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A rapid assessment of the amphibians and reptiles of an unprotected area of dry deciduous forest in north Madagascar

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ABSTRACT — 24 species of amphibians and reptiles (1 crocodilian, 10 lizards, 9 snakes and 4 anurans) are recorded from an unprotected area of dry deciduous forest located west of the Montagne D'Ambre massif in northern Madagascar. Although the survey area is currently under threat from increasing anthropogenic activity (especially agricultural clearance and charcoal production which still require careful and continuous monitoring), the results of this rapid assessment conclude that this area does not contain any species that are in serious danger from a current conservation perspective. 22 species (91.7% of the total species) currently receive protection within Montagne D'Ambre National Park, Ankarana Special Reserve or Lokobe Strict Nature Reserve. Of the 2 remaining species (8.3% of the total species) that are not protected by these important biological refuges, one (*Hoplobatrachus tigerinus*) is not endemic to Madagascar and the second (*Madascincus intermedius*) is not endemic to the Region of Antsiranana. Both species appear to possess relatively widespread distributions across a range of different habitat types. This paper contributes to the current understanding of Malagasy patterns of biodiversity by documenting the composition, geographical and ecological distribution of the herpetofauna of an unprotected and hitherto unstudied site. It supports the theory that prior to human invasion continuous lowland corridors of dry or transitional forest linked the lower slopes of the five major massifs found in the north of the country.

THE amphibians and reptiles of Madagascar are extremely diverse and display a level of endemism surpassed only by that of the Caribbean and Meso-America (Myers *et al.*, 2000). Although the amount of information regarding Malagasy herpetofauna has increased dramatically over the past decade (Goodman & Benstead, 2003) further detailed surveys focusing on Malagasy amphibians and reptiles are still required. In particular the current information regarding non-protected areas and secondary habitats is extremely scarce (Andreone *et al.*, 2003) and must be targeted in order to ensure that informative conservation decisions are made. This paper is the second in a series of research articles (D'Cruze & Sabel, 2005) that contributes to the existing literature by highlighting the findings of a rapid biodiversity survey conducted in the north of Madagascar.

The herpetofauna in the extreme north of Madagascar is currently conserved by a network of protected areas consisting of Montagne D'Ambre National Park, Ankarana Special

Reserve and Analamera Special Reserve on the mainland and Lokobe Strict Nature Reserve located on Nosy Be (an island off north-west Madagascar). Of these four biological refuges, only the rainforest found within Lokobe and Montagne D'Ambre and the dry deciduous forest of Ankarana have been subject to in-depth biodiversity surveys that have resulted in published species lists (Andreone *et al.*, 2003; Raxworthy & Nussbaum, 1994; Hawkins *et al.*, 1990).

The intention of this study was to survey a previously undocumented area of low altitude dry deciduous forest located outside of these protected areas. Firstly, this survey would serve to identify any species that do not currently receive protection within these biological refuges and provide researchers with the opportunity to assess the current conservation threats that they might face. Secondly it was hoped that the information gathered would contribute to the existing literature regarding Malagasy patterns of biodiversity by documenting the composition, geographical and



Geckolepis maculata. Photograph © N.C. D'Cruze.

ecological distribution of any species encountered. Crucially this information can then be used in the assessment of future conservation priorities.

MATERIALS AND METHODS

Fieldwork was carried out by Frontier researchers over a period of approximately two weeks at the end of the dry season from the 26th October-6th November 2005. Unfortunately the area could not be surveyed during the wet season [when Malagasy herpetofauna is typically at its most active (Glaw & Vences, 1994)] as access to this area by road is made impossible as a result of the incredible amount of rainfall that occurs during this period. Photographic records (held by the first author) were compared with specimens housed at the University of Antananrivo and were also verified by Dr. A.P. Raselimanana. Frontier-Madagascar is an arm of the Society for Environmental Exploration, a UK based non-governmental organisation carrying out scientific and socio-economic survey work with a view to making informed conservation decisions. The main techniques used to survey the amphibians and reptiles were pitfall trapping and active searches. Three pitfall lines were utilised in an area of dry deciduous forest with traps placed into the ground at 10 m intervals with drift fences along a transect line measuring 100 m in length. Both diurnal and nocturnal active searches lasting approximately three hours in length were carried throughout the duration of the survey.



Blaesodactylus boivini. Photograph © N.C. D'Cruze.

Investigators searched under stones, amongst dead wood, and on tree trunks both day and night in order to gauge the diversity of the full complement of species.

Description of the survey area

The survey period concentrated on an area of land surrounding the village of Manondro with researchers operating from a base camp situated on the edge of a fast flowing stream at 12Y27.56'S 49Y01.29'E. Located within the commune of Andranofanjava, Manondro village is situated approximately 30 km southwest of Diego-Suarez, the administrative capital of the Antsiranana region in north Madagascar. The extent of this area is bounded by the Mozambique Channel to the west and the Montagne D'Ambre Massif to the east. Ankarana Special Reserve can be found approximately 50 km to the south east.

Climate — The study site is part of the Western Ecoregion defined by Cornet (1974) and is characterized by a reliable wet season that runs from November to March during which the majority of rainfall occurs. This period is followed by a distinct dry season that can last up to seven months during which rainfall is highly infrequent. The presence of flowing rivers and small lakes at the height of the dry season indicates that the mean annual precipitation of this location is most likely higher than the 980 mm received by Antsiranana, but not as high as the 2378 mm received by Montagne D'Ambre (Nicoll & Langrand, 1989).

Vegetation Types — The area immediately surrounding the study site at Manondro is a mosaic of dry deciduous forest, riparian vegetation and anthropogenically disturbed habitat. The areas of dry deciduous forest are typified by a dense assemblage of vegetation which results in a relatively pronounced layer of leaf litter. Within these areas smaller pockets of seasonal semi-evergreen vegetation (maximum canopy height of 35 m) and substantial areas filled by stands of bamboo are present which supports the hypothesis that this forest is semi-humid in nature as a result of the high annual precipitation that it receives. Due to the transitional nature of these areas and the difficulty of differentiating between them, this type of vegetation has been designated simply as dry deciduous forest. Found near to the permanent rivers and lakes, the areas of riparian vegetation are more verdant in appearance than the areas of dry deciduous forest and are typified by a variety of broadleaf trees and a much thinner layer of leaf litter. Lastly, the area is also characterised by the presence of several villages and cultivated land that constitute the commune of Andranofanjava. As a result substantial areas of both dry deciduous forest and riparian vegetation have been altered creating a third distinct habitat.

Microhabitats — Many microhabitats exist for the species found at this location. The vegetation offers a wide variety of arboreal niches that can be utilized by a large number of different species, such as those belonging to the genus *Furcifer* and *Ithycyphus*. The accompanying shrub layer also provides shelter for terrestrial species such as *Paroedura stumpffi*. A layer of leaf litter is present in the gallery forest in which fossorial species such as *Madascincus intermedius* occur and the surrounding rivers and small lakes provides a large body of water in which *Crocodylus niloticus* can be found.

RESULTS

Composition — A total of 24 different species were encountered during this study (see Table 1 for complete list including pitfall trap captures) and it is now known that the reptile fauna of this area consists of at least 1 species of crocodilian (4.2%), 10 species of lizard (41.7%), 9 snakes (37.5%) and 4 anurans (16.7%).

Primary habitat — With regards to primary habitat, 12 species (50%) were found to occur only in dry deciduous forest and 3 species (12.5%) were found solely in riparian areas (Table 1). 2 species (8.3%) were found to occur solely in anthropogenically disturbed areas. No species were encountered in both riparian areas and dry deciduous forest, 1 (4.2%) in both riparian forest and anthropogenically disturbed areas, 4 (16.7%) in both dry deciduous forest and anthropogenically disturbed areas and 2 (8.3%) in all three of the primary habitats.

Ecological distribution — In terms of vertical positioning within the primary habitat, 12 species (50%) were usually found only in terrestrial situations, 9 (37.5%) were typically found only in arboreal situations, and 1 (4.2%) were found in both (Table 1). Only 1 species the crocodilian *Crocodylus niloticus* was only observed in aquatic situations (4.2%).

Relative abundance — The 24 species recorded from the area are classified using a system similar to that used by Wilson & McCranie (2004) and can be summarized as follows: Abundant (large numbers encountered on a regular basis), common (encountered on a regular basis), infrequent (unpredictable, few individuals seen), or rare (rarely seen). These classifications are based on



Ithycyphus miniatus. Photograph © N.C. D'Cruze.



Top left: *Boophis tephraeomystax*. **Top right:** *Ptychadena mascareniensis*. **Centre left:** *Paroedura stumpffi*. **Centre right:** *Trachylepis elegans*. **Lower left:** *Phelsuma madagascariensis*. **Lower right:** *Alluaudina bellyi*. All photographs © N. C. D'Cruze.



Top: *Acrantophis madagascariensis*. **Centre left:** *Leioheterodon madagascariensis*. **Centre right:** *Madagascarophis colubrinus* (colour variant). **Lower left:** *Madagascarophis colubrinus*. **Lower right:** *Liophidium torquatum*. All photographs © N. C. D'Cruze.

Species	Primary Habitat	Ecological Distribution	Relative Abundance	Literature		
				Montagne D'Ambre National Park	Ankarana Special Reserve	Lokobe Strict Nature Reserve
REPTILIA						
Crocodylidae						
<i>Crocodylus niloticus</i>	RIP	A	I		+	
Chamaeleonidae						
<i>Furcifer oustaleti</i>	A, RIP	AB	C		+	
Gekkonidae						
<i>Blaesodactylus boivini</i>	DDF	AB	I		+	
<i>Gekkelepis maculata</i>	A, DDF	AB	C	+		+
<i>Paroedura stumpffii</i>	DDF	AB, T	I	+	+	+
<i>Phelsuma abbotti chekei</i>	A, DDF	AB	C		+	+
<i>Phelsuma madagascariensis grandis</i>	A, DDF, RIP	AB	C	+	+	+
<i>Lygodactylus</i> cf. <i>heterurus</i>	DDF	AB	I		+	+
Scincidae						
<i>Madascincus intermedius</i>	DDF	T	R			
<i>Trachylepis elegans</i>	A	T	A	+	+	
<i>Trachylepis tavaratra</i>	DDF	T	I	+	+	
Boidae						
<i>Acrantophis madagascariensis</i> *	RIP	T	R	+		
Colubridae						
<i>Alluaudina bellyi</i>	DDF	T	R	+		+
<i>Dromicodryas quadrilineatus</i>	A, DDF, RIP	T	C			+
<i>Ithycyphus miniatus</i>	RIP	AB	I			+
<i>Leioheterodon madagascariensis</i>	A, DDF	T	C	+	+	+
<i>Liophidium torquatum</i>	DDF	T	I	+	+	+
<i>Stenophis grammiceps</i>	DDF	AB	R			+
<i>Madagascarophis colubrinus</i>	DDF	T	C			+
<i>Mimophis mahfalensis</i>	A	T	C		+	
AMPHIBIA						
Mantellidae						
<i>Boophis tephraeomystax</i>	DDF	AB	I			+
<i>Mantidactylus</i> cf. <i>pseudoasper</i>	DDF	T	I	+		+
Ranidae						
<i>Hoplobatrachus tigerinus</i>	DDF	A	R			
<i>Ptychadena mascareniensis</i>	A, DDF	T	A	+		+

Table 1. Distribution of the amphibian and reptile species found during this survey. Abbreviations include: Primary Habitat- A = anthropogenically disturbed areas, DDF = dry deciduous forest, RIP = riparian areas; Ecological Distribution- A = aquatic, AB = arboreal, T = terrestrial; Relative Abundance- A = abundant, C = common, I = infrequent, R = rare; Literature- + = previously documented. Occurrence in Montagne D'Ambre is given according to Raxworthy & Nussbaum (1994), occurrence in Ankarana according to Hawkins *et al.* (1990), occurrence in Lokobe according to Andreone *et al.* (2003). *Listed as Vulnerable in the 2005 IUCN Red List of Threatened Species.



Mimophis mahfalensis. Photograph © N.C. D’Cruze.

data collected using both active searching and pitfall traps. 2 species (8.3%) were abundant, 8 (33.3%) were common, 9 (37.5%) were infrequent and 5 (20.8%) were rare (Table 1).

Pitfall trap results — The pitfall trap lines are characterized in Table 2. A total of 5 vertebrates were captured over 264 trap days, giving an overall vertebrate capture rate of just 1.9% per trap day. The number of individuals of each species caught by the trap lines is summarized in Table 3. The pitfalls caught 4 species of lizard but failed to produce any snake or anuran captures. These results are relatively poor in comparison with other similar studies (e.g. Raxworthy & Nussbaum, 1994) and are probably due to reduced activity during the dry season. *Gekkelepis maculata* was the most abundant species caught in the pitfall traps. This is interesting as this species was only observed in arboreal situations during active searches.

Literature summary — 15 of these 24 encountered species (62.5%) receive protection within Lokobe Strict Nature Reserve and 5 species (20.8 %) have

Line	Forest Type	Microhabitat	Latitude	Longitude	Altitude (masl)	Start date	Finish date	Days	Trap days	Capture rate %
1	Dry deciduous forest	Ridge	12°28.02'S	49°00.44'E	190	28.10.05	06.11.05	8	88	1.1
2	Dry deciduous forest	Slope	12°27.98'S	49°00.31'E	203	28.10.05	06.11.05	8	88	1.1
3	Dry deciduous forest	Valley	12°27.96'S	49°00.23'E	209	28.10.05	06.11.05	8	88	3.4

been previously recorded from Montagne D'Ambre National Park (Table 1). They can not be considered strictly rainforest species as they are also found in the three primary habitats detailed in this survey. An additional 6 species (25%) are currently protected in the dry deciduous forest of the nearby Ankarana Special Reserve and 12 species (50%) have been recorded from two or more of these protected areas. Therefore according to the current literature the 2 remaining species (8.3%) are not protected within the network of refuges in the north of Madagascar. However importantly, the anuran *Hoplobatrachus tigerinus* is not endemic to Madagascar and the skink *Madascincus intermedius* is not endemic to the region of Antsiranana. Both species possess relatively wide distributions across Madagascar throughout a range of different habitats and therefore appear to be in no immediate danger from extinction.

Significance of the survey

Patterns of biodiversity in northern Madagascar -

The disruptive anthropogenic activity that followed human invasion approximately 2000 years ago is believed to be largely responsible for the current distribution of amphibians and reptiles in Madagascar (Vallan, 2003). It has been suggested that prior to human invasion continuous lowland corridors of dry or transitional forest linked the lower slopes of the five major massifs of Analamera,

Table 2. Pitfall lines used to capture amphibians and reptiles (capture rate % is number of vertebrate individuals caught per trap day).

Ankarana, Daraina, Montagne D'Ambre and Montagne des Français located in the north. The current distribution of the skink *Trachylepis tavaratra* at all of these locations has been used as evidence to support this claim (Ramanamanjato *et. al.*, 1999). The results of this survey also support this theory as 25% of the species found in this lowland area of semi humid dry deciduous forest are found in both Montagne D'Ambre and Ankarana Special Reserve. These former corridors help to explain how these species were able to cross the distance (approx. 50 km) between these sites. We strongly suspect that further detailed surveys focussed on the remaining 3 massifs (for which detailed species lists do not currently exist) will result in patterns of distribution similar to that of *Trachylepis tavaratra* for a significant number of other robust species and will add further weight to this theory.

Species	Number of individuals captured		
	Pitfall line number		
	1	2	3
REPTILIA			
Gekkonidae			
<i>Geckolepis maculata</i>	1	1	
<i>Paroedura stumpffii</i>			1
Scincidae			
<i>Madascincus intermedius</i>			1
<i>Trachylepis tavaratra</i>			1
TOTAL	TOTAL	TOTAL	TOTAL
1	1	3	
% Capture rate	1.1	1.1	3.4

Table 3. Pitfall trap capture of amphibians and reptiles.



The subject of various Malagasy proverbs and taboos, local staff member Onjaniaina Cecilia Paulariot demonstrates that chameleons (these examples are *Furcifer oustaleti*) are fascinating organisms that require our protection. Photograph © Janine E. Robinson.

Current threats to conservation — The data collected in this study contributes to the current understanding regarding patterns of biodiversity of Malagasy herpetofauna by documenting the fauna of a specific site located outside the network of protected areas found in the north of Madagascar. In addition to Manondro village, this study area is characterized by the presence of several other villages that constitute the commune of Andranofanjava and thus is subject to numerous human-caused environmental problems. The major threats to the integrity of the reptile fauna of this area appear to be agricultural clearance, charcoal production and zebu grazing (during which sites are either selectively logged or cleared of all trees) which have resulted in the degradation of large areas of forest.

Despite the fact that this area currently receives no formal protection its herpetofauna remains relatively diverse as a total of 24 species were

encountered during this survey. We conclude that these species are in no immediate danger from a conservation perspective as 22 species are currently protected in Montagne D'Ambre National Park, Ankarana Special Reserve and Lokobe Strict Nature Reserve. The 2 remaining species that are not protected by these biological refuges are also not under serious threat as the existing literature suggests that they are either non-endemic or widespread species found across a range of different habitats. However, we suggest that the area still requires careful and continuous monitoring as 7 species (*Blaesodactylus boivini*, *Paroedura stumpffi*, *Phelsuma madagascariensis grandis*, *Lygodactylus* cf. *heterurus*, *Trachylepis tavaratra*, *Acrantophis madagascariensis* and *Alluaudina bellyi*) have restricted ranges in the north of Madagascar and 1 species (*Acrantophis madagascariensis*) is listed as vulnerable on the 2005 IUCN Red List of Threatened Species.

Future action

The reptile and amphibian rich fauna found in the north of Madagascar is already recognized as one of the more speciose regions of the biodiversity hotspot that is Madagascar (Goodman &

Benstead, 2003). Although a series of effective nature reserves currently exist in this region the majority of these protected areas have not been subject to surveys resulting in published species lists for over a decade or indeed at all. In addition several unprotected sites such as Montagne des Français and Daraina have been identified as threatened areas of high biodiversity that also require some form of protection (ANGAP, 2003; Glaw *et al.* 2005). We recommend that further biodiversity surveys focused on the composition, geographical and ecological distribution of the species found at these localities should be conducted to ensure that informed and effective conservation making decisions are made.

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