

# The carnivores of Mariarano forest, Madagascar: first insights

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## Abstract

The carnivores of Mariarano forest, northwestern Madagascar, were surveyed in June–August 2012 as part of a wider biodiversity survey. Seven camera-traps provided photographs of Western Falanouc *Eupleres major* and the introduced Small Indian Civet *Viverricula indica*. Observations of tracks and faeces suggested the presence of Fosa *Cryptoprocta ferox*, although no direct sighting occurred.

**Keywords:** camera-trapping, *Cryptoprocta ferox*, deciduous forest, *Eupleres major*, *Viverricula indica*

## Ireo biby mpihina-nofa (Karnivôra) ao anaty alan'i Mariarano: fanadihadiana voalohany

### Famintinana

Natao ny fanadihadiana ny fisian'ireo karazam-biby mpihina-nofa (Karnivôra) mipetraka ao anaty alan'i Mariarano (any avatrana andrefan'i Madagasikara), tamin'ny volana Jiona sy Aogositra 2012, nandritra ny asa ankapobeny momba ny fanaraha maso ireo biby amin'ny faritra iny. Fakantsary fandrika fito (07) no nahitana ny fisian'ny Fanaloka Andrefana *Eupleres major* sy ilay biby vahiny Jaboady *Viverricula indica*. Ny tainy sy ny dian-tongony kosa no nahafantarana ny fisian'ny Fosa *Cryptoprocta ferox*. Hatreto izany dia tsy hita mivantana avy hatrany ireo biby ireo.

## Introduction

Madagascar has been described as the world's top conservation priority (Mittermeier *et al.* 2005), containing a mammal fauna both highly diverse and highly threatened. The endemic carnivores (Eupleridae) remain so poorly studied that their conservation planning is impeded.

Mariarano classified forest (15°29'00"S, 46°41'37"E) and the adjacent Matsedroy forest fragment (15°29'23"S, 46°38'25"E) (Fig. 1) are part of an unprotected forest block in the northwest of Madagascar, 50 km northeast of Mahajanga. Hereafter, the combined forest patches are together referred to

as Mariarano forest. Mariarano forest comprises 65 km<sup>2</sup> of western dry deciduous forest, wooded grass and bush land, a wetland complex and agricultural land (Moat & Smith 2007, Washington *et al.* 2009) and has been noted for its rich lemur populations (Andriantompohavana *et al.* 2006, Olivieri *et al.* 2006). Mariarano forest is one of the few remaining patches of unprotected western deciduous forest larger than 800 ha (Smith 1997) and is under intense anthropogenic pressure—Ackermann (2003) quantified annual deforestation rates of 3% in the forest.

Since 2009, a collaborative project has been assessing the forest's biodiversity. The partnership comprises Operation

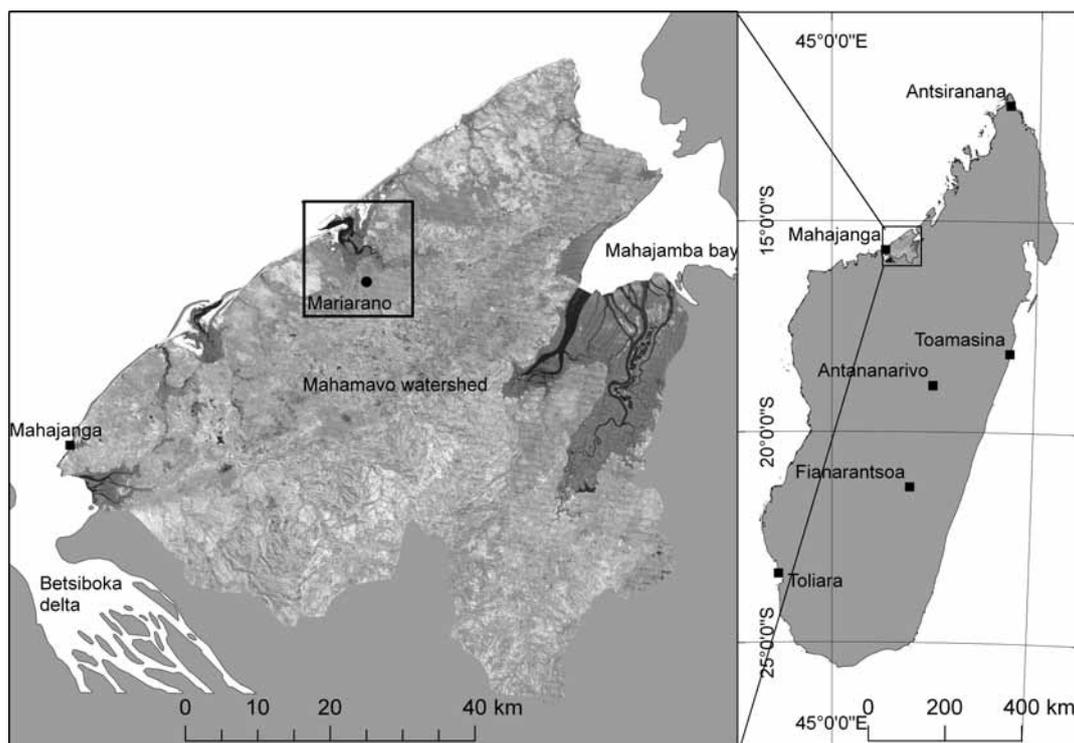


Fig. 1. Location of Mariarano Forest, Madagascar (image: P. Long).

Wallacea, an international volunteer-based NGO that supports conservation research through academic partnerships; Development and Biodiversity Action for Madagascar, a grassroots, community-based Malagasy conservation NGO; the local community forest management groups for Mariarano (*Tanteraka*) and Antanandavy; and the University of Antananarivo. The project is a landscape-scale long-term monitoring programme of multiple taxonomic groups. It aims to provide a biodiversity inventory of the area, to characterise spatial patterns and temporal trends in biodiversity, to monitor the condition of the forest habitat, to contribute revenue to local villages, and to secure further funding for environmental projects using the research results. Mariarano Forest is part of the Mahamavo catchment, a large landscape experiencing anthropogenic changes in land cover and configuration that threaten biodiversity in the area.

Biodiversity surveys and monitoring of Mariarano forest have been conducted since 2009 in each dry season between June and August. Multidisciplinary teams employ various survey techniques across a network of nine forest and six wetland sample routes, supplemented by opportunistic recording. Surveying began in the forest and mangrove system at the village of Mariarano in 2009, and extended to the Matsedroy forest fragment in 2011–2012 and has collected substantial spatial data on plants, reptiles, amphibians, lemurs, small mammals and birds (Washington *et al.* 2009, Long *et al.* 2012).

In the 2012 dry season, camera-traps were deployed to assess the area's carnivore community, supplemented by incidental observations (Fig. 2). An additional aim was to assess their efficacy as a survey tool.

## Methods

From June to August, seven Bushnell Trophy HD camera-traps were deployed across the study area (Fig. 2). Five were placed using the existing network of nine survey routes of 1.6–3.6 km

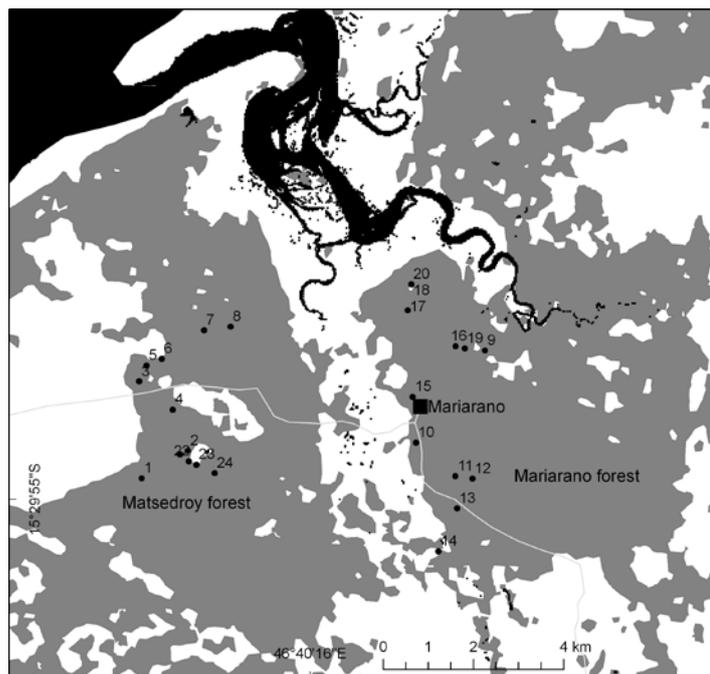


Fig. 2. Locations of camera-traps (1–24) amid forest (grey), the main settlement of Mariarano and surrounding roads (light grey).

in length. Each survey route contained two camera-trap locations, with one camera-trap at each location for 8–14 days (Table 1). Most camera-traps were placed directly on the survey routes, apart from a few localities with higher human traffic, where they were placed on smaller trails within 30 m of the main trail. Two camera-traps were used opportunistically, being placed deliberately in areas thought likely to produce photographic records, such as lake edges. Some were baited with chicken offal (Table 1). Camera-traps were set 30 cm above the ground. The overall surveys focused on the least-encroached parcels of semi-deciduous forest, so most cameras were placed within these parcels. However, some were also placed in wooded grassland, savannah and by the edges of small lakes (Table 1). The cameras were set to take three photographs in succession from each trigger, to aid identification. Successive observations of a species at a camera-trap within an hour of the previous observation were considered to constitute the same record. Altitudes were measured using GIS (ArcView v9.0). All co-ordinates were derived from Garmin GPS 60 receiver units, recording in UTM 38L, WGS84 datum.

## Species accounts

In total, the camera-traps were operated for 227 nights during June–August 2012, recording 25 encounters with carnivores (Table 1).

### Western Falanouc *Eupleres major*

*Eupleres* was photographed at three camera-trapping stations, over the course of 9–14 July. At the first station, unbaited (station 2), it was recorded singly on 9 July at 05h56 and 11 July at 05h58. At the second station, baited with chicken offal and bones and approximately 50 m from the first, photographs were taken on 11 July at 04h32, 12 July at 03h21 and 14 July at 04h25. The individual appeared to investigate the bait without taking any (Fig. 3). Both stations were on zebu trails just off the survey sample route. *Eupleres* was photographed at station 6, 2.7 km to the north, unbaited, in an open, scrubby area of the forest on 12 July at 00h51. The identification as *E. major* reflects the robustness of appearance (K. M. Helgen *in litt.* 2013) and is more consistent with this newly recognised species's known geographic range, than with that of residual Eastern Falanouc *E. goudotii* (Goodman & Helgen 2010). These records corroborate previous studies (Albignac 1974, Dollar 1999) showing a nocturnal to crepuscular activity for the genus. *Eupleres* occurs widely in Madagascar, but is apparently scarce (Garbutt 2007). There are particularly few records from the west (Goodman & Helgen 2010). The closest site to Mariarano forest where *Eupleres* has been recorded is Ankarafantsika National Park (Goodman & Helgen 2010). Mariarano forest represents an extension of known range for *Eupleres* of approximately 80 km northwest.

### Fosa *Cryptoprocta ferox*

Fresh tracks provisionally identified by FR as belonging to *C. ferox* were found near the forest camp at Matsedroy on 20 and 21 July (15°29'23"S, 46°38'56"E). Faeces found on 10 July, at 15°29'24"S 46°38'52"E, were provisionally identified by FR as belonging to *C. ferox* based on the grey colour, cylindrical shape with twisted ends, and strong smell (see Garbutt 2007).

**Table 1.** Camera-trapping locations, effort and carnivore records, Mariarano Forest, Madagascar, in dry-season 2012.

Location	Latitude S	Longitude E	Effort <sup>1</sup>	Habitat <sup>2</sup>	Trail	Carnivores camera-trapped
1	15°29'18"	46°38'44"	13	Prim. forest	on	<i>C. familiaris</i> (2), <i>F. catus</i> (3), <i>V. indica</i> (1)
2	15°29'33"	46°38'10"	12	Prim. forest	off	<i>E. major</i> (2) <i>F. catus</i> (1)
3	15°28'48"	46°38'32"	11	Sec. forest	on	<i>F. catus</i> (1)
4	15°28'28"	46°38'07"	11	Sec. forest	on	
5	15°28'17"	46°38'13"	11	Prim. forest	on	
6	15°28'11"	46°38'24"	11	Bushland	on	<i>E. major</i> (1)
7	15°27'50"	46°38'55"	11	Prim. forest	on	
8	15°27'48"	46°39'15"	11	Sec. forest	on	<i>C. familiaris</i> (1)
9	15°28'04"	46°42'24"	9	Xero. scrub	off	
10	15°29'11"	46°41'34"	8	Sec. forest	on	<i>C. familiaris</i> (2)
11	15°29'35"	46°42'37"	8	Prim. forest	on	
12	15°29'37"	46°42'16"	8	Prim. forest	on	
13	15°29'59"	46°42'05"	8	Sec. forest	on	<i>C. familiaris</i> (1)
14	15°30'30"	46°41'51"	8	Sec. forest	on	<i>C. familiaris</i> (1)
15	15°28'38"	46°41'31"	9	Sec. forest	off	
16	15°28'01"	46°28'02"	9	Prim. forest	off	
17	15°27'35"	46°41'27"	9	Prim. forest	on	
18	15°27'16"	46°41'29"	9	Prim. forest	off	
19	15°28'02"	46°42'09"	14	Forest clearing	on	
20	15°27'16"	46°41'29"	14	Lake edge	off	<i>V. indica</i> (2)
21	15°29'21"	46°38'38"	14	Prim. forest	on	<i>C. familiaris</i> (1), <i>E. major</i> (2), <i>F. catus</i> (2)
22	15°29'26"	46°38'45"	3	Savannah	on	
23	15°29'28"	46°38'45"	5	Forest edge	on	<i>F. catus</i> (1)
24	15°29'34"	46°39'04"	12	Lake edge	off	<i>C. familiaris</i> (2)

All camera-traps were located between 0 and 120 m above sea level. All camera-traps were unbaited except for location 21.

<sup>1</sup>Number of days deployed. <sup>2</sup>Habitats: Prim. forest = primary forest; Sec. forest = secondary forest; Xero. scrub = xerophytic scrub.



**Fig. 3.** Western Falanouc *Eupleres major*, Mariarano forest, Madagascar, 14 July 2012 (Photo: B. J. Evans).



**Fig. 4.** Small Indian Civet *Viverricula indica*, Mariarano Forest, Madagascar, 26 June 2013 (Photo: B. J. Evans).

The faeces contained fur apparently of Coquerel's Sifaka *Propithecus coquereli*. Further potential *C. ferax* faeces were found on 16 July 2012 on a zebu cart trail (15°30'11.5"S 6°38'14.9"E). DNA testing of faeces has shown that visual identifications of signs are often overconfident (e.g. Janečka *et al.* 2008), so these records cannot therefore confirm the species's presence.

#### Small Indian Civet *Viverricula indica*

The introduced *V. indica* (Fig. 4) was camera-trapped at two stations and was observed directly once. Camera-trap records

occurred at a small seasonal lake at Ambongalatsika (station 20) on 26 June at 03h26 and 30 June at 04h18, and near the forest camp at Matsedroy (station 1) on 18 July at 00h32. RG observed an individual *V. indica* in savannah (15°29'4.0"S, 46°39'28.4"E) by night (19h21) on 22 July.

Domestic Dog *Canis familiaris* and Domestic Cat *Felis catus*  
Dogs and cats were camera-trapped 11 and six times respectively, and were sighted in almost all areas surveyed.

## Conclusions

This initial assessment of the carnivores of Mariarano forest found *E. major*, considered by *The IUCN Red List of Threatened Species* to be part of *E. goudotii*, categorised as Near Threatened (Hawkins 2008) and, probably, *C. ferox*, categorised as Vulnerable (Hawkins & Dollar 2008). Three introduced species were also found, *V. indica*, *F. catus* and *C. familiaris*. This carnivore community is as expected for western deciduous forest, although local people also appeared familiar with the highly distinctive Ring-tailed Vontsira *Galidia elegans* (pers. obs.), which, however, is not widespread in western deciduous forest (Goodman 2012). It was considered extirpated from Anjohibe, 18 km west-south-west of Mariarano, by Samonds *et al.* (2010), based on fossils which may have dated from very different habitat conditions. This 2012 survey ran only in the dry season, with few traps and low survey effort. Increased effort, particularly during the wet season, might provide evidence of its presence. From this preliminary study, the efficacy of using camera-traps to gain multiple records of endemic carnivores in the area is proven: no other records of endemic carnivores were confirmed to species by the many hours of other survey methods.

The native carnivores in Mariarano forest face several threats. Habitat destruction through forest fires, charcoal production and logging have all been observed (Long *et al.* 2012). In Ankarafantsika, a large area of western dry deciduous forest roughly 80 km away, Barcala (2009) found that dog incidence rates related inversely to *C. ferox* incidence rates, suggesting that dogs could be extirpating *C. ferox*. Combined with the damage to ecosystems from dogs in general (Butler *et al.* 2004), their presence, in particular, is likely to be affecting the area's endemic carnivores negatively. Effects on the endemic carnivores of the other introduced carnivore species are less clear.

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## References

Ackermann, K. 2003. The role of dry forests in Madagascar as a safety net in the rural livelihood system. Paper presented at The International Conference on Rural Livelihoods, Forests and Biodiversity 19–23 May 2003, Bonn, Germany.

Albignac, R. 1974. Observations éco-éthologiques sur le genre *Eupleres*, viverridé de Madagascar. *Terre et Vie* 28: 321–351.

Andriantompohavana, R., Zaonarivelo, J. R., Randriamampionona, R., Razafindraibe, J. F. X. & Louis, E. E., Jr 2006. A preliminary study on resident lemur populations in the Mariarano Classified Forest. *Lemur News* 11: 21–24.

Barcala, O. 2009. *Invasive stray and feral dogs limit Fosa (Cryptoprocta ferox) populations in Ankarafantsika National Park, Madagascar*. Duke University (M.Sc. Thesis), Durham, N.C., U.S.A.

Butler, J. R. A., du Toit, J. T. & Bingham, J. 2004. Free-ranging Domestic Dogs (*Canis familiaris*) as predators and prey in rural Zimbabwe: threats of competition and disease to large wild carnivores. *Biological Conservation* 115: 369–378.

Dollar, L. 1999. Notice of *Eupleres goudotii* in the rainforest of southeastern Madagascar. *Small Carnivore Conservation* 20: 30–31.

Garbutt, N. 2007. *Mammals of Madagascar: a complete guide*. Yale University Press, New Haven, U.S.A. and London, U.K.

Goodman, S. 2012. *Les carnivora de Madagascar*. Association Vahatra, Antananarivo, Madagascar.

Goodman, S. M. & Helgen, K. M. 2010. Species limits and distribution of the Malagasy carnivoran genus *Eupleres* (family Eupleridae). *Mammalia* 74: 177–185.

Hawkins, A. F. A. 2008. *Eupleres goudotii*. In: IUCN 2012. *IUCN Red List of Threatened Species*. Version 2012.2. <www.iucnredlist.org>. Downloaded on 1 July 2013.

Hawkins, A. F. A. & Dollar, L. 2008. *Cryptoprocta ferox*. In: IUCN 2012. *IUCN Red List of Threatened Species*. Version 2012.2. <www.iucnredlist.org>. Downloaded on 1 July 2013.

Janečka, J. E., Jackson, R., Yuquang, Z., Diqiang, L., Munkhtsog, B., Buckley-Beason, V. & Murphy, W. J. 2008. Population monitoring of Snow Leopards using noninvasive collection of scat samples: a pilot study. *Animal Conservation* 11: 401–411.

Long, P., Rabenandrasana, M., Rabenoro, M., Darlington, A., McCann, R., Gandola, R., Morrison, R., Graham, S., Ellis, C., Washington, H., Evans, B., Palfrey, P., Raveloson, B., Rakontondravony, F., Jocque, M. & Andriambelo, H. 2012. *Biodiversity surveys of Mariarano and Matsedroy tropical dry forests and associated wetlands, western Madagascar; 2010–2012, status report*. Unpublished report to the Ministry of Forests and Environment, Antananarivo, Madagascar.

Mittermeier, R. A., Gil, P. R., Hoffman, M., Pilgrim, J., Brooks, T., Mittermeier, C. G., Lamoreux, J. & da Fonseca G. A. B. 2005. *Hotspots revisited*. University of Chicago Press, Chicago, U.S.A.

Moat, J. & Smith, P. 2007. *Atlas of the vegetation of Madagascar*. Kew Publishing, Kew, U.K.

Olivieri, G., Radespiel, U., Randrianambinina, B., Rasoloharijaona, S., Andrianarivo, C., Rakotondravony, D., Rakotosamimanana, B., Ramilijaona, O., Raminosoa, N. & Zimmermann, E. 2006. Biodiversité et évolution des lémurien nocturnes: un programme de collaboration germano-malgache. Pp. 113–125 in Schwitzer, C., Ackermann, D., Brandt, S., Razakamanana, T., Ramilijaona, O., Ganzhorn, J. U. & Razanahoera, M. (eds) *Biodiversity, ecology and conservation of Madagascar's fauna: case studies*. Proceedings of the German–Malagasy Research Cooperation in Life and Earth Sciences, Berlin, Germany.

Samonds, K. E., Parent, S. N., Muldoon, K. M., Crowley, B. E. & Godfrey, L. R. 2010. Rock matrix surrounding subfossil lemur skull yields diverse collection of mammalian subfossils: implications for reconstructing Madagascar's paleoenvironments. *Malagasy Nature* 4: 1–16.

Smith, A. P. 1997. Deforestation, fragmentation, and reserve design in western Madagascar. Pp. 415–441 in Laurence, W. F. & Bierregaard, R. O. (eds) *Tropical forest remnants: ecology, management, and conservation of fragmented communities*. University of Chicago Press, Chicago, U.S.A.

Washington, H., Rabenoro, M., Andriambololona, N., Griffin, O., Higgins, F., Osmond, T., Shah, P. & Clementine, V. M. 2009. *University of Bath Mahamavo Expedition 2009*. University of Bath, Bath, U.K.

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