Biological research conducted in the general Andasibe region of Madagascar with emphasis on enumerating the local biotic diversity

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Abstract

For nearly a century, extensive biological field studies have been conducted in the region surrounding Andasibe, and this general area can be considered the biologically best-known forested zone in Madagascar. Recent research in this zone has resulted in the discovery of previously described endemic Malagasy species that were considered rare or completely unknown. Furthermore, based on a literature survey, 229 new taxa of a variety of different organisms, mostly flowering plants and animals (invertebrates and vertebrates), have been described from the general Andasibe region between 1978 and 2009. This considerable number of new species to science, coming from one of the biologically best known areas of the island, underlines how little is really known about the plant and animal diversity of Madagascar. Certain groups of invertebrates, the focus of intensive surveys, represent the largest percentage of the recently described taxa. It is suggested that in order to understand patterns of biological diversity in Madagascar, continued long-term research, including inventories with voucher specimens or at least voucher tissues, are critical to have a better understanding of biotic patterns and species richness. Such information is paramount for the prioritization of new protected areas and decisions about economic development associated with resource exploitation.

Key words: Andasibe region, Madagascar, fauna, flora, endemism, rarity, new species

Résumé détaille

Depuis près d'un siècle, des inventaires biologiques relativement intensifs ont été menés dans la région d'Andasibe. Cette zone peut être considérée comme la région forestière de Madagascar la mieux connue sur le plan biologique. De récentes recherches effectuées dans la région d'Andasibe ont abouti à la découverte d'espèces malgaches décrites auparavant et considérées comme étant rares ou complètement inconnues. La découverte de ces organismes fournit une information importante sur les taxons existant localement, en particulier ceux qui ont un intérêt pour la conservation. D'autre part, certaines espèces venant de la région d'Andasibe et décrites des décennies auparavant n'ont pas été rencontrées ultérieurement dans cette région ou ailleurs à Madagascar, ce qui montre davantage les niveaux locaux de rareté et de micro-endémisme.

Sur la base d'étude littéraire, 229 nouveaux organismes, surtout les plantes à fleurs et les animaux (invertébrés et vertébrés), ont été décrits à partir de la région d'Andasibe entre 1978 et 2009. Ce nombre considérable d'espèces nouvelles pour la science, venant de l'une des régions les mieux connues de l'île sur le plan biologique, souligne combien la connaissance sur la diversité biologique terrestre de Madagascar est faible. En excluant les quelques espèces de lichens, de bryophytes, d'hépatiques, de fougères et de parasites décrites à partir de la région, ces nouveaux taxons sont largement dominés par les invertébrés (77 %), suivis par les plantes à fleurs (13 %) et par les vertébrés (10 %). Certains groupes d'invertébrés, comme les Ephemeroptera (éphémères), les Trichoptera (trichoptères) et les Culicidae (moustiques), ont fait l'objet d'inventaires intensifs, et représentent le plus grand pourcentage des taxons récemment décrits.

Pour comprendre les caractéristiques de la diversité biologique à Madagascar, il serait utile de poursuivre des recherches à long terme, y compris des inventaires utilisant des spécimens de référence ou au moins des tissus de référence, qui sont essentielles pour avoir une meilleure compréhension des caractéristiques biotiques et de la richesse en espèces. Ces informations sont primordiales pour la priorisation des nouvelles aires protégées ou pour les décisions relatives au développement économique associé à l'exploitation des ressources naturelles.

Mots clés: Région d'Andasibe, faune, flore, endémisme, rareté, espèces nouvelles

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Introduction

Associated with their close proximity and easy road access from Antananarivo, the forests in the general Andasibe region have been the most intensively studied by field biologists of any area on Madagascar (Dolch, 2008). As a result, it can be said that after close to a century of research, the biota of this area is amongst the best known on the island. Data on locally occurring plants and animals are of considerable importance in understanding the value of these forests in strict biological terms, as well as advancing conservation programs at local, regional, and national levels. The baffling and perhaps counter-intuitive aspect is that even though the Andasibe region forests are amongst "the best known" on the island, a remarkable number of new species to science have been described from the zone over the past few decades. Further, in order to advance regional conservation programs, other less known local forests outside of the Périnet-Andasibe block (=Réserve Spéciale d'Analamazaotra), need to be surveyed to understand local and regional distributional patterns of the fauna and flora.

One of the critical aspects to advance conservation programs, specifically prioritization, is to discern local patterns of micro-endemism and levels of biotic homogeneity/heterogeneity across different groups of organisms within a given region. Without such detailed data, it is difficult to properly evaluate the impact of regional development projects, in this case specifically the Ambatovy mining operation, which is having an impact on the Ambatovy-Analamay forest (e.g., Anonymous, 2007; see Dickinson & Berner, p. 2). Moreover, detailed data are required in order to have the needed foundation to advance conservation programs. The purpose of this monograph is specifically to review the known biodiversity of the Andasibe region, including the Ambatovy-Analamay forests, and, in this paper, the level of biotic discoveries (new taxa) is the principal focus.

Broad overview

The forests surrounding the Andasibe region are part of an extensive forest corridor linking the Zahamena forest in the north and the Ankeniheny forest in the south (Schmid & Alonso, 2005). This zone is variously referred to as the Zahamena-Ankeniheny, Zahamena-Moramanga, or Zahamena-Mantadia forest corridor. This is one of the last relatively extensive forests of the central east, albeit partially degraded and fragmented, in the area skirting the zone between the eastern escarpment and the lowlands. Currently, two protected areas have been established in the zone: 1) the Réserve Spéciale d'Analamazaotra, also known as Périnet, and in close vicinity to the village of Andasibe, which was given legal protection on 21 June 1970 and 2) Parc National de Mantadia created on 11 January 1989. During a 1995 workshop conducted in Antananarivo (Ganzhorn *et al*., 1997), associated with the prioritization of research and associated conservation actions on Madagascar, the Mantadia-Andasibe zone was given high priority due to its species diversity and levels of endemism.

The remaining forests of the Andasibe region are threatened by anthropogenic pressures associated with clearing for slash-and-burn agriculture (*tavy*), illegal and legal timber extraction, and small-scale artisanal and commercial mineral extraction. In a study published by Horning (2000), comparing forest cover images between the periods from 1993/94 to 1997/98, certain areas within the region had up to 5.6% annual forest loss. Further, based on data from 1993-2000, the mean annual deforestation rate in the Zahamena-Moramanga corridor or in the vicinity of the Route national 2 to the east of Moramanga ranged from 0.4% to 2.2% (Dufils, 2003).

One aspect that seriously hampers advancement of conservation programs in the region is thwarted economic development that results in a significant proportion of the growing population having to sustain themselves in a subsistence fashion. In the current socio-economic and educational system, many of these people have little choice. In order to advance properly development schemes, recent, well-founded, and comparable data are needed on the regional biota to form the basis of conservation and economic development evaluations. The associated decisions should be based on two different aspects that do not have to be seen as in conflict: 1) prioritization of the zones of highest conservation importance and 2) evaluation of economic development plans. In order to evaluate the first aspect of this equation, it is essential to know regional levels of micro-endemism, species richness, species turnover, and habitat heterogeneity. This information is, at least partially based, on biological inventories conducted with repeatable methodologies and including a range of taxonomic groups with different life-history traits.

Regional scale

In December 1998 and January 1999, portions of the Zahamena-Ankeniheny forest corridor were the subject of extensive multidisciplinary biological inventories to document the local biota (Schmid &

Alonso, 2005). The team visited five different sites using repeatable methodologies, and the accumulated data on plants, insects, reptiles, amphibians, birds, small mammals, and lemurs are important to place the biota of the Ambatovy-Analamay forests in a wider regional context. To highlight levels of discovery during this type of inventory, two species of frog and one species of reptile were found that the team herpetologists considered new to science (Rabibisoa *et al*., 2005).

Over the course of nearly a decade, different biologists conducted fieldwork in the Ambatovy-Analamay forests as part of environmental impact studies associated with the mining project, and many of these studies are presented in the current monograph. Between 6 January and 21 February 2009, a team of field biologists from the Association Vahatra conducted detailed biological inventories at numerous sites and habitats in this zone, using identical methodologies. The results of the herpetological (Raselimanana, p. 99), ornithological (Raherilalao, p. 124), mammalogical (Soarimalala & Raheriarisena, p. 153), and primatological (Ralison, p. 178) studies are presented herein.

The reserve complex of Analamazaotra-Mantadia is in close proximity to the Ambatovy-Analamay region (Figure 1) and the former forest blocks have been the subject of intense biological research for close to a century, covering a wide variety organisms and subjects, such as the local flora and forest regeneration (e.g. Abraham *et al*., 1996; Ramilison, 1996; Rasolofoharinoro *et al*., 1997; Holloway, 2000; Andriambelo *et al*., 2005), insect fauna (e.g. Viette, 1958a, 1958b, 1960; Andriamampianina, 2005; Rafamantanantsoa, 2005; Ratsirarson & Fisher, 2005), reptiles and amphibians (e.g. Rakotondravony, 2004; Vallan *et al*., 2004; Rabibisoa *et al*., 2005; Bora *et al*., 2008), birds (e.g. Nicoll & Langrand, 1989; Wilmé *et al*., 1997; ZICOMA, 1999; Rakotomanana *et al*., 2005), small mammals (e.g. Nicoll *et al*., 1988; Rakotondraparany, 1988; Stephenson, 1993), and particularly the lemur fauna (e.g. Petter & Peyrieras, 1974; Pollock, 1977, 1986; Ganzhorn & Rabesoa, 1986; Ganzhorn, 1992; Powzyk, 1997; Schmid *et al*., 2005; Biebouw *et al*., 2009). Even with this intensive level of inventory work and research, a considerable number of new discoveries concerning the regional biota have been made over the past decades. These can be divided into two different types of discovery: 1) already described species, unknown or poorly known from the region, and considered to be rare and 2) species completely new to science.

Local discoveries of poorly known taxa previously unrecorded or considered rare within the Andasibe region

Amongst the local avifauna, important discoveries have been made in the Andasibe region, which is one of the most extensively visited zones on the island by bird-watchers. ZICOMA (2000) reported the presence of the Slender-billed Flufftail, *Sarothrura watersi*, in the marsh system of Torotorofotsy, in close proximity to the Ambatovy-Analamay forests; this species was previously known from less than 20 specimens and very few recent observations (Wilmé & Langrand, 1990). Powzyk (1995) observed the Madagascar Red Owl, *Tyto soumagnei*, in the Parc National de Mantadia; this species was previously considered very rare (Lavauden, 1932; Halleux & Goodman, 1994), but is now known to have a wide geographic distribution (Cardiff & Goodman, 2008). Another example is the Madagascar Serpent Eagle, *Eutriorchis astur*, previously considered one of the rarest birds of prey in the world (Thiollay, 1994), which was reported from the regional forests before 1930 (Lavauden, 1932). This species was subsequently not recorded until the late 1990s, when it was noted at several different sites (Thorstrom & Rene de Roland, 1999; Rakotomanana *et al*., 2005). These discoveries are associated with a number of factors that include new field techniques not used by previous generations of naturalists (e.g. vocal recordings), greater knowledge of certain natural history traits of the organisms in question, researchers spending extensive periods of time living in the forest, and perhaps an element of chance.

As mentioned earlier, amongst mammals, the lemur fauna of the area has been intensively studied for several decades. Recent additions to the local species list underline the importance of long-term research in having greater insight in local species diversity, particularly rare or more difficult to observe animals. Primate taxa found in the region over the past few decades include *Daubentonia madagascariensis* (Ganzhorn & Rabesoa, 1986), *Allocebus trichotis* (Rakotoarison *et al*., 1996; Garbutt, 2001; Ramaromilanto *et al*., 2009), and *Hapalemur simus* (Dolch *et al*., 2004; Wright *et al*., 2008). Amongst the local insectivorous bats, specimens of *Neoromicia melckorum* (Family Vespertilionidae) have been recently collected in the Parc National de Mantadia; this is an African species that was previously unknown from Madagascar (Bates *et al*., 2006).

Extensive biological exploration of a zone helps to verify the distribution and conservation status of purportedly rare or poorly known organisms. An

excellent example for the Andasibe region is the tree *Brexia arborea* (Family Celastraceae), which was described from and only known from the Analamazaotra forests (Schatz & Lowry, 2004). Despite intensive botanical prospection of the forested portions of the area, this tree has not been located since 1924. Hence, over 85 years have passed since this species was found in the wild and it has an estimated extent of occurrence of less than 100 km^2. Given all of the botanical exploration of the area, including the Ambatovy-Analamay forests, the absence of subsequent records of this taxon clearly indicates that it is of considerable conservation concern.

Amongst the diverse palms of the Andasibe region, there is some clear evidence of local endemism. *Dypsis pulchella* was recently described based on older herbarium material from the portion of the Mangoro River drainage from Andasibe to Mahanoro (Dransfield & Beentje, 1995); the last known living specimen of this taxon was observed over 80 years ago. Another member of the genus, *D. jumelleana*, is common in the Analamazaotra forests, but largely unknown outside of this region. The massive palm *Beccariophoenix madagascariensis* was described from Analamazaotra and because of its large succulent "heart" tissue, has been extensively exploited, leaving very few living examples. Its conservation status is considered "Critical" (Dransfield & Beentje, 1995; Rakotoarinivo *et al*., 2007). Within the genus *Ravenea* there are two local species, *R. louvelli*, which is only known from a few individuals living on a steep slope within Analamazaotra, and *R. latisecta*, which has a very limited distribution in the Analamazaotra-Mantadia area and is considered "Endangered" (Dransfield & Beentje, 1995).

Species completely new to science

One of the remarkable aspects of the biota of Madagascar, is how little is really known about the fauna and flora, even in "well known" areas such as the Andasibe region. To illustrate this point, over the past few decades numerous different types of organisms (species and genera) have been described as new to science from the region. In some cases, taxonomists named these organisms using older specimens housed in museums/herbaria or based on recently collected material from field studies. After an extensive literature search, which by no means should be considered exhaustive, the following tabulation summarizes new taxa described over the last three decades from the general area from east of Moramanga, west to near Fanovana, south to Lakato, and north to the level of Fierenana. Angiosperm higher classification follows Angiosperm Phylogeny Group (2003), animals largely after Myers *et al*. (2008), and mites after Mahunka (2009).

Fungi

Phylum Ascomycota

Class Ascomycetes

- *Lepraria pallida* – a new species of dust lichen was described by Sipman (2004) based in part on material collected in the forests of Andasibe.

Class Lecanorales

- *Scoliciosporum arachnoideum* – a new species of lichen was described from Andasibe (Aptroot, 2008).

Plants

Bryophyta

Subclass Dicranaceae

- *Leucoloma madagascariense* – A new species of bryophyte was described from Andasibe (La Farge, 2002).

Marchantiophyta

Class Jungermanniopsida

- *Diplasiolejeunea andringitrae* – this species of liverwort was named based in part on paratypes from Andasibe and Maromiza (Pócs & Schäfer-Verwimp, 2006).

Pteridophyta

Class Pteridopsida

Family Cyatheaceae

- *Cyathea emilei* – this new species of tree fern was described from the Réserve Spéciale d'Analamazaotra **(**Janssen & Rakotondrainibe, 2008).

Angiosperm

Family Lauraceae

- *Aspidostemon capuronii*, *A. conoideum*, and *A. insigne* – three new species described from the route Moramanga-Anosibe, Ambatovy, and Périnet (Van der Werff, 2006).

Family Orchidaceae

- *Angraecum rubellum* – a new species of orchid was described based on a holotype coming from the Moramanga-Anosibe road (Bosser, 1988),
- *Bulbophyllum debile* – a new species of orchid was named based on material collected along the Lakato road (Bosser, 1989),

Table 1. Number of new species described from the general Andasibe region over the past three decades (n=229).

	1978-1985	1986-1990	1991-1995	1996-2000	2001-2005	2006-2009
Lichens					1	1
Bryophytes + liverworts					1	1
Ferns						1
Flowering plants						
Family Lauraceae						3
Family Orchidaceae		2		3	1	1
Family Arecaceae			1			
Family Melostomaceae						2
Family Elaeocarpaceae	1					
Family Sarcolaenaceae				1	1	
Family Thymelaeaceae					1	
Family Meliaceae				3		
Family Rubiaceae					4	
Family Lamiaceae				5		
Total for flowering plants	1	2	1	12	7	6
Protists		3				
Invertebrates						
Phylum Arthropoda						
Subphylum Crustacea						
Family Cyclophoridae			2			
Class Insecta						
Order Ephemeroptera						
Family Tricorythidae				5		
Family Polymitarcyidae				2		
Family Baetidae				8	5	
Family Oligoneuriidae						1
Family Palingeniidae		1				
Family Leptophlebiidae					1	
Order Hemiptera						
Family Aradidae						1
Family Caliscelidae						1
Family Cydnidae				2		
Family Tingidae			5			
Order Coleoptera						
Family Carabidae		1				
Family Cicindelidae				3	1	
Family Dytiscidae						1
Family Buprestidae					1	2
Family Elateridae					1	
Family Hydrophilidae					2	
Family Scarabaeidae				17		
Family Hybosoridae						1
Family Cetoniidae			1			
Family Staphylinidae			2	15		
Family Tenebrionidae				2		1
Order Diptera						
Family Drosophilidae		1	5			
Family Fannidae						1
Family Muscidae						1
Family Culicidae			1		19	1
Family Therevidae					1	
Order Hymenoptera						
Family Formicidae	1					2
Family Tiphiidae						2
Family Pompilidae					1	
Order Lepidoptera						
Family Pterophoridae			1			
Family Yponomeutidae					2	
Order Siphonaptera						
Family Ceratophyllidae					1	
Order Trichoptera						
Family Hydropsychidae						5
Family Hydroptilidae			1			
Family Leptoceridae				2		2
Family Philorheithridae						1
Family Lepidostomatidae						2
Family Petrothrincidae						1
Subphylum Myriapoda						
Order Spirobolida			1			2
Subphylum Chelicerata						
Class Arachnida						
Order Acari						
Family Hygrobatidae					1	
Family Oribotritiidae						1
Family Phthiracaridae			1			
Family Euphthiracaridae			1			
Family Tectocepheidae						1
Family Carabodidae						6
Family Oppiidae					1	
Family Suctobelbidae						2
Family Microzetidae			1			1
Family Otocepheidae			1			
Family Peloppiidae			1			
Family Haplozetidae						1
Order Araneae						
Family Cyatholipidae				2		
Family Gallieniellidae	3					
Family Migidae					1	
Family Salticidae						1
Family Sparassidae					1	
Family Theridiidae					6	1
Total for invertebrates	4	3	19	58	43	39
Vertebrates						
Class Actinopterygii (fishes)						
Family Bedotiidae						1
Class Reptilia						
Family Colubridae	1	2	1			
Ex-class Aves						
Family Bernieridae			1			
Class Amphibia						
Family Microhylidae					2	
Family Mantellidae			3	3	7	
Class Mammalia						
Family Tenrecidae			1			
Family Nesomyidae			1			
Family Cheirogaleidae					1	
Total for vertebrates	1	2	7	3	10	1

- *Bulbophyllum erythroglossum* and *B. anjozorobeense* – these new taxa were described by Bosser (2000) based on specimens collected along the Moramanga-Anosibe road,
- *Bulbophyllum petrae* – described from material collected at Ambatovy (Fischer *et al*., 2007a),
- *Bulbophyllum* sp. – Fischer *et al.* (2007b) noted that specimens of at least an additional three species of this genus, belonging to the sections *Elasmotopus*, *Lichenophylax*, and *Ploiarium*, were collected along the Lakato road. As these species have apparently not been named, they are not included in our summary tabulations (Table 1),
- *Beclardia grandiflora* – a news species of orchid was described from Andasibe (Bosser, 1997),
- *Bathiorchis rosea* – description of this new genus of orchid was based on specimens collected at Maromiza (Bosser & Cribb, 2003).

Family Arecaceae
- *Dypsis pulchella* – a specimen from Analamazaotra formed part of the type series of this new species of palm (Dransfield & Beentje, 1995).

Family Melastomataceae
- *Memecylon acrogenum* and *M. sejunctum* – the description of these two new species was based on specimens collected in the Andaside-Mantadia area (Stone, 2006).

Family Elaeocarpaceae
- *Elaeocarpus capuronii* – type material of this species was obtained from Périnet and Sandrangato (Moramanga) (Tirel, 1985).

Family Sarcolaenaceae
- *Rhodolaena coriacea* – this species was recently described based on a holotype collected at Anosibe An'Ala (Schatz *et al*., 2000),
- *Leptolaena abrahamii* – this new species, with the holotype from Andasibe and paratypes from Ambatovy, was described by Schatz *et al*. (2001).

Family Thymelaeaceae
- *Stephanodaphne pilosa* – a new species was named by Rogers (2004) based on material from the Parc National de Mantadia.

Family Meliaceae
- *Mallaestrum orientale* – this recently named species was based on specimens collected near Anosibe and Maromiza (Leroy & Lescot, 1996),
- *Astrotrichilia thouvenotii* and *A. parvifolia* – type material of these two taxa was collected near Analamazaotra/Périnet (Leroy & Lescot, 1996).

Family Rubiaceae
- *Breonia lowryi* – part of the types series of this new species was collected at "Forêt d'Analamazaotra" (Razafimandimbison, 2002),
- *Gaertnera darcyana* and *G. microphylla* – two new species to science from Andasibe and Mantadia (Malcomber & Davis, 2005),
- *Robbrechtia grandifolia* – new genus and species described from material collected in the general Andasibe, Lakato, and Moramanga region (de Block, 2003).

Family Lamiaceae
- *Plectanthus hirsutus*, *P. decaryi*, *P. ellipticus*, *P. humberti*, and *P. melleri* – type specimens of these new taxa were collected at the forêt d'Analamazaotra, Maromiza, Périnet, Andasibe, along the Lakato road, and Moramanga-Anosibe road (Hedge *et al.*, 1998).

Chromalveolata
Class Opalinea
Family Opalinidae
- *Protoopalina legeardi*, *P. grolleaui*, and *P. perantonii* – these three species of protist gut parasites were described from different species of *Mantidactylus*, *Scaphiophryne*, and *Aglyptodactylus* frogs collected in the Réserve Spéciale d'Analamazaotra (Delvinquier *et al*., 1998).

Animalia
Phylum Arthropoda (invertebrates)
Subphylum Crustacea
Family Cyclophoridae
- *Boucardicus perineti* and *B. peani* – two new species of land snail were described from Analamazaotra (Fischer-Piette *et al*., 1993).

Subphylum Hexapoda
Class Insecta
Subclass Pterygota (winged insects)
Order Ephemeroptera
Family Tricorythidae
- *Madecassorythus linae*, *M. ramanankasinae*, and *M. raphaeli* – a new genus and three new species of mayfly obtained at different sites within the Rianila River basin including "Tanambao-Pont routier", near the Lakato road, and "Andasibe-Réserve Mantady" (Elouard & Oliarinony, 1997; Oliarinony & Sartori, 2000),
- *Tricorythus ambinintsoae* – described from several different sites in the Mangoro River basin, as well as

the Sakanila River basin near Lakato (Oliarinony *et al*., 1998),
- *Ranorythus langrandi* – a new genus and species of mayfly was obtained near Ambodiriana, Rianila River basin (Oliarinony & Elouard, 1997).

Family Polymitarcyidae
- *Proboscidoplocia auberti* and *P. ruffieuxae* – two new species of mayfly were trapped near Ambodiriana and the "Tanambao-Pont routier" in the Rianila River basin (Elouard & Sartori, 1997).

Family Baetidae
- *Afroptiloides delphinae* and *A. spinosum* – holotypes of two new species of mayflies were collected from near Ambodiriana, Rianila River basin (Gattolliat, 2000),
- *Dabulamanzia gladius* – holotype of a new species from along the Lakato road, Rianila River basin (Gattolliat & Sartori, 2000a),
- *Demoulinia assimilis* – this new species of mayfly had the holotype collected from above Andasibe, Rianila River basin (Gattolliat, 2003),
- *Echinopus giboni* and *E. minutus* -- a new genus of mayfly with two species obtained 13 km from Moramanga (road to Anosibe An'ala) and near Moramanga in the Sahatandra River basin (Gattolliat, 2002a),
- *Guloptiloides gargantua* – a new genus with one species collected at Ambodiaviavy and Ambodiriana, Rianila River basin (Gattolliat & Sartori, 2000b),
- *Herbrossus christinae*, and *H. edmundsorum* – two new species of mayflies obtained at a site along the Lakato road, in the Parc National de Mantadia, and near Périnet in the Rianila River basin (Gattolliat & Sartori, 1998; Lugo-Ortiz & McCafferty, 1998),
- *Nigrobaetis cryptus* – a new species of mayfly from near Andasibe in the Rianila River basin (Gattolliat, 2004),
- *Xyrodromeus sartorii* – a new species of mayfly collected along the Lakato road in the Rianila River basin (Gattolliat, 2002b).

Family Oligoneuriidae
- *Rianilaneuria diminuta* – a new genus and species of mayfly named from material collected near Antanandava, Rianila River basin (Pescador & Peters, 2007).

Family Palingeniidae
- *Cheirogenesia laurencae* – a new species of mayfly from the "Pont routier Ambarikadera" in the Rianila River basin (Sartori & Elouard, 1999).

Family Leptophlebiidae
- *Radima edmundsorum* – a new genus and species of mayfly described from the Anevoka River, 15 km east of Andasibe by Akers *et al*. (2003).

Order Hemiptera
Family Aradidae
- *Chlonocoris bifurcatus* – a new species of flat bug was described from Maromiza (Heiss, 2006).

Family Caliscelidae
- *Signoreta victorina* – this new genus and species of a family previously not recorded on Madagascar was collected at Périnet (Gnezdilov & Bourgoin, 2009).

Family Cydnidae
- *Macroscytus simulans* and *M. tamatavei* – two species of burrower bugs described from "region of Mormanga" or "Mormanga env." (Lis, 1999).

Family Tingidae
- *Alinotingis perinetana*, *Hovatlas invaginatus*, *Cysteochila vicina*, *Conchotingis olsoufieffi*, and *Conchotingis longa* – five new species of lace bugs in five different genera were named from Périnet by Rodrigues (1992).

Order Coleoptera
Family Carabidae
- *Pseudomasoreus deuvei* – this new species of ground beetle was described based on material from along the Lakato road (Casale, 1998).

Family Cicindelidae
- *Pogonstoma andrei* – this new tiger beetle was described by Moravec (1999) from specimens collected at Beparasy and Maromiza,
- *Pogonstoma vybirali* and *P. praetervisum* – a portion of the type series of these new tiger beetles is from the region of Moramanga (Moravec, 2000, 2005),
- *Pogonostoma skrabali* – this species was named from specimens obtained near Lakato (Moravec, 2000).

Family Dytiscidae
- *Nethinius ballerioi* – a new species of predaceous diving beetle was described from Analamazaotra (Vitali, 2006).

Family Buprestidae
- *Falliellus richardi* – a new genus and species of jewel beetle was described based on material obtained at Périnet (Bellamy, 2001),
- *Madassetia unicolor* – a new genus and species

of jewel beetle named from material collected at Périnet (Bellamy, 2006),
- *Paranastella viridis* – Bellamy (2006) named this new species based on specimens collected at Périnet.

Family Elateridae
- *Agrypnus claudinae* – a new species of click beetle was named from Périnet (Dolin & Girard, 2003).

Family Hydrophilidae
- *Anacaena lutea* and *A. polita* – two new species of water scavenger beetles described from Andasibe (Komarek, 2004).

Family Scarabaeidae
- *Michaeloplia griveaudi*, *M. obscuram*, *M. tristis*, *M. peyrierasi*, *M. alboscutata*, and *M. marmorata* – six new species of scarab beetles were described by Lacroix (1997) from specimens collected near the Anosibe road, forest north of Anosibe, near Lakato, and Périnet,
- *Amorphochelus apicalis*, *A. breviarius*, *A. griseovarius*, and *A. gruveli* – four new species of scarab beetles were named from Périnet and near Moramanga (Lacroix, 1997),
- *Echyra semissaria*, *Paramorphochelus ciliatus*, *Blanchardoplia rufa*, *B. hirticula*, *Hopleidos echinatus*, *Pseudomicroplus vieui*, and *Delphinobius lebbei* – seven different species in an assortment of genera of scarab beetles were described from Périnet, Maromiza, and along the Lakato road (Lacroix, 1997).

Family Hybosoridae
- *Pseudosynarmostes mitsinjo* – this new genus and species was described from the forêt de Mitsinjo, which is part of the Station Forestière d'Analamazaotra (Ballerio, 2008).

Family Cetoniidae
- *Pygora pygidialoides* – a new species of flower beetle was named from Périnet (Paulian, 1994).

Family Staphylinidae
- *Adinopsis lemur* and *A. farakety* – two new species of rove beetle described from Andasibe (Janák, 1996),
- *Paederidus perrieri*, *Madacapaederus perinetensis*, *Astenus duflosi*, and *A. nodieri* – four new species of rove beetles from near Moramanga and Périnet (Lecoq, 1993, 1996),
- *Gyrophaena perinetensis*, *Hovastiba splendens*, *Madacazyras lemuriensis*, *Ditropandria implicata*, *Paracyphea perinetensis*, and *Aleochara hova* – six new species of rove beetle from the Périnet/ Andasibe area and along the Lakato road (Pace, 1999).
- *Stenus merina*, *S. stolarczyki*, *S. lecoqi*, *S. misaraka*, and *S. maromiza* – holotypes of these new taxa collected near Moramanga, Andasibe-Analamazaotra, and Maromiza (Janák, 2001).

Family Tenebrionidae
- *Antennoluprops bremeri* – part of the type series of this new genus and species is from the Andasibe and Maromiza region (Schawaller, 2007),
- *Macellocerus violanii* and *M. acutipenis* – these two new species were described based on holotypes collected at Périnet (Ferrer, 1998).

Order Diptera

Family Drosophilidae
- *Scaptomyza exilis* – this new taxon of fruit fly was described based on specimens from Andasibe (McEvey, 1990),
- *Zaprionus vurruca*, *Z. simplex*, *Z. litos*, *Z. circus*, and *Z. spinipilus* – paratypes and types of these five new fruit flies were collected at Andasibe (Chassagnard & McEvey, 1992).

Family Fannidae
- *Fannia malagasica* – one of the paratypes of this recently described fly was collected at Périnet (Pont, 2006).

Family Muscidae
- *Hydrotaea bella* – a new species of fly was named from Périnet (Couri *et al*., 2006).

Family Culicidae
- *Toxorhynchites fontenillei*, *T. brunhesi*, and *T. grjebinei* – three new species of mosquito described from the Périnet area; the first two species only known from this region (Ribeiro, 2004),
- *Uranotaenia* spp. – in a revision of this genus, Ramos & Brunhes (2004) described 16 new species of mosquito based on material collected in the general region of Moramanga-Andasibe,
- *Neomelaniconion nigropterum* – a new species of mosquito named from Andasibe (Le Goff *et al*., 2007),
- *Orthopodomyia fontenillei* – a new species of mosquito collected from between Moramanga and Beparasy (Brunhes & Hervy, 1995).

Family Therevidae
- *Microgephyra madagascariensis* – this new species

was described based on specimens collected in the Réserve Spéciale d'Analamazaotra (Hauser & Irwin, 2005).

Order Hymenoptera
Family Formicidae
- *Monomorium gongromos* and *M. micrommaton* – these two new species of ant were described by Heterick (2006) based on specimens collected in the Parc National de Mantadia and from the Zahamena-Ankeniheny corridor.
- *Pilotrochus besmerus* – an aberrant new genus and species of ant collected south of Moramanga on the road to Anosibe (Brown, 1978).

Family Tiphiidae
- *Anthobosca fisheri* and *A. hallucigenia* – material of these recently described wasp species was collected near Andasibe (Kimsey, 2009).

Family Pompilidae
- *Kyphopompilus atriventris* – the holotype of this new species of spider wasp was collected 25 km west of Morarano-Chrome and some of the paratypes are from Andasibe (Wahis, 2002).

Order Lepidoptera
Family Pterophoridae
- *Platyptilia peyrierasi* – a new species of plume moth collected from near Fanovana (Gibeaux, 1994).

Family Yponomeutidae
- *Rhabdocosma dolini* and *Yponomeuta madagascariensis* – two new species of ermine moth named from specimens obtained at Périnet (Gershenson, 2003).

Order Siphonaptera
Family Ceratophyllidae
- *Paractenopsyllus goodmani* – a new species of flea named from the Mantadia forest that is a parasite of the shrew-tenrec *Microgale soricoides* (Duchemin, 2003).

Order Trichoptera
Family Hydropsychidae
- *Cheumatopsyche chirapali*, *C. parafra*, *C. rineta*, *C. agha*, and *C. mahakaya* – five new species of net-spinning caddisfly from near Anosibe and Périnet (Olàh *et al*., 2008).

Family Hydroptilidae
- *Catoxyethira decampei* – new species of micro-caddisfly near the intersection between Moramanga and Beparasy, Mangoro River basin (Gibon & Ranaivoharindriaka, 1995).

Family Leptoceridae
- *Oecetis hertui* – a new species of long-horn caddisfly named from material collected in the "Réserve d'Andasibe" (Randriamasimanana & Gibon, 2000),
- *Leptocerina lakato* and *L. andringitra* – two new species of long-horn caddisfly from Ambodiriana, Rianila River basin, and along the Moramanga-Lakato road (Gibon & Randriamasimanana, 2007),
- *Leptocerus matilei* – a new species of long-horn caddisfly collected at several localities within the region including the Mangoro River and Sakanila River basins (Gibon & Randriamasimanana, 2000).

Family Philorheithridae
- *Afrorheithrus admirabilis* – a new genus and species of caddisfly from near Amboditafonana, Maningory River basin (Weaver *et al*., 2008).

Family Lepidostomatidae
- *Lepidostoma madagassicum* and *L. tamatavicum* – two new species of caddisfly from the Parc National de Mantadia and near Périnet (Weaver & Gibon, 2007).

Family Petrothrincidae
- *Petrothrincus dhritaparam* – a new species of caddisfly from Périnet (Johanson & Oláh, 2006).

Subphylum Myriapoda
Class Diplopoda
Order Spirobolida
- *Flagellobolus pauliani* and *Hylekobolus andasibensis* – two new species of millipedes described based on material collected at Périnet (Wesener *et al.*, 2009),
- *Betscheuma perinetense* – this millipede was described based on material obtained at Périnet (Mauriès, 1994).

Subphylum Chelicerata
Class Arachnida
Order Acari
Family Hygrobatidae
- *Moramangabates pauliani* – new genus and species of water mite was named from Sondrangato, 29 km route d'Anosibe (Gerecke, 2004).

Family Oribotritiidae
- *Oribotritia striata* – this new species of mite was described based on material collected in the Vohimana forest (Mahunka, 2009).

Family Phthiracaridae
- *Hoplophorella lemuria* – this species was named based on material obtained in the "Réserve spéciale Analamazaotra" (Mahunka, 1993).

Family Euphthiracaridae
- *Microtritia hauseri* – this species was described using specimens from the "Réserve spéciale Analamazaotra" (Mahunka, 1993).

Family Tectocepheidae
- *Tegeocranellus hungarorum* – Mahunka (2009) named this new species based on specimens collected in the Vohimana forest.

Family Carabodidae
- *Austrocarabodes armatus*, *A. blancharti*, *A. lateoalveolatus*, *A. parapustulatus*, *A. pustuloreticulatus*, and *Carabodes andasibe* – these six new species were described based on specimens collected in the Vohimana forest and Andasibe (Mahunka, 1993, 2009).

Family Oppiidae
- *Lanceoppia madagascariensis* – this new species of mite was found in the Maromiza forest (Mahunka, 2002).

Family Suctobelbidae
- *Parasuctobelba vohimana* and *Suctobelbella duplicondyla* – these new species were named based on material collected in the Vohimana forest (Mahunka, 2009).

Family Microzetidae
- *Hymenozetes csuzdii* – this new species was described based on material collected in the Vohimana forest (Mahunka, 2009),
- *Rhopalozetes madecssus* – this species was named based on material collected at the "Réserve spéciale Analamazaotra" (Mahunka, 1993).

Family Otocepheidae
- *Pseudotocephalus lienhardi* – this species was described using specimens obtained at the "Réserve spéciale Analamazaotra" (Mahunka, 1993).

Family Peloppiidae
- *Trichoppia longiseta* – Mahunka (1993) named this new species based on material collected in the "Réserve spéciale Analamazaotra".

Family Haplozetidae
- *Vilhenabates dissecatus* – Mahunka (2009) described this new species based on specimens collected in the Vohimana forest.

Order Araneae

Family Cyatholipidae
- *Vazaha toamasina* – this new genus and species were described based on specimens collected at Périnet (Griswold, 1997),
- *Alaranea merina* – this new taxon was described using material from Périnet (Griswold, 1997).

Family Gallieniellidae
- *Legendrena perinet*, *L. tamatave*, and *L. rolandi* – these three new species of long-jawed jumping spiders were described by Platnick (1984) from the forêt d'Analamazaotra.

Family Migidae
- *Paramigas andasibe* – this new species of trap door spider was described from An'Ala (Griswold & Ledford, 2001).

Family Salticidae
- *Tomocyrba andasibe* – this new species of jumping spider is only known from Andasibe (Maddison & Zhang, 2006).

Family Sparassidae
- *Chrosioderma mipentinapentina* – this spider was described from material collected in the "Andasibe National Park" (Silva-Dávila, 2005).

Family Theridiidae
- *Anelosimus may*, *A. nazariani*, *A. vondrona*, *A. andasibe*, *A. salut*, and *A. sallee* – six new species of cobweb weavers were described from Périnet (Agnarsson & Kuntner, 2005),
- *Asygyna huberi* – material used in the description of this new genus and species was obtained at Andasibe **(**Agnarsson, 2006).

Phylum Chordata

Subphylum Vertebrata (vertebrates)

Class Actinopterygii (fishes)

Family Bedotiidae
- *Bedotia leucopteron* – this species was described based on a holotype from near Ampasimbe, in the Rianila River drainage (Loiselle & Rodriguez, 2007),
- *Rheocles* sp. "Ambatovy" – this undescribed species was cited by Sparks & Stiassny (2008) in their review of Malagasy freshwater fishes. As this species has apparently not been named, it is not included in our summary tabulations (Table 1).

Class Reptilia

Order Squamata (reptiles, birds, crocodiles)

Family Colubridae

- *Ithycyphus perineti* – this new species of snake was described from Andasibe (Domergue, 1986),
- *Compsophis vinckei* – new species of snake named based on specimens from "Périnet (Analamazaotra)" (Domergue, 1988),
- *Pararhadinaea albignaci* – this species was described by Domergue (1984) using a specimen obtained "Foret tropicale d'Analamazaotra",
- *Stenophis jaosoloa* – briefly described by Domergue (1994) based on a single specimen collected at "Andasibe-Analamazaotra".

Family Scincidae

- *Amphiglossus* sp. – Rabibisoa *et al*. (2005) reported that a skink of this genus they collected in the Zahamena-Ankeniheny corridor was new to science. As this species has apparently not been named, it is not included in our summary tabulations (Table 1).

[ex-Class Aves]

Family Bernieridae

- *Cryptosylvicola randrianasoloi* – a new genus and species of bird (originally in the Family Sylvidae and now in the Family Bernieridae (Goodman & Hawkins, 2008) described from Maromiza (Goodman *et al*., 1995).

Class Amphibia

Family Microhylidae

- *Plethodontohyla mihanika* – the holotype of this new species was collected near Fierenana and a portion of the type series coming from Analamazaotra and Andasibe (Vences *et al*., 2003),
- *Plethodontohyla coronata* – this species was described from Ankeniheny (Vences & Glaw, 2003),
- *Plethodontohyla* sp. 1 – Rabibisoa *et al*. (2005) reported that a member of this genus collected in the Zahamena-Ankeniheny corridor was new to science. As this species has apparently not been named and might represent *P*. *mihanika* or *P*. *coronata*, it is not included in our summary tabulations (Table 1),
- *Stumpffia* spp. – Based on molecular phylogenetic inference, Vieites *et al*. (2009) estimate that two members of this genus remain undescribed from the Mantadia/Analamazaotra region. As these species have not been named, they are not included in our summary tabulations (Table 1).
- *Platypelis* sp. – Raselimanana (p. 108) found a species of this genus in the Ambatovy-Analamay forest that is apparently new to science. As this species has not been named, it is not included in our summary tabulations (Table 1).

Family Mantellidae

- *Boophis liami*, *B. lichenoides*, *B*. *solomaso*, *B*. *pyrrhus*, *B*. *picturatus*, *B*. *feonnyala*, *B*. *burgeri*, and *B*. *rufioculis* – eight new species of frog coming from Andasibe, Analamazaotra, An'Ala, Ambavaniasy, and Vohidrazana were recently named (Glaw & Vences, 1994; Glaw *et al*., 2001; Vallan *et al*., 1998, 2003),
- *Boophis* spp. – Based on molecular phylogenetic inference, Vieites *et al*. (2009) estimate that three members of this genus remain undescribed from the Mantadia/Analamazaotra region. As these species have not been named, they are not included in our summary tabulations (Table 1).
- *Gephyromantis moseri* and *G*. *thelenae* – two new species of frog described from Andasibe (Glaw & Vences, 1994, 2002),
- *Gephyromantis* and *Guibemantis* – Based on molecular phylogenetic inference, Vieites *et al*. (2009) estimate that one species in each of these genera remain undescribed from the Mantadia/Analamazaotra region. As these species have not been named, they are not included in our summary tabulations (Table 1).
- *Mantella* sp. – Rabibisoa *et al*. (2005) reported that a member of this genus collected in the Zahamena-Ankeniheny corridor was new to science. As this species has apparently not been described, it is not included in our summary tabulations (Table 1),
- *Mantidactylus phantasticus*, *M*. *kathrinae*, and *M*. *zipperi* – the holotypes of these new taxa were collected at An'Ala (Glaw & Vences, 1996, 2004; Glaw *et al*., 2000),
- *Mantidactylus* spp. – Based on molecular phylogenetic inference, Vieites *et al*. (2009) estimate that three members of this genus remain undescribed from the Mantadia/Analamazaotra region. As these species have not been named, they are not included in Table 1.

Class Mammalia

Family Tenrecidae

- *Microgale soricoides* – a new species of shrew-tenrec was described from Mantadia (Jenkins, 1993).

Family Nesomyidae

- *Eliurus petteri* – this new species of rodent was described from near Fanovana (Carleton, 1994).

Family Cheirogaleidae

- *Microcebus lehilahytsara* – a new species of mouse lemur described from the Station Forestière d'Analamazaotra (Kappeler *et al*., 2005).

Discussion

Remarkable new measures of local species richness

On the basis of this literature survey, 229 new taxa, mostly plants and animals, have been described from the general Andasibe region over the past three decades. This considerable number of new species to science, coming from one of the biologically best known areas of the island, underlines how little is really known about the terrestrial biological diversity of Madagascar. This begs the question of how many undescribed taxa occur in less biologically known areas of the island. Some of these descriptions used older material, but the majority were based on recently collected specimens. A critical point is that estimations of faunistic and floristic diversity is a dynamic process and even in a zone that has been intensively inventoried, previous measures are not definitive. Further, in many cases, it takes years for museum and herbarium scientists to work through collections, conduct systematic revisions, and describe new taxa. Hence, there is often a time lag between field research and naming new taxa represented in associated collections.

Most of these new taxa were named after 1996 (Figure 1) and very few were evaluated as new to science based on genetic studies. There are clearly some notable biases in certain taxonomic groups. The number of invertebrates named during this period is 176, which is notably greater than the 29 flowering plants and 24 vertebrates. For example, numerous new aquatic insects of the orders Ephemeroptera and Trichoptera are associated with large-scale inventory work and intensive museological studies conducted by Jean-Marc Elouard and colleagues (Elouard & Gibon, 2001). Mosquitoes, of the Family Culicidae, have been the subjects of considerable survey and taxonomic work due, at least in part, to their potential medical importance.

Recent collections made in the Andasibe area, while not necessarily containing new taxa, have also been primordial for resolving a range of systematic questions, ranging from higher level phylogenetic questions, the definition of generic and species limits, and biogeographic aspects. We could cite numerous recent publications in this regard, however we present only a few examples – for plants: revision of the genera *Bathiorhamnus* (Family Rhamnaceae) (Callmander *et al*., 2008), *Brexia* (Family Celastraceae) (Schatz & Lowry, 2004), and *Rhodolaena* and *Leptolaena* (Family Sarcolaenaceae) (Schatz *et al*., 2000, 2001) and for animals: revision of the ant genus *Anochetus* (Family Formicidae) and ant phylogenetic studies (Brady *et al*., 2006; Fisher & Smith, 2008) and molecular research on frogs (e.g., Vences *et al*., 2004) and shrew tenrecs (Family Tenrecidae) (Olson *et al*., 2004).

During different periods between 1978 and 2009, the number of species described from the region shows notable variation. The period with the greatest number of new species is 1996-2000, with slight declines in the subsequent two periods (2001-2005 and 2006-2009). It would be incorrect to interpret this reduction in new species after 1996-2000 as approaching a nearly complete inventory of the zone. Rather, this is associated with research cycles of different generations of researchers. Recent inventory work in the area will result in the identification and description of numerous new taxa. For example, invertebrate surveys conducted by Brian Fisher of the California Academy of Sciences and his collaborators have resulted in considerable new collections, which are only now being published on and show extraordinary levels of undescribed species and even genera (B. L. Fisher, pers. comm.).

Importance of systematic revisions in evolutionary and conservation biology

Taxonomic revisions and the associated descriptions of new plants and animals provide new insights into the evolution of the group in question; this is particularly the case with the advent of molecular studies. Field research examining aspects of evolutionary and conservation biology need to be based on a solid-foundation of systematic science and, when possible, voucher specimens or at least tissue samples of the study organisms. Without such representative material, certain subsequent problems can arise in terms of knowing which taxa are involved. To underline the importance of this point, here we cite two of many examples from the Analamazaotra-Périnet region.

1) Randrianandrianina *et al*. (2006) conducted a field project on the habitat use of insectivorous bats in forested and degraded zones of the Parc National de Mantadia and the Réserve Spéciale d'Analamazaotra. One of their study species, "*Miniopterus manavi*", has subsequently been shown to be paraphyletic based on molecular genetic and morphological characters, and at certain localities several similarly sized cryptic

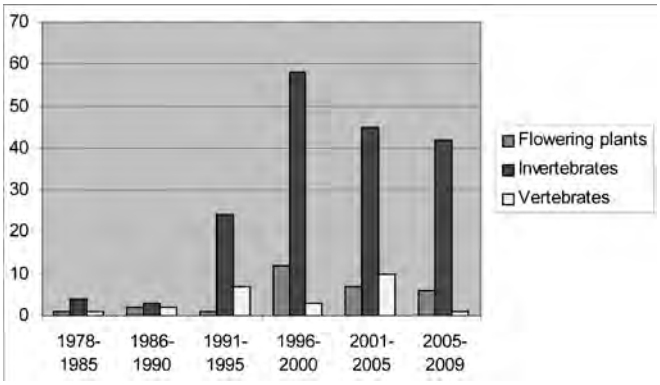

Figure 1. Summary of new species of plants, invertebrates, and vertebrates described from the general Andasibe region over the past three decades (n=229). A single species of lichen was described in the area in 2008 and is not presented in the figure.

species occur in strict sympatry (Goodman *et al*., 2009a, 2009b). There is a possibility that their study animals are not *M*. *manavi* sensu stricto, but rather another or other species.

2) Stephenson & Racey (1993) conducted studies on the physiology of different shrew-tenrecs of the genus *Microgale* (Tenrecidae) on Madagascar, including animals captured in Analamazaotra. These data provide interesting insights into the physiological adaptations of tenrecs to different climatic and reproductive regimes. As far as can be determined, no voucher specimens or tissue samples were saved of the individual animals tested. Subsequently, the genus *Microgale* has been extensively revised (summarized in Jenkins, 2003) and in several cases, the definition of the specific names Stephenson & Racey (1993) assigned to their study animals have been modified. Hence, in such cases it is unclear which taxon/taxa the data apply to and without associated voucher specimens, their proper identification will remain ambiguous.

The Périnet effect or mid-domain effect

In 1997, Lees published a paper on species richness gradients in the eastern humid forests of Madagascar using, for the most part, the distributions of satyrine butterflies. Based on the mapping of extensive locality data for a large number of taxa, these animals show the highest diversity in the elevational zone from 900-1300 m and the latitudinal/longitudinal zones from 17-20°S and 47-48°E. This biodiversity hot spot falls within the area of Périnet or Andasibe. Hence, the term “Périnet effect” was coined by Lees (1997) for measures of high diversity in the Andasibe area that was apparently not correlated with different ecological gradients, such as meteorology, altitudinal variation, or habitat area, or sampling effort. Rather, he concluded, that non-biological factors associated with constraining aspects of the distribution of these butterflies, was best explained by geometric constraints on the geographic ranges of these organisms.

The topic of the “Périnet effect” was further reassessed by Colwell & Lees (2000a) based on more extensive analysis, a larger database, and a broader geographical context. They examined different models to explain geographic patterns in species distribution and concluded that geometry of distribution, perhaps associated with physiographical and physiological boundaries, plays an important and previously neglected role in species richness patterns. This biogeographical pattern has become known as the “mid-domain effect”. Subsequently, several authors have questioned the application of mid-domain effect models in the humid eastern forests of Madagascar (e.g. Bokma & Mönkkönen, 2000; Kerr *et al.,* 2006), and these criticisms have been addressed (Colwell & Lees, 2000b; Lees & Colwell, 2007). Several more recent and relatively complete datasets, for example ants and mammals (Fisher, 2005; Townsend *et al*., 2009; Muldoon & Goodman, 2010), have not shown notably higher measures of species richness in the Andasibe region.

Conclusion

In this review, we underline the importance of biological inventories and associated systematic studies of collected specimens. The Andasibe region is presented as a case example. This zone has been studied by biologists for over a century, and can be considered the biologically best-known area on Madagascar. Having said that, numerous species thought to be rare and perhaps on the verge of extinction have been found locally, as well as named taxa that were previously unrecorded in the zone. Based on a literature survey, nearly 230 new species to science have been described from the general Andasibe region since 1978. This level of discovery has considerable importance for understanding biogeographic patterns and species turnover for the region. Continued exploration of such “well-known” areas, as well as less intensively studied forested zones, is critical in order to document the current biodiversity of Madagascar and to advance studies in the domain of evolutionary biology, using these data to prioritize conservation actions.

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References

Abraham, J.-P., Rakotonirina, B., Randrianasolo, M., Ganzhorn, J. U., Jeannoda, V. & Leigh, E. G. 1996. Tree diversity on small plots in Madagascar: A preliminary review. *Revue d'Ecologie*, 51: 93–116.

Agnarsson, I. 2006. Asymmetric female genitalia and other remarkable morphology in a new genus of cobweb spiders (Theridiidae, Araneae) from Madagascar. *Biological Journal of the Linnean Society*, 87: 211-232.

Agnarsson, I. & Kuntner, M. 2005. Madagascar: An unexpected hotspot of social *Anelosimus* spider diversity (Araneae: Theridiidae). *Systematic Entomology*, 30: 575-592.

Akers, A. A., Peters, W. L. & Peters, J. G. 2003. *Radima edmundsorum*, a new genus and species of Atalophlebiinae from Madagascar (Ephemeroptera: Leptophlebiidae). In *Research update on Ephemeroptera & Plecoptera*, ed. E. Gaino, pp. 85-89. University of Perugia, Perugia.

Andriamampianina, L. 2005. Inventaire des insectes cicindèles (Coléoptères, Cicindelidae) dans le corridor Mantadia-Zahamena, Madagascar. In Une évaluation biologique rapide du corridor Mantadia-Zahamena à Madagascar, eds. J. Schmid & L. E. Alonso. *Bulletin RAP d'Evaluation Rapide* (Conservation International, Washington, D.C.) 32: 122-128, 196-197.

Andriambelo, L. H., Andrianarisata, M., Randrianjanaka, M. L., Razakamalala, R. & Ranaivojaona, R. 2005. La diversité floristique du corridor Mantadia-Zahamena, Madagascar In Une évaluation biologique rapide du corridor Mantadia-Zahamena à Madagascar, eds. J. Schmid & L. E. Alonso. *Bulletin RAP d'Evaluation Rapide* (Conservation International. Washington, D.C.) 32: 33-60, 153-168.

Angiosperm Phylogeny Group. 2003. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. *Botanical Journal of the Linnean Society*, 141: 399-436.

Anonymous. 2007. Deforestation due to begin at the Dynatec mine, Ambatovy, Moramanga. *Ravintsara*, 4(2): 5.

Aptroot, A. 2008. A new *Scoliciosporum* from Madagascar. *The Lichenologist*, 40(2): 119-122.

Ballerio, A. 2008. Description of two new endemic genera and four new species of Ceratocanthinae (Insecta, Coleoptera, Scarabaeoidea, Hybosoridae) from Madagascar. *Zoosystema*, 30: 605-628.

Bates, P. J. J., Ratrimomanarivo, F., Harrison, D. L. & Goodman, S. M. 2006. A review of pipistrelles and serotines (Chiroptera: Vespertilionidae) from Madagascar, including the description of a new species of *Pipistrellus*. *Acta Chiropterologica*, 8: 299-324.

Bellamy, C. L. 2001. The Madagascan Coraebini Bedel (Coleoptera: Buprestidae: Grilinae): A new genus and species. *The Coleopterists' Bulletin*, 55: 167–171.

Bellamy, C. L. 2006. Insecta, Coleoptera, Buprestidae de Madagascar et des îles voisines. *Faune de Madagascar*, 92: 1-267.

Biebouw, K., Bearder, S. & Nekaris, A. 2009. Tree hole utilisation by the hairy-eared dwarf lemur (*Allocebus trichotis*) in Analamazaotra Special Reserve. *Folia Primatologica*, 80: 89-103.

Bora, P., Dolch, R., Jenkins, R., Jovanovic, O., Rabemananjara, F. C. E., Randrianirina, J., Rafanomezantsoa, J., Raharivololoniaina, L., Ramilijaona, O., Raminosoa, N., Randrianavelona, R., Raselimanana, Razafimahatratra, B., Razafindraibe, T. & Vences, M. 2008. Geographical distribution of three species of Malagasy poison frogs of high conservation priority: *Mantella aurantiaca*, *M. crocea* and *M. milotympanum*. *Herpetology Notes*, 1: 39-48.

Bosser, J. 1988. Contribution a l'étude des Orchidaceae de Madagascar et des Mascareignes. XXIII. *Adansonia*, série 4, 10 (1): 19-24.

Bosser, J. 1989. Contribution a l'étude des Orchidaceae de Madagascar et des Mascareignes. XXVI. *Adansonia*, série 4, 11 (4): 369-382.

Bosser, J. 1997. Contribution a l'étude des Orchidaceae de Madagascar et des Mascareignes. XXVII. *Adansonia*, série 3, 19 (2): 181-188.

Bosser, J. 2000. Contribution à l'étude des Orchidaceae de Madagascar et des Mascareignes. XXIX. Révision de la section *Kainochilus* du genre *Bulbophyllum. Adansonia,* série 3, 22 (2): 167-182.

Bosser, J. & Cribb, P. J. 2003. Contribution à l'étude des Orchidaceae de Madagascar, des Comores et des Mascareignes. XXXIV. *Bathiorchis*, nouveau genre monotypique de Madagascar. *Adansonia*, série 3, 25: 229-231.

Brady, S. G., Fisher, B. L., Schultz, T. R. & Ward, P. S. 2006. Evaluating alternative hypotheses for the early evolution and diversification of ants. *Proceedings of the National Academy of Sciences of the United States of America*, 103: 18172-18177.

Brown, W. L. 1978. An aberrant new genus of myrmicine ant from Madagascar. *Psyche*, 84: 218-224.

Brunhes, J. & Hervy, J.-P. 1995. Insectes, Diptères, Culicidae, Culicinae, Genre *Orthopodomyia* de la sous-région malgache et de la région afrotropicale. *Faune de Madagascar*, 85: 1-119.

Callmander, M. W., Phillipson, P. B. & Buerki, S. 2008. Révision du genre *Bathiorhamnus* Capuron (Rhamnaceae) endémique de Madagascar. *Adansonia*, série 3, 30: 151-170.

Casale, A. 1998. *Pseudomasoreus deuvei* new species from Madagascar, with notes about some genera of Afrotropical and Madagascan Cymidini (Coleoptera, Carabidae). *Bollettino della Societa Entomologica Italiana*, 130: 117-124.

Cardiff, S. G. & Goodman, S. M. 2008. Natural history of Red Owls (*Tyto soumagnei*) in dry deciduous tropical forest in Madagascar. *The Wilson Journal of Ornithology*, 20: 892–898.

Carleton, M. D. 1994. Systematic studies of Madagascar's endemic rodents (Muroidea: Nesomyinae): Revision of the genus *Eliurus*. *American Museum Novitates*, 3087: 1-55.

Chassagnard, M.-T. & McEvey, S. 1992. The *Zaprionus* of Madagascar, with descriptions of five new species (*Diptera: Drosophilidae*). *Annales de la Société Entomologique de France*, nouvelle série, 28: 317-335.

Colwell, R. K. & Lees, D. C. 2000a. The mid-domain effect: Geometric constraints on the geography of species richness. *Trends in Ecology and Evolution*, 15: 70-76.

Colwell, R. K. & Lees, D. C. 2000b. Reply from R. K. Colwell and D. C. Lees. *Trends in Ecology and Evolution*, 15: 289.

Couri, M. S., Pont, A. C. & Penny, N. D. 2006. Muscidae (Diptera) from Madagascar: Identification keys, descriptions of new species, and new records. *Proceedings of the California Academy of Sciences,* 4th series, 57 (29): 799-923.

de Block, P. 2003. *Robbrechtia*, a new Rubiaceae genus from Madagascar. *Systematic Botany*, 28: 145-156.

Delvinquier, B. L. J., Glaw, F., Markus, M. B. & Passmore, N. I. 1998. Opalinidae (Slopalinida) in Madagascan Anura: *Zelleriella* Metcalf, 1920 and *Protoopalina* Metcalf, 1918. *Systematic Parasitology*, 41: 187-196.

Dolch, R. 2008. Andasibe (Périnet) les efforts actuellement entrepris sont-ils suffisants pour protéger la nature du "hot-spot" de biodiversité a Madagascar? In *Paysages naturels et biodiversité de Madagascar*, ed. S. M. Goodman, pp. 547-557. Muséum national d'Histoire naturelle, Paris.

Dolch, R., Hilgartner, R. D., Ndriamiary, J. N. & Randriamahazo, H. 2004. The grandmother of all bamboo lemurs: Evidence for the occurrence of *Hapalemur simus* in fragmented rainforest surrounding the Torotorofotsy marshes, central eastern Madagascar. *Lemur News*, 9: 24-26.

Dolin, V. C. & Girard, C. 2003. Some new curious click-beetle species (Coleoptera, Elateridae) from Madagascar. *Vestnik zoologii*, 37(3): 85–88.

Domergue, C. A. 1984. Notes sur les serpents de la région malgache. IV. Le genre *Pararhadinaea* Boettger, 1898. Descriptions d'une espèce et d'une sous-espèce nouvelles. *Bulletin du Muséum National d'Histoire Naturelle*, Paris, série 4, 6A(1): 149-157.

Domergue, C. A. 1986. Notes sur les serpents de la région Malgache. VI. Le genre *Ithycyphus* Gunther, 1873; description de deux espèces nouvelles. *Bulletin du Muséum National d'Histoire Naturelle*, Paris, série 4, 8: 409-434.

Domergue, C. A. 1988. Notes sur les serpents de la région malgache VIII. Colubridae nouveaux. *Bulletin du Muséum National d'Histoire Naturelle*, série 4, 10: 135-146.

Domergue, C. A. 1994. Serpents de Madagascar : Note [pré] liminaire sur des espèces nouvelles du genre *Stenophis* Boulenger, 1896 (Colubridae-Boiginae). *Archives Institut Pasteur de Madagascar*, 61: 121-122.

Dransfield, J. & Beentje, H. 1995. *The palms of Madagascar*. The Royal Botanic Gardens, Kew.

Duchemin, J. B. 2003. Two new fleas (Siphonoptera: Ceratophyllidae: Leptopsyllinae) of Madagascar: *Tsaractenus rodhaini* n. sp. and *Paractenopsyllus* (*Consobrinopsyllus* n. subgen.) *goodmani* n. sp. *Parasite*, 10: 351-358.

Dufils, J.-M. 2003. Remaining forest cover. In *The natural history of Madagascar*, eds. S. M. Goodman & J. P. Benstead, pp. 88-96. The University of Chicago Press, Chicago.

Elouard, J.-M. & Gibon, F.-M. 2001. *Biodiversité et biotypologie des eaux continentales malgaches*. IRD, Montpellier.

Elouard, J.-M. & Oliarinony, R. 1997. Biodiversité aquatique de Madagascar. 6 - *Madecassorythus* un nouveau genre de Tricorythidae définissant la nouvelle sous-famille des Madecassorythinae (Ephemeroptera, Pannota). *Bulletin de la Société Entomologique de France*, 102 (3): 225-232.

Elouard, J.-M. & Sartori, M. 1997. *Proboscidoplocia*: A singular plural (Ephemeroptera: Polymitarcyidae: Euthyplociinae). In *Ephemeroptera & Plecoptera biology-ecology-systematics*, eds. P. Landolt & M. Sartori, pp. 439-448. Mauron, Tinguely & Lachat, Frieburg.

Fischer-Piette, E., Blanc, C. P., Blanc, F. & Salvat, F. 1993. Gastéropodes, terrestres prosobranches. *Faune de Madagascar*, 80: 1-281.

Fischer, G. A., Sieder, A., Cribb, P. J. & Kiehn, M. 2007a. Description of two new species and one new section of *Bulbophyllum* (Orchidaceae) from Madagascar. *Adansonia*, série 3, 29: 19-25.

Fischer, G. A., Gravendeel, B., Sieder, A., Andriantiana, J., Heiselmayer, P., Cribb, P. J., de Camargo Smidt, E., Samuel, R. & Kiehn, M. 2007b. Evolution of resupination in Malagasy species of *Bulbophyllum* (Orchidaceae). *Molecular Phylogenetics and Evolution*, 45: 358-376.

Fisher, B. L. 2005. A model for a global inventory of ants: A case study in Madagascar. In Biodiversity: A symposium held on the occasion of the 150th anniversary of the California Academy of Sciences, ed. N. G. Jablonski. *Proceedings of the California Academy of Sciences*, 56: 78-89.

Fisher, B. L. & Smith, M. A. 2008. A revision of Malagasy species of *Anochetus* Mayr and *Odontomachus* Latreille (Hymenoptera: Formicidae). *PLoS ONE*, 3(5): e1787. doi:10.1371/journal.pone.0001787.

Ferrer, J. 1998. Contribution a la connaissance des Tenebrionidae de Madagascar (Insecta, Coleoptera). *Entomofauna, Zeitschrift für Entomologie*, 19 (23): 353-404.

Ganzhorn, J. U. 1992. Leaf chemistry and the biomass of folivorous primates in tropical forests. *Oecologia*, Berlin 91: 540-547.

Ganzhorn, J. U. & Rabesoa, J. 1986. The aye-aye (*Daubentonia madagascariensis*) found in the eastern rainforest of Madagascar. *Folia Primatologica*, 46: 125-126.

Ganzhorn, J. U., Rakotosamimanana, B., Hannah, L., Hough, J., Iyer, L., Olivieri, S., Rajaobelina, S., Rodstrom, C. & Tilkin, G. 1997. Priorities for biodiversity conservation in Madagascar. *Primate Report*, 48-1: 1-81.

Garbutt, N. 2001. Brief observations of the hairy-eared dwarf lemur (*Allocebus trichotis*) in Analamazaotra Special Reserve, eastern Madagascar. *Lemur News*, 6: 37.

Gattolliat, J.-L. 2000. Three new species of *Afroptiloides* (Insecta: Ephemeroptera) and first report of this genus from Madagascar. *Bulletin de la Société entomologique Suisse*, 73: 305-315.

Gattolliat, J.-L. 2002a. Two new genera of Baetidae (Ephemeroptera; Insecta) from Madagascar. *Aquatic Insects*, 24:143-159.

Gattolliat, J.-L. 2002b. Three new Malagasy species of *Xyrodromeus* (Ephemeroptera: Baetidae) with the first generic description of the adults. *Revue Suisse de Zoologie*, 109 (2): 325-341.

Gattolliat, J.-L. 2003. The genera *Demoulinia* Gillies and *Potamocloeon* Gillies (Ephemeroptera: Baetidae) in Madagascar. *Zootaxa*, 184: 1-18.

Gattolliat, J.-L. 2004. First reports of the genus *Nigrobaetis* Novikova & Kluge (Ephemeroptera: Baetidae) from Madagascar and La Réunion with observations on Afrotropical biogeography. *Revue Suisse de Zoologie*, 111: 657-669.

Gattolliat, J.-L. & Sartori, M. 1998. Two new species of *Herbrossus* (Ephemeroptera: Baetidae) from Madagascar with the first generic description of the adults. *Annales de Limnologie*, 34: 305-314.

Gattolliat, J.-L. & Sartori, M. 2000a. Contribution to the systematics of the genus *Dabulamanzia* (Ephemeroptera: Baetidae) in Madagascar. *Revue Suisse de Zoologie*, 107: 561-577.

Gattolliat, J.-L. & Sartori, M. 2000b. *Guloptiloides*: An extraordinary new carnivorous genus of Baetidae (Ephemeroptera). *Aquatic Insects*, 22(2): 148-159.

Gerecke, R. 2004. The water mites of Madagascar (Acari, Hydrachnidia): A revised list completed by original material conserved at the Muséum national d'Histoire naturelle, Paris. *Zoosystema*, 26: 393-418.

Gershenson, Z. S. 2003. Two new species of Yponomeutoid moths (Lepidoptera, Yponomeutidae, Plutellidae) from Madagascar. *Vestnik zoologii*, 37(3): 93-95.

Gibeaux, C. 1994. Insectes, Lepidopteres, Pterophoridae. *Faune de Madagascar*, 81: 1-175.

Gibon, F.-M. & Ranaivoharindriaka, F. 1995. Présence du genre *Catoxyethira* à Madagascar et descriptions des premières espèces (Trichoptera, Hydroptilidae). *Revue française d'Entomologie*, nouvelle série, 17 (3): 107-114.

Gibon, F.-M. & Randriamasimanana, D. 2000. *Leptocerus matilei n. sp.* Première espèce du genre signalée à Madagascar (Trichoptera, Leptoceridae). *Revue française d'Entomologie*, nouvelle série, 22: 185-188.

Gibon, F.-M. & Randriamasimanana, D. 2007. Le genre *Leptocerina* Mosely 1932 à Madagascar : systématique, habitat et répartition géographique (Trichoptera: Leptoceridae). *Annales de la Société Entomologique de France,* nouvelle série, 43 (1): 87-94.

Glaw, F. & Vences, M. 1994. *A fieldguide to the amphibians and reptiles of Madagascar*, 2nd edition. Vences & Glaw Verlag, Koln.

Glaw, F. & Vences, M. 1996. Neue daten über die *Mantidactylus*-Untergattung *Spinomantis* (Anura: Ranidae: Mantellinae) aus Madagaskar, mit Beschreibung einer neuen art. *Salamanadra*, 32: 243-258.

Glaw, F. & Vences, M. 2002. A new species of *Mantidactylus* (Anura: Mantellidae) from Andasibe in eastern Madagascar. *Journal of Herpetology,* 36:372-378.

Glaw, F. & Vences, M. 2004. Revision of the subgenus *Chonomantis* (Anura: Mantellidae: *Mantidactylus*) from Madagascar, with description of two new species. *Journal of Natural History*, 38: 77-118.

Glaw, F., Vences, M. & Gossmann, V. 2000. A new species of *Mantidactylus* (subgenus *Guibemantis*) from Madagascar, with a comparative survey of internal femoral gland structure in the genus. *Journal of Natural History*, 34: 1135-1154.

Glaw, F., Vences, M., Andreone, F. & Vallan, D. 2001. Revision of the *Boophis majori* group (Amphibia: Mantellidae) from Madagascar, with descriptions of five new species. *Zoological Journal of the Linnean Society,* 133: 495-529.

Gnezdilov, V. M. & Bourgoin, T. 2009. First record of the Family Caliscelidae (Hemiptera: Fulgoroidea) from Madagascar, with description of new taxa from the Afrotropical Region and biogeographical notes. *Zootaxa*, 2020: 1-36.

Goodman, S. M. & Hawkins, A. F. A. 2008. Les oiseaux. In *Paysages naturels et biodiversité de Madagascar*, ed. S. M. Goodman, pp. 383-434. Muséum national d'Histoire naturelle, Paris.

Goodman, S. M., Langrand, O. & Whitney, B. M. 1995. A new genus and species of passerine from the eastern rain forest of Madagascar. *Ibis*, 138: 153-159.

Goodman, S. M., Maminirina, C. P., Weyeneth, N., Bradman, H. M., Christidis, L., Ruedi, M. & Appleton, B. 2009a. The use of molecular and morphological characters to resolve the taxonomic identity of cryptic species: The case of *Miniopterus manavi* (Chiroptera: Miniopteridae). *Zoologica Scripta*, 38: 339-363.

Goodman, S. M., Maminirina, C. P., Bradman, H. M., Christidis, L. & Appleton, B. 2009b. The use of molecular phylogenetic and morphological tools to identify cryptic and paraphyletic species: Examples from the diminutive long-fingered bats (*Miniopterus*:

Miniopteridae: Chiroptera) on Madagascar. *American Museum Novitates*, 3669: 1-33.

Griswold, C. E. 1997. The spider family Cyatholipidae in Madagascar (Araneae, Araneoidea). *The Journal of Arachnology*, 25: 53-83.

Griswold, C. E. & Ledford, J. 2001. A monograph of the migid trap door spiders of Madagascar and review of world genera (Araneae, Mygalomorphe, Migidae). *Occasional Papers of the California Academy of Sciences*, 151: 1-120.

Halleux, D. & Goodman, S.M. 1994. The rediscovery of the Madagascar Red Owl *Tyto soumagnei* (Grandidier, 1878) in north-eastern Madagascar. *Bird Conservation International*, 4: 263-277.

Hauser, M. & Irwin, M. E. 2005. The subfamily Xestomyzinae (Diptera: Therevidae) new to Madagascar, with the description of four new species. *African Invertebrates*, 46: 181–202.

Hedge, I. C., Clement, R. A., Paton, A. J. & Phillipson, P. B. 1998. Labiatae. *Flore de Madagascar et des Comores*, 175: 1-293.

Heiss, E. 2006. Two new species of the monobasic genus *Chlonocoris* USINGER et MATSUDA, 1959 from Madagascar (Heteroptera: Aradidae). *Polish Journal of Entomology*, 75: 219-226.

Heterick, B. 2006. A revision of the Malagasy ants belonging to genus *Monomorium* Mayr, 1855 (Hymenoptera: Formicidae). *Proceedings of the California Academy of Science*, 57: 69–202.

Holloway, L. 2000. Catalysing rainforest restoration in Madagascar. In *Diversité et endémisme à Madagascar*, eds. W. R. Lourenço & S. M. Goodman, pp. 115-124. Mémoires de la Société de Biogéographie, Paris.

Horning, N. 2000. Changes in forest cover from 1993/94 - 1997/98 in target zones around protected areas. *Lemur News*, 5: 28-30.

Janák, J. 1996. Zwei neue Arten der Gattung *Adinopsis* aus Madagaskar (Coleoptera, Staphylinidae, Aleocharinae, Deinopsini). *Zeitschrift für Entomologie*, 17 (19): 325-336.

Janák, J. 2001. *Stenus*-Arten, auf Madagaskar von tschechischen Entomologen gesammelt (Coleoptera: Staphylinidae). *Klapalekiana*, 37: 179-223.

Janssen, T. & Rakotondrainibe, F. 2008. A revision of the indusiate scaly tree ferns (Cyatheaceae, *Cyathea* subgen. *Alsophila* sect. *Alsophila*) in Madagascar, the Comoros and the Seychelles. *Adansonia*, série 3, 30: 221-376.

Jenkins, P. D. 1993. A new species of *Microgale* (Insectivora, Tenrecidae) from eastern Madagascar with an unusual dentition. *American Museum Novitates*, 3067: 1–11.

Jenkins, P. D. 2003. *Microgale*, shrew tenrecs. In *The natural history of Madagascar*, eds. S. M. Goodman & J. P. Benstead, pp. 1273-1278. The University of Chicago Press, Chicago.

Johanson, K. A. & Oláh, J. 2006. Eleven new species of Sericostomatoidea from Madagascar (Trichoptera: Helicopsychidae, Petrothrincidae, Sericostomatidae). *Zootaxa*, 1205: 1–30.

Kappeler, P. M., Rasoloarison, R. M., Razafimanantsoa, L., Walter, L. & Roos, C. 2005. Morphology, behaviour and molecular evolution of giant mouse lemurs (*Mirza* spp.) Gray, 1870, with description of a new species. *Primate Report*, 71: 3-26.

Kerr, J. T., Perring, M. & Currie, D. J. 2006. The missing Madagascan mid-domain effect. *Ecology Letters*, 9: 149-159.

Kimsey, L. S. 2009. Review of the Malagasy *Anthobosca*, the bizarre and the sublime (Hymenoptera: Tiphiidae: Anthoboscinae). *Zootaxa*, 2175: 1-18.

Komarek, A. 2004. Taxonomic revision of *Anacaena* THOMSON, 1859 I. Afrotropical species (Coleoptera: Hydrophilidae). *Koleopterologische Rundschau*, 74: 303-349.

Lacroix, M. 1997. Insectes, Coléoptères, Hopliidae. *Faune de Madagascar*, 88: 1-755.

La Frage, C. 2002. *Leucoloma* I: A revision of subgenus *Leucoloma* (Dicranaceae, Bryopsida) in Africa and Madagascar. *The Bryologist*, 105: 509-590.

Lavauden, L. 1932. Etude d'une collection d'oiseaux de Madagascar. *Bulletin Muséum d'Histoire Naturelle*, Paris, série 2, 4: 629-640.

Lecoq, J.-C. 1993. Insectes, Coléoptères, Staphylinidae, Paederinae, II, Paederini. *Faune de Madagascar*, 79: 1-91.

Lecoq, J.-C. 1996. Insectes, Coléoptères, Staphylinidae, Paederinae. *Faune de Madagascar*, 86: 1-73.

Lees, D. C. 1996. The Périnet effect? Diversity gradients in an adaptive radiation of Madagascan butterflies (Satyrinae, Mycalesina) contrasted with other species-rich rainforest taxa. In *Biogéographie de Madagascar*, ed. W. R. Lourenço, pp. 479-490. ORSTOM, Paris.

Lees, D. C. & Colwell, R. K. 2007. A strong Madagascan rainforest MDE and no equatorward increase in species richness: Re-analysis of 'The missing Madagascan mid-domain effect', by Kerr J. T., Perring M. & Currie D. J (Ecology Letters 9:149-159, 2006). *Ecology Letters*, 10: E4-E8.

Le Goff, G., Boussès, P. & Brunhes, J. 2007. Révision des *Neomelaniconion* Newstead (Diptera : Culicidae) de Madagascar : espèces présentes et description de cinq nouvelles espèces. *Annales de la Société Entomologique de France*, nouvelle série, 43 (2): 187-200.

Leroy, J.-F. & Lescot, M. 1996. Taxons nouveaux de Trichilieae (Meliaceae-Melioideae) de Madagascar. *Bulletin Muséum National d'Histoire Naturelle*, Paris, série 4, 18: 3-34.

Lis, J. A. 1999. Revision of the genus *Macroscytus* (Heteroptera: Cydnidae) in Madagascar and adjacent islands, with description of four new species. *European Journal of Entomology*, 96: 427-437.

Loiselle, P. V. & Rodriguez, D. 2007. A new species of *Bedotia* (Teleostei: Atherinomorpha: Bedotiidae) from the Rianila drainage of eastern Madagascar, with

redescriptions of *Bedotia madagascariensis* and *Bedotia geayi*. *Zootaxa*, 1520: 1-18.

Lugo-Ortiz, C. R. & McCafferty, W. P. 1998. The *Centroptiloides* complex of Afrotropical small minnow mayflies (Ephemeroptera: Baetidae). *Annals of the Entomological Society of America*, 91: 1-26.

Maddison, W. P. & Zhang, J. X. 2006. New lyssomanine and hisponine jumping spiders from Africa (Araneae: Salticidae). *Zootaxa*, 1255: 29-35.

Mahunka, S. 1993. Oribatids from Madagascar I. (Acari: Oribatida). New and interesting mites from the Geneva Museum LXXVI. *Revue Suisse de Zoologie*, 100: 289-315.

Mahunka, S. 2002. *Jermyia* gen. n. and some new oppiid mites from Madagascar (Acari: Oribatida). *Acta Zoologica Academiae Scientiarum Hungaricae*, 48 (supplement 1): 161-175.

Mahunka, S. 2009. Oribatid mites from the Vohimana Reserve (Madagascar) (Acari: Oribatida) I. *Acta Zoologica Academiae Scientiarum Hungaricae,* 55: 89–122.

Malcomber, S. T. & Davis, A. P. 2005. Six new *Gaertnera* (Rubiaceae) species from Madagascar and phylogenetic analyses that support *Hymenocnemis* as a synonym of *Gaertnera.* In *A festschrift for William G. D'Arcy, the legacy of a taxonomist*, eds. R. C. Keating, V. Hollowell & T. C. Croat, pp. 371-397. Monographs in Systematic Botany.

Mauriès, J.-P. 1994. Découverte de Diplopodes Craspedosomides à Madagascar: *Betscheuma* n.g. de la famille gondwanienne des Pygmaeosomatidae Cari, 1941. *Bulletin du Muséum national d' Histoire naturelle*, Paris, série 4, 16, A, 1: 55-86.

McEvey, S. F. 1990. New species of *Scaptomyza* from Madagascar and Mauritius with a note on terminology (*Dipterera: Drosophilidae)*. *Annales de la Société Entomologique de France*, nouvelle séries, 26: 51-64.

Moravec, J. 1999. New and rare Madagascar tiger beetles – 2. A new species of *Pogonostoma* (Coleoptera: Cicindelidae). *Folia Heyrovskyana*, 7: 243-249.

Moravec, J. 2000. New and rare Madagascar tiger beetles – 4. Four new species of *Pogonostoma* (Coleoptera: Cicindelidae). *Folia Heyrovskyana*, 8: 47-62.

Moravec, J. 2005. New and rare Madagascar tiger beetles – 10. Species closely related to *Pogonostoma* (*Pogonostoma*) *alluaudi* (Coleoptera: Cicindelidae). *Folia Heyrovskyana*, 13: 49-69.

Muldoon, K. M. & Goodman, S. M. 2010. Ecological biogeography of Malagasy non-volant mammals: Community structure is correlated with habitat. *Journal of Biogeography*. doi:10.1111/j. 1365-2699.2010.02276.x.

Myers, P., Espinosa, R., Parr, C. S., Jones, T., Hammond, G. S. & Dewey, T. A. 2008. The Animal Diversity Web (online). Accessed 24 September 2009 at http://animaldiversity.org.

Nicoll, M. E. & Langrand, O. 1989. *Madagascar: revue de la conservation des aires protégées*. WWF, Gland.

Nicoll, M. E., Rakotondraparany, F. & Randrianasolo, V. 1988. Diversité des petits mammifères en forêt tropicale humide de Madagascar : analyse préliminaire. In *L'équilibre des écosystèmes forestiers à Madagascar : actes d'un séminaire international*, eds. L. Rakotovao, V. Barre & J. Sayer, J., pp. 241-252. IUCN, Gland, Switzerland.

Olàh, J., Johanson, K. A. & Barnard, P. C. 2008. Revision of the Oriental and Afrotropical species of *Cheumatopsyche* Wallengren (Hydropsychidae, Trichoptera). *Zootaxa*, 1738: 1-171.

Oliarinony, R. & Elouard, J.-M. 1997. Biodiversité aquatique de Madagascar. 7. *Ranorythus* un nouveau genre de Tricorythidae définissant la nouvelle sous-famille des Ranorythinae (Ephemeroptera, Pannota). *Bulletin de la Société entomologique de France*, 102: 439-447.

Oliarinony, R. & Sartori, M. 2000. Première description des larves et des oeufs du genre malgache *Madecassorythus* (Ephemeroptera, Tricorythidae). *Mitteilungen der Schweizerischen Entomologischen Gesellschaft*, 73: 369-378.

Oliarinony, R., Elouard, J.-M. & Raberiaka, N. 1998. Biodiversité aquatique de Madagascar 19 – Neuf nouvelles espèces de *Tricorythus* Eaton [*Ephemeroptera, Pannota, Tricorythidae*]. *Revue française d'Entomologie*, nouvelle série, 20: 73-90.

Olson, L. E., Goodman, S. M. & Yoder, A. D. 2004. Illumination of cryptic species boundaries in long-tailed shrew tenrecs (Mammalia: Tenrecidae; *Microgale*), with new insights into geographic variation and distributional constraints. *Biological Journal of the Linnean Society*, 83: 1-22.

Pace, R. 1999. Insectes, Coléoptères, Staphylinidae, Aleocharinae. *Faune de Madagascar*, 89: 1-261.

Paulian, R. 1994. Insectes, Coléoptères, Cetoniidae, Genre *Pygora*. *Faune de Madagascar*, 82: 1-101.

Pescador, M. L. & Peters, J. G. 2007. A new genus of Oligoneuriidae (Ephemeroptera) from Madagascar. *Annals of the Entomological Society of America*, 100: 173-177.

Petter, J.-J. & Peyrieras, A. 1974. A study of population density and home range of *Indri indri* in Madagascar. In *Prosimian biology*. eds. R. D. Martin, G. A. Doyle & A. C. Walker, pp. 39-48. Duckworth, London.

Platnick, N. I. 1984. Studies on Malagasy spiders, 1. The family Gallieniellidae (Araneae, Gnaphosoidea). *American Museum Novitates*, 2801: 1-17.

Pócs, T. & Alfons Schäfer-Verwimp, A. 2006. East African Bryophytes, XXIII. Three new species of *Diplasiolejeunea* (Lejeuneaceae, Jungermanniopsida) from Madagascar. *Cryptogamie, Bryologie*, 27: 439-452.

Pollock, J. I. 1977. The ecology and sociology of feeding in *Indri indri*. In *Primate ecology: Studies of feeding and ranging behaviour in lemurs, monkeys and apes*. ed. T. H. Clutton-Brock, pp. 37-69. Academic Press, London.

Pollock, J. I. 1986. The song of the Indris (*Indri indri*; Primates: Lemuroidea): Natural history, form, and

function. *International Journal of Primatology*, 7: 225-267.

Pont, A. C. 2006. A new species of *Fannia* Robineau-Desvoidy, 1830 from Madagascar and La Réunion (Diptera: Fanniidae). *African Invertebrates*, 47: 315–319.

Powzyk, J. 1995. Sighting of Madagascar Red Owl (*Tyto soumagnei*) in Mantadia National Park. *Working Group on Birds in the Madagascar Region Newsletter*, 5(2): 5.

Powzyk, J. 1997. *The socio-ecology of two sympatric indrids,* Propithecus diadema diadema *and* Indri indri*: A comparison of feeding strategies and their possible repercussions on species-specific behaviors*. Ph.D. thesis, Duke University, Durham.

Rabibisoa, N., Randrianirina, J. E., Rafanomezantsoa, J. & Rabemananjara, F. 2005. Inventaire des reptiles et amphibiens du corridor Mantadia-Zahamena, Madagascar. In Une évaluation biologique rapide du corridor Mantadia-Zahamena à Madagascar, eds. J. Schmid & L. E. Alonso. *Bulletin RAP d'Evaluation Rapide* (Conservation International, Washington, D.C.), 32: 102-116, 176-188.

Rafamantanantsoa, C. 2005. Inventaire entomologique du corridor Mantadia-Zahamena, Madagascar. In Une évaluation biologique rapide du corridor Mantadia-Zahamena à Madagascar, eds. J. Schmid & L. E. Alonso. *Bulletin RAP d'Evaluation Rapide* (Conservation International, Washington, D.C.), 32: 117-121, 189-195.

Rakotoarinivo, M., Ranarivelo, T. & Dransfield, J. 2007. A new species of *Beccariophoenix* from the High Plateau of Madagascar. *Palms*, 51(2): 63–75

Rakotoarison, N., Zimmermann, H. & Zimmermann, E. 1996. First discovery of the Hairy-eared Dwarf Lemur (*Allocebus trichotis*) in a highland rain forest of eastern Madagascar. *Folia Primatologica*, 68: 86–94.

Rakotomanana, H., Randrianasolo, H. & Sam The Seing. 2005. L'avifaune du corridor Mantadia-Zahamena, Madagascar. In Une évaluation biologique rapide du corridor Mantadia-Zahamena à Madagascar, eds. J. Schmid & L. E. Alonso. *Bulletin RAP d'Evaluation Rapide* (Conservation International, Washington, D.C.), 32: 98-101, 171-175.

Rakotondraparany, F. 1988. *Influence des microhabitats sur la distribution des petits mammifères d'Analamazaotra-Andasibe*. Mémoire de DEA en Sciences Biologiques Appliquées, Université de Madagascar.

Rakotondravony, H. A. 2004. Diversité des caméléons forestiers de la région d'Andasibe (Madagascar) et modèle de distribution de cette communauté selon différents types physionomiques. *Revue d'Ecologie (Terre Vie)*, 59: 529–543.

Ramaromilanto, B., Lei, R., Engberg, S. E., Johnson, S. E., Sitzmann, B. D. & Louis, Jr., E. E. 2009. Sportive lemur diversity at Mananara-Nord Biosphere Reserve, Madagascar. *Occasional Papers Museum of Texas Tech University*, 286: 1-22.

Ramilison, C. 1996. Inventaire des espèces d'orchidées dans le Parc National d'Andasibe-Mantadia. Rapport non-publié. Association Nationale pour la Gestion des Aires Protégées (ANGAP) & Volunteers in Technical Assistance (VITA), Andasibe.

Ramos, H. da Cunha & Brunhes, J. 2004. Insecta, Diptera, Culicidae, *Uranotaenia. Faune de Madagascar*, 91: 1-463.

Randriamasimanana, D. & Gibon, J.-M. 2000. Nouveaux *Oecetis* Malgaches [Trichoptera, Leptoceridae]. *Revue française d'Entomologie*, nouvelle série, 22: 43-56.

Randrianandrianina, F., Andriafidison, D., Kofoky, A. F., Ramilijaona, O., Ratrimomanarivo, F., Racey, P. A. & Jenkins, R. K. B. 2006. Habitat use and conservation of bats in rainforest and adjacent human-modified habitats in eastern Madagascar. *Acta Chiropterologica*, 8: 429-437.

Rasolofoharinoro, M., Bellan, M. F. & Blasco, F. 1997. La reconstitution végétale après l'agriculture itinérante à Andasibe-Périnet (Madagascar). *Ecologie*, 28: 149-165.

Ratsirarson, H. J. & Fisher, B. L. 2005. Diversité des fourmis du corridor Mantadia-Zahamena, Madagascar. In Une évaluation biologique rapide du corridor Mantadia-Zahamena à Madagascar, eds. J. Schmid & L. E. Alonso. *Bulletin RAP d'Evaluation Rapide* (Conservation International, Washington, D.C.), 32: 129-138.

Razafimandimbison, S. G. 2002. A systematic revision of *Breonia* (Rubiaceae–Naucleeae). *Annals of the Missouri Botanical Garden*, 89: 1–37.

Ribeiro, H. 2004. Les *Toxorhynchites* Theobald de Madagascar (Diptera: Culicidae). *Annales de la Société Entomologique de France*, nouvelle série, 40 (3-4): 243-257.

Rodrigues, P. D. 1992. Insectes, Hétéroptères, Tingidae. *Faune de Madagascar*, 78: 1-94.

Rogers, Z. S. 2004. A revision of *Stephanodaphne* Baill. (Thymelaeaceae). *Adansonia*, série 3, 26: 7-35.

Sartori, M. & Elouard, J.-M. 1999. Biodiversité aquatique de Madagascar 30: le genre *Cheirogenesia* Demoulin, 1952 (Ephemeroptera, Palingeniidae). *Revue Suisse de Zoologie*, 106: 325-337.

Schatz, G. E. & Lowry II, P. P. 2004. A synoptic revision of *Brexia* (Celastraceae) in Madagascar. *Adansonia*, série 3, 26: 67-81.

Schatz, G. E., Lowry II, P. P. & Wolf, A.-E. 2000. Endemic families of Madagascar. VI. A synoptic revision of *Rhodolaena* (Sarcolaenaceae). *Adansonia*, série 3, 22: 239-252.

Schatz, G. E., Lowry II, P. P. & Wolf, A.-E. 2001. Endemic families of Madagascar. VII. A synoptic revision of *Leptolaena* Thouars sensu stricto (Sarcolaenaceae). *Adansonia*, série 3, 23: 171-189.

Schawaller, W. 2007. *Antennoluprops bremeri*, gen. nov., spec. nov. from Madagascar, with remarkable antennal and tibial morphology (Insecta, Coleoptera, Tenebrionidae, Lupropini). *Spixiana*, 30: 29-32.

Schmid, J. & Alonso, L. E. (eds). 2005. Une évaluation biologique rapide du corridor Mantadia-Zahamena à Madagascar. *Bulletin RAP d'Evaluation Rapide*

(Conservation International, Washington, D.C.), 32: 1-202.

Schmid, J., Fietz, J. & Randriarimalala, Z. L. 2005. Lemurs of the Mantadia-Zahamena corridor, Madagascar. In Une évaluation biologique rapide du corridor Mantadia-Zahamena à Madagascar, eds. J. Schmid & L. E. Alonso. *Bulletin RAP d'Evaluation Rapide* (Conservation International, Washington, D.C.), 32: 61-73, 169-170.

Silva-Dávila, D. 2005. Revision of the spider genus *Chrosioderma* Simon (Araneae: Sparassidae). *Proceedings of the California Academy of Sciences*, 56: 337-377.

Sipman, H. J. M. 2004. Survey of *Lepraria* species with lobed thallus margins in the tropics. *Herzogia*, 17: 23–35.

Sparks, J. S. & Stiassny, M. L. J. 2008. Les poissons d'eau douce. In *Paysages naturels et biodiversité de Madagascar*, ed. S. M. Goodman, pp. 283-309. Muséum national d'Histoire naturelle, Paris.

Stephenson, P. J. 1993. The small mammal fauna of Réserve Spéciale d'Analamazaotra, Madagascar - the effects of human disturbance of endemic species diversity. *Biodiversity and Conservation*, 2: 603-615.

Stephenson, P. J. & Racey, P. A. 1993. Reproductive energetics of the Tenrecidae (Mammalia: Insectivora). II. The shrew-tenrecs, *Microgale* spp. *Physiological Zoology*, 66: 664-685.

Stone, R. D. 2006. New species of *Memecylon* L. and *Warneckea* Gilg (Melastomataceae) from Madagascar and Mayotte. *Adansonia*, série 3, 28: 337-358.

Thiollay, J.-M. 1994. Family Accipitridae (hawks and eagles). In *Handbook of the birds of the World*, vol. 2, eds. J. del Hoyo, A. Elliott & J. Sargatal. Lynx Edicions, Barcelona.

Thorstrom, R. & Rene de Roland, L-A. 1999. Première découverte du nid, reproduction et distribution de l'Aigle serpentaire de Madagascar *Eutriorchis astur. Working Group on Birds in the Madagascar Region Newsletter*, 9(1): 3-13.

Tirel, C. 1985. Eléocarpacées. *Flore de Madagascar et des Comores*, 125: 1-53.

Townsend, T. M., Vieites, D. R., Glaw, F. & Vences, M. 2009. Testing species-level diversification hypotheses in Madagascar: The case of microendemic *Brookesia* leaf chameleons. *Systematic Biology*, 58: 641-656.

Vallan, D., Glaw, F., Andreone, F. & Cadle, J. E. 1998. A new treefrog species of the genus *Boophis* (Anura: Ranidae: Rhacophorinae) with dermal fringes from Madagascar. *Amphibia-Reptilia*, 19: 357-368.

Vallan, D., Vences, M. & Glaw, F. 2003. Two new species of the *Boophis mandraka* complex (Anura, Mantellidae) from the Andasibe region in eastern Madagascar. *Amphibia-Reptilia,* 24: 305-319.

Vallan, D., Andreone, F., Raherisoa, V. H. & Dolch, R. 2004. Does selective wood exploitation affect amphibian diversity? The case of An'Ala, a tropical rainforest in eastern Madagascar. *Oryx*, 38: 410–417.

Van der Werff, H. 2006. A revision of the Malagasy endemic genus *Aspidostemon* Rohwer & Richter (Lauraceae). *Adansonia*, série 3, 28: 7-44.

Vences, M. & Glaw, F. 2003. New microhylid frog (*Plethodontohyla*) with a supraocular crest from Madagascar. *Copeia*, 2003: 789-793.

Vences, M., Raxworthy, C. J., Nussbaum, R. A. & Glaw, F. 2003. New microhylid frog (*Plethodontohyla*) from Madagascar, with semiarboreal habits and possible parental care. *Journal of Herpetology,* 37: 629-636.

Vences, M., Chiari, Y., Raharivololoniaina, L. & Meyer, A. 2004. High mitochondrial diversity within and among populations of Malagasy poison frogs. *Molecular Phylogenetics and Evolution*, 30: 295-307.

Vieites, D. R., Wollenberg, K. C., Andreone, F., Köhler, J., Glaw, F. & Vences, M. 2009. Vast underestimation of Madagascar's biodiversity evidenced by an integrative amphibian inventory. *Proceedings of the National Academy of Science*, USA, 106: 8267-8272.

Viette, P. 1958a. Descriptions préliminaires de nouvelles espèces de noctuelles de Madagascar, II (Lep. Noctuidae). *Bulletin de la Société Entomologique de France*, 63: 146-152.

Viette, P. 1958b. Thyridides malgaches nouveaux ou peu connus (Lépidoptères). *Bulletin Mensuel de la Société Linnéenne de Lyon*, 27: 206-208.

Viette, P. 1960. Thyridides et thaumetopoeides nouveaux ou peu connus de Madagascar (Lépidoptères). *Bulletin Mensuel de la Société Linnéenne de Lyon*, 29: 68-72.

Vitali, F. 2006. Contribution à la connaissance des *Nethinius* malgaches (Coleoptera Disteniidae). *L'Entomologiste*, 62: 175-178.

Wahis, R. 2002. Sur un genre peu connu de Pompilides afrotropicaux *Kyphopompilus* Arnold, 1959 (Hymenoptera: Pompilidae, Pompilinae). *Notes fauniques de Gembloux*, 49: 103-113.

Weaver III, J. S. & Gibon, F.-M. 2007. The Lepidostomatidae of Madagascar (Trichoptera). In *Proceedings of the XIIth International Symposium on Trichoptera*, June 18-22, 2006, eds. J. Bueno-Soria, R. Barba-Álvarez & B. Armitage, pp. 335-348. The Caddis Press, Athens, Alabama.

Weaver III, J. S., Gibon, F.-M. & Chvojka, P. 2008. A new genus of Philorheithridae (Trichoptera) from Madagascar. *Zootaxa*, 1825: 18-28.

Wesener, T., Enghoff, H. & Sierwald, P. 2009. Review of the Spirobolida on Madagascar, with descriptions of twelve new genera, including three genera of 'fire millipedes' (Diplopoda). *Zookeys*, 19: 1-128.

Wilmé, L. & Langrand, O. 1990. Rediscovery of Slender-Billed Flufftail *Sarothrura watersi* (Bartlett, 1879), and notes on the genus *Sarothrura* in Madagascar. *Biological Conservation,* 51: 211–223.

Wilmé, L., Langrand, O. & Goodman, S. M. 1997. Bird lists. *Working Group on Birds in the Madagascar Region Newsletter*, 7(1): 34-39.

Wilmé, L., Goodman, S. M. & Ganzhorn, J. U. 2006. Biogeographic evolution of Madagascar's microendemic biota. *Science*, 312: 1063-1065.

Wright, P. C., Johnson, S. E., Irwin, M. T., Jacobs, R., Schlichting, P., Lehman, S., Louis Jr. E. E., Arrigo-Nelson, S. J., Raharison, J.-L., Rafalirarison, R. R., Razafindratsita, V., Ratsimbazafy, J., Ratelolahy, F. J., Dolch, R. & Tan, C. 2008. The crisis of the critically endangered greater bamboo lemur (*Prolemur simus*). *Primate Conservation,* 23: 5-17.

ZICOMA. 1999. *Les zones d'importance pour la conservation des oiseaux à Madagascar*. Projet ZICOMA, Antananarivo.

ZICOMA. 2000. Evaluation de la faune aviaire dans les zones humides entre le Parc National de Ranomafana et celui d'Andringitra. EPIQ IQC, PCE-I-00-96-00002-00, Task Order No.839. Projet d'Appui à la Gestion de l'Environnement, International Resources Group, Washington, D.C.