# Novelties from the Northern Mountains Complex of Madagascar. III. Two new species of *Turraea* L. (Meliaceae)

**Martin W. CALLMANDER**
Missouri Botanical Garden,
P.O. Box 299, St. Louis, MO 63166-0299 (USA)
and Conservatoire et Jardin botaniques de la Ville de Genève,
chemin de l'Impératrice 1, case postale 60,
CH-1292 Chambésy (Switzerland)
martin.callmander@mobot.org

**Peter B. PHILLIPSON**
**Porter P. LOWRY II**
Missouri Botanical Garden,
P.O. Box 299, St. Louis, MO 63166-0299 (USA)
and Muséum national d'Histoire naturelle,
Département Systématique et Évolution (UMR 7205),
case postale 39, 57 rue Cuvier, F-75231 Paris cedex 05 (France)
peter.phillipson@mobot.org
pete.lowry@mobot.org

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ABSTRACT
Two new species of *Turraea* L. are described from northern Madagascar, *T. andriamiarisoana* Callm., Phillipson & Lowry, sp. nov. and *T. buerkii* Callm., Phillipson & Lowry, sp. nov., both endemic to a region bounded by four relatively well-studied protected areas (Tsaratanana, Manongarivo, Marojejy and Anjanaharibe-Sud). The region harbors extensive low to high elevation humid forest that was botanically virtually unknown until recently. The new species differ from each other and from other members of the genus in Madagascar by leaf features, flower colour, length of the staminal appendices, and the shape and the pubescence of the ovary. Line drawings are provided for both of the new taxa, along with discussions of their morphological affinities and preliminary risk of extinction assessments.

KEY WORDS
Meliaceae,
*Turraea*,
Madagascar,
taxonomy,
IUCN Red List,
new species.

**RÉSUMÉ**

*Nouveautés du complexe montagneux du nord de Madagascar. III. Deux espèces nouvelles de* Turraea *L. (Meliaceae).*

Deux nouvelles espèces de *Turraea* L. sont décrites du Nord de Madagascar: *T. andriamiarisoana* Callm., Phillipson & Lowry, sp. nov. and *T. buerkii* Callm., Phillipson & Lowry, sp. nov., toutes deux endémiques d'une zone délimitée par quatre aires protégées relativement bien étudiées (Tsaratanana, Manongarivo, Marojejy and Anjanaharibe-Sud). Cette zone de forêt de basse à haute altitude était pratiquement inconnue du point de vue botanique jusqu'à récemment. Ces nouvelle espèces diffèrent l'une de l'autre et des autres espèces du genre par leurs feuilles, la couleur des fleurs, la longueur des appendices staminaux et la forme et la pubescence de l'ovaire. Des dessins au trait sont fournis pour chacun des nouveaux taxons, accompagnés d'une discussion sur leurs affinités morphologiques ainsi que d'une évaluation préliminaire de leur risque d'extinction.

**MOTS CLÉS**
Meliaceae,
*Turraea*,
Madagascar,
taxonomie,
liste rouge UICN,
espèces nouvelles.

## INTRODUCTION

The Malagasy flora is remarkably rich, with an estimated 13-14 000 native species of vascular plants (Phillipson *et al*. 2006) and an exceptionally high proportion of endemic taxa. Species endemism was recently calculated at 84% for the currently accepted published species (Callmander *et al*. 2011), but is likely to be even higher as many additional endemics are described. These facts, coupled with Madagascar's very high rate of deforestation and the rapid expansion of other unsustainable land use practices, rightly place Madagascar among the world's most important biodiversity hotspots (Myers *et al*. 2000). Moreover, many Malagasy plants have narrow distributions and a large proportion of them are highly threatened. We are thus engaged in a race against time to document the island's floristic diversity, an essential undertaking to inform conservation planning and actions, and to understand the processes that have generated Madagascar's remarkable biota.

Toward this end, a team of botanists conducted a series of field expeditions between 2005 and 2008 to explore the flora and vegetation in a long-neglected region of low to high elevation humid forest in northern Madagascar, which we refer to as the Northern Mountains (NM) Complex. This area is situated roughly within a region bounded by four relatively well-studied protected areas: Tsaratanana (2876 m) and Manongarivo (1876 m) to the northwest, and Marojejy (2132 m) and Anjanaharibe-Sud (2064 m) to the southeast (Fig. 1A). The western portion of the NM Complex includes the Ambohimirahavavy (2301 m) and Biempoko (2219 m) massifs, along with a rather isolated pair of mountains, Kalabenono (1028 m) and Galoka (1133 m) in the south of the Galoka chain, whereas the eastern portion of the complex includes the Andramanalana (2260 m) and Ankarongameloka (1785 m) massifs situated to the west of Doany, as well as the forests along the upper Bemarivo River east of Morafeno. Fieldwork also focused on the Sorata massif (1767 m) in the northernmost part of the NM Complex (Fig. 1B). Seven separate field expeditions were conducted during which more than 4400 collections were made, yielding material of many plant species new to science. This present article is the third contribution in a series devoted to novelties from the NM Complex. Earlier contributions dealt with a new taxon from Galoka, including a species of *Pandanus* Parkinson (Callmander *et al*. 2008) and eight new species belonging to a variety of families (Callmander *et al*. 2009). A new species of *Micronychia* Oliv. (Anacardiaceae), also from Galoka, was published recently together with other new taxa in this genus from elsewhere in Madagascar (Randrianasolo & Lowry 2009).

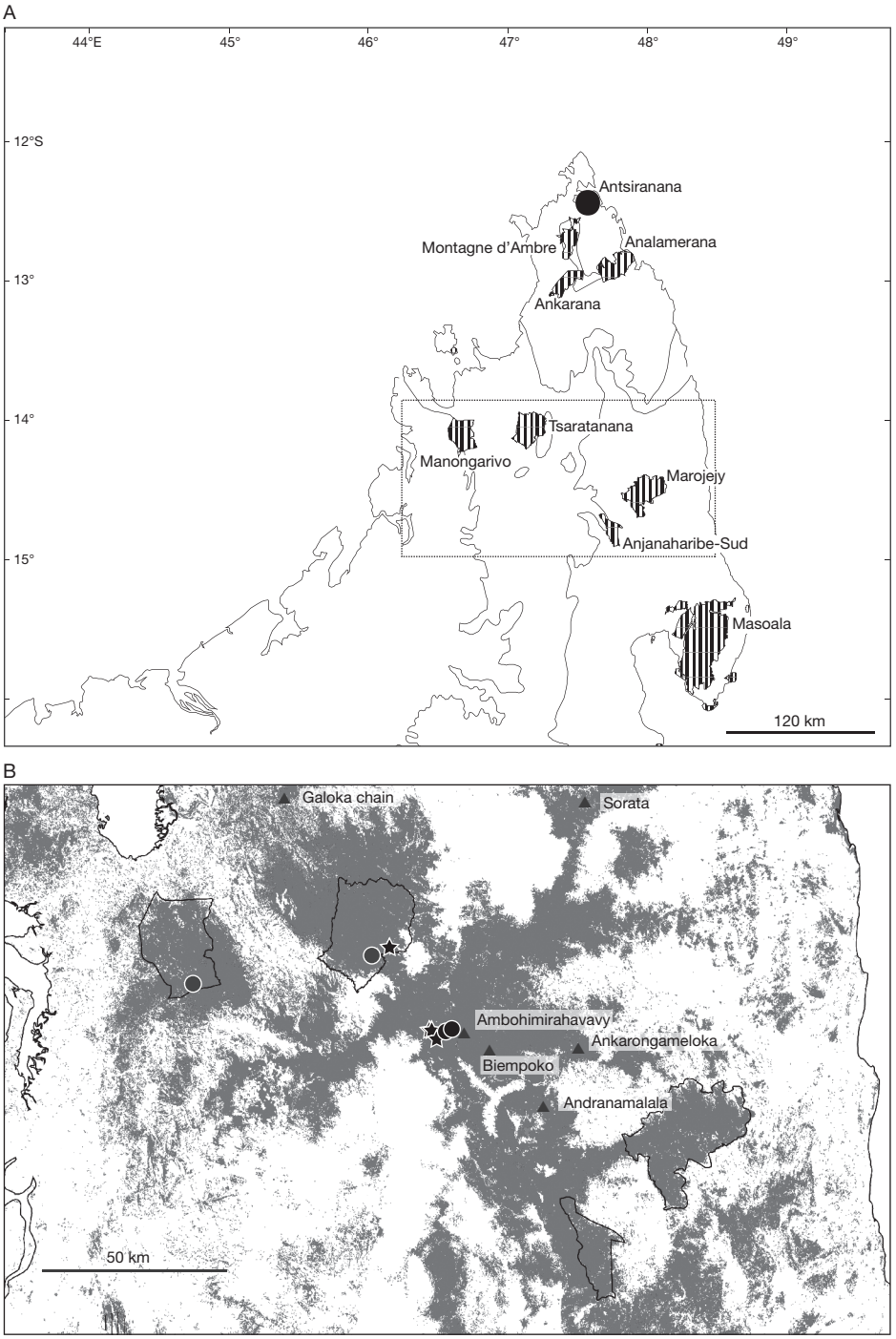


Fig. 1. — Northern Madagascar: **A**, current protected areas bounding the Northern Mountains Complex (hatched) (enlarged in B); **B**, sites at which general collecting was conducted in the Northern Mountains Complex (▲), with remaining primary forest in grey; known localities of *T. andriamiarisoana* Callm. Phillipson & Lowry, sp. nov. (★) and *T. buerkii* Callm. Phillipson & Lowry, sp. nov. (●).

While working in the herbaria of Antananarivo (TAN and TEF) in late 2005 to identify material of Meliaceae from the NM Complex, the first author determined that several of the new collections represent two yet undescribed species of *Turraea* L. This initial conclusion was made several years before he became aware of the existence of an unpublished and incomplete draft treatment of the family prepared by J.-F. Leroy and M. Lescot for the "*Flore de Madagascar et des Comores*". After detailed examination of the material available to Leroy & Lescot and careful consideration of the species circumscriptions they intended to propose, we have confirmed that the two species merit recognition. Having not seen the excellent material collected as part of the inventory of the NM Complex, Leroy and Lescot had not discerned either of the two new species, although some relatively poor older specimens of these entities were available to them but had been interpreted as belonging to more broadly circumscribed species. In our continuing effort to describe additional new species from the NM Complex, we present formal descriptions of these two taxa in this third article in our series of NM Complex novelties. We also provide preliminary risk assessments based on the IUCN Red List Categories and Criteria (IUCN 2001), accompanied by line drawings and a discussion of the morphological affinities of the new species with other members of the genus occurring in Madagascar.

## SYSTEMATICS

*Turraea*, a paleotropical genus of *c.* 75 species, is characterized by a unique combination of features, viz. a *receptaculum pollinis* (a strongly modified style head), a complete staminal tube bearing appendages, and a dehiscent fruit (Pennington & Styles 1975). The center of diversity of the genus clearly lies in the Afro-Malagasy region, where Meliaceae are hypothesized to have originated (Muellner *et al.* 2006), an interpretation that may be reflected in the region's large number of endemic genera (six of the 12 genera indigenous to Madagascar are endemic, according to Leroy & Lescot's [unpub. manuscript]), including *Calodecaryia* J.-F. Leroy and *Humbertioturraea* J.-F. Leroy, which form a clade that is sister to *Turraea* (Muellner *et al.* 2008). Recent treatments indicate that *Turraea* comprises *c.* 35 spp. in Africa (African Plant Database 2011), eight in the Mascarene Islands (Scott 1997) and one in Indo-Malaysia (Mabberley *et al.* 1995). In Madagascar, Leroy & Lescot's unpublished manuscript lists a total of 31 species, of which 16 remain to be formally described. A full account of the published Malagasy species of *Turraea* can be found in the *Catalogue of the Vascular Plants of Madagascar* (Madagascar Catalogue 2011), and a complete treatment of the genus for Madagascar, including descriptions of the other new species, will be published in the future, building on the manuscript of Leroy & Lescot.

For the specimens cited below, historical collections lacking geographic coordinates were post-facto georeferenced as accurately as possible using the *Gazetteer to Malagasy Botanical Collecting Localities* (Schatz & Lescot 2005) and other sources (these coordinates are placed in square brackets in the citation of material examined). The risk of extinction status of each species was assessed using the current IUCN Red List Criteria (2001). Calculations of the area of occupancy (AOO), extent of occurrence (EOO) and number of subpopulations were based on the methods presented in Callmander *et al.* (2007).

### *Turraea andriamiarisoana*
Callm., Phillipson & Lowry, sp. nov.
(Fig. 2)

*Haec species inter congeneros madagascarienses foliis chartaceis pubescentibus, floribus 5-meris, appendicibus staminalibus quam antheris brevioribus atque ovario conico trichomatibus luteis densissimis occulto recognoscitur.*

Typus. — **Madagascar.** Prov. Mahajanga, Bealanana, 13 km au NE de la commune rurale de Mangindrano, 14°13'29"S, 49°03'40"E, 1730 m, 30.X.2005, fl., *Rakotovao et al. 2307* (holo-, MO[MO5933527]!; iso-, G[G00340046]!, K!, P[P00568730]!, TAN!).

Paratypi. — **Madagascar.** Prov. Mahajanga, dist. de Bealanana, 1949, fl., *Dufournet s.n.* (P). — 7 km au NE de Mangindrano, sur les deux côtés de la rivière d'Antsahivo, 14°14'40"S, 49°00'45"E, 1306 m, 28.XI.2005, fr., *Rakotovao & Jaovazaha 2593* (MO, P, TAN). — Sur le


Fig. 2. — *Turraea andriamiarisoana* Callm. Phillipson & Lowry, sp. nov., *Réserves Naturelles 6633* (paratype, TEF): **A**, flowering branch; **$B_1$**, stamens with developing style; **$B_2$**, stamens in adaxial view; **C**, detail of staminal appendices; **D**, detail of stigma; **E**, ovary; **F**, transverse section of ovary; **G**, longitudinal section of ovary. Scale bars: A, 2 cm; B-E, G, 1 mm; F, 2 mm.

TABLE 1. — Salient features distinguishing *Turraea andriamiarisoana* Callm., Phillipson & Lowry, sp. nov. from *T. richardii* Baill. and *T. thouvenotii* Danguy.

| | ***T. andriamiarisoana*** sp. nov. | ***T. richardii*** | ***T. thouvenotii*** |
|---|---|---|---|
| Leaf shape | elliptic | obovate | elliptic |
| Leaf texture | chartaceous | subcoriaceous | subcoriaceous |
| Flower colour | red | white | white |
| Ovary shape | ovoid | subglobose | subglobose |
| Ovary surface | pubescent | pubescent | glabrous |

mi-versant du Mont d'Antsahivo, Ambohimirahavavy, 14°14'36"S, 49°00'44"E, 1328 m, 27.XI.2005, y. fr., *Randrinarivelo et al. 434* (G, MO, P, TAN). — Dist. de Mangindrano, cant. de Mangindrano, Réserve Naturelle n°IV, Tsaratanana, [14°00'S, 48°52'E], 23.X.1952, fl., *Réserves Naturelles 4523* (P); *s. loc.*, 3.VII.1953, fl., *Réserves Naturelles 6022* (G, MO, P, TEF); *s. loc.,* 4.IX.1954, fl., *Réserves Naturelles 6633* (P, TEF); *s. loc.*, 2.IX.1954, fl., *Réserves Naturelles 6636* (P, TEF); *s. loc.*, 20.IX.1955, fl., *Réserves Naturelles 7524* (P, TEF).

DISTRIBUTION AND ECOLOGY. — *Turraea andriamiarisoana* sp. nov. is known from humid forest at 900-1700 m in the Ambohimirahavavy and Tsaratanana massifs (Fig. 1), where it grows along river banks on substrates derived from igneous rocks.

ETYMOLOGY. — This plant is named in honor of our friend and colleague Roger Lala Andriamiarisoa, a dedicated Malagasy botanist with a special interest in bryophytes. He was a member of the team that conducted field work in the Ambohimirahavavy massif, where he focused on collecting mosses. Roger Lala is also renowned as an exceptionally talented artist who has contributed to many publications on the Malagasy flora by producing wonderfully detailed and informative line drawings, including those presented here.

CONSERVATION STATUS. — With an EOO of 85 km$^2$, an AOO of 27 km$^2$, and 3 subpopulations, one of which is situated within a protected area (Tsaratanana), *Turraea andriamiarisoana* sp. nov. is assigned a preliminary status of vulnerable (VU D2) based on the IUCN Red List Categories and Criteria (IUCN 2001).

## DESCRIPTION

Treelet to 6 m; stems brownish, glabrous, young stem bearing a dense yellowish indumentum. Leaves unifoliate, blade elliptic, chartaceous, abaxial surface puberulent on the primary vein, adaxial surface glabrous, (2-)4-7(-9) × (1.5-)2-3(-4) cm, base attenuate, margin entire, apex acuminate, acumen *c.* 5 mm; domatia absent; midrib and secondary veins prominent on both surfaces, reticulation visible; petiole 2-3(-6) mm long, glabrescent. Inflorescences with 1 or 2 axillary flowers. Flowers 3.5-4.5 cm long; pedicel *c.* 1 mm in diam., 4-5 mm long, covered with a dense appressed indumentum. Calyx cupuliform, 3-4 × 3-4 mm, 5-lobed, each lobe with an apical tooth, covered with a dense appressed indumentum of short white trichomes. Corolla red, of 5 linear petals, longer than the staminal tube, 40-50 mm long, 1-1.5 mm wide at base, 2-3 mm wide in the distal part, apex acute, puberulent outside, glabrous inside. Staminal tube red, membranaceous, cylindrical, 25-30 mm long, glabrous outside, puberulent inside, with rudimentary bifid appendices each *c.* 1 mm long. Anthers 10, oblong, 3 × 0.5 mm, apiculate, apicule *c.* 0.5 mm. Ovary ovoid, *c.* 1 × 1.5 mm, hidden by a very dense mass of yellow trichomes, locules 5, each with 2 collateral ovules. Style exserted 6-10 mm beyond the staminal tube, 0.3 mm in diam. *Receptaculum pollinis* oblong, 4 × 1.2 mm, stigma discoid, *c.* 0.3 × 1.2 mm, ridge with conical lobes, apex truncate, striate, 1 × 0.8 mm. Fruit a capsule, 8 × 10 mm, outer surface with 5 longitudinal ridges, covered by a dense appressed yellowish indumentum, dehiscing by 5 valves, with a small apicule at apex, pericarp *c.* 1 mm thick. Seeds 6 × 3 mm, internally curved, shiny, brownish, micropyle pointed.

## REMARKS

*Turraea andriamiarisoana* sp. nov. is part of a group of three species (also including *T. richardii* Baill. and *T. thouvenotii* Danguy) that can be distinguished from all other members of the genus in Madagascar by having flowers with 5 sepals and 5 petals, stami-

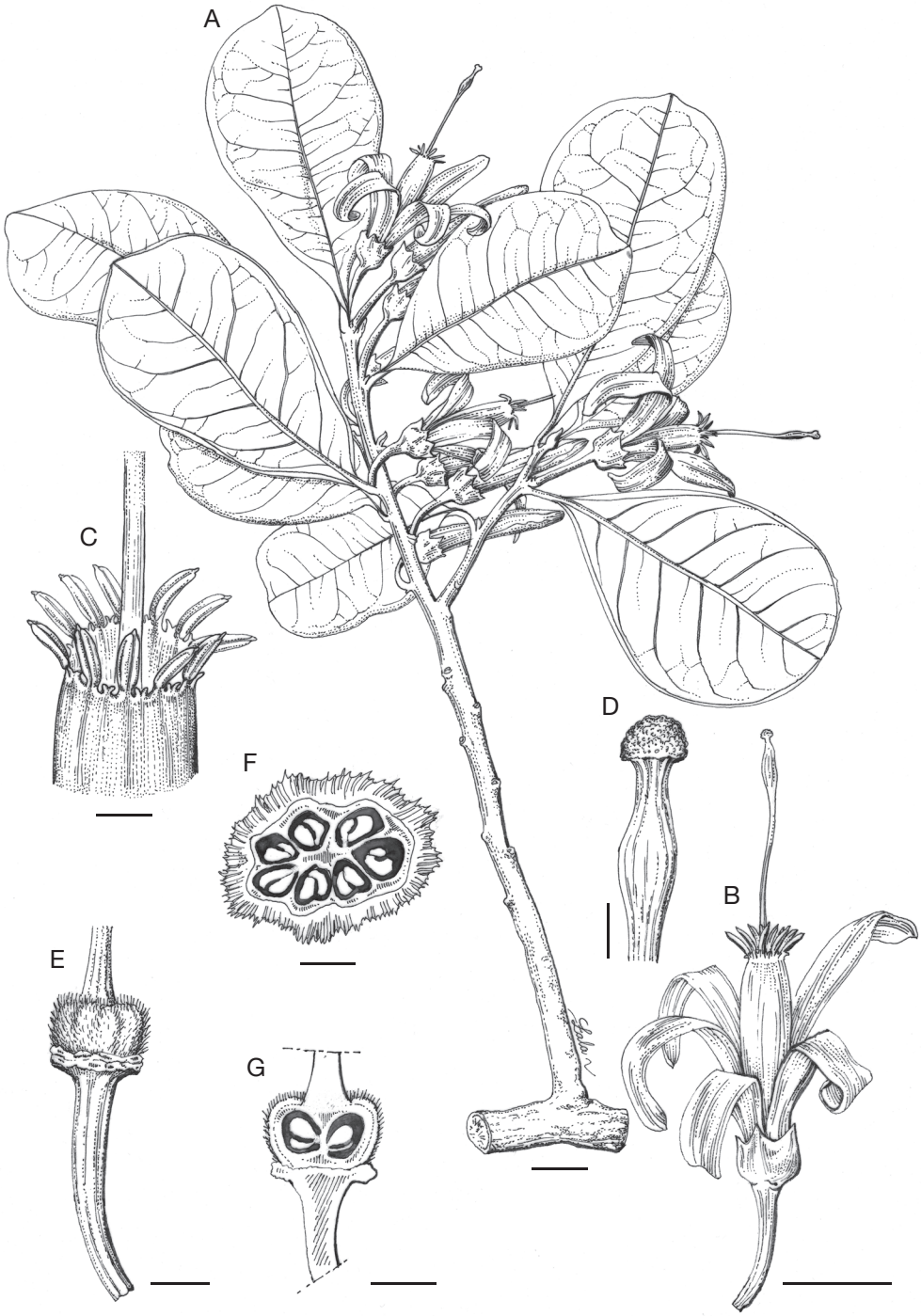


Fig. 3. — *Turraea buerkii* Callm. Phillipson & Lowry, sp. nov., *Buerki, Rakotovao & Callmander 125* (isotype, TAN): **A**, flowering branch; **B**, flower; **C**, stamens; **D**, stigma; **E**, ovary; **F**, transverse section of ovary; **G**, longitudinal section of the ovary. Scale bars: A, 2 cm; B, 1 cm; C, 3 mm; D, F, 1 mm; E, G, 2 mm.

nal appendices that are shorter than the anthers, and 5-lobed ovaries. Within this group, *T. andriamiarisoana* sp. nov. is characterized by several unique vegetative and floral features, as summarized in Table 1.

*Turraea richardii* is only known from the dry forests in the region of Antsiranana and the Baie de Rigny, whereas *T. thouvenotii* is widespread in humid forest, but in the NM Complex is only known from the Ambohimirahavavy massif, where it co-occurs with *T. andriamiarisoana* sp. nov. Material of *Turraea andriamiarisoana* sp. nov. seen by Leroy & Lescot was assigned by to an unpublished species that they intended to call "*T. mangindranensis*". However, their concept of this entity contains clearly discordant elements, including specimens collected from *c.* 150 km further south, in the upper Bemarivo valley and on the Tampoketsa d'Analamaitso, which we do not include in *T. andriamiarisoana* sp. nov., but which do merit recognition as another new species.

## *Turraea buerkii*
Callm., Phillipson & Lowry, sp. nov.
(Fig. 3)

*Haec species inter congeneros madagascarienses foliis coriaceis glabris, floribus 5-meris, appendicibus staminalibus quam antheris brevioribus atque ovario oblato indumento denso adpresso luteolo vestito recognoscitur.*

Typus. — **Madagascar.** Prov. Mahajanga, Ambohimirahavavy, campement 3, 14°12'16"S, 49°05'46"E, 2078 m, 30.X.2005, fl., *Buerki, Rakotovao & Callmander 125* (holo-, MO[MO6103817]!; iso-, G[G00340047]!, K!, P[P00568731]!, TAN!).

Paratypi. — **Madagascar.** Prov. Mahajanga, Ambohimirahavavy, 14°12'16"S, 49°05'46"E, 2169 m, 11.XI.2005, fl., *Andriamiarinoro & Randrianarivony 20* (G, MO, P, TAN). — Massif du Tsaratanana et haute vallée du Sambirano, [14°02'S, 48°55'E], XI-XII.1937, fl., *Humbert 18272* (G, K, MO, P, TAN, US). — Massif du Manongarivo, versant de l'Andranomalaza, [14°03'00"S, 48°21'30"E], X.1908, fl., *Perrier de la Bâthie 5924* (P). — Distr. Ambanja, entre Ambinan'Antsoha et Andilambe, 25.IX.1959, fl., *Service Forestier 19732* (P).

Distribution and ecology. — *Turraea buerkii* sp. nov. is known from montane evergreen forests between 1500 and 2100 m in the NM Complex (Fig. 1), where it occurs on substrates derived from igneous rocks.

Etymology. — The species is named in honor of our friend and colleague Sven Buerki, who collected the type material while participating in the expedition that reached the summit of Ambohimirahavavy (2301 m) more than 50 years after it was first explored by Henri Humbert and René Capuron (Capuron 1952). Sven has always shown great enthusiasm for the Malagasy flora and its biogeography and systematics, in particular regarding the families Rhamnaceae, Sapindaceae and Pandanaceae, the latter two of which are the focus of much of his current research.

Conservation status. — With an EOO of 950 km$^2$, an EOO of 27 km$^2$, and 3 subpopulations occurring within two of Madagascar's protected areas (Manongarivo and Tsaratanana), *Turraea buerkii* sp. nov. is assigned a preliminary status of Vulnerable (VU D2) based on the IUCN Red List Categories and Criteria (IUCN 2001).

### Description
Treelet to tree, 3 to 18 m; stems brownish, glabrous. Leaves unifoliolate, blade elliptic to sub-ovate, sub-coriaceous, glabrous, (5-)8-14 × (2-)3.5-5.5 cm, slightly shiny on adaxial surface, base abruptly attenuate, margin entire, apex acute to broadly cuspidate; domatia absent; midvein and secondary veins prominent on the both surfaces, reticulation visible; petiole 3-5 mm long, glabrescent. Inflorescence with 2 (or 3) axillary flowers. Flowers 4-4.5 cm long; pedicel *c.* 1 mm in diam., 4-10 mm long, pubescent. Calyx cupuliform, 5-7 × 5-7 mm, 5-lobed, each lobe with an apical tooth, puberulent with short white trichomes. Corolla red, of 5 linear petals, longer than the staminal tube, 40-50 mm long, 1.5-3 mm wide at base, (3-)5-8 mm wide in the distal part, apex acute, puberulent outside, glabrous inside. Staminal tube red, except white in the distal part, membranaceous, cylindrical, 25-30 mm long, glabrous, with rudimentary bifid appendices each *c.* 1 mm long. Anthers 10, elliptic, *c.* 3 × 0.3 mm, mucronate. Ovary oblate, *c.* 2 × 3 mm, with dense appressed brownish indumentum, locules 5 to 7, each with 2 collateral ovules. Style exserted 15-30 mm beyond the staminal tube, 0.3 mm in diam. *Receptaculum pollinis* oblong, 3 × 1 mm, stigma globose, *c.* 0.4 × 1 mm, ridge with conical lobes, apex truncate, striate, 0.6 × 0.5 mm. Fruit unknown.

Remarks

*Turraea buerkii* sp. nov. can be recognized by its coriaceous, glabrous leaves, 5-merous flowers with a red corolla and staminal tube, and staminal appendices that are shorter than the anthers. The only species in Madagascar with similar character is *T. humbertii* Danguy, which differs from our new species in having chartaceous, pubescent leaves and white flowers. Furthermore, *T. humbertii* is only known from low elevation dry forest between sea level and 200 m around Mahajunga and in far northern Madagascar, a habitat that differs strikingly from those at the high elevation sites with montane evergreen forest where *T. buerkii* sp. nov. occurs (Fig. 1). Leroy & Lescot, in their unpublished manuscript, assigned the material of *T. buerkii* sp. nov. available at the time to a species they intended to call "*T. sambiranensis*", in which they also included several collections from Marovato and the Sambirano region that represent a distinct new species that remains to be described.

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