# Species new to science described from Andrafiamena-Andavakoera since 1988

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## Abstract

The Andrafiamena-Andavakoera protected area comprises a zone that little scientific exploration has been conducted, including the period after 1988. During these limited investigations, specimens of a range of different organisms have been obtained and deposited in museum and herbarium collections; these specimens have been used in scientific investigations and a certain number of new species to science have been described based on this material. Herein, we tabulate the new taxa named from this protected area since 1988 and separate specimen material cited in these descriptions based on those collected before 1988 and after 1988. In the following tabulations, numbers presented as total number of described species published since 1988, and then in parentheses those based on specimen collections made pre-1988 (in standard font) and post-1988 (in bold font): Angiosperms = 14 (2 and **12**), non-insect Arthropoda = 3 (0 and **3**), insects = 20 (0 and **20**), Vertebrata = 2 (0 and **2**), total number new to science = 39 (2 and **37**). To underline how poorly known the protected area is with regards to it biodiversity, of the 20 new species of insects recently described from the area, 19 were collected at a single site during the course of three days of fieldwork. The relatively few new taxa described from the Andrafiamena-Andavakoera protected area is a reflection of little inventory work at the site and subsequent research by taxonomists working with associated collections. Clearly more survey work with associated voucher specimens is needed to better understand the local plants and animals and such data is important to document the island's biodiversity, address different questions in evolutionary biology, and advance different conservation programs.

**Keywords:** plants, invertebrates, vertebrates, new described species, since 1988, Andrafiamena-Andavakoera

## Résumé détaillé

L'aire protégée d'Andrafiamena-Andavakoera comprend une zone où peu d'exploration scientifique y a été menée, même durant la période après 1988. Au cours de ces investigations limitées, des spécimens d'une gamme d'organismes différents ont été obtenus et déposés dans des collections de musées et d'herbiers. Ces spécimens ont été traités, et un certain nombre de nouvelles espèces pour la science a été décrit. Ici, nous présentons les taxons nouvellement décrits dans cette aire protégée depuis 1988 en distinguant les spécimens collectés avant et après cette date. Sur la base de notre recherche documentaire le nombre d'espèces décrites avant 1988 est en police standard, et celles d'après 1988 sont en caractères gras : Angiospermes = 14 (2 et **12**), non-insectes = 3 (0 et **3**), insectes = 20 (0 et **20**), Vertébrés = 2 (0 et **2**) – nombre total de nouvelles espèces pour la science = 39 (2 et **37**). Le faible nombre d'espèces récemment décrites à partir du matériel collecté avant 1988, représentant 7,4 % du total, revèle plusieurs éléments importants : 1) peu de collections ont été réalisées sur le site avant la période récente d'exploration biologique à Madagascar, 2) de nouvelles espèces ont été découvertes grâce aux collections récentes et 3) l'importance de nouveaux travaux d'inventaire dans la zone protégée pour comprendre sa richesse biologique.

Pour souligner à quel point l'aire protégée est mal connue en ce qui concerne sa biodiversité, sur les 20 nouvelles espèces d'insectes récemment décrites dans la zone, 19 ont été collectées sur un seul site au cours de trois jours de travail sur le terrain. Le nombre relativement faible de nouveaux taxons décrits dans l'aire protégée d'Andrafiamena-Andavakoera est le reflet du peu de travail d'inventaire effectué sur le site et des recherches ultérieures menées par les taxonomistes travaillant avec les collections associées. Il est clair que des travaux d'inventaires

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supplémentaires avec des spécimens de référence associés sont nécessaires pour mieux comprendre sa faune et sa flore. De telles données sont importantes pour documenter la biodiversité de l'île, répondre à différentes questions de biologie évolutive et biogéographie et renforcer différents programmes de conservation.

**Mots clés** : plantes, invertébrés, vertébrés, nouvelles espèces décrites, depuis 1988, Andrafiamena-Andavakoera

## Introduction

The biota of Madagascar is unique to our planet and has one of the highest levels of endemism at different taxonomic levels of any region in the world of similar surface area (Antonelli *et al*., 2022; Goodman, 2022) and at the same time the island is threatened by a range of different factors founded in social, economic, and biological aspects (Jones *et al*., 2022; Ralimanana *et al*., 2022). In different portions of this island nation, with expanding human populations, the rates of deforestation and other anthropogenic pressures remain serious impediments to advance conservation programs (e.g., Harper *et al*., 2007; Jones *et al*., 2018; Vieilledent *et al*., 2018; Grinand & Nourtier, 2022). From the perspective of biodiversity, encompassing natural habitats, species distributions, biological richness, and biotic importance, conservation prioritization assessments on Madagascar have been based on data of species diversity and patterns of local endemism (e.g. Kremen *et al*., 2008; Allnutt *et al*., 2012). Such information provides insights into zones that are particularly important to retain as functional ecosystems, particularly in light of the island's high levels of habitat heterogeneity (Vences *et al.,* 2009; Brown *et al*., 2014; Omollo *et al*., 2024), and those zones that are in need of further research, for example, at the very least to document the organisms occurring within the limits of currently recognized protected areas (Goodman *et al*., 2018a).

One unique aspect to the tropical portions of the world is the number of new species to science described each year from Madagascar. On the basis of biological inventories that involve the collection of specimens and subsequent taxonomic research, measures of the local plants and animals occurring in a given area can increase through time. Insights from these measures underline the biotic representation of named or future protected areas, their importance to safeguard the plants and animals of the site, and the persistence of key endemic species in generating rankings of conservation zones and the steps needed to advance their protection (Kremen *et al*., 1999; Lehtomäki *et al*., 2019; Morales-Barbero & Ferrer-Castán, 2019; Carvalho *et al*., 2020).

A protected area in northern Madagascar known as Paysage Harmomieux Protégé d'Andrafiamena-Andavakoera, herein referred to as Andrafiamena-Andavakoera, is not particularly well known from the biodiversity perspective (Goodman *et al.*, 2018a, 2018b). Most of the research conducted at this site of nearly 74,000 ha has been largely focused on its primate fauna (Louis *et al*., 2006, 2008; Ranaivoarisoa *et al*., 2006; Zaonarivelo *et al*., 2007; Salmona *et al*., 2013; Frasier *et al*., 2016), with the exception of the Andavakoera Massif portion of the protected area were some faunal work has been conducted (Goodman & Wilmé, 2006). In a recent analysis of 98 terrestrial protected areas on the island with regards to its vertebrate fauna, it was rated as the 24th most poorly known site (Goodman *et al.*, 2018b). Figures on the documented flora of Andrafiamena-Andavakoera was tabulated in mid-2017, based on 498 herbarium specimens identified to species (Phillipson *et al*., 2018a), which for an area of its size is remarkably low; this value underlines from the botanical perspective how little is known from this protected area.

The northern portion of Madagascar contains a series of protected areas that are adjacent to one another or in close proximity and these include from west to east the Réserve Spéciale d'Ankarana, Andrafiamena-Andavakoera, Réserve Spéciale d'Analamerana, and Paysage Harmomieux Protégé de Loky-Manambato (Tahinarivony & Goodman, 2025, herein). In order to understand the species representation of each site, and, in particular, the uniqueness of each with respect to one another or general regional biogeographic patterns, detailed information from biological inventories is critical and these analyses form in part the basis of future conservation programs.

Using published literature on the flora and fauna of Madagascar, we review herein species new to science that have been described from Andrafiamena-Andavakoera since 1988. This summary serves at least two different aspects: 1) the uniqueness of the site with respect to its biodiversity and 2) how remarkably little is known of this area and the importance of continued biological inventories with associated specimens being studied by taxonomists.

## Methods

After an extensive literature search, we were able to tabulate species described from the Andrafiamena-Andavakoera protected area during the period from early 1988 until early June 2024. For plants we have extensively used the Missouri Botanical Garden's Tropicos database (MBG, no date). The short accounts presented below of taxa named from specimens collected in Andrafiamena-Andavakoera either as holotypes, paratypes, type series, and referred material are based on named localities within the protected area mentioned in the original descriptions. We do not integrate updated distributional information published after these descriptions based on field surveys and research. Hence, for example, a description published in 1992 for a new taxon named from material collected at Analamerana and thought to be a local endemic but subsequently found or identified at Andrafiamena-Andavakoera does not appear in this contribution. A number of new species were collected at sites near "Anjahakely", which throughout this monograph is spelled as Anjakely.

To further emphasize in the accounts presented herein on the importance of modern biological inventories and the collection of specimens in and around Andrafiamena-Andavakoera into estimates of the local biodiversity, for holotypes, paratypes or referred material published since 1988 based on pre-1988 specimens the scientific names are given in *italic* type, and those using post-1988 collections are presented in mixed **bold** and *italic* type. We have not included in these accounts new varieties, subspecies, or geographic forms named from Andrafiamena-Andavakoera. Within a family, we present genera and associated species in alphabetical order.

For terms associated with vegetation types we generally employ those of Gautier *et al*. (2018). For flowering plants, we follow the classification of The Angiosperm Phylogeny Group (2016) and for insects, we follow Misof *et al*. (2014). Otherwise, we employ the taxonomy used in a recent book on the natural history of Madagascar (Goodman, 2022).

## Results

### Angiosperms

Asparagales

Orchidaceae

***Cynorkis windsorensis* –** This new species to science was described from material collected at Andrafiamena, "forêts aux alentours d'Anjahankely, tsingys, 431 m", on 20 December 2010 (Hervout & Hermans, 2022).

Myrtales

Melastomataceae

***Memecylon linearifolium*** – This species was recently described based on a type material collected in July 2005 and is known only from the western side of the Andrafiamena-Andavakoera protected area (Stone, 2022).

Sapindales

Burseraceae

*Ambilobea madagascariensis* – In their description of this new genus, represented by *A. madagascariensis*, material was examined from the Andrafiamena-Andavakoera area, including the Massif d'Ampatsoa, near the confluence of the Rodo and Andrafiamena Rivers on 24 December 1963, and Massif d'Andavakoera, north of Angodromena along the Ambilobe-Vohémar road on 11 November 1958 (Thulin *et al*., 2008).

Ericales

Sapotaceae

***Capurodendron andrafiamenae*** – The holotype and paratype collected in late 2010 of this recently named species comes from the Andrafiamena-Andavakoera protected area and specifically in the forests near "Anjahankely" (Boluda *et al*., 2022).

***Donella ranirisonii*** – The type specimen of this species was collected in 2010 from Andrafiamena, specifically the forest around "Anjahankely" at 410 m (Mackinder *et al*., 2016).

Ebenaceae

***Diospyros antsirananae*** – In their naming of this species, Schatz *et al*. (2021) cited specimens coming from Andrafiamena-Andavakoera, including material collected from the Andrafiamena Mountains in 2010 and the Andavakoera Massif in 2007.

***Diospyros malandy*** – This recently described species is only known from northern Madagascar and in two areas, including the Andrafiamena-Andavakoera protected area (Schatz *et al*., 2021).

***Diospyros quadrangularis*** – Schatz *et al*. (2021) mentioned in their description of this species material collected in the Andrafiamena-Andavakoera protected area, including specimens from **"**Anjahankely" and the Massif d'Antsahabe.

Gentianales
Gentianaceae
***Exacum alberti-grimaldii*** – the type specimen of this species was collected in the Andrafiamena Mountains and more specifically "chaîne d'Andrafiamena, bassin-versant d'Ampantsona, falaises gréseuses en forêt de transition, "12°55'10"S 49°21'13"E", 650 m", on 1 May 2007 (Wohlhauser & Callmander, 2012).

Lamiales
Acanthaceae
***Barleria glandulostamina*** – In their description of this new species, Darbyshire *et al.* (2014) used herbarium material collected in the Andrafiamena-Andavakoera protected area in July 2011 at "Anjahakely".

***Isoglossa pterocalyx*** – Part of the studied material associated with the description of this new species came from Andrafiamena, forest around "Anjahakely", 430 m, and collected on 20 December 2010 (Darbyshire *et al*., 2023).

Bignoniaceae
***Ophiocolea ratovosonii*** – One of the paratypes used by Callmander *et al*. (2011) in the description of this species was collected in the "Chaîne de montagne d'Andrafiamena, aux alentours d'Anjahankely, 513 m", on 18 November 2010.

## Invertebrates

### Order Gastropoda

Acavidae
***Ampelita andavakoerae*** – This species was described from the Andavakoera Massif based on material collected on 29 August 2007 at "13°05.567'S, 49°14.946'E", 250 m, and "in dry deciduous forest with some big trees, sandstone bedrock" (Emberton & Rakotondrazafy, 2020).

### Order Araneae

Archaeidae
***Eriauchenius lavatenda*** – While the holotype of this new species comes from the Baie de Baly, in the central west, other examined material assigned to this taxon was collected from the Forêt d'Andavakoera at "13°7′6″S, 49°13′48″E", 15 December 2023, 425 m, by Brian L. Fisher and colleagues (Wood, 2008).

Salticidae
***Padilla mitohy –*** Material used in the description of this species was obtained in the Forêt d'Andavakoera at "13°07'06"S, 49°13'48"E", 15 December 2003, 425 m, Brian L. Fisher and colleagues (Andriamalala, 2007).

## Insects

### *Order Hymenoptera*

Dryinidae
***Madecadryinus humicolus*** – One of the type specimens of this new species was collected from sifted litter (leaf mold, rotten wood) in the Andavakoera Forest at "13°07.06'S, 49°13.48'E", 15 December 2003, 425 m, Brian L. Fisher and colleagues (Olmi, 2007).

Formicidae and Megalyridae

Of the 19 species of ants listed below and recently described as new to science from the Andrafiamena-Andavakoera protected area, all were collected by Brian L. Fisher and colleagues in the Forêt d'Andavakoera, 21.4 km 75° ENE Ambilobe, 4.6 km 356° N Betsiaka, "13.11833°S, 49.23°E", 425 m, over the course of three days between 15 and 17 December 2003.

***Anochetus goodmani*** – In the description of this species material was examined from Forêt d'Andavakoera (Fisher & Smith, 2008).

***Bothroponera tavaratra*** – Material of this species collected in the Forêt d'Andavakoera was used in its description (Rakotonirina & Fisher, 2013).

***Camponotus mita*** – As designated by Rakotonirina *et al*. (2017), the holotype of this new species was collected in the Forêt d'Andavakoera.

***Camponotus raina*** – The holotype of this species is from the Forêt d'Andavakoera (Rakotonirina & Fisher, 2018).

***Camponotus sada*** – Material collected in the Forêt d'Andavakoera was employed by Rakotonirina and Fisher (2018) in the description of this species.

***Dinapsis scriptus –*** In the naming of this new species, Mita and Shaw (2020) used paratype material from the Forêt d'Andavakorea.

***Malagidris dulcis*** – Non-paratypic material used in the description of this species was examined by Bolton and Fisher (2014) and collected in the Forêt d'Andavakoera.

***Nesomyrmex exiguus*** – In the redescription of this species by Csősz and Fisher (2016) non-type material from the Forêt d'Andavakoera was employed.

***Pheidole antsahabe*** – In the description of this new species by Salata and Fisher (2020a), they examined material from Forêt d'Andavakoera.

***Pheidole fitarata*** – Specimens collected in the Forêt d'Andavakoera were used in the description of this species (Salata & Fisher, 2002b).

***Pheidole maro*** – Material from the Forêt d'Andavakoera was employed in the naming of this species (Salata & Fisher, 2002a).

***Pheidole podargea*** – The holotype of this recently named species (Salata & Fisher, 2002b) was collected in the Forêt d'Andavakoera.

***Pheidole tenebrovulgaris*** – Material obtained in the Forêt d'Andavakoera was employed in the description of this species (Salata & Fisher, 2002a).

***Pheidole voreios*** – In their naming of this new species, Salata and Fisher (2020a) used material from Forêt d'Andavakoera.

***Prionopelta vampira*** – In the description of this species, Overson and Fisher (2015) utilized specimens collected in the Forêt d'Andavakoera.

***Tetramorium avaratra*** – In their description of this species, Hita Garcia and Fisher (2012a) employed material from the Forêt d'Andavakoera.

***Tetramorium olana*** – Hita Garcia and Fisher (2012b) in the naming of this taxon used a holotype worker collected in the Forêt d'Andavakoera.

***Tetramorium ryanphelanae*** – In the description of this species by Hita Garcia and Fisher (2012b), specimens from the Forêt d'Andavakoera were employed.

***Tetramorium vony*** – Material from the Forêt d'Andavakoera was used in the diagnosis of this species (Hita Garcia & Fisher, 2012b).

**Vertebrata**

**Class Mammalia**

**Order Primates**

Cheirogalidae

***Cheirogaleus shethi*** – The holotype material of this species was obtained at Andrafiamena-Andavakoera, specifically in the Anjakely Forest at 316 m on 12 March 2005 (Frasier *et al*., 2016).

Megaladapidae

***Lepilemur milanoii*** – This species was described largely based on molecular genetic characters from material obtained in the Loky-Manambato protected area (Louis *et al*., 2006) and in the same publication it is mentioned that this species also occurs in the Andrafiamena forests.

## Discussion

### New species descriptions: little detailed biological exploration

During the period from early 1988 until early June 2024, a total of 37 species belonging to a range of plant and animal groups were described as new to science based on specimens collected in and around the Andrafiamena-Andavakoera protected area (Table 1). It is important to keep in mind that the inclusion of a given taxon in this tabulation is based on the holotype, other specimens in the type series or referred material having been obtained in the protected area and explicitly mentioned in the original species description. As highlighted in some of the contributions in this monograph, subsequent field surveys and associated collections made in the Andrafiamena-Andavakoera area or elsewhere in northern Madagascar after the description of a given species was published, extend the taxa's known distribution, but such records are not incorporated in this current contribution, as our focus is on initial discovery and description. In general, with the exception of ants, notably few new taxa to science have been named from the protected area since 1988, the period that coincides with a new era of biological exploration of the island and associated taxonomic descriptions based on the study of voucher specimens collected during inventories. The relatively few named taxa from the site is directly related to the lack of local biological exploration. For comparison in and around the Marojejy Massif, a zone of considerable scientific research for several decades and including the collection of specimens, a total of 450 species new to science have been described since 1988 (Goodman *et al*., 2023).

We have grouped the material used for the published species descriptions after 1988 into two separate categories: 1) based on specimens collected before 1988 employed in the diagnosis of the new taxon and 2) specimens obtained after 1988 and used in the descriptions. Below we present some overview details for different taxonomic groups on the role of specimens in the unfurling of knowledge on the biodiversity of the Andrafiamena-Andavakoera protected area. As a general rule, the lack of biological inventories at the site has hampered advancements on documenting the local biota, which in turn does not provide some of the needed information in

**Table 1.** Tabulations of new species of plants and animals described from the Andrafiamena-Andavakoera protected area since 1988 and segregated based on type material being collected before 1988 and after 1988.

| Taxonomic group | Type material collected before 1988 | Type material collected after 1988 | Total number of new species since 1988 |
|---|---|---|---|
| **Angiosperms** (flowering plants) | | | |
| Orchidaceae | 1 | 2 | 3 |
| Melastomataceae | 0 | 1 | 1 |
| Burseraceae | 1 | 0 | 1 |
| Sapotaceae | 0 | 2 | 2 |
| Ebenaceae | 0 | 3 | 3 |
| Gentianaceae | 0 | 1 | 1 |
| Acanthaceae | 0 | 2 | 2 |
| Bignoniaceae | 0 | 1 | 1 |
| **Total number for Angiosperms** | 2 | 12 | 14 |
| **Gastropoda** (terrestrial snails) | 0 | 1 | 1 |
| **Arthropoda** | | | |
| Araneae (spiders) | 0 | 2 | 2 |
| **Non-insect arthropods** | 0 | 3 | 3 |
| **Insects** | | | |
| Hymenoptera (sawflies, wasps, bees, and ants) | 0 | 20 | 20 |
| **Total number insects** | 0 | 20 | 20 |
| **Vertebrata** | | | |
| Mammals (rodents, tenrecs, and bats) | 0 | 2 | 2 |
| **Total number of Vertebrata** | 0 | 2 | 2 |
| **Total number across all taxa** | **2** | **37** | **39** |

placing the protected area into the needed context with regards to its conservation importance.

## Pre-1988 and post-1988 collections

### *Plants*

Of the 12 species of plants described from Andrafiamena-Andavakoera since 1988, all but one were based on post 1988 collections. Further, it is notable how little is known about the flora of the protected area. In their tabulation of herbarium specimens collected in the boundaries of the site (73,170 ha), Phillipson *et al*. (2018a) noted that as of March 2018, 696 plant collections were documented in the major herbaria of the world with Malagasy holdings and this translates to a density of one collection per km$^2$ of the protected area. This is in comparison, for example, to Ankarana (25,354 ha) with a similar flora to Andrafiamena-Andavakoera, which has 1278 herbarium specimens and a density of 7.0 collections per km$^2$ (Phillipson *et al*., 2018b) or to Marojejy (55,885 ha) with distinctly more mesic forest formations across a broad elevational gradient, which has 3125 herbarium specimens and a density of 5.2 collections per km$^2$ (Phillipson *et al*., 2018c). We interpret these figures to show that Andrafiamena-Andavakoera is poorly collected and its floristic importance remains to be documented.

### *Non-insect arthropods*

Little work has been published on the non-insect arthropods (scorpions, spiders, crabs, millepedes, and snails) in the Andrafiamena-Andavakoera protected area. On the basis of our review, only three new species of this group have been described from the site in the past decades and all obtained during the post-1988 period (Table 1). This is comparison to Marojejy, with 111 new species, and all, with the exception of one, named using material collected after 1988 (Goodman *et al*., 2023).

On the basis of the literature, snails have been the subject of collecting trips in the Andavakoera area in 1995 and 2007 (Pearce, 2003; Emberton & Rakotondrazafy, 2020). The notably low number of new species described from the region, as compared to 41 from Marojejy (Goodman *et al*., 2023), for example, can be best explained by the lack of biological exploration and associated vouchers of snails in the region. This is clearly a void that needs to be filled in. Of the invertebrates collected during the late 2023 mission, it is presumed that after study by taxonomic specialists some taxa new to science will be described.

### *Insects*

For a group on Madagascar with a remarkable number of species, notably few collections of insects have been made in certain portions of the northern

Madagascar, particularly in the zone that now comprises the Andrafiamena-Andavokoera protected area. In Viette's (1991) compilation of the "Chief field stations where insects were collected in Madagascar", entries are presented for Andavakoera area ("ca. 35 km au NE. d'Ambilobe, région de l'Andavakoera) and the Andrafiamena Mountains ("60/65 km au S. de Diego-Suarez, chaîne de l'Andrafiamena"). The listed field collector is Andre Peyrieras who visited these areas during field missions in June 1971 and January 1972 and in the context of his work for the Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM) (Petter *et al*., 1977; Andriamialisoa & Langrand, 2022). Other sites that would have been accessible during the colonial and post-colonial period in the peripheral zone of the protected area are not included in Viette's complitation, such as Ambery, Ananjaka, Anivorano-Nord, Anjakely, Betsiaka,

**Table 2.** A list of ant species collected during three days of fieldwork in the Forêt d'Andavakoera, 21.4 km 75° ENE Ambilobe; 4.6 km 356° N Betsiaka, 13.11833°S, 49.23°S, 425 m, by Brian L. Fisher and colleagues. Species names in **bold** were decribed based on these collections. Most species are native and in many cases endemic to Madagascar with the exception of those followed by "(I)" that are introduced to to the island. In certain cases, known species remain to be described and the confirmed species candidate code is given (e.g., mg02, js108, fhg_let, psw083).

| Family-Subfamily | Genus | Species |
|---|---|---|
| **Formicidae-Amblyoponinae** | *Mystrium* | *voeltzkowi* |
| | *Mystrium* | *voeltzkowi*_complex |
| | *Prionopelta* | *descarpentriesi* |
| | *Prionopelta* | ***vampira*** |
| **Formicidae-Dolichoderinae** | *Technomyrmex* | *fisheri* |
| | *Technomyrmex* | *madecassus* |
| **Formicidae-Dorylinae** | *Lioponera* | mg02 |
| | *Lioponera* | mg06 |
| | *Lioponera* | mg09 |
| **Formicidae-Formicinae** | *Camponotus* | *boivini* |
| | *Camponotus* | *chrislaini* |
| | *Camponotus* | *madagascarensis* |
| | *Camponotus* | mg094 |
| | *Camponotus* | ***mita*** |
| | *Camponotus* | *mixtellus* |
| | *Camponotus* | ***raina*** |
| | *Camponotus* | *roeseli* |
| | *Camponotus* | ***sada*** |
| | *Nylanderia* | jsl08 |
| | *Paraparatrechina* | *glabra* |
| | *Plagiolepis* | *alluaudi* |
| **Formicidae-Myrmicinae** | *Aphaenogaster* | *swammerdami* |
| | *Carebara* | *grandidieri* |
| | *Carebara* | *raberi* |
| | *Carebara* | *vazimba* |
| | *Cataulacus* | *ebrardi* |
| | *Cataulacus* | *porcatus* |
| | *Crematogaster* | *hova*_complex_morphotype1 |
| | *Crematogaster* | *kelleri* |
| | *Crematogaster* | *ranavalonae* |
| | *Crematogaster* | *rasoherinae* |
| | *Malagidris* | ***dulcis*** |
| | *Monomorium* | ***exiguum*** |
| | *Monomorium* | *termitobium* |
| | *Nesomyrmex* | mg06_a |
| | *Nesomyrmex* | *nitidus* |
| | *Pheidole* | ***antsahabe*** |
| | *Pheidole* | *ensifera* |
| | *Pheidole* | ***fitarata*** |
| | *Pheidole* | ***maro*** |
| | *Pheidole* | mg004 |
| | *Pheidole* | mg063 |
| | *Pheidole* | mgs043 |
| | *Pheidole* | ***podargea*** |
| | *Pheidole* | *sikorae*_group |
| | *Pheidole* | *spinosa* |
| | *Pheidole* | ***tenebrovulgaris*** |
| | *Pheidole* | ***voreios*** |
| | *Strumigenys* | *dicomas* |
| | *Strumigenys* | *lucomo* |
| | *Strumigenys* | *maxillaris* (I) |
| | *Strumigenys* | *olsoni* |
| | *Syllophopsis* | *cryptobia* |
| | *Syllophopsis* | *hildebrandti* |
| | *Terataner* | *alluaudi* |
| | *Tetramorium* | ***avaratra*** |
| | *Tetramorium* | *delagoense* |
| | *Tetramorium* | fhg_let |
| | *Tetramorium* | fhg_lili |
| | *Tetramorium* | fhg_mogw |
| | *Tetramorium* | fhg_pand |
| | *Tetramorium* | *ibycterum* |
| | *Tetramorium* | *kelleri* |
| | *Tetramorium* | mg121 |
| | *Tetramorium* | ***olana*** |
| | *Tetramorium* | ***ryanphelanae*** |
| | *Tetramorium* | *simillimum* (I) |
| | *Tetramorium* | ***vony*** |
| | *Anochetus* | ***goodmani*** |
| **Formicidae-Ponerinae** | *Anochetus* | *madagascarensis* |
| | *Bothroponera* | ***tavaratra*** |
| | *Bothroponera* | *wasmannii* |
| | *Hypoponera* | mg011 |
| | *Hypoponera* | mg025 |
| | *Hypoponera* | mg040 |
| | *Hypoponera* | mg045 |
| | *Hypoponera* | mg048 |
| | *Leptogenys* | *coerulescens* |
| | *Leptogenys* | *variabilis* |
| | *Mesoponera* | *ambigua* |
| | *Platythyrea* | *arthuri* |
| | *Discothyrea* | sp. |
| **Formicidae-Pseudomyrmecinae** | *Tetraponera* | *fictrix* |
| | *Tetraponera* | *perlonga* |
| | *Tetraponera* | psw083 |
| | *Tetraponera* | psw084 |
| | *Tetraponera* | psw086 |
| | *Tetraponera* | psw096 |
| **Megalyridae** | *Dinapsis* | ***scriptus*** |

Betsimiranja, Marivorahana, and Marotaolona; altogether this emphasizes the lack of entomological research in the Andrafiamena-Andavakoera area.

With regard to the more recent period of zoological exploration, the only entomological mission we are aware of to the area was in 2015, when a group under the direction of Brian L. Fisher with Malagasy colleages from the Madagascar Biodiversity Center visited the Andavakoera Massif from 15 to 17 December 2003, specifically a site in the Forêt d'Andavakoera, 21.4 km 75° ENE Ambilobe, 4.6 km 356° N Betsiaka, 425 m. All of the 22 species of arthropods described from the protected area since 1988 were collected by Fisher and colleagues during the course of three days. On the basis of data on the ants of Andavakoera (Table 2), established from the Fisher *et al*. collections of mid-December 2003, a total of 88 species, including two that are introduced to Madagascar, are known from the site. Of these, rather remarkedly, 21.6% of these taxa have been subsequently described as new to science based on these collections. This underlines how poorly known the site is, the importance of even a single mission of only three days on the local measures of biodiversity, and clearly the need for more invertebrate exploration of the protected area.

### *Vertebrates*

Since 1988, two species of vertebrates occurring in the Andrafiamena-Andavakoera protected area have been described as new to science and all based on material collected after 1988. Before our late 2023 biological inventory of the protected area, the vast majority of local work conducted on the vertebrates was lemurs (Rafalimanana, 2025, herein). There are several lemur species that occur in the protected area that are considered rare. Most notable is *Propithecus perrieri*, Perrier's Sifaka, considered Critically Endangered, and one of the most threatened primates in the world (Mittermeier *et al*., 2022). A number of studies have been conducted on the ecology and distribution of this species, several in the Andrafiamena-Andavakoera protected area (Ranaivoarisoa *et al*., 2006; Salmona *et al*., 2013).

Researchers examining aspects of lemur phylogeography and systematics have in a few cases included tissue samples from the protected area in molecular studies. This work has lead to the description of two lemur species new to science with populations in Andrafiamena-Andavakoera, including *Cheirogaleus shethi*, Sheth's Dwarf Lemur, which is also known from the neighboring Réserve Spéciale d'Ankarana and Réserve Spéciale d'Analamerana (Fraiser *et al*., 2016). In a broad geographic study of members of the genus *Lepilemur*, Louis *et al*. (2006) described a new species, *Lepilemur milanoii*, Daraina Sportive Lemur, from the Paysage Harmonieux Protégé de Loky Manambato, which is also known from Andrafiamena-Andavakoera. Material from *Microcebus tavaratra*, Tavaratra Mouse Lemur, obtained at Andavakoera was used in a molecular analysis of members of this genus from northern Madagascar (Louis *et al*., 2008).

Field research has also been conducted in the Andavakoera-Andrafiamena protected area on other mammal species, such as a general survey of locally occurring lemurs (Zaonarivelo *et al*., 2007) and a study of the distribution of *Phaner electromontis* (Hending *et al*., 2020). Raheriarisena and Goodman (2006) presented details on a field inventory of small mammals at Andavakoera. Work has also been conducted on the genomic diversity of members of the endemic rodent genus *Eliurus* in the protected area and other portions of northern Madagascar (Sgarlata *et al*., 2024).

From Andavakoera-Andrafiamena, no species of fish, frog, reptile, bird or non-primate mammal has been described since 1988 as new to science. There is one suspected new species in the recent material from the 2023 inventory that might be new to science (Goodman & Soarimalala, 2025, herein). In comparison, for these different groups at Marojejy, a total of 42 different species new to science have been described in the past decades (Goodman *et al*., 2023).

## Conclusion

As tabulated herein, since 1988 a total of 37 species of plants and animals have been named as new to science from the Andrafiamana-Andavakoera. Approximately 97% of these specices have been described using material collected since 1988, which clearly underlines the importance of continuing biological inventories and associated collection of voucher specimens housed in natural history museums. This figure of 37 new species, is dramatically different than the 450 new species described from on and around the Marojejy Massif during the same period, which has been extensively visited by researchers and for certain groups such as plants the focus of inventory projects. While on one hand given the topographic variation and the vegetational types, it is important to underline that

the total biodiversity of Marojejy is notably greater than that of Andrafiamena-Andavakoera, while on the other hand, much more work needs to be done in the Andrafiaman-Andavakoera protected area documentating its biota. We suggest that with further prospection of the site and the study of voucher specimens by taxonomists, it is certain that numerous new taxa remain to be discovered and named.

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