

Species composition and relative sighting frequency of carnivores in the Analamazaotra rainforest, eastern Madagascar

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Abstract

Observations of endemic Malagasy Carnivora (Eupleridae) from Analamazaotra rainforest in Andasibe, Madagascar, from 1992 to 2010 show that the carnivoran assemblage consists of at least four species. They are (in decreasing relative sighting frequency) Malagasy Ring-tailed Mongoose *Galidia elegans*, Fanaloka or Malagasy Civet *Fossa fossana*, *Fossa Cryptoprocta ferox* and Eastern Falanouc *Eupleres goudotii*. An increase in the number of euplerid observations with time is paralleled by a reduction of snaring terrestrial mammals in Analamazaotra, and may suggest recovering populations. While the number of carnivoran species observed was not different from other rainforest sites in Madagascar, the relative observation frequency of particular species showed marked disparities, with *Galidia elegans* accounting for almost 70% of all observations in Analamazaotra.

Keywords: Andasibe, *Cryptoprocta ferox*, *Eupleres goudotii*, Eupleridae, *Fossa fossana*, *Galidia elegans*

Fitambaran'ireo vondrona carnivores fahita matetika amin'ny ala mando Analamazaotra, antsinanan'i Madagasikara

Famintinana

Ny fanaraha-maso ireo carnivores malagasy (ireo karazana biby mihinan-kena) ato anatin'ny ala mando Analamazaotra eto Andasibe, izay heverina fa misy karazany efatra eo ho eo ny taona 1992–2010. Izy ireo nefa dia (nandritra ny fanaraha-maso dia hita fa nihena ny fahitana azy ireo) *Galidia elegans*, *Fossa fossana*, *Cryptoprocta ferox*, ary ny *Eupleres goudotii*. Ny fitomboan'ny isan'ireo fanaraha-maso ny Eupleridae ara-potoana dia napetraka mira-zotra amin'ny fampihenana ny fihazana ireo biby mampinono an-tanety eto Analamazaotra, izay heverina fa mety mbola ahitana fonenana maromaro. Nandritra ny fanaraha-maso ny isan'ireo karazana carnivores izay tsy nisy fahasamihafana tamin'ireo faritra misy ala mando hafa eto Madagasikara, dia voatsikaritra fa nisy fihenana ireo karazana voatokana izay nanaovana fanaraha-maso matetika, tamin'ny *Galidia elegans* izay mampiseho fa ny 70% ny fanaraha-maso rehetra natao teto Analamazaotra.

Introduction

Except for feral cats *Felis catus*, domestic dogs *Canis familiaris* and the introduced Small Indian Civet *Viverricula indica*, all Malagasy carnivoran species belong to the endemic family Eupleridae (Wozencraft 2005). Formerly considered to belong dispersed among various other families, their taxonomic distinctness has been revealed by molecular studies (Veron & Catzeflis 1993, Veron *et al.* 2004).

Eupleridae are a monophyletic lineage (Yoder *et al.* 2003) most closely related to hyaenids and herpestids (Baryka 2007). While the species of the subfamily Galidiinae also phenotypically resemble mongooses, the more ancient Euplerinae are more civet-like, with one species, *Fossa Cryptoprocta ferox*, showing a number of characteristics convergent with cats that had earlier led to now futile assumptions of its phylogeny (e.g. Köhncke & Leonhardt 1986).

The nomenclature of Eupleridae could unhesitatingly be called unfortunate. For example, the Fossa (or Fosa) *Cryptoprocta ferox* often gets confused with the Fanaloka *Fossa fossana*. But in some regions of Madagascar, the term 'fanaloka' or 'falanoka' is also being used for *Eupleres goudotii* (hence its anglicised name of Falanouc). The Fanaloka itself (i.e. *Fossa fossana*) has—again according to region—a wide range of vernacular names, including 'teza' (in Andasibe) or indeed 'fosa' (in Ranomafana). The use of scientific names therefore nowhere seems to be more appropriate than in the case of the Eupleridae, which currently comprises 10

species (Table 1).

Given the elusive nature of carnivores, behavioural and ecological studies are difficult. Studies of Malagasy carnivores have generally focused on analysing faeces to investigate feeding ecology (Goodman *et al.* 1997, 2003, Hawkins & Racey 2008, Andriatsimetry *et al.* 2009). Initially, research on Malagasy carnivorans focused on the larger species in the western dry forests rather than on the eastern rainforests (e.g. Hawkins 1998, Hawkins & Racey 2005, 2008).

Rainforest sites in Madagascar where carnivorans have been studied include Betampona (Britt 1999, Britt & Virkaitis 2003), Andritra (Goodman 1996) and Andohahela (Goodman & Pidgeon 1999). Most observations on euplerid carnivorans in rainforest come from Ranomafana (Dunham 1998, Dollar 1999a, 1999b, Gerber *et al.* 2010).

While almost all these studies have focused on population ecology of particular species, few have looked at community ecology. Gerber *et al.* (2010) produced the first intensive account of the carnivore community of a particular site, looking at species composition, apparent relative abundance and density.

Here are presented data on the carnivore community of another rainforest site, Analamazaotra, gathered over a period of almost 20 years.

Survey area and methods

The Analamazaotra forest (18°56'17"S, 48°24'51"E) lies immedi-

ately south of the village of Andasibe, formerly known as Périnet, at altitudes of 920–970 m. The annual rainfall is 1,700 mm, and the vegetation is mid-altitude rainforest. Analamazaotra consists of two parcels (700 ha and 800 ha, respectively) bisected by a 3-km road that links Andasibe to the Antananarivo–Toamasina paved Route Nationale 2. These parcels are the Station Forestière (SF), managed by Association Mitsinjo, and the former Réserve Spéciale (RS), now part of Andasibe–Mantadia National Park and managed by Madagascar National Parks (e.g. Dolch 2003). Agents of Association Mitsinjo started regular patrols in 2001, in the course of taking over the management of Station Forestière Analamazaotra from the Ministry in charge; they have maintained the same level of patrolling effort since. Reflecting Analamazaotra forest's proximity and connection via a paved road to the capital, Antananarivo, it is both a very popular nature tourism destination and a well-studied forest (Dolch 2003). Yet, the carnivores of the

area have never been subject to any detailed study, although many species have been observed and/or collected in and around Andasibe (e.g. Albignac 1973). Still, information on their distribution and relative abundance remains scant.

Having lived (with minor breaks) in Andasibe from 1992 to 2010, I have recorded all personal observations of carnivores during that period, noting the date and time. Encounters were opportunistic, usually made walking along or close to the road bisecting the Analamazaotra forest.

Although walking on that road was pretty much a daily business, it is difficult to quantify in retrospect, how often I actually walked it. While total time spent on this road may appreciably differ between single years, the overall duration of the observation period may be sufficient to level out these differences.

Results and discussion

In total, 36 observations involving carnivorans were made. The species found, in decreasing order of number of observation events, were *Galidia elegans* (n=25), *Fossa fossana* (n=8), *Cryptoprocta ferox* (n=2) and *Eupleres goudotii* (n=1; Table 2). Neither *Galidictis fasciata* nor *Salanoia concolor* (both known to occur in the area; Albignac 1973) were observed.

Although *F. fossana* superficially resembles the introduced *V. indica*, it can easily be distinguished from it by its stocky appearance, bushy tail without complete rings, elongated snout and absence of longitudinal bands on the back (Garbutt 2007). Local hunters also clearly discriminate between the two species by using the vernacular names 'teza' for the former and 'jaboady' for the latter. The absence of any observation of *Viverricula* in Analamazaotra comes despite its abundance in degraded habitats in the vicinity as reflected by records of hunters (J. Rafalimandimby verbally 2005). With the exception of *Viverricula* records, the species composition and relative sighting frequency of all euplerid species found in Analamazaotra are supported by accounts from hunters in the wider Andasibe region (RD unpubl. data).

The euplerid assemblage in Analamazaotra resembles that of other rainforest sites, and is identical to that reported from Makira (Golden 2009). While no details on the relative encounter rate of euplerids are given by Golden (2009), data from Ranomafana in Gerber *et al.* (2010) represent the first investigation of the relative abundance and density of carnivores in the eastern rainforest of Madagascar.

Gerber *et al.* (2010) conducted their study in the austral win-

Table 1. Extant species of Eupleridae.

English name	Scientific name	IUCN category
Euplerinae		
Fossa	<i>Cryptoprocta ferox</i>	VU
Eastern Falanouc	<i>Eupleres goudotii</i>	NE
Western Falanouc	<i>Eupleres major</i>	NE
Fanaloka or Malagasy Civet	<i>Fossa fossana</i>	NT
Galidiinae		
Malagasy Ring-tailed Mongoose	<i>Galidia elegans</i>	LC
Broad-striped Mongoose	<i>Galidictis fasciata</i>	NT
Giant-striped Mongoose	<i>Galidictis grandidieri</i>	EN
Malagasy Narrow-striped Mongoose	<i>Mungotictis decemlineata</i>	VU
Brown-tailed Mongoose	<i>Salanoia concolor</i>	VU
Durrell's Mongoose	<i>Salanoia durrelli</i>	NE

English names for species and Red List categories follow IUCN (2010). EN = Endangered, NT = Near Threatened, VU = vulnerable, LC = Least Concern, NE = Not Evaluated. The Not Evaluated species comprise *E. major*, which has only lately been proposed as a species in its own right (Goodman & Helgen 2010) and thus by consequence the residual *E. goudotii*, and *S. durrelli*, recently described from the marshlands of Lac Alaotra (Durbin *et al.* 2010).

Table 2. Euplerid observations in Analamazaotra forest, Andasibe, Madagascar, 1992–2010.

Species	Month of observation	Season	Time of day
<i>Cryptoprocta ferox</i>	Oct 2000	dry	night
<i>Cryptoprocta ferox</i>	Oct 2010	dry	day
<i>Eupleres goudoti</i>	Apr 1993	dry	night
<i>Fossa fossana</i>	Sep 1992, May 1996, Aug 1996, Aug 1999	dry	night
<i>Fossa fossana</i>	Jan 2001, Nov 2007, Nov 2008, Mar 2009	wet	night
<i>Galidia elegans</i>	Mar 1994, Nov 2000, Jan 2001, Jan 2002, Feb 2002, Feb 2002, Jan 2003, Dec 2003, Feb 2004, Mar 2004, Mar 2005, Feb 2006, Dec 2007, Aug 2008, Mar 2008	wet	day
<i>Galidia elegans</i>	Apr 1995, Aug 1996, Oct 1999, Oct 1999, Oct 2000, Jul 2004, Sep 2004, Oct 2005, Jun 2009, Oct 2010	dry	day

Observations were defined as 'wet season' between November and March, and 'dry season' between April and October.

Table 3. Relative sighting frequency of euplerids in Analamazaotra (1992–2010) and Ranomafana (2007), Madagascar. Tabled values are number of observations (percentage).

Species	Analamazaotra ¹	Ranomafana ²
<i>Cryptoprocta ferox</i>	2 (5.6%)	63 (11.3%)
<i>Eupleres goudoti</i>	1 (2.8%)	0 (0)
<i>Fossa fossana</i>	8 (22.2%)	342 (61.5%)
<i>Galidia elegans</i>	25 (69.4%)	143 (25.7%)
<i>Galidictis fasciata</i>	0 (0%)	8 (1.5%)
Total	36 (100%)	556 (100%)

¹Data from this study; all observations are individual sightings.

²Data from Gerber *et al.* (2010); all observations are individual capture events (with one capture event defined as all photographs of that species taken by a camera trap within a 30-minute period).

ter, while in Analamazaotra observations were gathered across all months of the year. Still, Gerber *et al.* (2010) provide the only investigation of relative abundance of euplerids in a rainforest. In the following, sightings from Analamazaotra are therefore primarily compared with their findings from Ranomafana (Table 3).

While *G. elegans* is the most frequently seen species in Analamazaotra and accounts for more than two-thirds of all observations, it makes up about a quarter of all observations in Ranomafana. For *F. fossana*, the ratio is almost exactly reversed, accounting for about a quarter of observations in Analamazaotra, as opposed to more than two-thirds of observations in Ranomafana.

These differences may be explained by *G. elegans* being largely diurnal (Hawkins 2008a) and *F. fossana* strictly nocturnal (Hawkins 2008b). Since I walked the Analamazaotra road largely during the daytime or the early evening hours, diurnal species were likely to be encountered more often than nocturnal ones. In fact, all *G. elegans* observed in Analamazaotra were encountered during the daytime, whereas all *F. fossana* were seen after sunset (Table 2). The camera traps in the Ranomafana study (Gerber *et al.* 2010) were set to operate 24 hours per day, so are more likely to have documented nocturnal or cathemeral species as well.

This difference in methodology may also explain why the relative sighting frequency of the cathemeral (Hawkins 1998, Dollar 1999b) *C. ferox* in Analamazaotra was found to be only half of that in Ranomafana. In both sites, *C. ferox* was only the third most frequently seen euplerid species, which is most likely to be explained by its larger territorial requirements (and therefore lower population density) due to its strictly carnivorous top-predator trophic position.

The least frequently seen carnivore in Analamazaotra was *E. goudotii*, encountered just once in 19 years. Its elusiveness is reflected by Gerber *et al.* (2010) not finding it during 755 camera-trap days, although it inhabits the Ranomafana area (Dollar 1999a). Little is known about the biology of the species (e.g. Albignac 1974) or the factors explaining its apparent natural rarity.

Despite reported sightings of hunters of ‘vontsira fotsy’ in the wider Andasibe region (J. Rafalimandimby verbally 2005), I never encountered *Galidictis fasciata* in Analamazaotra. Again, this species is largely nocturnal (Goodman 2003) and therefore likely to be missed when not searched for at night. Even in Ranomafana, the species was found only very rarely (Gerber *et al.* 2010).

There is no large difference (sufficient to suggest seasonal suspension of activity) in the occurrence of observations between

Table 4. Snares found during regular patrols in Station Forestière Analamazaotra, Madagascar, 2001–2010.

Year	Number of snares
2001	12
2002	6
2003	2
2004	2
2005	1
2006	0
2007	0
2008	1
2009	0
2010	0

seasons. The number of observations per year increased during the survey period (Spearman’s rank correlation, $r_s = 0.43$, $P = 0.066$; Table 2). Observation effort was neither held constant nor measured over the years, but no strong directional trend in effort occurred over the years, despite some variation between years. Thus, the increase in sightings might be due to my increasing capacity to spot these animals with the years. Alternatively, it could also reflect a real increase of overall carnivore abundance in Analamazaotra due to more effective protection and a considerable decrease of snaring in these forests. Whereas some species of carnivores are considered ‘fady’ (taboo) in certain regions (Jones *et al.* 2008), almost all species are widely consumed in many rainforest areas to supplement local people’s diet (e.g. Golden 2009). Andasibe is no exception, and the Analamazaotra forest has traditionally been a target for people hunting with snares (‘fandrikan-dia’). The number of snares found during patrols decreased across years (Spearman’s rank correlation, $r_s = -0.818$, $P = 0.004$; Table 4), consistent with general perceptions of progressive reduction in snaring effort in the area during the period. This might have led to a relief of euplerids (the main targets of snaring) from hunting pressure.

The opportunistic way data were gathered in Analamazaotra allow only very rudimentary conclusions. Complementing these data by a more methodical approach (preferably camera-trapping) in the future would allow much more rigorous conclusions.

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