

Novelties in the genus *Acalypha* (Euphorbiaceae, Acalyphoideae): two new species from northern Madagascar

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Academic editor: João Farminhão ♦ Received 14 June 2023 ♦ Accepted 11 September 2023 ♦ Published 11 October 2023

Abstract

Background and aims – Taxonomic knowledge of *Acalypha* in the Western Indian Ocean Region (WIOR; including Madagascar, Comoros, Mascarenes, Seychelles, and the Scattered Islands) has increased greatly in the last few years. This paper is the latest in a series of publications that have contributed to create a robust taxonomic framework for *Acalypha* in this region.

Material and methods – The descriptions and illustrations of the new species are based on herbarium specimens and on some field images. Descriptions were made following standard procedures. Maps were prepared using QGIS software and preliminary conservation assessments were made following IUCN guidelines and criteria.

Key results – Two species of *Acalypha* from northern Madagascar are described as new to science: *Acalypha bardotiana* sp. nov., found on the Montagne des Français (Diana region), and *Acalypha inaequibracteata* sp. nov., found in the Binara forest (Sava region). Line drawings, field images, distribution maps, and a discussion of their morphological and phylogenetic affinities, as well as the preliminary conservation assessments are provided.

Keywords

biodiversity, conservation, IUCN Red Listing, protected areas, taxonomy, WIOR

INTRODUCTION

Acalypha L. (Euphorbiaceae, Acalyphoideae) is a monophyletic genus with its morphological synapomorphies including pendent anthers that become twisted after dehiscence, finely sculptured pollen grains with brevicolporate apertures, lacinate styles, and diverse epidermal crystals (Nowicke and Takahashi 2002; Sagun et al. 2006; Cardiel et al. 2020; Levin et al. 2022). Most species have spikelike inflorescences with the bracts subtending the female flowers becoming foliaceous in fruit. With ca

500 accepted species, *Acalypha* is the third largest genus in the family, after *Euphorbia* L. and *Croton* L. It is found mainly in the tropics and subtropics worldwide, with its greatest diversity in tropical America, with ca 250 species (Ulloa-Ulloa et al. 2017; Cardiel et al. 2023a), followed by continental Africa, with ca 65 species (Cardiel and Montero-Muñoz 2018), and the Western Indian Ocean Region, with 49 species currently recognised, including 39 from Madagascar (Montero-Muñoz et al. in press).

This paper builds on the revisionary work on *Acalypha* for the Western Indian Ocean Region (WIOR; including

Madagascar, Comoros, Mascarenes, Seychelles, and the Scattered Islands), which was begun by Montero-Muñoz et al. (2018a, 2018b, 2020a, 2020b, 2022, in press).

MATERIAL AND METHODS

The taxonomic status of the new species is based on morphological, geographical, molecular, and ecological data. The descriptions and illustrations provided are based on herbarium specimens, including type material hosted in G, K, MO, and P (acronyms follow Thiers 2023), and on some field images provided by Martine Bardot-Vaucoulon. All the specimens were studied using an Olympus SZX7 stereomicroscope. Information about habit, plant size, and habitat is based on field notes on the specimen labels. The distribution maps were prepared using QGIS Desktop v.3.28.4 (QGIS 2023). Preliminary conservation assessments are based on the IUCN Red List Categories and Criteria (IUCN 2022). Area of occupancy (AOO) and extent of occurrence (EOO) were calculated with GeoCAT, a geospatial conservation assessment tool (Bachman et al. 2011), using a 2 × 2 km grid cell size as recommended by IUCN (2022). Layers of protected areas were obtained from UNEP-Protected Areas Planet (UNEP-WCMC and IUCN 2023).

Taxonomic and biogeographical information about *Acalypha* is available online on the regularly updated *Acalypha* Taxonomic Information System website (Cardiel et al. 2023b; <http://www.acalypha.es>).

TAXONOMIC TREATMENT

Acalypha bardotiana I.Montero & Cardiel, **sp. nov.**

urn:lsid:ipni.org:names:77328079-1

Figs 1, 2

Type. MADAGASCAR – Diana region [Antsiranana prov.] • Montagne des Français, descent of the canyon starting from the ruins of the military camp; 12°19'46"S, 49°20'23"E; 260 m; 6 Apr. 2007; *Bardot-Vaucoulon M., Véné G. & Razafindrabalahasy G. 1645*; holotype: P [P00643172]; isotypes: K, MO [MO-2966289, accession n° 6120147], TAN (not seen).

Diagnosis. *Acalypha bardotiana* is morphologically close to *A. lanceolata* Willd. var. *glandulosa* (Müll.Arg.) Radcl.-Sm. but differs mainly by having a suffruticose habit and unisexual inflorescences (vs herbaceous habit and androgynous inflorescences), conspicuous stipules up to 8 mm long (vs inconspicuous stipules up to 2 mm long), petioles up to 8 mm long and leaf blades up to 9 cm long (vs petioles up to 4.6 mm long and leaf blades up to 6.5 cm long), and papillose-hispid capsules (vs smooth capsules).

Description. Suffruticose herbs, 0.5–0.6 m tall, monoecious. Branches pubescent with short, antrorsely curved, simple trichomes and long, erect trichomes to 1 mm long, glabrescent when mature. Axillary buds

inconspicuous. Stipules conspicuous, up to 8 mm long and 3.5 mm wide at base, ovate-lanceolate to triangular-lanceolate, acuminate, sparsely hairy with long, simple trichomes to 1 mm long and minute glandular trichomes at margin. Petioles thin, 6–8 cm long, indumentum similar to that on young branches. Leaf blades 6–9 × 4–6 cm, broadly ovate to elliptic-lanceolate, membranous; base obtuse to subcordate; apex acute to acuminate; margins serrate, teeth rounded, sometimes mucronate; upper surface with sparse, erect, simple trichomes up to 1 mm long; lower surface subglabrous, with appressed simple trichomes on veins; venation actinodromous, basal veins 3(–5), secondary veins 4–5 per side. Stipels absent. Inflorescences spiciform, unisexual, male axillary, female terminal on lateral branches. Male inflorescences up to 3 cm long, flowers glomerate; bracts minute to 0.5 mm long, linear-lanceolate, sparsely hairy. Female inflorescences moderately densely flowered, up to 8 cm long; peduncle up to 1 cm long, indumentum similar to that on young branches; bracts to 30, sessile, enlarging in fruit to 2.5 × 5 mm, sparsely hairy with erect, hyaline, simple trichomes up to 1 mm long and glandular trichomes up to 1 mm long; margin deeply dentate, teeth 10–12, triangular, acute, up to 1.5 mm long, central tooth not prominent; bracteoles absent. Male flowers with pedicel up to 0.5 mm long, glabrous; buds up to 0.5 mm diameter, glabrous. Female flowers 1 per bract, sessile; sepals 3, up to 0.5 mm long, distinct, ovate-lanceolate, ciliate, with minute simple trichomes up to 0.2 mm long; ovary ca 1 mm diameter, 3-lobed, papillose-hispid, each papilla ending in a long, hyaline trichome up to 1 mm long; styles 3, up to 5 mm long, slightly connate, each divided into 5–6 slender segments, with some hyaline erect trichomes up to 1 mm long. Allomorphic flowers not seen. Capsules up to 2.5 mm diameter, papillose-hispid, each papillae ending in a simple, erect trichome up to 1 mm long, surface sparsely hairy with minute, simple trichomes up to 0.2 mm long. Seeds ca 1.7 × 1 mm, pyriform, minutely foveolate.

Etymology. The epithet honours Mrs Martine Bardot-Vaucoulon, a French botanist who has conducted extensive botanical research in Madagascar. She is also one of the collectors of the type specimens of this species and kindly provided us with some field images included in this paper.

Distribution and habitat. *Acalypha bardotiana* is known only from the north side of Montagne des Français, at 260 m elevation. Montagne des Français is a limestone massif covered with dry deciduous forest, in the Diana region in the extreme north of Madagascar. *Acalypha bardotiana* grows on reduced clay soil on outcropping blocks of Eocene limestone, in an area of sparse vegetation on sunny rocks in the canyon (Fig. 4).

Preliminary IUCN conservation assessment. *Acalypha bardotiana* is only known from a single collection and location in the protected area of Montagne des Français. In this location, there were around ten individuals of this species (Martine Bardot-Vaucoulon pers. comm.). The extent of occurrence (EOO) could not be calculated.

Its area of occupancy (AOO) is estimated to be 4 km². Montagne des Français has been relatively well collected (Porter P. Lowry II pers. comm.), so the absence of previous collections suggests this species is not common. *Acalypha bardotiana* is found in only one location, and its habitat is continuing to decline due to woodcutting,

primarily for charcoal, and to the slash-and-burn agriculture (Goodman et al. 2018; Wilding et al. 2021). *Acalypha bardotiana* is assessed provisionally as Critically Endangered: CR B2ab(ii,iii,iv).

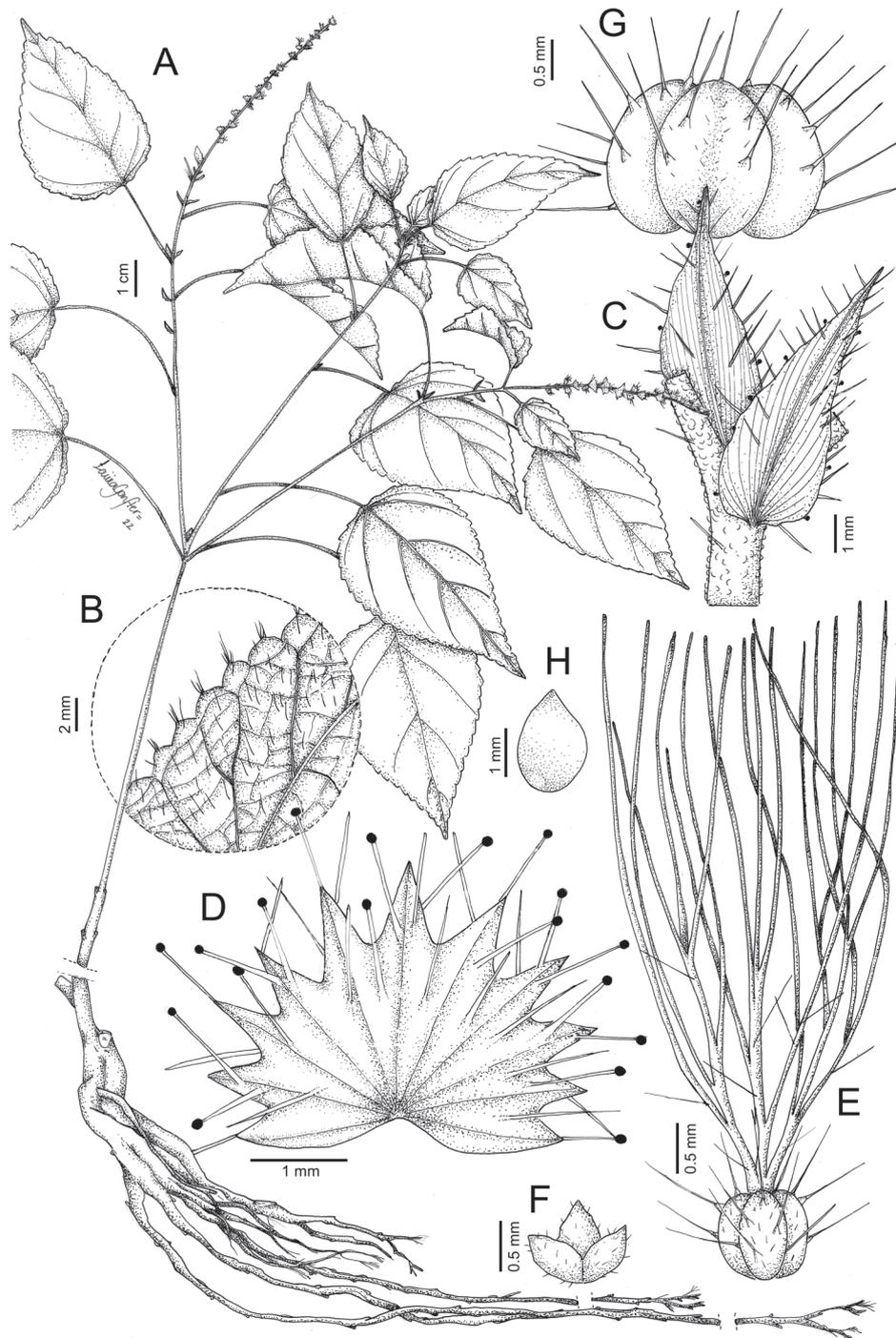


Figure 1. *Acalypha bardotiana*. A. Habit. B. Detail of lower leaf surface. C. Detail of node, stipules, and petiole base. D. Mature female bract. E. Ovary and styles. F. Calyx of the female flower. G. Capsule. H. Seed. Based on M. Bardot-Vaucoulon. G. Véné & G. Razafindrabelahasy 1209 (P and K). Illustration by Laura González Hernández.

Acalypha inaequibracteata I.Montero & Cardiel, **sp.****nov.**

urn:lsid:ipni.org:names:77328081-1

Fig. 3

Type. MADAGASCAR – **Sava region** [Antsiranana prov.] • Vohimarina district, Vohemar sub-prefecture, rural municipality of Daraina, Binara forest; 13°15.42'S, 49°36.8'E; 440 m; 22 Dec. 2003; *Nusbaumer* L. LN875; holotype: G [G00006971]; isotype: P [P04786262].

Diagnosis. *Acalypha inaequibracteata* is morphologically similar to *A. ankaranensis* I.Montero & Cardiel, but differs mainly by having minute stipules up to 2 mm long, with simple trichomes (vs. stipules up to 5 mm long, with simple and glandular trichomes), petioles 0.5–1(–1.5) cm long (vs petioles 3–5 cm long), ovate to elliptic-lanceolate leaf blades that are rounded to obtuse at the base and lack domatia (vs broadly ovate-lanceolate leaf blades that are subcordate to cordate at the base and have pocket-shaped domatia), and dimorphic female bracts (vs monomorphic female bracts).

Description. **Shrubs**, probably deciduous, 0.2–0.3 m tall, monoecious. **Branches** pubescent with short, antrorsely curved, simple, trichomes, glabrescent when mature. **Axillary buds** inconspicuous. **Stipules** inconspicuous, up to 1.5–2 mm long and 0.5 mm wide at base, triangular-lanceolate to linear-lanceolate, sparsely hairy with minute simple trichomes up to 0.2 mm long. **Petioles** thin, 0.5–1(–1.5) cm long, indumentum similar to that on young branches. **Leaf blades** (3–)4–5(–6) × 1.5–2(–2.7) cm, ovate to elliptic-lanceolate, membranous; base rounded to obtuse; apex acute to acuminate, acumen mucronate; margins crenate to serrate, teeth minute with small, sessile, glandular trichomes at apex; upper surface laxly pubescent with sparse, erect, simple trichomes up to 1 mm long and antrorsely curved trichomes on veins; lower surfaces with indumentum similar to that on the upper surface but less dense; venation actinodromous, basal veins 3(–5), secondary veins 4–5 per side. **Stipels** absent. **Inflorescences** spiciform, androgynous, and

solitary female bracts, mainly axillary, some androgynous inflorescences terminal in lateral branches. **Androgynous inflorescences** up to 5.5 cm long; peduncle up to 0.8 cm long, indumentum similar to that on young branches; female segment up to 3 cm long, bracts 2–5, sessile, enlarging in fruit, dimorphic on the same plant (broadly ovate-lanceolate to subtriangular, up to 10 × 10 mm, on some inflorescences and oblate, up to 11 × 6.5 mm, on other inflorescences), both sparsely hairy with simple trichomes on both surfaces, oblate bracts also with minute glandular trichomes on lower surface; margin crenate to subentire, with minute, sessile, glandular trichomes at tooth apices, central tooth not prominent, bracteoles up to 0.6 mm long, triangular, sparsely hairy; usually there are inflorescences with all the bracts of the female segment oblate and other inflorescences with all the bracts of the female segment ovate-lanceolate to subtriangular; male segment persistent, up to 2.5 cm long, flowers glomerulate, bracts up to 0.5 mm long, triangular, sparsely hairy. **Solitary female bracts** mostly broadly ovate-lanceolate to subtriangular, similar to those found on androgynous inflorescences. **Male flowers** with pedicel up to 0.5 mm long, glabrous; buds up to 0.5 mm diameter, sparsely hairy, papillose. **Female flowers** 1 per bract, sessile; sepals 3, up to 0.7 mm long, distinct, triangular, ciliate with minute simple trichomes up to 0.2 mm long; ovary ca 1 mm diameter, 3-lobed, densely papillose-hispid, each papilla ending in a long, hyaline trichome up to 1 mm long; styles 3, up to 6 mm long, distinct, each divided into 6–7 very slender segments, sparsely hairy. **Allomorphic flowers** not seen. **Capsules** (immature) up to 2 mm diameter, papillose-hispid, each papilla ending in a simple trichome up to 1 mm long, surface pubescent with simple, minute trichomes. **Seeds** not seen.

Etymology. The specific epithet refers to the presence of female bracts showing different shapes.

Distribution and habitat. *Acalypha inaequibracteata* is known only from the Binara forest, in Daraina commune, Sava region, at 440 m elevation. The Binara forest is located in north-eastern Madagascar. *Acalypha inaequibracteata*



Figure 2. *Acalypha bardotiana* in situ. **A.** Female inflorescence, leaves, and stipules. **B.** Habit. Photos by Mrs Martine Bardot-Vaucoulon, used with permission.

grows on secondary grassland at the edge of the dense humid semi-deciduous forest, on rough boulders. (Fig. 4). **Preliminary IUCN conservation assessment.** *Acalypha inaequibracteata* is only known from a single collection

and location. The extent of occurrence (EOO) could not be calculated. Its area of occupancy (AOO) is estimated to be 4 km². The Binara forest belongs to the network protected area of Loky-Manambato (Category

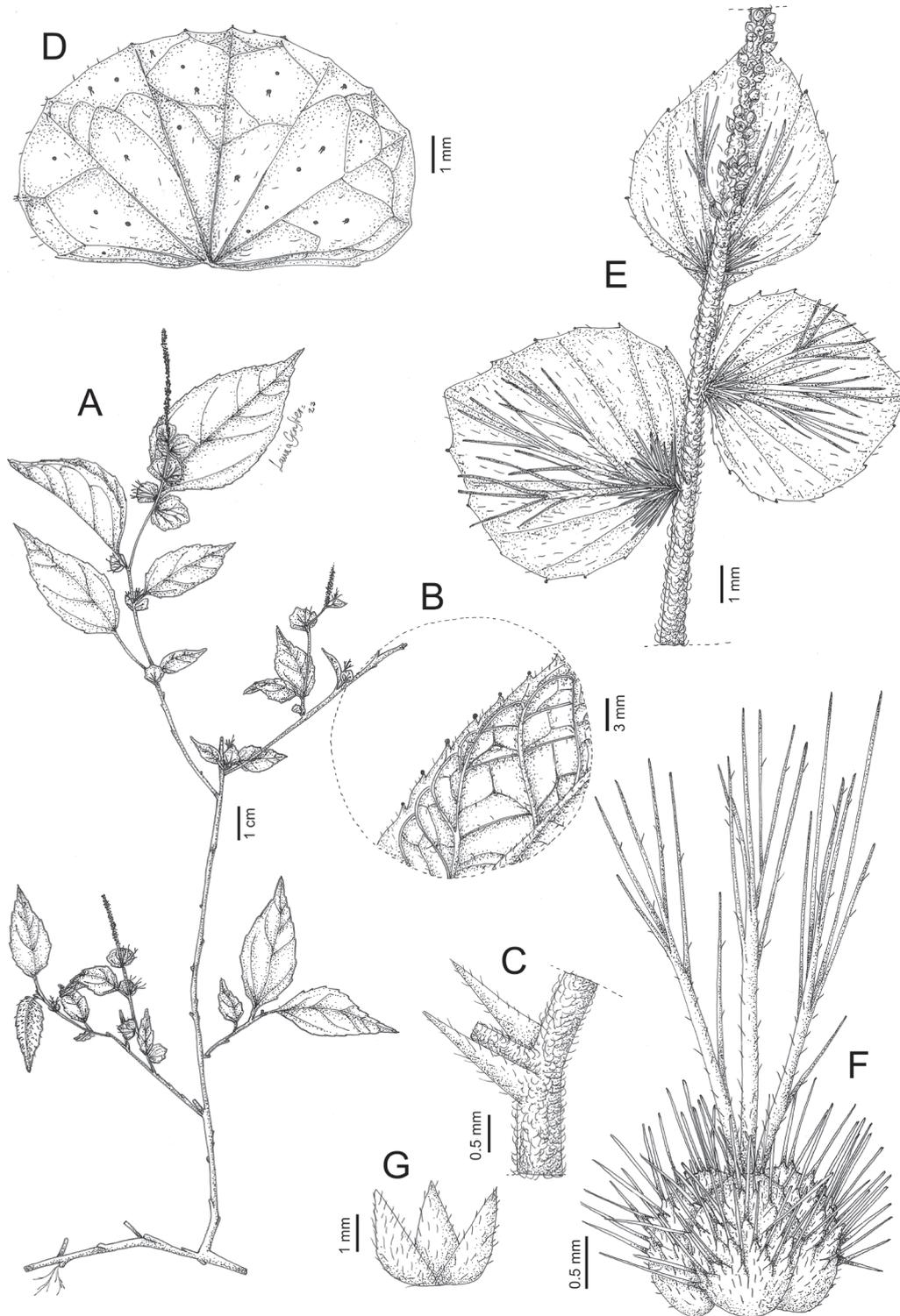


Figure 3. *Acalypha inaequibracteata*. A. Flowering branch. B. Detail of lower leaf surface. C. Detail of node, stipules, and petiole base. D. Mature female bract. E. Detail of androgynous inflorescence. F. Capsule (immature) and styles. G. Calyx of the female flower. Based on M. L. Nusbaumer LN875 (G and P). Illustration by Laura González Hernández.

V; Dudley 2008) and still is relatively well preserved but recently, human activities are affecting the habitat where *A. inaequibracteata* occurs. The main current threats to the site are subsistence farming and fires to clear land for grazing, logging, and mining (Rakotondravony 2006; Goodman et al. 2018; BirdLife International 2003). Due to these threats, *A. inaequibracteata* could be affected in the near future and we do not know if this species grows in other nearby areas. The presumably continued degradation of the habitat lead us to assess *A. inaequibracteata* as Critically Endangered: CR B2ab(ii,iii,iv).

Note. We found a specimen at K labelled *L. Nusbaumer* LN875, thus belonging to the same collection series at G and P. However, the specimen at K corresponds to *Acalypha lamiana* (Leandri) I.Montero & Cardiel, a species distinctly different from *A. inaequibracteata*. The original label is on the specimen at G and the specimens were distributed from there, so the K specimen is most likely mislabelled.

DISCUSSION

The new species described here belongs to *Acalypha* subgenus *Acalypha*, characterised by sessile pistillate flowers with 3(–4) sepals, and the subtending bracts usually foliaceous and accrescent in fruit. The new species can be clearly differentiated from morphologically similar ones.

Among the Malagasy species, *Acalypha bardotiana* is morphologically most similar to *A. lanceolata* var.

glandulosa, from which it is easily differentiated by the characters outlined in the above diagnosis. The most striking morphological feature of *A. bardotiana*, at first sight, is the conspicuous ovate-lanceolate stipules, about 1 cm long. *Acalypha lanceolata* var. *glandulosa* was described from mainland Africa and probably is not native to Madagascar; its taxonomic status is currently under review. Four other *Acalypha* species are found on the Montagne des Français: *Acalypha gillespieae* G.A.Levin & I.Montero, *A. lamiana*, *A. menavody* (Leandri) I.Montero & Cardiel, and *A. tremula* I.Montero & Cardiel, all of them distinctly different from *A. bardotiana* (Table 1).

Acalypha inaequibracteata is morphologically most similar to *A. ankaranensis*, and the main differences between them are outlined in the above diagnosis. *Acalypha inaequibracteata* also resembles *A. levinii* I.Montero & Cardiel, which differs from *A. inaequibracteata* mainly by having divaricate, red-tinged branches, leaf blades with only simple trichomes and filiform stipels, monomorphic female bracts with only simple trichomes, and allomorphic flowers (vs branches neither divaricate nor red-tinged, leaf blades with simple and glandular trichomes and no stipels, dimorphic female bracts with simple and glandular trichomes, and no allomorphic flowers in *A. inaequibracteata*). Three other *Acalypha* species are known from the Binara forest, *Acalypha emirnensis* Baill., *A. leonii* Baill., and *A. urophylla* Baill., all of them distinctly different from *A. inaequibracteata* (Table 2).

The most remarkable characteristic of *Acalypha inaequibracteata* is its dimorphic female bracts. Mature

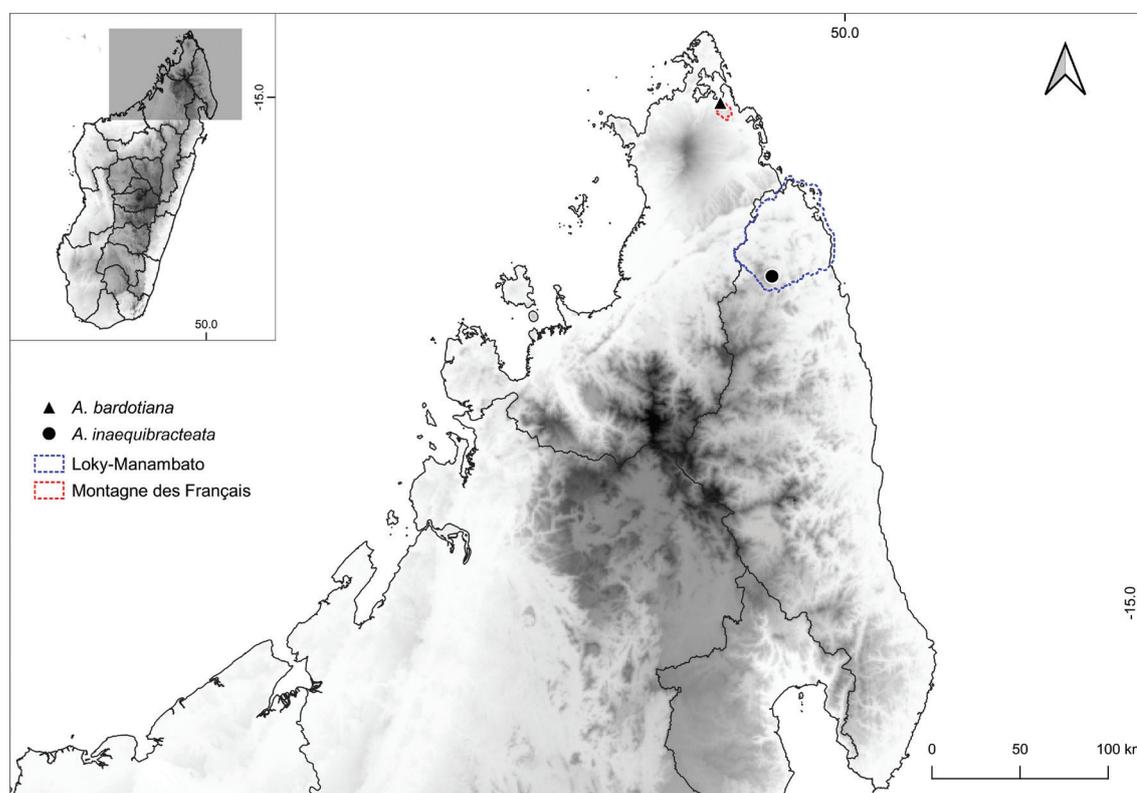


Figure 4. Distribution map of *Acalypha bardotiana* and *A. inaequibracteata*. Map created with QGIS (2023).

Table 1. Summary of diagnostic characters to distinguish *Acalypha* species of Montagne des Français.

	<i>A. bardotiana</i>	<i>A. gillespieae</i>	<i>A. lamiana</i>	<i>A. menavody</i>	<i>A. tremula</i>
Habit	suffruticose herbs	shrub	shrub	shrub	shrub
Stipule length (mm)	up to 8	up to 2–3.5	up to 6	up to 8	up to 3
Petiole length (cm)	6–8	0.2–0.5	1–2.5(–4)	1–2.5(–3)	(3–)4–6
Leaf blade size (cm)	6–9 × 4–6	1.5–4 × 1–3	5–7 × 2–2.5(–3.5)	6–8(–9.5) × 4–6(–7.5)	(4–)5–7.5 × (3.5–)4–6.5
Inflorescences	unisexual; male axillary, female terminal	androgynous, axillary	androgynous, axillary	androgynous, axillary	androgynous and male, axillary
Female bract size (mm)	up to 2.5 × 5	up to 5 × 9	up to 7 × 6	up to 13 × 13	up to 3 × 4
Female bract margin	deeply dentate	entire	slightly crenate-dentate	entire	subentire
Female bract indumentum	sparsely hairy with simple and glandular trichomes	sparsely hairy with simple trichomes only	glabrous	glabrous	glabrous

Table 2. Summary of diagnostic characters to distinguish *Acalypha* species of Binara forest.

	<i>A. inaequibracteata</i>	<i>A. emirnenis</i>	<i>A. leonii</i>	<i>A. urophylla</i>
Petiole length (cm)	0.5–1(–1.5)	(1–)1.5–4(–5.5)	0.5–2.5(–3)	1–1.5(–3)
Leaf blade length (cm)	(3–)4–5(–6)	(5–)7–12(–18)[–26.5]	7–10(–12.5)	(4–)5–7.5(–10)[–11]
Inflorescence	all androgynous	usually unisexual, rarely androgynous	androgynous and male	androgynous and male
Androgynous inflorescences	up to 5.5 cm long, with 2–5 female bracts	up to 9 cm long, with 1–2 female bracts	up to 10 cm long, with 1–4 female bracts	up to 6 cm long, with 1 female bract
Female bract shape	dimorphic on the same plant; margin crenate to subentire	all equal on the same plant; margin dentate with ca 41 teeth	all equal on the same plant; margin deeply dentate with ca 9 teeth	all equal on the same plant; margin crenate to dentate, with ca 7–10 teeth
Female bract size (mm)	up to 10 × 10 and 11 × 6.5	up to 15 × 18	up to 5 × 6	up to 4 × 5.5
Capsules	up to 2 mm in diameter, papillose-hispid	up to 5 mm in diameter, smooth	up to 2.5 mm diameter, papillose	up to 3 mm diameter, papillose

female bracts also vary in shape in *Acalypha urophylla* and *A. filiformis* Poir., but in neither are the bracts truly dimorphic. *Acalypha urophylla* is widely distributed in Madagascar, and female bract shapes can differ slightly among regions. *Acalypha filiformis* is endemic to the Mascarene Islands and bears two types of female bracts: one type with a long, filiform peduncle up to 2 cm long and only with female flowers, and the other type sessile with a long male inflorescence above it, but they are not dimorphic because both of them have similar shapes: orbicular with an entire margin (Montero-Muñoz et al. in press).

We are currently working on a molecular phylogeny of *Acalypha* species from the WIOR (Montero-Muñoz et al. in prep.) in the context of the phylogeny of the whole genus proposed by Levin et al. (2022). The preliminary results of our work confirm that *A. bardotiana* and *A. inaequibracteata* belong to subgenus *Acalypha* and that their DNA sequences differ from other sequenced species. Our results place *A. bardotiana* in a small clade that includes two African species (*Acalypha bipartita* Müll.Arg. and *A. villicaulis* Hochst. ex A.Rich.) and one

Indian species (*A. capitata* Willd.), which is closest to *A. capitata* and *A. villicaulis*. This clade, in turn, is related to Clade H5 of Levin et al. (2022), which includes species from southeast Asia and Oceania. Morphologically, *Acalypha bardotiana* is clearly different from the species that appear to be its closest relatives. *Acalypha villicaulis* is also a suffruticose herb with axillary male inflorescences and terminal female inflorescences, and has glandular trichomes on its female bracts, but its leaves are narrowly lanceolate and have petioles 1–1.5 cm long (vs ovate to elliptic-lanceolate leaves and petioles 6–8 cm long).

Our preliminary analysis places *Acalypha inaequibracteata* in the part of Clade G of Levin et al. (2022) that includes *A. glabrata* Thunb. and *A. neptunica* Müll.Arg. from continental Africa, and *A. gillespieae*, *A. mayottensis* I.Montero & Cardiel, and *A. perrieri* Leandri from WIOR. This clade is related to another clade that includes only Asian species (*Acalypha acmophylla* Hemsl., *A. kerrii* Craib, *A. matsudae* Hayata, and *A. siamensis* Oliv. ex Gage). *Acalypha inaequibracteata* appears to be most closely related to *A. perrieri* (Madagascar) and *A. mayottensis* (Mayotte Island). Morphologically, it can

be well differentiated from both species by its terminal bisexual inflorescences with 2–5 female bracts (vs axillary bisexual inflorescences with 1–2 female bracts) and its female bracts that are ovate-lanceolate to triangular, sparsely hairy, and with minute glandular trichomes (vs female bracts reniform and subglabrous).

Many angiosperm species have been described recently from northern Madagascar (Bogner and Nusbaumer 2012; Callmänder et al. 2012, 2020; Daniel et al. 2013; Thulin et al. 2014; Wahlert 2016; Davis and Rakotonasolo 2021; Klein et al. 2021, 2022; Schatz et al. 2021; Wilding et al. 2021; Stone 2022; and including up to six *Acalypha* species: Montero-Muñoz et al. 2020a, 2020b). This region is an important biodiversity hotspot with high regional endemism (Davis and Rakotonasolo 2021). The two new species described here occur in two protected areas in northern Madagascar: Montagne des Français and Loky-Manambato. Despite being a region with high diversity and endemism, its habitats are under threat, including those where these newly described *Acalypha* species occur. We classify both species under the Critically Endangered category because of the current and presumably ongoing threats. The discovery of these new species highlights the importance of these protected areas and the need to conserve them.

Taxonomic knowledge of *Acalypha* in the WIOR, including Madagascar, has increased greatly in the last few years. This paper is the latest in a series of publications that have contributed to creating a robust taxonomic framework for *Acalypha* in this region. It is noteworthy that since 2018 a total of 15 new species (including those described here), three new combinations, and one new name were published. These new species represent 29.4% of the currently known *Acalypha* species in this region (34% if we only consider native species). If we consider only Madagascar, the percentages reach 31.7% and 36% respectively. A deeper study of this genus in other regions, especially mainland Africa, where knowledge of *Acalypha* is still fragmentary, may reveal similar new diversity.

ACKNOWLEDGEMENTS

This research has received support from the SYNTHESYS Project (<https://www.synthesys.info>; FR-TAF 6307) financed by European Community Research Infrastructure Action under the FP7 “Capacities” Program and from the European Molecular Biology Organization (<https://www.embo.org>; STF-8222). Also, the author Iris Montero-Muñoz has received a Juan de la Cierva – Formación-2021, grant ref. FJC2021-046607-I, funded by MCIN/AEI/ 10.13039/501100011033 and European Union NextGenerationEU/PRTR. We kindly thank the curators and staff of the herbaria mentioned for facilitating the study of their specimens, and Mrs Martine Bardot-Vaucoulon for kindly providing us with field images of *Acalypha bardotiana*. Finally, thanks to the reviewers and the editor for their comments and suggestions.

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