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## AMPHIBIANS AND REPTILES OF THE TSINGY DE BEMARAHA PLATEAU, WESTERN MADAGASCAR: CHECKLIST, BIOGEOGRAPHY AND CONSERVATION

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**Abstract.**—We surveyed the Tsingy de Bemaraha plateau in central-western Madagascar for amphibians and reptiles. We recorded 19 species of amphibians and 60 species of reptiles by opportunistic searching, bioacoustic identification (frogs), and pitfall trapping. Among the species recorded, 13% were previously unknown to science and a further 15% are of uncertain taxonomic status and possibly represent undescribed species. Of all the species recorded, 28% are endemic to the Bemaraha plateau and 48% appear to be dependent on forest habitat. Phylogenetic relationships of Bemaraha amphibians suggest a biogeographic link to eastern rainforests; whereas, those of reptiles demonstrate a link to the forests of northern Madagascar. We comment on former species records from the area and discuss conservation issues for amphibians and reptiles related to the habitat alteration observed in several parts of the protected area complex.

**Key Words.**—Amphibia; biogeography; checklist; conservation, endemism; Madagascar; Tsingy de Bemaraha; Reptilia.

**Résumé.**—Nous avons surveillé les amphibiens et les reptiles dans le plateau du Tsingy de Bemaraha dans le central-ouest de Madagascar. Nous avons recensé 19 espèces d'amphibiens et 60 espèces de reptiles par des recherches opportunistes, identification bioacoustique (amphibiens) et des piégeages par trous pièges. Parmi les espèces recensées, 13% sont auparavant inconnues par la science et plus de 15% ont des statuts taxonomiques incertains et sont possibles des espèces non-décrites. Vingt-huit pourcent de toutes les espèces recensées sont considérées pour représenter les endémicités à Bemaraha et 48% des espèces pourraient être dépendantes de l'habitat forestier. Les relations phylogénétiques des amphibiens de Bemaraha indiquent une continuité biogéographique aux forêts humides de l'Est et celles de reptiles une continuité aux forêts au nord de Madagascar. Nous avons fait des commentaires sur les espèces recensées auparavant dans la région et avons discuté à propos des actions de conservation des amphibiens et des reptiles reliées à l'altération des habitats observée dans certaines parties du complexe aire protégée.

**Mots Clés.**—Amphibiens; biogéographie; conservation; endémisme; liste; Madagascar; Tsingy de Bemaraha; Reptiles.

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### INTRODUCTION

The Tsingy de Bemaraha plateau is in the central-western part of Madagascar, in the province of Mahajanga, and its protected area complex covers 157,710 ha<sup>2</sup> (Rasoloarison and Paquier 2003). A limestone massif with steep slopes to the east primarily characterizes the protected area complex. The western part of the plateau presents a very ragged relief, largely covered by dense, dry deciduous forests. In its eastern parts, savannahs impinge on the forest habitats. Part of the reserve (72,340 hectares) earned national park status in August 1997 to promote the development of ecotourism (Plan de Gestion et de

Conservation 2002). The northern part of the protected area covers 85,370 ha<sup>2</sup> and is an Integral Natural Reserve (Réserve Naturelle Intégrale). The ANGAP (Association Nationale pour la Gestion des Aires Protégées) managed complex became a UNESCO World Heritage site in 1990 and National Cultural Heritage Site in 1991. ANGAP has recently been changed to MNP (Madagascar National Parks). For the purpose of this study, we use the term 'Bemaraha' to refer to habitats on karst formations within the national park, integral natural reserve, or on the boundary. It is difficult to access, especially during the wet season and from the rugged karstic relief, and this affords some protection from human

TABLE 1. Sites of the Bemaraha area, western Madagascar, investigated for this study in 2006.

Site	Coordinates	Altitude (m a.s.l.)	Survey team	Survey dates	Habitat description
S1: Antsalova	S18°40'54'' E044°37'33''	103	Team 2	15-17 March and 2-4 April	Mango-trees, banana plants and rice fields
S2: Andranopasazy	S18°42'31'' E044°43'02''	146	Team 1 Team 2	13-30 January 17-23 March	Dry dense deciduous forest with selective felling trees
S3: Andafiabe	S18°47'03'' E044°46'46''	177	Team 2	24-25 March and 31 March - 1 April	Forest dense sub-humid and boasts vegetation on sand and on tsingy formation along the Beboka River
S4: Bendrao	S18°47'50'' E044°51'37''	427	Team 1 Team 2	26 February - 7 March 25-31 March	Dry dense deciduous forest including savannah formations with scattered trees and limestone caves
S5: Ankily	S18°40'15'' E044°46'86''	286	Team 1	5-14 February	Dry and deciduous primary forest with vegetation on tsingy
S6: Anjaha	S18°39'43'' E044°49'33''	403	Team 1	15-24 February	Dry deciduous disturbed forest
S7: Ankazomanga	S18°44'14'' E044°54'89''	571	Team 1	8-17 March	Dry dense deciduous forest on tsingy rocks and highly disturbed outside of the park
S8: Ranotsara	S19°02'08'' E044°46'29''	65	Team 1	16-26 November	Dry deciduous forest on tsingy inside of park
S9 : Ankilogo	S19°07'52'' E044°48'32''	57	Team 1	6-15 December	Dry deciduous forest, vegetation on tsingy, including savannah trees
S10: Andolombazimba	S19°08'25'' E044°49'42''	59	Team 1	27 November - 6 December	Dry deciduous forest, vegetation on tsingy and wooded savannahs and/or savannah grassland

activities. Nevertheless, there is growing pressure on the forest from local farming communities for new land, grazing areas, and forest products.

Bemaraha contains a diversity of natural habitats that constitute various ecosystems, including deciduous dry forest, xerophytic shrublands, sub-humid forest, swamps, and savannah. This area is important for a range of mammal species, including the endemic lemur *Avahi cleesei* (Goodman and Schütz 2003; Goodman et al. 2005a, b; Thalmann and Geissmann 2005). Furthermore, a recent analysis of multi-taxa distribution (Kremen et al. 2008) identified the eastern parts of Bemaraha as an area of high conservation priority.

Bemaraha has a rich fauna and the earliest herpetological record known from the area is the spectacular Antsingy Leaf chameleon, *Brookesia perarmata* (Angel 1933). More recently, herpetological expeditions to the area revealed several previously undescribed species, most of which are endemic to the plateau (e.g., Schimmenti and Jesu 1996; Jesu et al. 1999; Nussbaum et al. 1999; Raselimanana et al. 2000; Vences et al. 2000). In addition, several brief reports on other species are available, but these mainly refer to only a few single sites within the area (Emanueli and Jesu 1995; Schimmenti and Jesu 1997; Hallmann et al. 1999). Very recently, Raselimanana (2008) published a comprehensive species list of many forests in western Madagascar, including Tsingy de Bemaraha. Despite these considerable efforts, no comprehensive assessment of the area's importance for endemic herpetofauna exists.

This contribution provides the first comprehensive species assessment of amphibians and reptiles of the Tsingy de Bemaraha plateau, and provides a list of

voucher specimens to allow future verification of species' identities. It covers the northern and southern part of the national park and includes an evaluation of species richness, endemism, biogeographical affinities, and conservation.

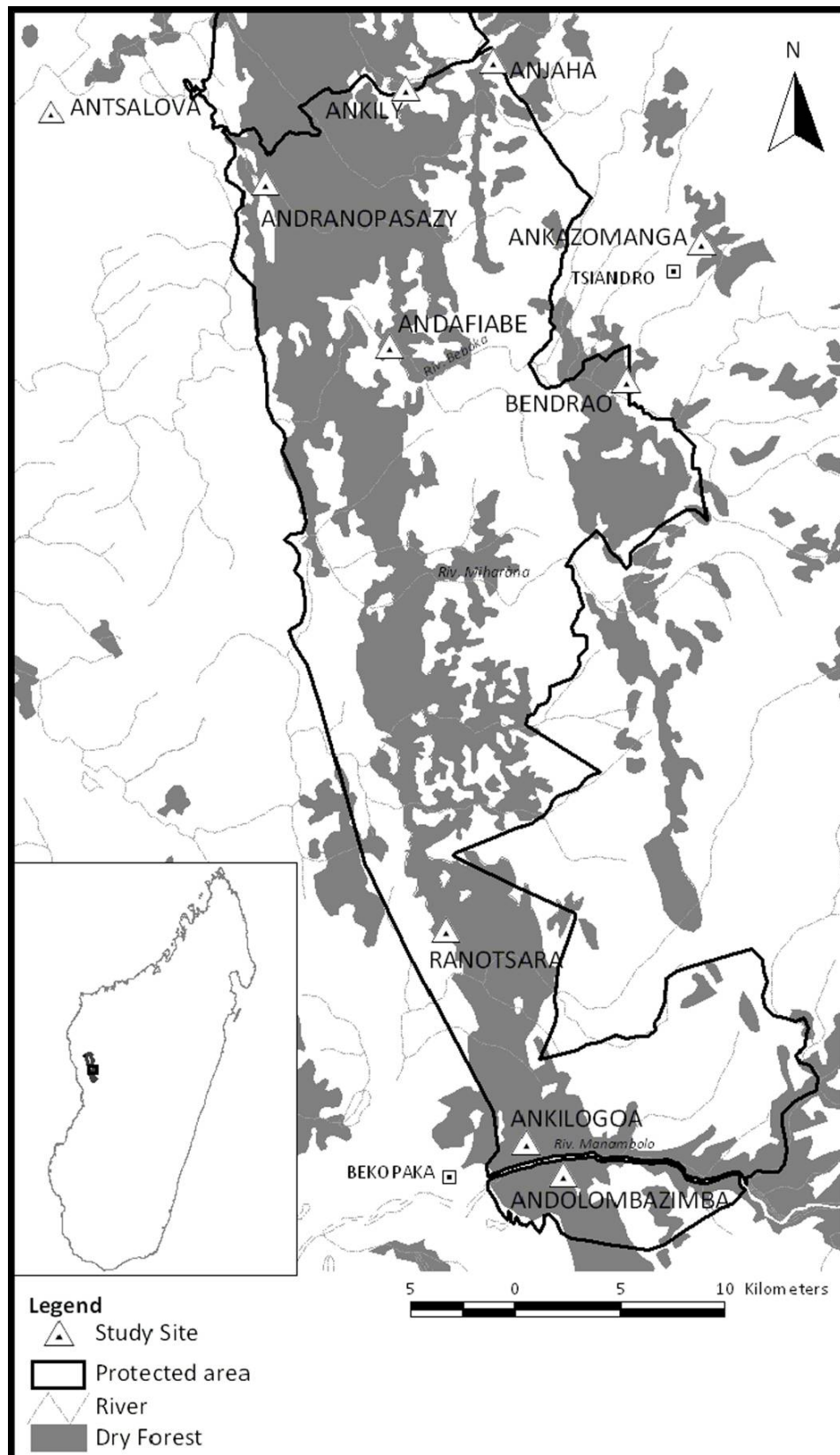
## MATERIALS AND METHODS

**Study sites.**—Two different teams of investigators carried out the field work. We investigated 10 sites during the rainy seasons of 2006 (Fig. 1; Table 1)

**Survey methods.**—*Opportunistic searching:* Reptiles and amphibians were surveyed along transects or trails, streams and rivers, around ponds, within caves, and within the forest during day and night using headlamps and hand torches (flashlights with batteries). Each team used broadly the same search techniques with a day-search typically consisting of 4 diurnal hours and 3–5 hours during the night.

*Drift fencing and pitfall trapping:* Lines of at least 10 plastic buckets each with a plastic sheeting drift fence approximately 100 m long were used at each site (except Antsalova). We oriented lines in parallel and approximately 150–300 m apart. We distributed lines among representative habitats within the forest and they were usually placed at the apex, on, and at the base of slopes.

*Bioacoustic identification:* We occasionally recorded anuran calls and compared these to known calls (Vences et al. 2006) to identify frog species present. Although we made an effort to collect vouchers for all species, we could only identify some frog species at specific locations by their call.



**FIGURE 1.** Schematic map of the southern portion of the Tsingy de Bemaraha area, western Madagascar, with the names of survey sites: Antsalova (S1); Andranopasazy (S2); Andafiabe (S3); Bendrao Forest (S4); Ankily (S5); Anjaha (S6); Ankazomanga (S7); Ranotsara (S8); Ankilogo (S9); Andolombazimba (S10).

**Voucher specimens.**—We euthanized voucher specimens with chlorobutanol solution, fixed them in 90% ethanol or 4% formalin solution, and we stored specimens in 70% ethanol. We deposited vouchers (Appendix I) in the Université d'Antananarivo, Département de Biologie Animale (UADBA) and the Zoologische Staatssammlung München (ZSM). A few reptile species were recorded by photo vouchers only (Fig. 2), without collected specimens being available. The nomenclature and order of species in tables largely follows Glaw and Vences (2007).

**RESULTS**

We recorded 19 amphibian and 60 reptile species for a total herpetofaunal diversity of 79 species (Tables 2–5; Fig. 2) for the area. The herpetofauna consisted of 19 anuran (24%), 43 lizard (54%) and 17 snake species (22%). Despite intensive surveys, we were not able to discover all species of amphibians and reptiles previously reported from the area, meaning that our results probably represent a minimum value of species richness for the area (see also Discussion). Among the species recorded, 10 (13%) were previously unknown to science and a further 12 (15%) are of uncertain taxonomic status and possibly represent undescribed species. In total, approximately 22 species (28%) are only known from the Tsingy de Bemaraha protected area complex and are therefore considered local endemics.

**DISCUSSION**

**Species-richness.**—With only 19 species, the amphibian fauna of Bemaraha appears depauperate when compared to the rainforests in northern and eastern Madagascar. Amphibian species richness in Bemaraha is comparable to western and northern dry

regions, although slightly higher. For example, Glos (2003) recorded only 15 species from the Kirindy dry forest further south; whereas, Mori et al. (2006) and D'Cruze et al. (2007) found only nine species of frogs at Parc National d'Ankarafantsika and Montagne des Français, respectively. Raselimanana (2008) recorded 17 anuran species from Bemaraha and 2–14 species from 16 other western and southern forests. In comparison with other western sites, the number of recorded reptile species from Bemaraha is higher than in Parc National d'Ankarafantsika (Ramanamanjato and Rabibisoa 2002; Mori et al. 2006; Raselimanana, 2008), but lower than reported from the Kirindy dry forest (Bloxam et al. 1996; Appendix II). Raselimanana (2008) recorded 54 reptile species from Bemaraha, 58 from Foret de Mikea, and 15–53 from 15 other western and southern forests. Although his surveys revealed slightly fewer amphibian and reptile species than our survey, he recorded several additional species, indicating that the species richness in Bemaraha is significantly higher than in any other dry forest site.

**Taxonomy and local endemism.**—Apart from those relatively widespread anurans occurring in the dry western parts of Madagascar (e.g., *Heterixalus luteostriatus*, *Dyscophus insularis*, *Aglyptodactylus securifer*, *Laliostoma labrosum*, *Boophis doulioti*, *B. occidentalis*, *Mantella betsileo*, *Ptychadena mascareniensis*), the records from Bemaraha include some remarkable findings. The Recently described species *Plethodontohyla fonetana* and *Boophis tampoka* are both endemic to the Bemaraha plateau, although their closest relatives are congeners from the eastern rainforests (Glaw et al. 2007; Köhler et al. 2007).

*Gephyromantis* sp. (aff. *corvus*) represents another undescribed, potentially endemic taxon (currently

**TABLE 2.** List of amphibian species recorded from the different study sites in the Bemaraha area, western Madagascar. The following abbreviations indicate studied sites within the Bemaraha area (+ = confirmed presence of species; – = no record): S1 = Antsalova; S2 = Andranopasazy; S3 = Andafiabe; S4 = Bendrao Forest; S5 = Ankily; S6 = Anjaha; S7 = Ankazomanga; S8 = Ranotsara; S9 = Ankilogo; S10 = Andolombazimba. \*Exact locality for *Rhombophryne* sp. provided by Andreone and Randrianirina (2008) as Andamozavaky (19°01.86'S, 44°46.80'E, 122 m a.s.l.).

Species	Study site									
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
<i>Ptychadena mascareniensis</i>	–	+	+	+	–	–	–	–	–	–
<i>Heterixalus carbonei</i>	–	+	–	–	–	–	–	–	–	–
<i>Heterixalus luteostriatus</i>	–	+	–	–	–	–	–	–	–	–
<i>Dyscophus insularis</i>	–	–	–	+	–	–	+	–	+	–
<i>Plethodontohyla fonetana</i>	–	–	–	+	–	–	–	–	–	–
<i>Rhombophryne</i> sp.*	–	–	–	–	–	–	–	+	–	–
<i>Scaphiophryne</i> sp. (aff. <i>calcarata</i> )	–	–	–	–	–	+	–	–	+	+
<i>Scaphiophryne menabensis</i>	–	+	–	+	–	+	–	–	–	–
<i>Stumpffia</i> sp. (aff. <i>helenae</i> )	–	+	–	+	–	–	–	+	+	+
<i>Aglyptodactylus securifer</i>	–	+	–	+	+	–	–	+	+	–
<i>Laliostoma labrosum</i>	+	+	+	+	–	+	+	–	+	+
<i>Boophis doulioti</i>	+	+	+	+	–	–	+	+	+	+
<i>Boophis occidentalis</i>	–	+	–	–	+	–	–	–	–	–
<i>Boophis tampoka</i>	–	–	+	+	–	+	–	–	–	–
<i>Blommersia</i> sp. (aff. <i>wittei</i> )	–	+	–	+	–	–	–	–	+	–
<i>Gephyromantis</i> sp. (aff. <i>corvus</i> )	–	+	–	+	+	+	–	+	+	–
<i>Mantella betsileo</i>	–	+	–	–	–	–	–	–	–	–
<i>Mantella</i> sp. (aff. <i>expectata</i> )	–	+	–	+	–	–	–	+	–	–
<i>Mantidactylus</i> sp. (aff. <i>ulcerosus</i> )	–	+	+	+	–	+	–	–	–	–



**FIGURE 2.** Unvouchered species that we recorded during the survey of Bemaraha National Park, western Madagascar: (A) *Trachylepis elegans*, (B) *Furcifer* cf. *petteri*, (C) *Zonosaurus karsteni*, (D) *Leioheterodon modestus*. (Photographed by C. Randrianantoandro).

being studied by F. Andreone, Museo Regionale di Scienze Naturali, Torino, Italy). The status of two other species requires clarification. Molecular studies suggest that the *Stumpffia* sp. from our study is closely related to *S. helenae* from Réserve Spéciale d'Ambohitantely but may warrant species status (Wollenberg et al. 2008). Similarly, the species status of *Mantella* sp. (aff. *expectata*) requires evaluation, although genetic studies suggest two different syntopic haplotype lineages at Andranopasazy, which include *Mantella betsileo* and *Mantella* sp. (aff. *expectata*; Rabemananjara et al. 2007). In contrast, the status of two other taxa is fairly clear: *Blommersia* sp. (aff. *wittei*) is an undescribed species distributed in western Madagascar that will be subject to a forthcoming study and *Mantidactylus* sp. (aff. *ulcerosus*) represents a new species known also from Parc National d'Isalo (Glaw and Vences 2007:232), currently being studied by Aumüller et al. (in prep.). In addition to our records, Andreone and Randrianirina (2008) reported a species of *Rhombophryne* from the Bekopaka commune, a further potential endemic of Bemaraha. Summarizing, five amphibian species appear to represent endemics of the Bemaraha plateau.

Among the reptiles, at least three species are new to science. The recently described snake *Thamnosophis mavotenda* is morphologically similar to *T. martae* from northern Madagascar, but differs in aspects of coloration and in the sequences of mitochondrial genes

(Glaw et al. 2009b). *Paroedura* sp. (aff. *tanjaka*) superficially resembles small individuals of *P. tanjaka*, but distinctly differentiated genetically (Jackman et al. 2008). *Phelsuma borai*, a new cryptically colored and recently described species (Glaw et al. 2009a), occurs in Bemaraha and apparently also in the Parc National d'Ankarafantsika (Mori et al. 2006, as *P. mutabilis*). Both, *Thamnosophis mavotenda* and *Paroedura* sp. (aff. *tanjaka*) are potential endemics to Bemaraha. Other candidates for undescribed endemic species are two species of *Amphiglossus* and two species of *Typhlops*, which are also in need of further study. The same might be true for the genus *Geckolepis*, which is in urgent need of revision. Although we have possibly collected more than one species in Bemaraha, we prefer to consider them tentatively all as *Geckolepis* sp., which is also consistent with preliminary molecular data. We collected a single, likely undescribed, specimen of *Lygodactylus* sp., possibly related to *L. madagascariensis*, from the northern rainforests. A number of additional species are of uncertain taxonomic status and could include new locally endemic taxa: *Uroplatus* cf. *ebenau*, *Uroplatus* cf. *henkeli*, *Paroedura* cf. *homalorhina*, *Madascincus* cf. *intermedius*, *Zonosaurus* cf. *madagascariensis*, and *Furcifer* cf. *petteri*. Clarification of their taxonomic status will be subject to future studies. Apart from some taxonomic novelties and some taxonomic uncertainty, the

**TABLE 3.** List of snake species recorded from the different study sites in the Bemaraha area, western Madagascar. The following abbreviations indicate studied sites within the Bemaraha area (+ = confirmed presence of species; – = no record): S1 = Antsalova; S2 = Andranopasazy; S3 = Andafiabe; S4 = Bendrao Forest; S5 = Ankily; S6 = Anjaha; S7 = Ankazomanga; S8 = Ranotsara; S9 = Ankilogo; S10 = Andolombazimba. \*Photo voucher only.

Species	Study sites									
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
<i>Acrantophis madagascariensis</i>	–	–	–	+	–	–	–	–	–	–
<i>Sanzinia madagascariensis voluntary</i>	–	+	–	+	–	–	–	–	–	–
<i>Alluaudina bellyi</i>	–	–	–	+	–	–	–	–	–	–
<i>Dromicodryas bernieri</i>	–	–	–	+	–	–	–	–	–	–
<i>Heteroliodon lava</i>	–	+	–	–	–	–	–	–	+	+
<i>Langaha madagascariensis</i>	–	–	–	–	–	–	–	+	–	–
<i>Leioheterodon madagascariensis</i> *	–	+	+	+	+	+	–	+	–	–
<i>Leioheterodon modestus</i>	–	–	–	–	–	–	–	+	–	–
<i>Liophidium torquatum</i>	–	–	–	–	–	–	–	+	+	–
<i>Madagascarophis colubrinus</i>	–	+	–	–	–	–	–	–	–	–
<i>Mimophis mahfalensis</i>	–	+	–	–	–	–	–	–	–	–
<i>Stenophis citrinus</i>	–	+	–	–	–	–	–	–	+	–
<i>Stenophis pseudogranuliceps</i>	–	–	–	+	–	–	+	–	+	–
<i>Stenophis cf. variabilis</i>	–	+	–	–	–	–	+	–	+	–
<i>Thamnosophis mavotenda</i>	–	–	–	+	–	–	–	–	–	–
<i>Typhlops</i> sp. 1 (aff. <i>arenarius</i> )	–	–	–	+	–	–	–	+	–	–
<i>Typhlops</i> sp. 2	–	–	–	–	–	+	–	–	+	–

following species are considered local endemics of the Bemaraha plateau: *Lygodactylus klemmeri*, *Trachylepis volamenaloha*, *Brookesia exarmata*, and *B. perarmata*.

**Species recorded by previous surveys.**—Previous publications (Hallmann et al. 1999; Blommers-Schlösser and Blanc 1991; Emanuelli and Jesu 1995; Schimmenti and Jesu 1997) recorded species that we did not find during our surveys. This is partly due to recent taxonomic changes: *Aglyptodactylus madagascariensis* is now *A. securifer* (Glaw et al. 1998), *Boophis albilabris* is now *B. occidentalis* (Andreone et al. 2002), *Boophis tephraeomystax* is now *B. doulioti* (Vences and Glaw 2002), *Brookesia ebenau* is now *B. brygooi* (Raxworthy and Nussbaum 1995), *Furcifer verrucosus* is now *F. nicosiai* (Jesu et

al. 1999), *Heterixalus betsileo* is now *H. carbonei* (Vences et al. 2000), *Langaha nasuta* is now *L. madagascariensis* (Anonymous 1987), *Paroedura bastardi* is now *P. sp. aff. tanjaka* (this study), and *Scaphiophryne marmorata* is now *S. menabensis* (Glos et al. 2005). In other cases, misidentifications are quite likely (e.g., in the cases of *Brookesia bonsi*, *Pelusios subniger*, *Mantidactylus biporus*, *M. curtus*, *M. granulatus*, *M. luteus*, and *M. ulcerosus*). All of these species are unlikely to occur in Bemaraha, but no attempt was made to re-identify the corresponding voucher specimens. Finally, we have been unable to confirm older records for *Crocodylus niloticus*, *Pelomedusa subrufa*, *Dromicodryas quadrilineatus*, *Heterixalus tricolor*, *Phelsuma lineata*, *Erymnochelys madagascariensis* (being frequently attributed to Bemaraha on many websites), and *Zonosaurus*

**TABLE 4.** List of gecko species recorded from the different study sites in the Bemaraha area, western Madagascar. The following abbreviations indicate studied sites within the Bemaraha area (+ = confirmed presence of species; – = no record): S1 = Antsalova; S2 = Andranopasazy; S3 = Andafiabe; S4 = Bendrao Forest; S5 = Ankily; S6 = Anjaha; S7 = Ankazomanga; S8 = Ranotsara; S9 = Ankilogo; S10 = Andolombazimba.

Species	Study sites									
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
<i>Blaesodactylus sakalava</i>	–	+	–	–	–	–	+	–	–	–
<i>Geckolepis</i> sp.	–	+	–	+	–	–	–	+	+	–
<i>Hemidactylus frenatus</i>	+	–	–	–	–	–	–	–	–	–
<i>Hemidactylus mercatorius</i>	–	–	–	–	–	+	–	–	+	–
<i>Lygodactylus heterurus</i>	–	+	+	+	–	–	–	+	+	–
<i>Lygodactylus klemmeri</i>	–	+	–	–	–	–	–	–	+	–
<i>Lygodactylus tolampyae</i>	–	+	–	+	+	–	–	+	+	–
<i>Lygodactylus</i> sp.	–	–	–	+	–	–	–	–	–	–
<i>Paragehyra cf. petiti</i>	–	–	–	–	–	–	–	+	–	–
<i>Paroedura cf. homalorhina</i>	+	+	–	+	–	–	–	–	–	–
<i>Paroedura tanjaka</i>	–	+	+	–	–	+	–	+	+	+
<i>Paroedura</i> sp. (aff. <i>tanjaka</i> )	–	–	+	–	–	–	–	–	–	–
<i>Phelsuma abbotti chekei</i>	–	+	+	–	+	+	–	–	+	–
<i>Phelsuma dubia</i>	+	–	–	–	–	–	–	–	–	–
<i>Phelsuma kochi</i>	–	+	+	–	–	+	–	+	+	–
<i>Phelsuma mutabilis</i>	+	–	–	–	–	–	–	–	–	–
<i>Phelsuma borai</i>	–	–	+	–	–	–	–	–	–	–
<i>Uroplatus cf. ebenau</i>	–	–	–	+	–	–	–	–	–	–
<i>Uroplatus guentheri</i>	–	–	–	–	–	–	–	+	+	–
<i>Uroplatus cf. henkeli</i>	–	+	+	+	+	–	–	–	–	–

# Herpetological Conservation and Biology

**TABLE 5.** List of lizard species (except gekkonids) recorded from the different study sites in the Bemaraha area, western Madagascar. The following abbreviations indicate studied sites within the Bemaraha area (+ = confirmed presence of species; - = no record): S1 = Antsalova; S2 = Andranopasazy; S3 = Andafiabe; S4 = Bendrao Forest; S5 = Ankily; S6 = Anjaha; S7 = Ankazomanga; S8 = Ranotsara; S9 = Ankilogo; S10 = Andolombazimba.

Species	Study sites									
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
<i>Amphiglossus reticulatus</i>	-	+	-	-	-	+	-	-	-	-
<i>Amphiglossus splendidus</i>	-	-	-	-	-	-	-	+	+	+
<i>Amphiglossus</i> sp.1	-	-	-	-	-	+	-	+	-	-
<i>Amphiglossus</i> sp.2	-	-	-	-	-	+	-	-	-	+
<i>Madascincus</i> cf. <i>intermedius</i>	-	-	-	-	-	+	-	+	+	-
<i>Trachylepis</i> cf. <i>dumasi</i>	-	+	-	-	-	-	-	-	+	-
<i>Trachylepis elegans</i> (photo voucher only)	-	-	-	-	-	-	-	-	-	+
<i>Trachylepis gravenhorstii</i>	-	-	-	-	-	+	-	-	+	-
<i>Trachylepis tandrefana</i>	+	+	-	-	+	-	-	+	+	-
<i>Trachylepis volamenaloha</i>	-	+	+	+	-	+	-	+	+	-
<i>Brookesia brygooi</i>	-	+	-	+	+	+	+	+	+	-
<i>Brookesia exarmata</i>	-	+	-	+	+	+	+	+	+	-
<i>Brookesia perarmata</i>	-	+	-	+	+	+	-	-	-	-
<i>Furcifer lateralis</i>	-	-	-	-	-	-	-	-	+	-
<i>Furcifer nicostai</i>	+	+	-	+	+	+	+	+	+	+
<i>Furcifer</i> cf. <i>petteri</i> (photo voucher only)	-	-	-	+	-	-	-	-	-	-
<i>Furcifer oustaleti</i>	+	+	-	+	-	-	+	-	+	+
<i>Zonosaurus bemaraha</i>	-	+	-	-	+	+	-	-	-	-
<i>Zonosaurus karsteni</i> (photo voucher only)	-	-	-	-	-	-	-	-	+	-
<i>Zonosaurus laticaudatus</i>	-	+	-	-	-	-	-	+	+	+
<i>Zonosaurus</i> cf. <i>madagascariensis</i>	-	-	-	+	-	-	-	-	-	-
<i>Chalarodon madagascarensis</i>	+	-	-	-	-	-	-	-	-	-
<i>Oplurus cuvieri</i>	+	+	+	-	-	-	-	-	+	+

*maramaintso*, which was recently described from the "Antsalova region" (Raselimanana et al. 2006). Most of these species likely occur in Bemaraha but require confirmation. A recent record of an apparently undescribed *Rhombophryne* species that resembles *R. coudreaui* from northeastern Madagascar (Andreone and Randrianirina 2008) highlights the incompleteness of our survey and the current knowledge of the herpetofauna of Bemaraha. This is even more true for the recent records provided by Raselimanana (2008), who identified three additional amphibian species (*Heterixalus betsileo*, *Aglyptodactylus laticeps* and *Scaphiophryne brevis*). Although the record of *H. betsileo* is likely to refer to *H. carbonei* (see above), the two other records indicate that at least 21 amphibian species occur at Bemaraha. Raselimanana (2008) also recorded a number of additional reptile species. Although differences in the use of nomenclature does not allow us to interpret all of these records reliably, at least *Paroedura stumpffi*, *Paroedura karstophila*, *Amphiglossus ornaticeps*, *Compsophis albiventris*, *Liopholidophis doliocercus*, *Liopholidophis lateralis* and *Pseudoxyrhopus kely* are likely to refer to species not recorded by us and might elevate the number of reptile species known from Bemaraha to almost 70 species.

**Range extensions.**—Several species encountered during this study require particular mention as their occurrence in Bemaraha significantly contributes to the current information regarding their distribution in Madagascar. Apart from the need to clarify the taxonomic status of *Furcifer* cf. *petteri*, *Paroedura* cf. *homalorhina*, *Uroplatus* cf. *ebenai* and *U.* cf. *henkeli*, the Bemaraha populations of these taxa constitute by

far the southernmost records (see Glaw and Vences 2007). The same is true for *Lygodactylus heterurus*, *Amphiglossus reticulatus* and *Alluaudina bellyi*, formerly known only from more northern localities. Moreover, Bemaraha is the southernmost confirmed locality of *Phelsuma dubia* in western Madagascar, the north-westernmost locality for *Amphiglossus splendidus* and *Boophis occidentalis*, and the westernmost locality for *Liophidium torquatum*.

**Habitat use.**—With regards to habitat, 38 species (48%) were observed in forest only; whereas, 18 species (23 %) were apparently dependent on forest structures, but also occurred in heavily disturbed forests or at forest edges. We observed 23 species (29%) that were restricted to open savannah habitat or strongly degraded bushy areas. Some terrestrial anuran species show a degree of adaptation to the tsingy limestone habitat by exhibiting well-expanded finger discs, which might support climbing ability on rock surfaces (*Plethodontohyla fonetana*, *Stumpffia* sp., *Gephyromantis* sp.). *Gephyromantis* sp. and *Plethodontohyla fonetana* were discovered at night sitting on tsingy rocks; whereas, *Stumpffia* sp. seems to occur exclusively in caves and deep clefts within tsingy formations in forest areas. Exclusive occurrence in caves was observed for *Paroedura* cf. *homalorhina*.

**Biogeography.**—As already emphasized by Glaw et al. (2007) and Köhler et al. (2007), the Bemaraha plateau is remarkable for its biogeographic relationship to eastern Madagascar. Recently described *Boophis tampoka* and *Plethodontohyla fonetana* both have their closest relatives in the humid

eastern rainforests. Formerly, only species that were not dependent on relatively intact forest habitats demonstrated an east-west relationship of species pairs (e.g., Vences et al. 2000; Vences and Glaw 2002; Glos et al. 2005). By contrast, *B. tampoka* and *P. fonetana* and their relatives are closely associated with forest habitats. Köhler et al. (2007) proposed that remnants of gallery forest are important habitats for dispersal because recurrent expansion of humid forest into western Madagascar by repeated climate change events probably triggered respective distribution patterns. A similar scenario may explain the species pair *Stumpffia helenae* (known from Réserve Spéciale d'Ambohitantely) and *Stumpffia* sp. (aff. *helenae*).

The reptile fauna of Bemaraha shows certain affinities to the Sambirano domain in northern Madagascar. This affinity is indicated by the presence of *Alluaudina bellyi*, *Amphiglossus reticulatus*, *Heteroliodon lava*, *Lygodactylus heterurus*, and some nominal taxa with populations of uncertain status (e.g., *Furcifer* cf. *petteri*, *Lygodactylus* sp., *Paroedura* cf. *homalorhina*, *Uroplatus* cf. *ebenau* and *U.* cf. *henkeli*). Furthermore, *Thamnosophis mavotenda* has its closest relative in northernmost Madagascar (Glaw et al. 2009b).

Summarizing, the Bemaraha herpetofauna is characterized by: (1) high local amphibian endemism with close relationships to eastern rainforest areas; (2) a reptile fauna with close relationships to the Sambirano region in northern Madagascar; (3) northern forest reptiles that reach their southernmost distribution limit in the Bemaraha region; and (4) widespread amphibian and reptile species from western Madagascar. The varied topography and climate of the Bemaraha plateau enables the existence of forest species during drier periods in western Madagascar. The humid microclimate within limestone caves and deep clefts were probably crucial for their survival and to some extent characterize the Bemaraha plateau as a refuge during climate change events.

**Conservation.**—With a remarkable number of restricted-range species found only in the forest of Bemaraha, the protected area complex and surrounding forest habitats must be key sites for herpetofaunal conservation in western Madagascar. Many areas in the Integral Natural Reserve are difficult to patrol because of security problems, and the forests in this area are not well-protected or surveyed. Further south in the national park, the periphery of the forest and areas near to human settlements or thoroughfares receive sustained degradation because of the demand for new agricultural land, cattle grazing, and wood. The loss of habitat constitutes a major threat to Malagasy amphibians (Andreone et al. 2008) and likely to reptiles also. Many of the park's endemic species have very specific microhabitat requirements or only occur in a small area. This places them at a

disproportionate risk from changes to the forest. Locally endemic forest species (e.g., *Boophis tampoka*, *Plethodontohyla fonetana*, *Stumpffia* sp. (aff. *helenae*), *Brookesia exarmata*, *B. perarmata*, *Uroplatus* cf. *henkeli*, *Paroedura* sp. (aff. *tanjaka*), *Trachylepis volamenaloha*, *Thamnosophis mavotenda*) may thus be seriously threatened.

Conversely, the occurrence of reproductively active *Brookesia brygoi*, *B. exarmata*, and *B. perarmata* in moderately disturbed forest at Bendrao (Randrianantoandro et al. 2007; 2008) leads to many ecological and conservation-relevant questions. The Bemaraha plateau contains vast areas of difficult-to-access habitat, so the disturbance observed at our study sites may not represent the condition of the whole area. Nevertheless, the persistence of a mixture of diversified microhabitats such as the tsingy, caverns, and caves within dry and sub-humid forests are an essential precondition for the survival of Bemaraha's amphibians and reptiles.

This survey of the Bemaraha herpetofauna has led us to preliminary recommendations for its conservation within this unique area: (1) The forest remnants of Anjaha and Ankazomanga (S6 and S7) should be included in the protected area complex; (2) Further herpetofaunal surveys need to be conducted, especially in the centre of the national park and in the Réserve Naturelle Intégrale; (3) There should be further assessment and monitoring of natural resource-use activities; and (4) Intensified patrols in the existing protected areas need to occur by ANGAP (MNP) officials to trace illegal practices (e.g., cattle browsing, slash-and-burn practice, lemur trapping) and these activities need to be reduced more efficiently.

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LITERATURE CITED

- Andreone, F., A.I. Carpenter, N. Cox, L. du Preez, K. Freeman, S. Furrer, G. Garcia, F. Glaw, J. Glos, D. Knox, J. Köhler, J.R. Mendelson III, V. Mercurio, R.A. Mittermeier, R.D. Moore, N.H.C. Rabibisoa, H. Randriamahazo, H. Randrianasolo, N. Raminosoa, O. Ramilijaona, C.J. Raxworthy, D. Vallan, M. Vences, D.R. Vieites, and C. Weldon. 2008. The challenge of conserving amphibian megadiversity in Madagascar. *PLoS Biology* 6:e118. doi: 10.1371/journal.pbio.0060118.
- Andreone, F., and J.E. Randrianirina. 2008. An unexpected *Rhombophryne* record at Tsingy de Bemaraha confirms the presence of cophyline frogs in western Madagascar. *Zootaxa* 1812:46–48.
- Andreone, F., M. Vences, F.M. Guarino, F. Glaw, and J.E. Randrianirina. 2002. Natural history and larval morphology of *Boophis occidentalis* (Anura: Mantellidae: Boophinae) provide new insights into the phylogeny and adaptive radiation of endemic Malagasy frogs. *Journal of Zoology* 257:425–438.
- Angel, F. 1933. Sur un genre malgache nouveau de la famille de Chamaeleontidés. *Bulletin Museum Paris*, T, LVIII, 6:443.
- Anonymous. 1987. Opinion 1463. De Lacépède, 1788–1789, *Histoire Naturelle des Serpens* and later editions: rejected as a non-binominal work. *Bulletin of Zoological Nomenclature* 44 (4):265–267.
- Blommers-Schlösser, R.M.A., and C.P. Blanc. 1991. Amphibiens (première partie). *Faune de Madagascar* 75:1–379.
- Bloxam, Q.M.C., J.L. Behler, E.R. Rakotovo, H.J.A.R. Randriamahazo, K.T. Hayes, S.J. Tonge, and J.U. Ganzhorn. 1996. Effects of logging on the reptile fauna of the Kirindy forest with special emphasis on the Flat-tailed Tortoise (*Pyxis planicauda*). In Ganzhorn, J.U. and J.-P. Sorg (Eds.). *Ecology and economy of a tropical dry forest in Madagascar*. Primate Report 46:189–201.
- D'Cruze, N., J. Sabel, K. Green, J. Dawson, C. Gardner, J. Robinson, G. Starkie, M. Vences, and F. Glaw. 2007. The first comprehensive survey of amphibians and reptiles at Montagne des Français, Madagascar. *Herpetological Conservation and Biology* 2:87–99.
- Emanueli, L., and R. Jesu. 1995. The herpetofauna of the World Heritage site "Tsingy de Bemaraha" (Western Madagascar). In: Llorente et al., eds., *Scientia Herpetologica* 1995:341–348.
- Glaw, F., J. Köhler, P. Bora, N.H.C. Rabibisoa, O. Ramilijaona, and M. Vences. 2007. Discovery of the genus *Plethodontohyla* (Anura: Microhylidae) in dry western Madagascar: description of a new species and biogeographic implications. *Zootaxa* 1577:61–68.
- Glaw, F., J. Köhler, and M. Vences. 2009a. A new species of cryptically coloured day gecko (*Phelsuma*) from the Tsingy de Bemaraha National Park in western Madagascar. *Zootaxa*.
- Glaw, F., Z.T. Nagy, J. Köhler, M. Franzen, and M. Vences. 2009b. Phylogenetic relationships of a new species of pseudoxyrhophiine snake (Reptilia: Lamprophiidae: *Thamnosophis*) suggest a biogeographic link between western and northern Madagascar. *Organisms Diversity & Evolution* 9:13–22.
- Glaw, F., and M. Vences. 2007. A Field Guide to the Amphibians and Reptiles of Madagascar. 3<sup>rd</sup> Edition. Vences and Glaw Verlag, Köln, Germany.
- Glaw, F., M. Vences, and W. Böhme. 1998. Systematic revision of the genus *Aglyptodactylus* Boulenger, 1919 (Anura: Ranidae) and analysis of its phylogenetic relationships with other ranid genera from Madagascar (*Tomopterna*, *Boophis*, *Mantidactylus* and *Mantella*). *Journal of Zoological Systematics and Evolutionary Research* 36:17–37.
- Glos, J. 2003. The amphibian fauna of the Kirindy dry forest in western Madagascar. *Salamandra* 39:75–90.
- Glos J., F. Glaw, and M. Vences. 2005. A new species of *Scaphiophryne* from western Madagascar. *Copeia* 2005:252–261.
- Goodman, S.M., D. Andriafidison, R. Andrianaivoarivelo, S.G. Cardiff, E. Ifticene, R.K.B. Jenkins, A. Kofoky, T. Mbohoahy, D. Rakotondravony, J. Ranivo, F. Ratrimomanarivo, J. Razafimanahaka, V. Razakarivony, and P.A. Racey. 2005a. The distribution and conservation of bats in the dry regions of Madagascar. *Animal Conservation* 8:153–165.
- Goodman, S.M., R.K.B. Jenkins, and F.H. Ratrimomanarivo. 2005b. A review of the genus *Scotophilus* (Chiroptera: Vespertilionidae) on Madagascar, with the description of a new species. *Zoosystema* 27:867–882.
- Goodman, S.M., and H. Schütz. 2003. Specimen evidence of the continued existence of the Malagasy rodent *Nesomys lambertoni* (Muridae: Nesomyinae). *Mammalia* 67:445–449.
- Hallmann, G., E. Hoffmann, J. Krüger, P. Schlagböhmer, and G. Trautmann. 1999. Reptilien und Amphibien im Naturschutzgebiet "du Tsingy de de Bemaraha" (West-Madagaskar) - Ein photographischer Steckbrief. *Reptilia* 4:43–45.
- Jackman, T.R., A.M. Bauer, E. Greenbaum, F. Glaw, and M. Vences. 2008. Molecular phylogenetic relationships among species of the Malagasy-Comorran gecko genus *Paroedura* (Squamata: Gekkonidae). *Molecular Phylogenetics and Evolution* 46:74–81.
- Jesu, R., F. Mattioli, and G. Schimmenti. 1999. On the discovery of a new large chameleon inhabiting the limestone outcrops of western Madagascar: *Furcifer nicosiai* sp. nov. (Reptilia, Chamaeleonidae). *Doriana* 7:1–14.

- Köhler, J., F. Glaw, and M. Vences. 2007. A new green treefrog, genus *Boophis* Tschudi 1838 (Anura Mantellidae), from arid western Madagascar: phylogenetic relationships and biogeographic implications. *Tropical Zoology* 20:215–227.
- Kremen, C., A. Cameron, A. Moilanen, S.J. Phillips, C.D. Thomas, H. Beentje, J. Dransfield, B.L. Fisher, F. Glaw, T.C. Good, G.J. Harper, R.J. Hijmans, D.C. Lees, E. Louis Jr., R.A. Nussbaum, C.J. Raxworthy, A. Razafimpahanana, G.E. Schatz, M. Vences, D.R. Vieites, P.C. Wright, and M.L. Zjhra. 2008. Aligning conservation priorities across taxa in Madagascar with high-resolution planning tools. *Science* 320:222–226.
- Mori, A., I. Ikeuchi, and M. Hasegawa. 2006. Herpetofauna of Ampijoroa, Ankarafantsika Strict Nature Reserve, a dry forest in northwestern Madagascar. *Herpetological Natural History* 10:31–60.
- Nussbaum, R.A., C.J. Raxworthy, and J.B. Ramanamanjato. 1999. Additional species of *Mabuya* Fitzinger (Reptilia: Squamata: Scincidae) from western Madagascar. *Journal of Herpetology* 33:264–280.
- Plan de Gestion et de Conservation. 2002. Programme Bemaraha, 8/ACP/MAG/037, National Park Component, internal document, 63 pp.
- Rabemananjara, F.C.E., A. Crottini, Y. Chiari, F. Andreone, F. Glaw, R. Duguet, P. Bora, O. Ravoahangimalala Ramilijaona, and M. Vences. 2007. Molecular systematics of Malagasy poison frogs in the *Mantella betsileo* and *M. laevigata* species groups. *Zootaxa* 1501:31–44.
- Ramanamanjato, J.B., and N. Rabibisoa. 2002. Evaluation rapide de la diversité biologique des reptiles et amphibiens de la Réserve Naturelle Intégrale d'Ankarafantsika. Pp. 98–103 and 135–138 *In* Une évaluation biologique de la Réserve Naturelle Intégrale d'Ankarafantsika, Madagascar. Alonso, L.E., T.S. Schulenberg, S. Radilofe, and O. Missa (Eds.). Bulletin RAP d'évaluation rapide No. 23, Conservational International, Washington, D.C., USA.
- Randrianantoandro, J.C., R. Randrianavelona, R.R. Andriantsimanarilafy, H.E. Fidelity, D. Rakotondravony, and R.K.B. Jenkins. 2007. Roost site characteristics of sympatric dwarf chameleons (genus *Brookesia*) from western Madagascar. *Amphibia-Reptilia* 28:577–581.
- Randrianantoandro, J.C., R. Randrianavelona, R.R. Andriantsimanarilafy, H.E. Fidelity, D. Rakotondravony, M. Randrianasolo, H.L. Ravelomanantsoa, and R.K.B. Jenkins. 2008. Identifying important areas for the conservation of dwarf chameleons (*Brookesia* spp.) in Tsingy de Bemaraha National Park, western Madagascar. *Oryx* 42:578–583.
- Raselimanana, A.P. 2008. Herpétofaune des forets sèches malgaches. *Malagasy Nature* 1:46–75.
- Raselimanana, A.P., R.A. Nussbaum, and C.J. Raxworthy. 2006. Observations and redescription of *Zonosaurus boettgeri* Steindachner 1891 and description of a second new species of long-tailed *Zonosaurus* from western Madagascar. *Occasional Papers Museum of Zoology, University of Michigan* 739:1–16.
- Raselimanana, A.P., C.J. Raxworthy, and R.A. Nussbaum. 2000. A revision of the dwarf *Zonosaurus* Boulenger (Reptilia: Squamata: Cordylidae) from Madagascar, including descriptions of three new species. *Scientific Papers of the Natural History Museum, University of Kansas* 18:1–16.
- Rasoloarison, V., and F. Paquier. 2003. Tsingy de Bemaraha. Pp. 1507–1512 *In* The Natural History of Madagascar. Goodman, S.M., and J. Benstead (Eds.). University of Chicago Press, Chicago, USA.
- Raxworthy, C.J., and R.A. Nussbaum. 1995. Systematics, speciation and biogeography of the dwarf chameleons (*Brookesia*; Reptilia, Squamata, Chamaeleontidae) of northern Madagascar. *Journal of Zoology, London* 235:525–558.
- Schimmenti, G., and R. Jesu. 1996. *Brookesia exarmata* sp. nov. (Reptilia, Chamaeleonidae): a new dwarf chameleon from the limestone outcrops of western Madagascar. *Italian Journal of Zoology* 63:193–197.
- Schimmenti, G., and R. Jesu. 1997. Some significant reptile discoveries from the Antsingy Forest ("Tsingy de Bemaraha" massif, western Madagascar). Pp. 317–329 *In* Böhme, W., W. Bischoff, and T. Ziegler (Eds.). (Proceedings of the eighth ordinary general meeting of the Societas Herpetologica Europaea), Bonn (SEH), 416 pp.
- Thalmann, U., and T. Geissmann. 2005. New species of woolly lemur *Avahi* (Primates: Lemuriformes) in Bemaraha (Central Western Madagascar). *American Journal of Primatology* 67:371–376.
- Vences, M., and F. Glaw. 2002. Molecular phylogeography of *Boophis tephraeomystax*: a test case for east-west vicariance in Malagasy anurans (Amphibia, Anura, Mantellidae). *Spixiana* 25:79–84.
- Vences, M., F. Glaw, R. Jesu, and G. Schimmenti. 2000. A new species of *Heterixalus* (Amphibia: Hyperoliidae) from western Madagascar. *African Zoology* 35:269–276.
- Vences, M., F. Glaw, and R. Marquez. Eds. 2006. The Calls of the Frogs of Madagascar (3 Audio CD's and booklet, 44 pp.). Alosa, Barcelona (ISBN 84-609-8402-8).
- Wollenberg, K.C., D.R. Vieites, A. van der Meijden, F. Glaw, D.C. Cannatella, and M. Vences. 2008. Patterns of endemism and species richness in Malagasy cophyline frogs support a key role of mountainous areas for speciation. *Evolution* 62:1890–1907.

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**I) RICHARD K.B. JENKINS** is a conservation biologist with a Ph.D. from Cardiff University. He first visited Madagascar in 1992 and made a series of return visits to study rainforest chameleons between 1993 and 1999. Through field studies in the UK and Tanzania, he developed a broad interest in vertebrate ecology and conservation. With his Malagasy colleagues, he founded a national biodiversity conservation organization called 'Madagasikara Voakajy' in 2005, which currently has projects focusing on a number of different endemic species, including *Mantella aurantiaca*, *Furcifer belalandaensis*, *Pteropus rufus* and *Adansonia grandidieri*. He currently works for Bangor University and the University of Kent and coordinates projects on the sustainable use of wild animals in Madagascar.

**J) FRANK GLAW** is the curator of the herpetology section at the Zoologische Staatssammlung München, Germany. He received his diploma degree at the University of Cologne and the doctoral degree at the Zoologisches Forschungsmuseum A. Koenig in Bonn. Since 1987, he has carried out field work in Madagascar and has specialized on the systematics, bioacoustics and biogeography of the Malagasy herpetofauna.

**K) JÖRN KÖHLER** is curator for vertebrate zoology at the Hessisches Landesmuseum Darmstadt, Germany. He received his diploma and doctoral degree at the Zoologisches Forschungsmuseum A. Koenig in Bonn and has mainly been working on systematics, natural history, and biogeography of Neotropical and African amphibians and reptiles. Since his undergraduate days, he has collaborated with Frank Glaw and Miguel Vences.

APPENDIX I  
Voucher Specimens

AMPHIBIANS: *Ptychadena mascareniensis*: Andafiabe: ZSM 97/2006, 133/2006; Andranopasazy: UADBA 25667; Bendrao: UADBA 25661; *Heterixalus carbonei*: Andranopasazy: UADBA 25619, ZSM 83/2006; *Heterixalus luteostriatus*: Andranopasazy: UADBA 25629; *Dyscophus insularis*: Bendrao: UADBA 25613, ZSM 87-88/2006; Tsiandro: UADBA 39051, 39073, 39092; *Plethodontohyla fonetana*: Bendrao: UADBA 39001, ZSM 123/2006; *Scaphiophryne sp. (aff. calcarata)*: Anjaha: UADBA 39083, 39085, 39101; *Scaphiophryne menabensis*: Andolombazimba: UADBA 39080, 39086; Andranopasazy: ADBA 39062, 39087, 39090, ZSM 39/2006; Bendrao: UADBA 25611, 25612, 25615, 25627, 25630, 39103, ZSM 89-91/2006, 122/2006; Anjaha: UADBA 39060; *Stumpffia sp. (aff. helenae)*: Andafiabe: ZSM 137/2006; Andranopasazy: UADBA 25634, 25660, 25663, ZSM 21-22/2006; Bendrao: 114/2006; *Aglyptodactylus securifer*: Andranopasazy: UADBA 25621, 25628, 25646, 25668, 39061, 39098, ZSM 8/2006, 14/2006, 28/2006, 31/2006; 34/2006; Bendrao: UADBA 25614, 25649, ZSM 111/2006; *Laliostoma labrosum*: Andafiabe: 132/2006; Andranopasazy: UADBA 25605, 25608, 25617, ZSM 16/2006, 33/2006; Ankilogo: UADBA 39088, 39094; Bendrao: UADBA 25607, 39066, 39068; Anjaha: UADBA 39096; *Boophis doulioti*: Andranopasazy: UADBA 25604, 25639, 25650, 28520, 39079, 39089, ZSM 4/2006, 29/2006, 38/2006; Bendrao: UADBA 25655, 25669, 39055, 39072, ZSM 92/2006; *Boophis occidentalis*: Andranopasazy: UADBA 28513, 28515, 28518, ZSM 65-66/2006, 69/2006; Ankily: UADBA 39102; *Boophis tampoka*: Andafiabe: UADBA 25616, 25618, 25620, 25622-624, 25654, 25664, ZSM 95-100/2006, 101/2006, 139/2006, 144/2006; Anjaha: UADBA 39097; *Blommersia sp. (aff. wittei)*: Andranopasazy: UADBA 39091, 25635, 25637-638, 25640, 25657, 28517, ZSM 13/2006, 30/2006, 52/2006, 68/2006; Bendrao: UADBA 25641, 25662; *Gephyromantis sp. (aff. corvus)*: Anjaha: UADBA 39057, 39100; Ankily: UADBA 39058, 39093; Andranopasazy: UADBA 39081, 39082, 39099, ZSM 23/2006, 37/2006; Bendrao: ZSM 107/2006; *Mantella betsileo*: Andranopasazy: ZSM 44/2006 (=FGZC 759); *Mantella sp. (aff. expectata)*: Andranopasazy: UADBA 25632, 25636, 25647, 25653, 25656, 25666, ZSM 15/2006, 32/2006, 44/2006, 58/2006; Anjohimbazimba: UADBA 39095; Bendrao: ZSM 73/2006, 120/2006; *Mantidactylus sp. (aff. ulcerosus)*: Andafiabe: UADBA 25631, 25670, ZSM 134-136/2006; Andranopasazy: UADBA 25610, 25648, ZSM 9-10/2006, 61-62/2006; Bendrao: UADBA 25606, 25609, 25625, 25642, 25651, 25659, 25671, ZSM 74-75/2006, 78/2006.

REPTILES: *Acrantophis madagascariensis*: Bendrao: ZSM 155/2006; *Sanzinia madagascariensis volontany*: Andranopasazy: UADBA 28539, ZSM 48/2006, 67/2006; Bendrao: UADBA 28540; *Alluaudina bellyi*: Bendrao: UADBA 28535, 39014, ZSM 93/2006, 115/2006; *Dromicodryas bernieri*: Bendrao: UADBA 28541; *Heteroliodon lava*: Andranopasazy: UADBA 39021; Ankilogo: UADBA 28075; *Langaha madagascariensis*: Ranotsara: UADBA 28006; *Liophidium torquatam*: Ankilogo: UADBA 28139; Ranotsara: UADBA 28115, 28135; *Madagascarophis colubrinus*: Andranopasazy: UADBA 28542; *Mimophis mahfalensis*: Andafiabe: ZSM 85/2006; Andranopasazy: UADBA 28536; *Stenophis citrinus*: Andranopasazy: UADBA 28537-538, 39010, ZSM 82/2006; Bendrao: ZSM 117/2006; *Stenophis pseudogranuliceps*: Bendrao: UADBA 39020, ZSM 148/2006; Tsiandro: UADBA 39016; *Stenophis cf. variabilis*: Andranopasazy: UADBA 28534; *Thamnosophis mavotenda*: Bendrao: ZSM 127/2006; *Typhlops sp. 1*: Bendrao: UADBA 39045; Ranotsara: UADBA 39045; *Typhlops sp. 2*: Ankilogo: UADBA 28077; *Blaesodactylus sakalava*: Andranopasazy: UADBA 28522;

Bendrao: ZSM 106/2006; Tsiandro: UADBA 39004; *Geckolepis sp.*: Andafiabe: ZSM 141/2006; Andranopasazy: UADBA 28458, 28464, 28472, 28525, 28530, ZSM 49-50/2006; Ankilogo: UADBA 28058; Bendrao: UADBA 28533, ZSM 81/2006, 104/2006, 110/2006; Ranotsara: UADBA 28065; *Hemidactylus frenatus*: Antsalova: UADBA 28498; *Hemidactylus mercatorius*: Anjaha: UADBA 39035; *Lygodactylus heterurus*: Ankily: UADBA 39070; Ranotsara: UADBA 28041; *Lygodactylus klemmeri*: Andranopasazy: UADBA 28488, 28489, ZSM 46-47/2006; Ankily: UADBA 39070; *Lygodactylus tolampyae*: Andranopasazy: UADBA 39067, 39069, ZSM 5/2006, 26/2006; Ankily: UADBA 39059, 39065; Bendrao: UADBA 39053; *Lygodactylus sp.*: Bendrao: ZSM 77/2008; *Paragehyra cf. petiti*: Ranotsara: UADBA 28038, 28056; *Paroedura cf. homalorhina*: Andolombazimba: UADBA 39030, 39036, ZSM 27/2006; Bendrao: UADBA 39029; Grotte d'Anjohimbazimba: UADBA 28529, ZSM 42/2006; *Paroedura tanjaka*: Andafiabe: UADBA 28456, 28499, 28500, 28504, 28531, ZSM 142-143/2006, 149/2006; Andranopasazy: UADBA 28455, 28524, 28527, 28528, 39019, 39074, ZSM 18/2006, 43/2006, 40/2006, 53/2006; Anjaha: UADBA 39023; Grotte d'Anjohimbazimba: ZSM 36/2006; *Paroedura sp. (aff. tanjaka)*: Andafiabe: UADBA 39033, ZSM 128/2006, 163/2006; *Phelsuma abbotti chekei*: Andafiabe: UADBA 28501; Andranopasazy: UADBA 39005, ZSM 63/2006; Anjaha: UADBA 39015; *Phelsuma dubia*: Antsalova: UADBA 28505, ZSM 145/2006; *Phelsuma kochi*: Andafiabe: UADBA 28526, ZSM 140/2006; Andranopasazy: UADBA 28521, ZSM 7/2006; Grotte d'Anjohimbazimba: UADBA 28532; *Phelsuma mutabilis*: Antsalova: UADBA 28502; *Phelsuma borai*: Andafiabe: ZSM 103/2006; *Uroplatus cf. ebenau*: Bendrao: UADBA 39009; *Uroplatus guentheri*: Ankilogo: UADBA 28031, 28045; *Uroplatus cf. henkeli*: Andafiabe: UADBA 25603; Ankily: UADBA 39032; Bendrao: UADBA 25601, 25602, 39017, ZSM 112-113/2006, 130-131/2006; *Amphiglossus reticulatus*: Andranopasazy: UADBA 39049; *Amphiglossus splendidus*: Ankilogo: UADBA 28019; Ranotsara: UADBA 28017, 28021, 28080; *Amphiglossus sp. 1*: Andolombazimba: UADBA 28015; *Amphiglossus sp. 2*: Andolombazimba: UADBA 28030; Anjaha: UADBA 39027, 39038, 39050; *Madascincus cf. intermedius*: Anjaha: UADBA 39027, 39038, 39040, 39044, 39045, 39047, 39050; *Trachylepis cf. dumasi*: Andafiabe: ZSM 146/2006; Andranopasazy: UADBA 39054, 39075; *Trachylepis gravenhorstii*: Anjaha: UADBA 28042, 39026, 39034; *Trachylepis tandrefana*: Andranopasazy: UADBA 39037; Ankily: UADBA 39031; *Trachylepis volamenaloha*: Andranopasazy: UADBA 39078; Anjaha: UADBA 39071; *Brookesia brygooi*: Andafiabe: ZSM 138/2006; Andranopasazy: UADBA 28468, 28471, 28491, 28493-497, 39056, ZSM 11-12/2006, 35/2006; Bendrao: UADBA 39077, ZSM 80/2006, 119/2006; *Brookesia exarmata*: Andafiabe: ZSM 147/2006; Andranopasazy: UADBA 28486, 39052, 39063-064, ZSM 72/2006; *Brookesia perarmata*: Andranopasazy: ZSM 17/2006; Bendrao: UADBA 25358, 28482, 28487, 28492, ZSM 118/2006, 125-126; *Furcifer lateralis*: river near Andafiabe: ZSM 79/2006; *Furcifer nicosiai*: Andranopasazy: UADBA 28440, 28481, 28485, 39011, 39041, ZSM 2/2006, 20/2006, 51/2006; Ankily: UADBA 39043; Bendrao: ZSM 84/2006; Tsiandro: UADBA 39048; *Furcifer oustaleti*: Andranopasazy: ZSM 1/2006; Bendrao: UADBA 28484, 28490, ZSM 105/2006; Tsiandro: UADBA 39039; *Zonosaurus bemaraha*: Anjaha: UADBA 39008, 39013; Andranopasazy: UADBA 39018, ZSM 3/2006; Ankily: UADBA 39022; *Zonosaurus laticaudatus*: Andranopasazy: ZSM 64/2006; Andolombazimba: UADBA 28036; *Zonosaurus cf. madagascariensis*: Andranopasazy: ZSM 25/2006; Bendrao: UADBA 28523; *Chalarodon madagascariensis*: Antsalova: UADBA 28507; *Oplurus cuvieri*: Andranopasazy: UADBA 28503, 28506, ZSM 86/2006.

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**APPENDIX II.** Comparative species composition of surveyed sites in western Madagascar: X1, Tsingy de Bemaraha (present study); X2, Ankarana; X3, PN Ankarafantsika; X4, Kirindy (CFPF); X5, PN Mikea; X6, PN Tsimanampetsa; X7, Bemaraha (data from X2-X7 unchanged after Raselimanana, 2008).

Species	Study site						
	X1	X2	X3	X4	X5	X6	X7
<b>Amphibians</b>							
<i>Ptychadena mascareniensis</i>	+	+	+	+	+	+	+
<i>Heterixalus betsileo</i>							+
<i>Heterixalus carbonei</i>	+			+			+
<i>Heterixalus luteostriatus</i>	+			+	+		+
<i>Heterixalus tricolor</i>			+	+			
<i>Hoplobatrachus tigerinus</i>		+					
<i>Cophyla berara</i>							
<i>Cophyla phyllodactyla</i>		+					
<i>Dyscophus guineti</i>				+			
<i>Dyscophus insularis</i>	+		+	+		+	+
<i>Plethodontohyla fonetana</i>	+						
<i>Rhombophryne</i> sp.	+						+
<i>Scaphiophryne brevis</i>				+	+	+	+
<i>Scaphiophryne calcarata</i>			+	+	+		+
<i>Scaphiophryne</i> sp. (aff. <i>calcarata</i> )	+						
<i>Scaphiophryne menabensis</i>	+			+			+
<i>Stumpffia gimmeli</i>		+					
<i>Stumpffia</i> aff. <i>pygmaea</i>			+				
<i>Stumpffia</i> sp. (aff. <i>helenae</i> )	+						+
<i>Aglyptodactylus laticeps</i>				+			+
<i>Aglyptodactylus securifer</i>	+	+		+			+
<i>Laliostoma labrosum</i>	+	+	+	+	+	+	+
<i>Boophis doulioti</i>	+		+	+	+		+
<i>Boophis madagascariensis</i>			+				
<i>Boophis occidentalis</i>	+						
<i>Boophis tampoka</i>	+						
<i>Boophis</i> aff. <i>occidentalis</i>							
<i>Boophis xerophilus</i>				+			
<i>Blommersia wittei</i>			+				+
<i>Blommersia</i> sp. (aff. <i>wittei</i> )	+						
<i>Gephyromantis pseudoasper</i>		+					
<i>Gephyromantis</i> sp. (aff. <i>corvus</i> )	+						
<i>Mantella betsileo</i>	+			+			+
<i>Mantella ebenau</i>							
<i>Mantella</i> sp. (aff. <i>expectata</i> )	+						
<i>Mantella</i> aff. <i>viridis</i>		+					
<i>Mantidactylus bellyi</i>		+					
<i>Mantidactylus</i> aff. <i>corvus</i>							+
<i>Mantidactylus ulcerosus</i>			+				
<i>Mantidactylus</i> sp. (aff. <i>ulcerosus</i> )	+						
<i>Tsingymantis antitra</i>		+					
<b>Total Amphibians :</b>	19	10	10	15	6	4	17
				Study site			
	X1	X2	X3	X4	X5	X6	X7
<b>Reptiles</b>							
<i>Acrantophis dumerili</i>					+	+	+
<i>Acrantophis madagascariensis</i>	+	+	+		+		
<i>Sanzinia madagascariensis volontany</i>	+		+	+			+
<i>Alluaudina bellyi</i>	+	+					+
<i>Alluaudina mocquardi</i>		+					
<i>Compsophis albiventris</i>							+
<i>Dromicodryas bernieri</i>	+		+	+	+	+	+
<i>Dromicodryas quadrilineatus</i>		+	+				
<i>Heteroliodon lava</i>	+	+					
<i>Heteroliodon occipitalis</i>				+	+	+	
<i>Ithycyphus miniatus</i>			+	+			
<i>Ithycyphus oursi</i>					+	+	
<i>Langaha alluaudi</i>					+		
<i>Langaha madagascariensis</i>	+	+	+	+	+	+	
<i>Leioheterodon geayi</i>				+	+	+	
<i>Leioheterodon madagascariensis</i>	+	+	+	+	+		+
<i>Leioheterodon modestus</i>	+	+	+	+	+		+
<i>Liophidium apperti</i>					+	+	
<i>Liophidium chabaudi</i>				+	+		
<i>Liophidium therezieni</i>			+				
<i>Liophidium torquatium</i>	+	+	+	+			+

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<i>Liophidium trilineatus</i>							+
<i>Liophidium vaillanti</i>						+	
<i>Liopholidophis doliocercus</i>							+
<i>Liopholidophis lateralis</i>			+				+
<i>Madagascarophis citrinus</i>							
<i>Madagascarophis colubrinus</i>	+	+	+	+	+	+	+
<i>Madagascarophis meridionalis</i>					+	+	
<i>Madagascarophis ocellatus</i>					+	+	
<i>Mimophis mahfalensis</i>	+	+	+	+	+	+	+
<i>Pararhadinea melanogaster</i>			+				
<i>Pseudoxyrhopus kely</i>							+
<i>Pseudoxyrhopus quinquelineatus</i>			+				
<i>Stenophis pseudogranuliceps</i>	+						
<i>Stenophis cf. variabilis</i>	+		+				
<i>Stenophis capuroni</i>			+				
<i>Stenophis citrinus</i>	+			+			+
<i>Stenophis inornatus</i>					+		
<i>Stenophis granuliceps</i>							+
<i>Stenophis pseudogranuliceps</i>			+	+	+		+
<i>Stenophis tulearensis</i>					+		+
<i>Stenophis n. sp.</i>							+
<i>Thamnosophis mavotenda</i>	+						
<i>Typhlops arenarius</i>			+	+	+	+	+
<i>Typhlops decorsei</i>			+		+	+	
<i>Typhlops mucronatus</i>			+			+	
<i>Typhlops sp. 1 (aff. arenarius)</i>	+						
<i>Typhlops sp. 2</i>	+						
<i>Erymnochelys madagascariensis</i>			+				
<i>Pelomedusa subrufa</i>				+	+		
<i>Astrochelys radiata</i>						+	
<i>Pyxis arachnoides</i>				+	+	+	
<i>Pyxis planicauda</i>				+			
<i>Crocodylus niloticus</i>			+	+			+
<i>Blaesodactylus boivini</i>			+				
<i>Blaesodactylus sakalava</i>	+		+	+	+	+	+
<i>Ebenavia maintimainty</i>						+	
<i>Geckolepis maculata</i>			+	+	+		+
<i>Geckolepis typica</i>			+	+		+	+
<i>Geckolepis sp.</i>	+						
<i>Hemidactylus frenatus</i>	+				+		
<i>Hemidactylus mercatorius</i>	+	+	+	+	+	+	+
<i>Lygodactylus heterurus</i>	+	+					+
<i>Lygodactylus klemmeri</i>	+						+
<i>Lygodactylus madagascariensis</i>			+				
<i>Lygodactylus tolampyae</i>	+		+	+	+	+	+
<i>Lygodactylus tuberosus</i>						+	
<i>Lygodactylus verticillatus</i>					+		
<i>Lygodactylus sp.</i>	+						
<i>Matoatoa brevipes</i>					+	+	
<i>Paragehyra petiti</i>							+
<i>Paragehyra cf. petiti</i>	+						
<i>Paroedura bastardi</i>				+	+	+	+
<i>Paroedura homalorhina</i>			+				+
<i>Paroedura cf. homalorhina</i>	+						
<i>Paroedura karstophila</i>			+				+
<i>Paroedura maingoka</i>						+	
<i>Paroedura picta</i>				+	+	+	
<i>Paroedura stumpffii</i>			+				+
<i>Paroedura tanjaka</i>	+						+
<i>Paroedura sp. (aff. tanjaka)</i>	+						
<i>Paroedura vahiny</i>				+	+	+	
<i>Paroedura vazimba</i>			+				
<i>Phelsuma abbotti</i>			+				+
<i>Phelsuma abbotti chekei</i>	+						
<i>Phelsuma breviceps</i>					+	+	
<i>Phelsuma bombetokensis</i>			+	+			
<i>Phelsuma madagascariensis</i>			+	+	+		+
<i>Phelsuma dubia</i>	+						
<i>Phelsuma kochi</i>	+						
<i>Phelsuma mutabilis</i>	+		+	+	+	+	+
<i>Phelsuma borai</i>	+						
<i>Phelsuma standingi</i>					+		
<i>Uroplatus ebenau</i>			+				
<i>Uroplatus cf. ebenau</i>	+						
<i>Uroplatus giganteus</i>			+				+

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<i>Uroplatus guentheri</i>	+		+	+			+
<i>Uroplatus henkeli</i>		+					
<i>Uroplatus cf. henkeli</i>	+						
<i>Amphiglossus andranovahensis</i>						+	+
<i>Amphiglossus mandokava</i>							
<i>Amphiglossus ornaticeps</i>			+	+	+	+	+
<i>Amphiglossus aff. ornaticeps</i>		+					
<i>Amphiglossus reticulatus</i>	+		+				
<i>Amphiglossus splendidus</i>	+						+
<i>Amphiglossus stumpffi</i>							
<i>Amphiglossus n. sp.</i>		+					
<i>Amphiglossus sp.1</i>	+						
<i>Amphiglossus sp.2</i>	+						
<i>Androngo trivittatus</i>							+
<i>Cryptoblepharus boutonii</i>							
<i>Madascincus igneocaudatus</i>					+	+	
<i>Madascincus intermedius</i>		+	+	+	+		+
<i>Madascincus cf. intermedius</i>	+						
<i>Trachylepis aureopunctata</i>					+	+	
<i>Trachylepis dumasi</i>				+			+
<i>Trachylepis cf. dumasi</i>	+						
<i>Trachylepis elegans</i>	+	+	+	+	+	+	+
<i>Trachylepis gravenhorstii</i>	+		+	+		+	
<i>Trachylepis tavaratra</i>		+					
<i>Trachylepis tandrefana</i>	+			+			+
<i>Trachylepis vato</i>					+		
<i>Trachylepis volamenaloha</i>	+						+
<i>Pygomeles braconnieri</i>					+	+	
<i>Sirenoscincus yamagishii</i>			+				
<i>Voeltzkowia fierinensis</i>							+
<i>Voeltzkowia lineata</i>						+	+
<i>Voeltzkowia petiti</i>						+	
<i>Voeltzkowia rubrocaudata</i>						+	+
<i>Voeltzkowia n. sp.</i>							+
<i>Tracheloptychus madagascariensis</i>							+
<i>Tracheloptychus petersi</i>					+		
<i>Brookesia brygooi</i>	+			+			+
<i>Brookesia decaryi</i>			+				
<i>Brookesia ebenau</i>		+					
<i>Brookesia exarmata</i>	+						+
<i>Brookesia minima</i>							
<i>Brookesia perarmata</i>	+						+
<i>Brookesia stumpffi</i>		+					
<i>Furcifer angeli</i>							
<i>Furcifer antimena</i>					+		
<i>Furcifer labordi</i>				+	+		
<i>Furcifer lateralis</i>	+				+	+	
<i>Furcifer nicosiai</i>	+						+
<i>Furcifer petteri</i>		+					
<i>Furcifer cf. petteri</i>	+						
<i>Furcifer oustaleti</i>	+	+	+	+	+	+	+
<i>Furcifer pardalis</i>		+					
<i>Furcifer rhinoceratus</i>			+				
<i>Furcifer tuzetae</i>							
<i>Furcifer verrucosus</i>					+	+	
<i>Furcifer n. sp.</i>				+			
<i>Zonosaurus bemaraha</i>	+						+
<i>Zonosaurus haraldmeieri</i>		+					
<i>Zonosaurus karsteni</i>	+			+	+	+	+
<i>Zonosaurus laticaudatus</i>	+		+	+		+	+
<i>Zonosaurus quadrilineatus</i>					+		
<i>Zonosaurus rufipes</i>		+					
<i>Zonosaurus trilineatus</i>						+	
<i>Zonosaurus tsingy</i>		+					
<i>Zonosaurus cf. madagascariensis</i>	+						
<i>Chalarodon madagascarensis</i>	+				+	+	
<i>Oplurus cuvieri</i>	+		+	+			+
<i>Oplurus cyclurus</i>					+	+	
<i>Oplurus quadrimaculatus</i>						+	
<i>Oplurus saxicola</i>						+	
<b>Total Reptiles</b>	<b>60</b>	<b>40</b>	<b>44</b>	<b>42</b>	<b>58</b>	<b>53</b>	<b>54</b>