions and investigated *fady*(s) and hunting habits with particular focus on lemurs. First, subjects were shown lemur pictures in order to assess their ability to identify locally present species. The subjects able to recognize locally present lemur species were then asked: (1) whether they adhere to lemur-related *fady* in general and (2) whether they have observed wildlife

specific taxa (each locally present lemur genus, birds, tenrecs, bats, fossa, and Malagasy civet), adhere to *fady* and/or hunt each of these same wildlife specific taxa (16 taxa with 3 questions each). In this study, we only report the analysis of the results concerning sifaka and other lemurs *fady* adherence and hunting.

**INFORMAL CONVERSATIONS.** In June 2016, informal conversations were conducted by AA in the Anjahankely village. Questions and answers were translated by native speaker RR. No pre-arranged questionnaire was used. All participants were men living in the village. Nine local guides were asked in which sites in Andrafiamena they had recently observed sifakas. An elderly ex-guide, at that time nurseryman, was asked: (1) whether traditionally sifakas were hunted or considered *fady* and, in this latter case, (2) whether he knew a traditional tale associated with the sifaka *fady*.

## RESULTS

**PRESENCE OF LEMURS IN ANDRAFIAMENA.** Overall, five lemur species were visually recorded during our visits (Table 1), including one diurnal (*Propithecus perrieri*), one nocturnal (*Lepilemur cf ankaranensis* in Anjahankely), and three cathemeral species (*Hapalemur occidentalis* in Andohan'i Barabanjabe, *Eulemur coronatus*, *E. sanfordi*). *E. coronatus*, locally called *ankomba mavo* (literally 'grey lemur'), was found in Anjahankely and Andohan'Ambilobe, while *E. sanfordi*, whose vernacular name is *ankomba mavo beharavoaka* (literally 'grey lemur with large mustache'), was observed only in Anjahankely. The presence of other individuals of *Eulemur* spp. was recorded in Ambatombazaha, Andohan'Ambilobe, and Dilanandrovo forests.

**PRESENCE OF SIFAKAS IN ANDRAFIAMENA.** In Anjahankely village, sifakas are called *ankomba joby* (literally 'black lemur'). We directly observed sifakas only in Anjahankely, Andohan'Ambilobe, and Ambatombazaha forests (Table 2). In Andohan'Ambilobe, a guide reported the presence of sifakas observed a few weeks before the survey, on the riverside, not far from where he witnessed the presence of two groups during the survey. Local guides also observed sifakas in Beangivy. One group of five individuals was also reported by local guides in Dilanandrovo two weeks before the survey, but we failed to find it during our survey. One group of four individuals was observed independently by some guides in Andohan'i Barabanjabe during the week, but we failed to find it on the following day. We found no evidence of sifaka presence in Andohan'Ampantsona. A guide reported that some sifakas had been observed in Antsandrotona in the past, but we had no time to visit the site. In addition, an ex-guide told us that in the past, four groups were present on the way between Anjahankely and Ambatombazaha. A bibliographic review of surveys across *Propithecus perrieri* range since 2003 is shown in Table 2 and includes unpublished data on the sites surveyed in

Table 1. Observed species in Andrafiamena in 2016. (GR = According to local guide's report)

Site	Observed species
Ambatombazaha	<i>Propithecus perrieri</i> , <i>Eulemur</i> sp.
Andohan'Ambilobe	<i>E. coronatus</i> , <i>Eulemur</i> sp., <i>P. perrieri</i>
Andohan'i Barabanjabe	<i>P. perrieri</i> (GR), <i>Hapalemur occidentalis</i>
Anjahankely	<i>P. perrieri</i> , <i>E. coronatus</i> , <i>E. sanfordi</i> , <i>Lepilemur cf ankaranensis</i>
Bengivy	<i>P. perrieri</i> (GR)
Dilanandrovo	<i>P. perrieri</i> (GR), <i>Eulemur</i> sp.

2012–2013 (see Salmona et al. 2013). The mean group size for the five directly observed groups was ( $4.6 \pm 3.8$ ); when also considering reports by locals (9 groups), the mean was ( $4.3 \pm 2.7$ ). Group size ranged from one to nine individuals.

Two of the five groups habituated in Anjahankely forest by Banks in 2007–2011 were found in 2016. The presence of radio and GPS collars on some individuals facilitated the identification. Sifakas produced terrestrial disturbance alarm calls (mostly Zzuss-Tsk calls) in a contagious fashion and then started an ordered group movement when the presence of the team was detected. One of these groups showed higher tolerance to human presence and did not exhibit fleeing behavior. All observed groups and isolated individuals produced terrestrial alarm calls before fleeing. Zzuss-Tsk call playbacks efficiently allowed us to determine the presence of sifakas.

**LANDSCAPE AND HABITAT OBSERVATIONS.** Perrier's sifakas were observed in transitional semi-humid forests (Anjahankely), dry deciduous forest patches (Ambatombazaha), and humid riverside forests (Andohan'Ambilobe). These observations ranged from 276 to 727 m of altitude. Andrafiarana is a patchy area, with huge grazing zones surrounding forest fragments, and some rice fields. Several areas between Ampantsona village and Ambatombazaha, in Ambatombazaha itself, and not far from Beangivy had been burned not much long before our survey. Almost in every site we recorded traces of past or recent selective logging, with the vegetation sometimes degraded down to short shrubs. In Andohan'Ambilobe, we observed one lonely individual in a riverside forest, surrounded by the bleak landscape of a recently slashed area, reduced to low grassland.

**TABOO ADHERENCE AND HUNTING IN PERRIER'S SIFAKA AREA.** The 2012 interviews showed that most of the interviewees (~90%) were aware of the presence of *Propithecus perrieri* in those neighboring forests where the species is supposed to still occur (presence = 29, absence = 2) and that the large majority of those who answered (>95%) declared to adhere the taboo prohibiting the hunting of *P. perrieri* (*fady* = 22, hunting = 1, no response = 11). Results for *P. perrieri* are comparable with those relative to other lemur taxa, such as *Eulemur* species (90%,

*fady* = 18, hunting = 2, no response = 14), *Lepilemur* species (95%, *fady* = 19, hunting = 1, no response = 14), *Microcebus* species (94%, *fady* = 16, hunting = 1, no response = 17), and *Daubentonia madagascariensis* (100%, *fady* = 15, hunting = 0, no response = 19). In contrast, 30% of the respondents declared hunting lemurs (whithout species distinction, yes = 10, no = 23, no response = 1), and most interviewees (76%) admitted hunting at least one of the following wildlife groups (birds, lemurs, tenrecs, bats, fossa and Malagasy civet, yes = 26, no = 8, no response = 0).

**SIFAKA TABOO ORIGIN STORY.** During a 2016 conversation, an elder ex-guide from Anjahankely stated that the ancestors used to hunt *Eulemur* species but not *Propithecus perrieri*, as sifakas were considered *fady*. He also said that, according to a local tale, an unruly child who did not obey to his parents was once hit by them with a ladle as punishment. Consequently, he transformed into a sifaka and this is the reason why sifakas were considered family members by the ancestors and it was forbidden to kill them and consume their meat.

## DISCUSSION

**PRESENCE OF SIFAKAS AND OTHER LEMURS IN ANDRAFIARANA.** We confirmed the presence of *Eulemur coronatus*, *E. sanfordi*, *Lepilemur* cf. *ankaranensis*, and *Hapalemur occidentalis* in Andrafiarana, where these species had already been documented (Ranaivoarisoa et al. 2006, Mittermeier et al. 2015). Andrafiarana also continues to host sifaka populations. The results of the 2016 survey allowed us to confirm the presence of Perrier's sifakas in three of seven visited sites, although their presence was reported by local guides for six sites. The survival of two groups studied in 2007–2011 in Anjahankely forest (Banks 2013) is cause for hope and the forest appears one of the safest blocks for sifakas. Despite the presence of sifakas in Andohan'Ampantsona forest was reported in literature (Mittermeier et al. 2015), we could not detect it, confirming the results of the surveys carried out in 2012–2013.

In Andrafiarana, mean recorded sifaka group size is slightly larger than the one reported from Camp Antobiratsy in Analamerana (Mayor and Lehman 1999), which counted ( $3.7 \pm 0.6$ ) individuals (3 study groups). Interestingly, we observed sifakas at

Table 2. Bibliographic review of *Propithecus perrieri* surveys since 2003. (P = Presence, N.O. = Not Observed, G.R. = Presence according to guides' reports; (1) Rasolaharijaona et al. 2005, (2) Ranaivoarisoa et al. 2006, (3) Zaonarivelo et al. 2007, (4) Banks et al. 2007, (5) Banks 2013, (6) Salmona et al. 2013 and unpub. data, (7) This study)

Protected Area	Sites	2003 (1)	2005 (2)	2006 (3)	2003–2004 (4)	2003–2012 (5)	2012–2013 (6)	2016 (7)
Andrafiarana-Andavakoera	Ambatombazaha					P	N.O.	P
	Ambery				P			
	Ampantrogno-Ampantsogno						P	
	Andohan'Ambilobe							P
	Andohan'Ampantsona						N.O.	N.O.
	Andohan'i Barabanjabe							G.R.
	Anjahankely		P			P	P	P
	Antsahabe					N.O.	P	
	Antsahandrontogno						P	
	Beangivy					P	N.O.	G.R.
	Dilanandrevo						P	G.R.
	Madorimasina					P	P	
	Ambohibe					P		
	Ampondrabe-Antserasera					P	N.O.	
Mahanoro					P	P		
Andavakoera				N.O.		N.O.	N.O.	
Analamerana	Analamerana	P	P		P	P		
	Antsohy	P	P		P		P	
Ankarana	Ankarana	N.O.			N.O.	N.O.	N.O.	

an altitude of 727 m, which is much higher than the maximum altitude of 500 m that is usually reported (Mittermeier et al. 2015). We found that playbacks could be a potentially useful means for detectings.

**TABOO ADHERENCE IN PERRIER'S SIFAKA AREA.** Our interviews are of limited reach but clearly suggest that in 2012 the Perrier's sifaka-related *fady* was strongly adhered to in the species region, while overall consumption of other wildlife species was common. We found a very high adherence to sifaka-related *fady* (>95%) compared to the Alaotra-Mangoro Region (eastern Madagascar). In that region, *Propithecus diadema* was considered *fady* by less than 10% interviewees and 58% of the interviewees from rural communes declared that had eaten sifaka meat at least once in their lifetime, in strong contrast with the results from urban communes (Jenkins et al. 2011). Our result is even more striking when compared to data from *Propithecus candidus* range: in Marojejy National Park (northeastern Madagascar) only 2% householders reported a *fady* protecting this species (Loudon et al. 2017), despite the existence of a large number of animal taboos (including lemur *Eulemur albifrons*). A similar trend was reported in Makira National Park (northeastern Madagascar), where only 5% of male householders adhered to a taboo prohibiting *P. candidus* meat consumption (Golden and Comaroff 2015a).

Previous studies reported that most but not all sifaka species are protected by a traditional *fady*. Whereas the taboo exists and had some protection outcomes for *Propithecus coronatus* (Harpet 2011b, Salmona et al. 2014a), *P. coquereli* (Kun-Rodrigues et al. 2014, Salmona et al. 2014b), *P. deckenii* (Durbin et al. 2003), *P. edwardsi* (Harpet 2011b), *P. tattersalli* (Meyers 1993, Vargas et al. 2002), and *P. verreauxi* (Hawkins 1999, Loudon et al. 2006, Lawler 2008, Harpet 2011b), it is nearly absent in *P. candidus* and *P. diadema* (Patel et al. 2005, Jenkins et al. 2011, Golden and Comaroff 2015a, Loudon et al. 2017). Like all other lemur species, sifakas are also protected by Malagasy legislation (Rakotoarivelo et al. 2011), and their killing causes legal sanctions to the hunter (Jenkins et al. 2011). Despite the existence of traditional taboos and national laws, restrictions are not applied ubiquitously by a given ethnic group and most species are still hunted in some or even all areas of their range, including *P. coquereli* (Garcia and Goodman 2003, Razafimanahaka et al. 2012, Salmona et al. 2014b), *P. coronatus* (King et al. 2012, Rakotonirina et al. 2014, Salmona et al. 2014a), *P. deckenii* (Rakotonirina et al. 2014), *P. diadema* (Jenkins et al. 2011), *P. edwardsi* (Irwin et al. 2000, Lehman and Ratsimbazafy 2000, Lehman and Wright 2000, Irwin et al. 2005, Lehman et al. 2006), *P. tattersalli* (Meyers 1996, Mittermeier et al. 2015), *P. verreauxi* (Goodman and Raselimanana 2003, Randrianandrianina et al. 2010) or they were hunted in areas where they have now disappeared as in the case of *P. verreauxi* (Gardner and Davies 2004). This trend is common to another diurnal indriid, the indri (*Indri indri*), traditionally protected by a *fady* in Betsimisaraka regions (Harpet 2011b) and nevertheless threatened by hunting in several areas of eastern Madagascar (Thalmann et al. 1993, Powzyk and Thalmann 2003, Golden 2009, Jenkins et al. 2011).

**SIFAKA TABOO ORIGIN STORY.** The existence and persistence of an origin story (*tantara*) associated with a given taboo is not insignificant for a species' conservation, as the knowledge of an oral story can make an individual up to seven times more likely

to adhere to the taboo (Golden and Comaroff 2015a). The origin stories through which food taboos are explained can have different forms, such as educational (humans learned skills from animals), security (humans were saved by animals), and direct indigenous descent (Golden and Comaroff 2015b). For instance, the folklore traditionally depicted the sifaka as the savior of a founding ancestor who learned lemur healing powers (*Propithecus coronatus*), a metamorphosed man (*P. verreauxi*, *P. edwardsi*) or a descendant from a common/founding ancestor (*P. verreauxi*, *P. coronatus*) (Loudon et al. 2006, Harpet 2011b). These last two themes exist also for *P. perrieri*.

The story recorded in Anjahankely shows a strong similarity with other stories from the Sakalava region of Boina (northwestern Madagascar) and the Mayotte Island (Harpet 2005). In these stories, the theme is also the disobedience of a child, which causes an excess of anger of the mother (or both parents) and the transformation into lemur as the resulting punishment. As in the Anjahankely story, this punishment is triggered by a spoon blow, a common element with other two types of origin stories. In the second type, a man (called Rajako/Radjako/Rajaka or Itovo) is hit by his nasty wife with a spoon and transformed into *maque* lemur (probably *Lemur catta*, Szumski 1968), indri (Decary 1950) or *rajako* (probably *Propithecus perrieri*, Abinal and De la Vaissière 1885) according to the version. A conjugal quarrel triggers the transgression of a sorcerer's rule by the woman and the metamorphosis of her husband. This type was recorded in the Antandroy and Betsimisaraka regions. A third type, with two envious women married to the same husband transforming each other into lemurs (*L. catta* and *P. verreauxi*) through a spoon, was documented in Beza Mahafaly, southern Madagascar (Loudon et al. 2006). All these stories appear to provide norms of behavior and to explain the kinship between humans and lemurs.

For the Antankarana people living close to the Analamerana forest, Rajako was regarded as the name of a legendary hero of whom sifakas would be the descendants (Lavauden 1931) and is one of the local names used for Perrier's sifaka (Mittermeier et al. 2015). Another Antankarana belief is that sifakas harbor the spirits of deceased ancestors that have been buried in the sacred forests where these lemurs often reside (Banks 2013). The richness of folklore regarding human's kinship with indriids, especially *Indri indri* (Abinal and De la Vaissière 1885, Ferrand 1893, Catat 1895, Decary 1950, Ruud 1960, Dahle and Sims 1992, Harpet 2011a,b) may be explained with their "vertical clinging and leaping" upright posture (Napier and Walker 1967), possibly reminding of humans. For instance, lack of preference for some lemur meats by locals lacking taboos was connected to lemur resemblance to humans (Jones et al. 2008). This could possibly explain why diademed sifakas are not considered top-ranking meat by people from the Alaotra-Mangoro region (eastern Madagascar) although *fady* adherence is low there (Jenkins et al. 2011). Nevertheless, a regional variability in food preference seems apparent, as in an area close to Betampona, Antsinanana region (eastern Madagascar), diademed sifakas were conversely reported as a favored food (Welch and Katz 1992).

**LEMUR HUNTING IN PERRIER'S SIFAKA AREA.** According to the interviews, lemur hunting in Perrier's sifaka region appears less common (30% of the interviewees) than in Makira, where 49% of households declared hunting of lemurs (Golden et al. 2014), although wildlife is widely hunted in both areas. Our re-



sult is more alarming when compared to the Ankarana National Park, which is located nearby Andrafiarana, on its west side. In the buffer zone surrounding the park, only 11.4% of villagers reported to have hunted lemurs at least once in lifetime despite only 20.7% stating that they have taboos against lemur consumption/hunting (Gilles and Reuter 2014).

Hunting of Perrier's sifakas for food has been documented since the 1990s in some parts of their range like Analamerana (Harcourt and Thornback 1990, Meyers 1996), where it was possibly pushed by the breaking down of the *fady* (Mayor and Lehman 1996). At that time, a lemur taboo was spread in Ankarana (Fowler 1989), where this species probably later disappeared. Some recent reports suggest the persistence of the hunting practice of this species (Banks et al. 2015, Mittermeier et al. 2015).

Besides the limited sample size of the interviews, hunting was probably underestimated in the present study for several reasons. First, people generally hesitate to admit to hunting species that are protected by national or informal institutions as they may fear self-incrimination or that they may be negatively judged by their community. Second, people who are forbidden to kill sifakas may purchase them for food and we did not consider in our questionnaire the case in which interviewees received a carcasse from someone else, without hunting the animal by themselves. Moreover, stating to personally observe a taboo does not necessarily mean that interviewees adhere to it over the whole life, or that the taboo is shared with the whole ethno-linguistic group or with the local community (Boucher 2011, Golden and Comaroff 2015a). An observation-based local monitoring of transported, offered for sale, and consumed wildlife in the villages (a method that was adopted by Jenkins et al. 2011) may be an useful tool for verifying our results and provide a reliable measure of the *fady* adherence degree in the future. Nevertheless, unlike other areas in Madagascar (Golden and Comaroff 2015b), we have reason to think that food taboos in this region are likely to serve as a direct form of conservation.

Lemur hunting can be undertaken using slingshots, blowguns, firearms, spears, dogs, traps, and snares (Irwin et al. 2000, Golden 2009). Sifakas are generally reported to be hunted using slingshots and dogs (Goodman and Raselimanana 2003, Randrianandrianina et al. 2010). In the Diana region, snares and the remains of slingshots have been found in forests and along fragment edges within *Propithecus perrieri* range (Banks 2013). However, during our quick survey, we did not detect the presence of snares nor remains of slingshots or bullet shells. Despite past detections, hunting in the Diana region did not show a strong effect on lemur populations (Banks 2013), but one should be mindful that even occasional bushmeat consumption may significantly pressure an already fragile population (Jenkins et al. 2011).

Hunting is not the only human-driven menace responsible for sifaka killing. Introduced mammalian carnivores such as wildcats (*Felis silvestris*) and dogs (*Canis lupus familiaris*) constitute a concrete threat to sifakas in some areas (Brockman et al. 2008). In addition to being used by poachers, dogs are known to attack Perrier's sifakas descending to the ground to cross open areas (Banks 2013), a common behavior in this lemur species (Mayor and Lehman 1999). Dog attacks were reported from an area very close to Anjahankely village and throughout the wider region (Banks 2013). In 2016, we interviewed a villager who reported a recent case of a dog killing a Perrier's sifaka in Anjahankely. This additional predation pressure may be fatal as carnivore attacks can

make lemur species disappear from small forest fragments in a very short time (Irwin 2006). Therefore, both taboo persistence and different forms of anthropogenic threats (including forest clearing, hunting, and dogs attacks) are factors to be considered and monitored in future.

## CONCLUSIONS

Our quick survey confirmed the presence of the rare Perrier's sifaka in Andrafiarana, three years after the last visit by researchers. Within the area, Anjahankely forest appears one of the safest areas for sifakas. On the contrary, we had difficulties in finding sifakas in forests away from Anjahankely, where the presence of single individuals in small forest fragments is not reassuring. Although limited in sample size, and possibly biased by non-response, our interviews showed that in 2012 the sifaka-related *fady* was declared to be observed by most interviewees. While the strong taboo adherence is expected to act as hunting deterrent, it does not prevent logging and *tavy*. Forest clearing and fragmentation as well as occasional attacks by dogs and a progressive erosion of the traditional taboos may put the fragile Perrier's sifaka population increasingly at risk. Regular, more extensive and systematic surveys across the species' range are needed to monitor the population trend, especially in a crucial refuge like Andrafiarana. For instance, some sites like Ambery, close to the border with Analamerana, have not been surveyed since the discovery of sifakas in 2003-2004, and an update on that population is needed. Furthermore, as taboo systems are in continuous evolution and adherence to them can change over a generation or an individual lifetime, monitoring their persistence and confirming their effectiveness with observational data on hunting is of major importance for conservation aims.

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