European Journal of Taxonomy 834: 22–37
https://doi.org/10.5852/ejt.2022.834.1895
ISSN 2118-9773
www.europeanjournaloftaxonomy.eu
2022 · Barberá P. *et al.*

Research article

A new species of *Paranecepsia* (Euphorbiaceae-Acalyphoideae) from Madagascar and its relationships among the 'alchorneoids clade'

Patricia BARBERÁ [1,*], Olivier LACHENAUD [2] & Ricarda RIINA [3]

[1]Africa & Madagascar Department, Missouri Botanical Garden, P.O. Box 299,
63166-0299, St. Louis, Missouri, USA.
[2]Meise Botanic Garden, Nieuwelaan 38, B-1860 Meise, Belgium.
[2]Herbarium et Bibliothèque de Botanique africaine, CP 265, Université Libre de Bruxelles,
Boulevard du Triomphe, B-1050 Brussels, Belgium.
[3]Real Jardín Botánico (RJB), CSIC, Plaza de Murillo 2, 28014, Madrid, Spain.

[*]Corresponding author: pbarbera@mobot.org
[2]Email: olivier.lachenaud@plantentuinmeise.be
[3]Email: rriina@rjb.csic.es

Abstract. The formerly monotypic genus *Paranecepsia* Radcl.-Sm. is expanded with the description and illustration of a second species, *Paranecepsia andrafiabensis* Barberá & O.Lachenaud sp. nov. Molecular phylogenetic analyses of plastid *rbcL* and *trnL-F* data confirm a sister relationship between the new species and *P. alchorneifolia* Radcl.-Sm., as members of the alchorneoids clade. *Paranecepsia andrafiabensis* sp. nov. is notable for expanding the character states for the genus (now including both 2- and 3-locular ovary species) and broadening the geographic range of the genus from continental Africa to Madagascar. The new species adds to the diverse karst limestone endemics of northwestern Madagascar, where it has a very restricted distribution at the base of the western wall of the Ankarana tsingy. An amended generic description of *Paranecepsia* and a key to the species are also presented. *Paranecepsia andrafiabensis* sp. nov. is provisionally assessed as VU D1 based on the IUCN Red List criteria.

Keywords. Alchorneeae, Ankarana, Africa, Madagascar, tsingy.

Barberá P., Lachenaud O. & Riina R. 2022. A new species of *Paranecepsia* (Euphorbiaceae-Acalyphoideae) from Madagascar and its relationships among the 'alchorneoids clade'. *European Journal of Taxonomy* 834: 22–37. https://doi.org/10.5852/ejt.2022.834.1895

Introduction

Euphorbiaceae Juss. in the strict sense (excluding Phyllanthaceae Martinov, Picrodendraceae Small, Putranjivaceae Meisn. and Peraceae Klotzsch) is a highly diverse family with about 230 genera and more than 6300 species. It includes some of the largest genera of flowering plants like *Euphorbia* L. and *Croton* L., but most genera have only few species, including more than 120 genera with 1 to 3 species. These small genera are often poorly understood and, in most cases, known from sparse and/or incomplete collections. An example of one such genus is *Paranecepsia* Radcl.-Sm. (Radcliffe-

Smith 1987). This African genus was described based on specimens with staminate flowers and fruit (Radcliffe-Smith 1975) as a monotypic, dioecious group characterized by its conspicuous leaf stipels, staminate flowers with an accrescent calyx and apiculate anthers, and 3-lobed fruits (Radcliffe-Smith 2001). The type species, *Paranecepsia alchorneifolia* Radcl.-Sm., is a small tree of riverine forests occurring in northeastern Mozambique and southern Tanzania. The pistillate flowers of *Paranecepsia* were originally unknown, causing subsequent misinterpretation of floral details inferred from the fruits (i.e., 5–7 unequal sepals and no petals indicated in Radcliffe-Smith 1987, 2001), which were later amended by Vorontsova & Hoffmann (2007) based on a petaliferous flowering pistillate specimen from Tanzania collected in 2001. As its name suggests, *Paranecepsia* has morphological similarities with *Necepsia* Prain, with both genera included in tribe Bernardieae G.L.Webster (Webster 1994; Radcliffe-Smith 2001) or Pycnocomeae subtribe Necepsinae G.L.Webster (Webster 2014). Previous molecular phylogenetic analyses of Euphorbiaceae using a comprehensive sampling of genera (Wurdack *et al.* 2005; Tokuoka 2007) have shown that *Paranecepsia alchorneifolia* is part of the informally recognized 'alchorneoids' clade, a group partially supported by morphological data (Wurdack *et al.* 2005). *Paranecepsia alchorneifolia* was included by Wurdack *et al.* (2005) in the *rbcL* analysis, where it was recovered sister to *Pseudagrostistachys* Pax & K.Hoffm. In the combined analysis (*rbcL* + *trnL-F*), the authors excluded *Paranecepsia*, but *Pseudagrostistachys* was recovered at the most basal node of the alchorneoids (Wurdack *et al.* 2005).

Madagascar is a major hotspot of diversity and endemism for plants in general and for Euphorbiaceae in particular. Approximately 44 genera and 478 species of Euphorbiaceae s. str. (Madagascar Catalogue 2022) have been recorded from this country, and new species from different genera continue to be described every year (e.g., Kainulainen *et al.* 2017; McPherson 2017, 2019; Castillon & Castillon 2018; Montero-Muñoz *et al.* 2020, 2022; Haevermans & Hetterscheid 2021). The family occurs all over Madagascar but is especially well represented in dry areas, and especially in the limestone karsts formations named 'tsingys' that form large massifs in the west of the island and harbour many endemic species.

While studying unidentified Euphorbiaceae specimens from Madagascar in 2018, the second author discovered two fruiting collections that did not match any genus recorded from the island, and reminded him of the East African *Paranecepsia*, although their fruits were bilocular (instead of trilocular). Both collections were made in 1969 at the base of the Ankarana tsingy wall by R. Capuron and P. Morat, and their discovery spurred a recent expedition in November 2019 to the western part of Ankarana National Park to search for flowering material of this plant. Morphological features of the resulting new collections confirmed that they represented an undescribed species of *Paranecepsia*, which clearly broadened the generic concept for that genus (notably for locule ovary number) and extended its distribution from continental Africa to Madagascar. We describe this new species herein and present an expanded description of genus *Paranecepsia*. In addition, we generated sequence data from the plastid *rbcL* and *trnL-F* regions for the new species to verify its generic placement and provide a phylogenetic framework, further refining relationships within the alchorneoids clade.

Material and methods

The work is based on a study of herbarium material from BR, COI, DSM, K, MA, MO, NHT, P, TAN and TEF, flowers preserved in spirit, and field observations. Acronyms of herbaria follow Index Herbariorum (Thiers continuously updated). Most of the specimens have been seen.

For the phylogenetic analysis, silica gel dried leaf samples of the new *Paranecepsia* were extracted following the CTAB protocol (Doyle 1991). The *trnL-F* region was amplified using the same primers as in Silva *et al.* (2020). The *rbcL* region was sequenced using the following sets of primers: rbcLaf (ATG-

TCA-CCA-CAA-ACA-GAG-ACT-AAA-GC) and rbcLar (GTA-AAA-TCA-AGT-CCA-CCR-CG); rbcL1f (ATG-TCA-CCA-CAA-ACA-GAR-AC) and rbcL724r (TCG-CAT-GTA-CCC-TGC-AGT-TGC); rbcL427f (GCT-TAT-AAA-ACT-TTC) and rbcL1368r (CTT-TCC-AAA-TTT-CAC-AAG-CAG-CA); rbcL628f (CCA-TTT-ATG-CGT-TGG-AGA-GAY-CG) and 1360r (CTT-CAC-AAG-CAG-CAG-CTA-GTT-C). Polymerase chain reaction (PCR) amplification and sequencing followed the laboratory procedures described in Masa-Iranzo *et al.* (2021). Nucleotide sequences for each genetic region were assembled and edited in Geneious Prime ver. 2019.0.3 (Biomatters Ltd, Auckland, New Zealand). The new sequences (*trnL-F*/*rbcL*) were first analysed using the Basic Local Alignment Search Tool (BLAST) available at the National Center for Biotechnology Information (NCBI) website to verify their closet similarity to members of Acalyphoideae Beilschm. and more specifically to members of the alchorneoids clade, as suggested by morphological features. The BLAST search was conducted using NCBI default parameters.

Based on the results of the BLAST search (i.e., the new species was most similar to either sequences of *Paranecepsia* or *Necepsia* in GenBank), we built a dataset of 26 samples including all the available sequences of member of the alchorneoids clade and their most closely related taxa according to the phylogenetic analyses of Wurdack *et al.* (2005). We also included two species (*Cheilosa montana* Blume and *Neoscortechinia kingii* (Hook.f.) Pax & K.Hoffm.) from subfamily Cheilosoideae K.Wurdack & Petra Hoffm., to serve as most distant outgroup. All sequences, except the ones of the new species (three samples, six sequences), were downloaded from GenBank (Appendix 1); most of them have been generated in the context of Euphorbiaceae studies (e.g., Wurdack *et al.* 2005; Kulju *et al.* 2008; Cervantes *et al.* 2016; van Welzen *et al.* 2020). Bayesian MCMC analyses were implemented in MrBayes ver. 3.2.6 (Ronquist *et al.* 2012), with 2 concurrent runs, each with 4 chains and sampling every 1000 generations over 10 000 000 generations, a 0.2 temperature coefficient. The substitution models HKY+G and GTR+I+G were selected for the *trnL-F* and *rbcL* markers, respectively, using the Akaike information criterion in jModelTest ver. 2.1.6 (Guindon & Gascuel 2003; Darriba *et al.* 2012). Tracer ver. 1.7.1 was used to check convergence and mixing of the Markov chains (Rambaut *et al.* 2014). A 50% majority-rule consensus tree was built after discarding the first 25% of samples (burn-in).

Geographical data were used to make a distribution map for the two species of *Paranecepsia* with ArcView GIS ver. 3.2. for Windows. A preliminary assessment of conservation status using the IUCN categories and criteria (IUCN 2019) is provided for the new species. The geographical parameters of Area of Occupancy (AOO) and Extent of Occurrence (EOO), were calculated with GeoCAT (Bachman *et al.* 2011) using a 2 × 2 km grid.

Results

Phylogenetic relationships

The three accessions of the new species of *Paranecepsia* have identical sequences within each locus. The *trnL-F* sequences were most similar to *Necepsia afzelii* Prain (97.88% identity, 100% of query cover) and the *rbcL* sequences to *Paranecepsia alchorneifolia* (99.71% identity, 100% of query cover). In the phylogenetic analysis, the sequences of the new species were recovered monophyletic with high posterior probability (PP = 1), and sister in turn to *Paranecepsia alchorneifolia* (PP = 0.94) (Fig. 1). This clade was sister to the *Necepsia*-*Pseudagrostistachys* clade (PP = 9.98); both clades form the two main lineages, clades A and B (Fig. 1), of the alchorneoids (PP = 1). Alchorneeae s. str. excluding *Mareyopsis* Pax & K.Hoffm. formed a strongly supported (PP = 1) monophyletic group that was nested in a polytomy with other members of the alchorneoids (Fig. 1).

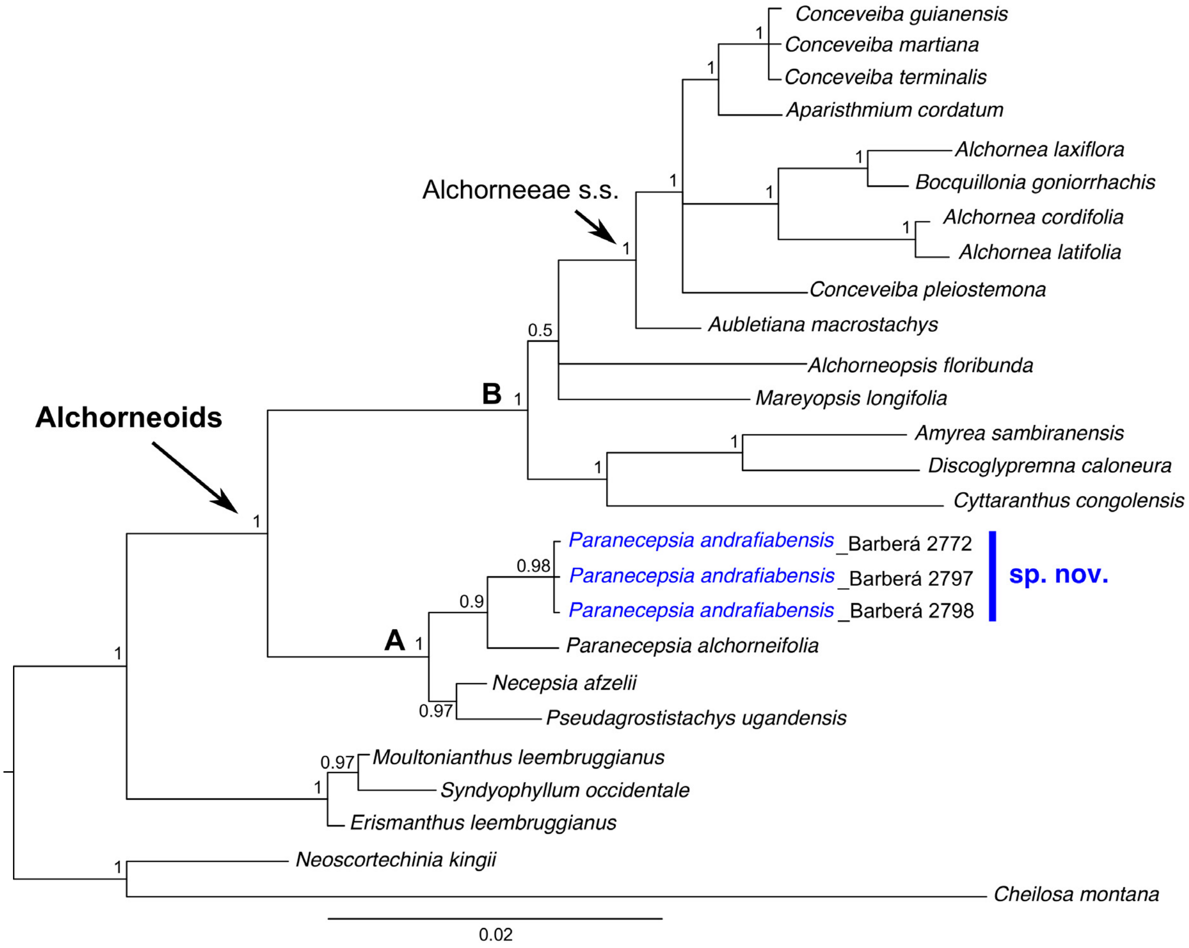

Fig. 1. Phylogenetic relationships of representatives of the alchorneoids clade within Euphorbiaceae-Acalyphoideae, including samples of the new species. Bayesian 50% majority-rule consensus tree based on the combined 2-marker, 26-tip dataset with posterior probability values indicated at nodes. Note: the name *Conceveiba terminalis* (Baill.) Müll.Arg. is used in place of *Gavarretia terminalis* Baill. in Wurdack *et al.* (2005).

Taxonomic treatment

Class Magnoliopsida Brongn.
Order Malpighiales Mart.
Family Euphorbiaceae Juss.

Genus ***Paranecepsia*** Radcl.-Sm.

Kew Bulletin 30: 684 (Radcliffe-Smith 1975 publ. 1976), **here amended**.

Type species

Paranecepsia alchorneifolia Radcl.-Sm., *Kew Bulletin* 30: 684 (Radcliffe-Smith 1975 publ. 1976).

Description

Dioecious shrubs to medium-sized trees up to 15 m high, very ramose with *Terminalia*-like branching (Aubréville's model); bark greyish. Indumentum of simple trichomes. Buds perulate. Stipules subulate, tardily caducous. Leaves deciduous, alternate, spirally arranged, clustered near apices of twigs and interspersed with bud scales, simple, petiolate, stipellate or not; vernation involute; leaf blade oblanceolate to elliptic, shallowly serrate or crenate-serrate with glandular teeth; venation pinnate, midrib prominent above, lateral veins 10–16 pairs, tertiary veins scalariform to reticulate; domatia present as hairy tufts in the axils of the secondary veins; basilaminar glands present or absent. Inflorescences racemose (strongly reduced in *P. andrafiabensis* sp. nov.), axillary, solitary; the staminate ones with 1–5 flowers per bract; the pistillate ones with 1–2 flowers; bracts small, subulate. Staminate flowers with pedicel articulate; calyx closed in bud, later splitting into 3–5 valvate lobes which become reflexed; petals absent; stamens 20–40, glabrous, with filaments free, anthers 2-locular, dorsifixed, introrse, thecae pendulous and longitudinally dehiscent, connective not enlarged; receptacle subglobose; disk glands free, interstaminal, numerous, forming a raspberry-like structure; pistillode absent. Pistillate flowers long-pedicellate; pedicels articulate; sepals 5, free, slightly unequal, elliptic to obovate, entire, foliaceous and prominently veined, green, persistent and slightly accrescent in fruit; petals 5, free, alternisepalous, linear to oblanceolate, entire, glabrous, similar in colour and texture to the sepals but much smaller and with hardly prominent venation; staminodes 1–10, sometimes absent; disc annular to slightly undulate, glabrous; ovary sessile, 2 or 3 locular, with strigose indumentum; ovules 1 per locule; styles bifid, connate at base, persistent; stigmas shortly frimbriate. Fruits capsular, 2 or 3 lobed, pubescent, dehiscent in 2 or 3 bivalved mericarps (cocci); endocarp thinly woody; columella persistent. Seeds globose, smooth, ecarunculate and exarillate, testa plain brown or mottled, hilum ellipsoid to narrowly oblong.

Key to the species of *Paranecepsia*

1. Leaves with petioles 0.2–0.8 cm long and stipels 2.5–5 mm long; staminate inflorescences up to 9 cm long; pistillate flowers with sepals 5–9 mm long; ovary 3-locular; fruits 5–6 × 10 mm; seed coat plain brown .... ***Paranecepsia alchorneifolia*** Radcl.-Sm.
– Leaves with petioles 0.6–2.6 cm long and stipels (if present) 1–2.2 mm long; staminate inflorescences up to 1.3 cm long; pistillate flowers with sepals 9–15 mm long; ovary 2-locular; fruits 7–8 × 13 mm; seed coat mottled ....***Paranecepsia andrafiabensis*** Barberá & O.Lachenaud sp. nov.

Paranecepsia alchorneifolia Radcl.-Sm.

Kew Bulletin 30: 684 (Radcliffe-Smith 1975 publ. 1976).

Material examined

Type

MOZAMBIQUE – **Niassa Province** • into a forest gallery of a dried stream, at side of the road Negomano-Mueda, ca 30 km N of Chomba; 11°20′ S, 38°30′ E; 11 Nov. 1959; staminate fl.; *A. Gomes e Sousa 4514*; holotype: K[K000425585], K[K000425586] (image!); isotypes: COI[COI00077121], COI[COI00077122] (image!), EA n.v., LISC[011861], PRE[PRE0659451-0] (image!), SRGH[SRGH0106464-0] (image!).

Note: the holotype consists of two sheets with cross labelling as "sheet 1" and "sheet 2", both with a "holotype" annotation in A. Radcliffe-Smith's handwriting, and they should be taken to constitute a single specimen according Turland *et al.* (2018, Art. 8.3). There are several variations of the type collection label, the most specific of which is typewritten in Portuguese on COI[COI00077121] and indicates "Á beira de um rio seco, a poucos metros da ponte da estrada Mueda-Negomano, cerca de 30 kms oeste de Chomba [On the edge of a dry river, a few meters from the Mueda-Negomano highway

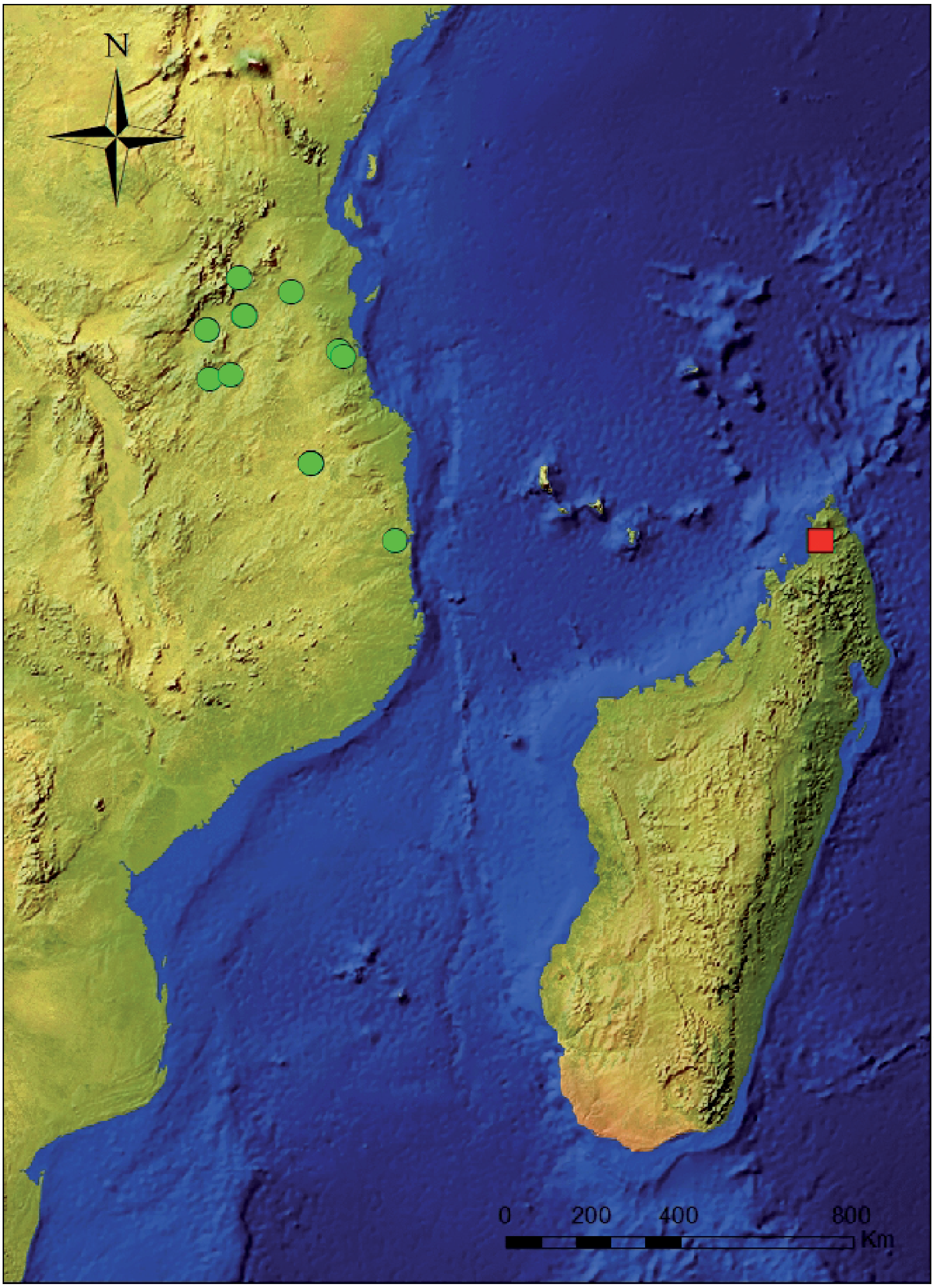

Fig. 2. Distribution of the genus *Paranecepsia* Radcl.-Sm. in east Africa and Madagascar. *Paranecepsia alchorneifolia* Radcl.-Sm. (circles), *Paranecepsia andrafiabensis* Barberá & O.Lachenaud sp. nov. (square).

bridge, about 30 kms west of Chomba], 11°20′ S, 38°30′ E. The label coordinates are clearly very inaccurate (in Tanzania, ca 100 km from Chomba) but from Google Earth imagery the closest match to this bridge locality is 36 km NNW of Chomba at 11°15′49.54″ S, 39°10′55.09″ E, in an area presently very degraded by agricultural activity.

Other material

MOZAMBIQUE – no locality; 4 Apr. 1960; sterile; *A. Gomes e Sousa 4514A*; COI, K, LISC[011862]. – **Maputo Province** • gallery of the river Ridi, westwards Porto Amélia town; 12°55′ S, 40°15′ E; alt. 15 m; 1 Oct. 1964; sterile; *A. Gomes e Sousa 4831*; BR, COI, K. – **Cabo Delgado Province** • Macondes, andados 30 km de Chomba para Negomano, ao longo do rio Matiu; alt. 300 m; 13 Apr. 1964; sterile; *A.R. Torre & J. Paiva 11880*; LISC.

TANZANIA – **Lindi Region** • Nanjilinji Division, Likawage Ward, ca 6 km E of Liwiti Village, Dagano ya Kiyenje na Mavunji [Junction of Ndagano and Mavuji Rivers]; 9°7′ S, 39°10′ E; alt. 60 m; 14 Nov. 2005; staminate fl.; *C.J. Kayombo, P. Ezrom, H. Makelele and A. Mabruki 5203*; MO[5940755] • Namatimbili Forest; alt. 250 m; 26 Nov. 2001; pistillate fl.; *F. Mbago and B. Mpanda 2244*; K. – **Morogoro Region** • Kilombero Game Control Area; alt. 300 m; 2 Nov. 1998; fruit; *A.S. Mkeya and P. Metele 1062*; MO[5677723], NHT • ibid.; staminate fl.; *A.S. Mkeya and P. Metele 1063*; K, MO[6575002], NHT • Kilombero Game Control Area (near Mofu village); alt. 550 m; 4 Oct. 1998; pistillate fl.; *H.O. Suleiman/ Frontier team 934*; DSM • Selous Game Reserve, Kigombe River; alt. 430 m; Nov. 1970; fruit; *A.F. Rees T56*; K • Vigade, Kidodi, Kilosa District; Nov. 1952; staminate fl.; *S.R. Semsei 1046*; K • Selous Game Reserve, Mlahi; 8°17′ S, 37°05′ E; alt. ca 275 m; 15 Oct. 1975; sterile; *K.B. Vollesen MRC 2838*; DSM, WAG • Selous Game Reserve, Lukula; ca 9°30′ S, 36°50′ E; 19 Nov. 1976; fruit; *K.B. Vollesen MRC 4128*; DSM, K • Selous Game Reserve, ca 4 km E of Mlahi; 8°17′ S, 37°07′ E; 31 Oct. 1977; staminate fl.; *K.B. Vollesen MRC 4746*; DSM, K.

Distribution, habitat, and phenology

Paranecepsia alchorneifolia is only known from southern Tanzania and northern Mozambique (Fig. 2), in gallery forest, bush savannah, and wooded grassland, between 15 and 550 m. Flowering specimens were collected in October and November, and fruiting ones in November.

Paranecepsia andrafiabensis Barberá & O.Lachenaud sp. nov.

urn:lsid:ipni.org:names:77302734-1

Figs 3–6

Diagnosis

Paranecepsia andrafiabensis sp. nov. is morphologically similar to *P. alchorneifolia*, but differs from it mainly by having longer petioles (0.6–2.6 vs 0.3–0.8 cm long), stipels shorter or absent (1–2.2 mm when present vs 2.5–5 mm long, always present), shorter staminate inflorescences (< 1.3 cm vs 4.5–9 cm long), pistillate flowers with longer sepals (9–15 mm vs 5–9 mm long), bilocular ovary (vs trilocular), and seed coat mottled with dark and pale brown (vs uniformly brown).

Etymology

The specific epithet refers to the type locality, Andrafiabe village, at the western border of the Ankarana tsingy.

Material examined

Type

MADAGASCAR – **Diana Region** • Ambilobe, Andrafiabe, at the base of the wall of Ankarana; 12°55′40″ S, 49°03′41″ E; alt. 66 m; 21 Nov. 2019; pistillate fl.; *P. Barberá, P. Antilahimena, J. Razanatsoa and S. Andriazafy 2770*; holotype: MO-6956134; isotypes: BR, P, TAN.

Paratypes

MADAGASCAR – **Diana Region** • Andrafiabe, PM 200 from the camp, on the circuit to Grotte de Andrafiabe; 12°55′55″ S, 49°03′29″ E; alt. 72 m; 21 Nov. 2019; pistillate fl.; *P. Barberá, P. Antilahimena, J. Razanatsoa and S. Andriazafy 2764*; BR, MA, MO, P, TAN • ibid.; staminate fl.; *P. Barberá, P. Antilahimena, J. Razanatsoa and S. Andriazafy 2765*; BR, MO, P, TAN • ibid.; offshoot; *P. Barberá, P. Antilahimena, J. Razanatsoa and S. Andriazafy 2767*; BR, MO, P, TAN • Andrafiabe, at the base of the wall of Ankarana; 12°55′40″ S, 49°03′41″ E; alt. 66 m; 21 Nov. 2019; staminate fl.; *P. Barberá, P. Antilahimena, J. Razanatsoa and S. Andriazafy 2769*; BR, MA, MO, P, TAN • ibid.; 12°55′38″ S, 49°03′45″ E; alt. 49 m; 21 Nov. 2019; pistillate fl.; *P. Barberá, P. Antilahimena, J. Razanatsoa and S. Andriazafy 2771*; BR, MO, P, TAN • ibid.; 12°55′51″ S, 49°03′32″ E; alt. 48 m; 21 Nov. 2019; pistillate fl.; *P. Barberá, P. Antilahimena, J. Razanatsoa and S. Andriazafy 2772*; BR, MO, P, TAN • ibid., 12°56′08″ S, 49°03′22″ E; alt. 37 m; 23 Nov. 2019; pistillate fl.; *P. Barberá, P. Antilahimena, J. Razanatsoa and S. Andriazafy 2797*; BR, MO, P, TAN • ibid., 12°56′08″ S, 49°03′20″ E; alt. 38 m; 23 Nov. 2019; pistillate fl.; *P. Barberá, P. Antilahimena, J. Razanatsoa and S. Andriazafy 2798*; BR, MA, MO, P, TAN • ibid.; 12°56′05″ S, 49°03′23″ E; alt. 62 m; 23 Nov. 2019; staminate fl.; *P. Barberá, P. Antilahimena, J. Razanatsoa and S. Andriazafy 2799*; BR, MO, P, TAN • à la base du mur de l'Ankarana; 16–28 Jan. 1969; fr.; *Service Forestier (R. Capuron) 28711_SF*; BR[0000025668131V], G, K, MO[6911563], P[05570467], TEF • forêt au pied de la falaise de l'Ankarana; Jan. 1969; fr.; *P. Morat 3054*; MO[5990069], P[05570468], P[05570469], P[05570470], P[05570471], TAN.

Description

Medium sized tree, 5–15 m high, 14–40 cm DBH; bark smooth when young, with numerous warty lenticels, gray; older bark scaly forming small or medium-sized loosely attached plates; twigs cylindrical, glabrous, soon woody with pale buff-grey bark. Bud scales triangular to ovate, 2–5.5 × 0.7–2 mm, apex acuminate to very long acuminate, glabrous to densely pubescent on both faces. Stipules linear-lanceolate, 3–8 mm long, caducous, densely pubescent with simple trichomes to 0.8 mm long. Leaves with petiole 0.6–2.6 cm long, canaliculate above and obscurely bipulvinate, eglandular, glabrous to puberulous, trichomes sometimes confined to upper side of petiole in the older leaves; leaf blade elliptic to oblanceolate, 4–15.5 × 1.2–5.5 cm long; chartaceous to papyraceous, glabrous above, below with scattered short simple trichomes on the midrib and domatia present as hairy tufts in the axils of the secondary veins; midrib prominent above and more strongly so below; secondary veins 10–13 pairs, prominent on both sides, strongly ascending and irregularly arching near the margin; tertiary veins scalariform, prominent and rather dense beneath; quaternary veins very densely reticulate forming small squares, only visible with hand lens; base rounded to subcordate; apex acute to acuminate, sometimes rounded, and rarely emarginate; margin serrate with 20–30 glandular teeth per side; leaf glands absent, or 1–4(–5) present near the base of the lamina on the lower surface, rarely reaching upper parts of the leaf, flat, elliptic to rounded, 0.3–0.6 × 0.2–0.3 mm; stipels setaceous, 1–2.2 × 0.1–0.15 mm, glabrous, inserted on the petiole distinctly below the blade insertion, erect, sometimes absent. Staminate inflorescences up to 1.3 cm long; axis slightly pubescent or with scattered trichomes, bearing up to 3 bracts and (1–)2–6 flowers and 1–3(–5) flowers per bract; bracts ovate to lanceolate, sometimes oblong, 2–3 × 1–1.5 mm, acute, densely pubescent outside, glabrous inside; bracteoles 1 per pedicel, linear, ca 1 × 0.2 mm, sparsely pubescent outside, sometimes absent. Staminate flowers with pedicel 3–5.5 mm long, jointed 1–2 mm from the base; bud subglobose, 1.8 mm in diameter, pubescent, greenish; calyx lobes 3–5, ovate-lanceolate, 2.7–4.8 × 0.4–2.5 mm, acute to shortly acuminate, papyraceous, appressed-pubescent outside at least towards apex, glabrous inside, yellowish to greenish; stamens 20–33, filaments 2–3.5 mm long, greenish, anthers 0.4–0.7 mm long, yellowish, thecae elliptic, connective minutely apiculate; disk glands elongated, glabrous, greenish. Pistillate inflorescences 1(–2)-flowered, axis glabrous; bract very narrowly lanceolate, 1.1–3 × 0.2–0.3 mm, acute, pubescent. Pistillate flowers with pedicel 0.6–1.6 cm long, articulate (0.1–)0.4–1 cm from the bract; sepals 4–5, separate from each other, slightly unequal in size, narrowly elliptic or elliptic to oblanceolate, sometimes oblong, 7–15 × 2–6(–7) mm, papyraceous, glabrous inside, sparsely pilose on the central part outside, hairy apically, conspicuously veined, apex acute to acuminate,

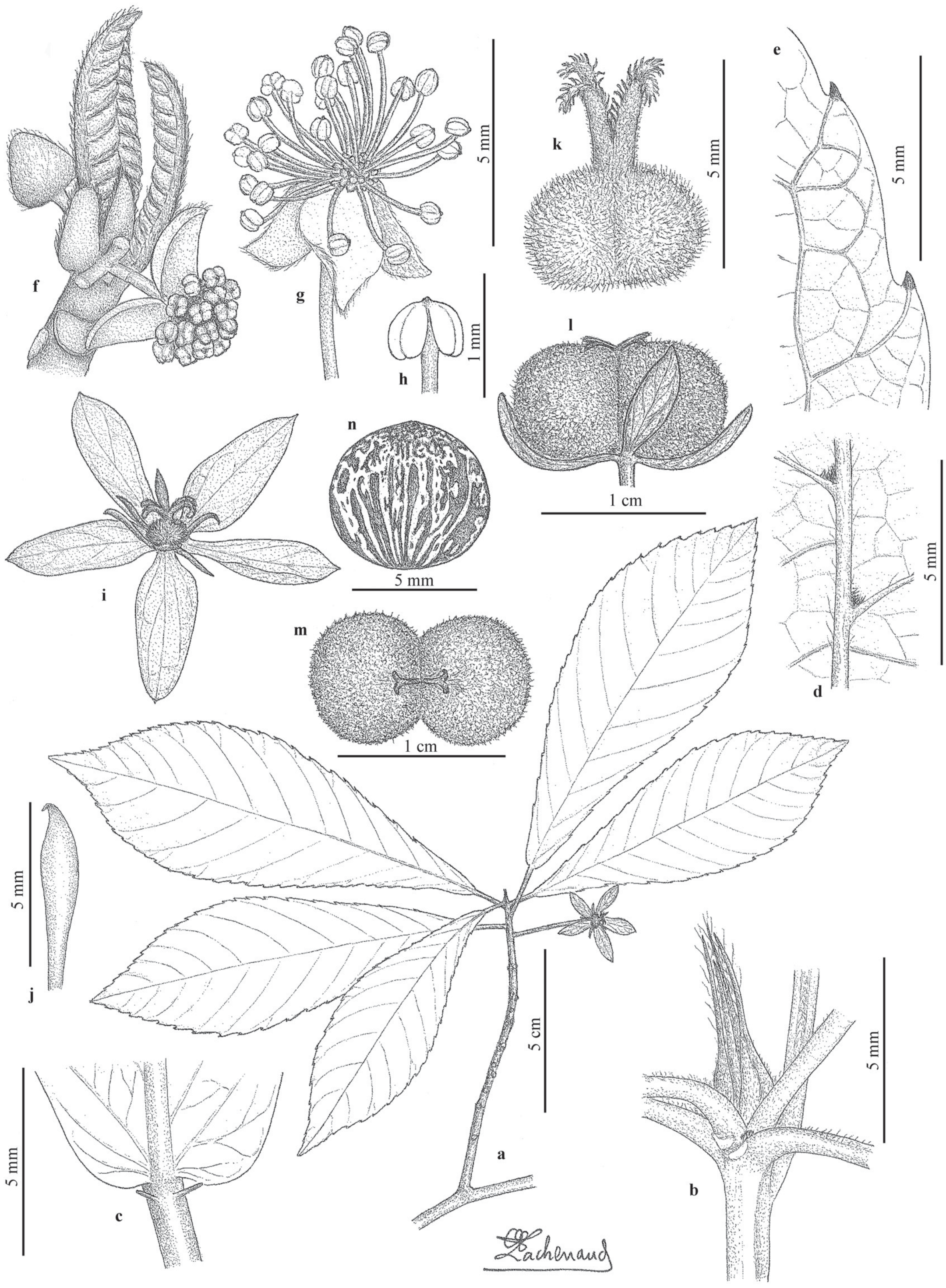

Fig. 3. Illustration of *Paranecepsia andrafiabensis* Barberá & O.Lachenaud sp. nov. **a**. Branch with pistillate flower. **b**. Bud. **c**. Leaf base with stipels. **d**. Detail of the lower leaf surface with domatia. **e**. Leaf margin. **f**. Staminate inflorescence. **g**. Staminate flower. **h**. Stamen. **i**. Pistillate flower. **j**. Petal of pistillate flower. **k**. Ovary and stigmas, lateral view. **l**. Fruit with persistent calyx, lateral view. **m**. Fruit, top view. **n**. Seed, lateral view. From *Barberá et al. 2797* (a–b), *Capuron SF-28711* (c–e, l–n), *Barberá 2799* (f), *Barberá et al. 2765* (g–h), *Barberá et al. 2771* (i), *Barberá et al. 2798* (j), *Barberá et al. 2764* (k). Drawn by O.Lachenaud.

rarely rounded, margins entire; petals (1–)2–5, unequal, linear or narrowly elliptic to narrowly oblanceolate, (0.2–)0.6–5(–5.4) × (0.05–)0.1–0.8(–1.2) mm, acute, glabrous, yellowish to greenish; staminodes 1 or absent, extending to the same length as the disc, basally terete, apically enlarged; disc 1.8–2.6 mm wide, yellowish to greenish, glabrous; ovary 2-locular, 2–4.2 × 3.5–7.3(–8.3) mm, greenish-yellowish; styles 2, 2.5–3.2 mm long, connate, pilose, greenish, stigmas bifid, shortly fimbriate. Fruits strongly bilobed, 7–8 × 13 × 7.5 mm,

Fig. 4. Field photographs of *Paranecepsia andrafiabensis* Barberá & O.Lachenaud sp. nov. **a**. Forest of *Paranecepsia andrafiabensis.* **b**. Old trunk. **c**. Seedlings. **d**. Detail of old tree trunk. **e**. Detail of young tree trunk. From *Barberá et al. 2769* (b, d), *Barberá et al. 2767* (c), *Barberá et al. 2798* (e). Photos by P. Barberá.

minutely tuberculate, covered with a dense rufous puberulous indumentum, and with sparse longer whitish trichomes ca 0.2 mm long (one at the top of each tubercle), brownish when dry; pedicel 1.4–1.9 cm long; calyx and petals persistent; columella ca 5 mm long; seeds globose, ca 6 × 6 mm, testa mottled with dark and pale brown, hilum broadly ellipsoid, ca 2.2 × 2 mm.

Distribution, habitat, and phenology

Paranecepsia andrafiabensis sp. nov. is only known from the dry, deciduous forest on karstic limestone ('tsingy') that surrounds part of the base of the western wall of the Ankarana tsingy, in northwestern Madagascar, at elevations between 37 and 72 m. The flowering material of this species was collected in November and the fruiting one in January.

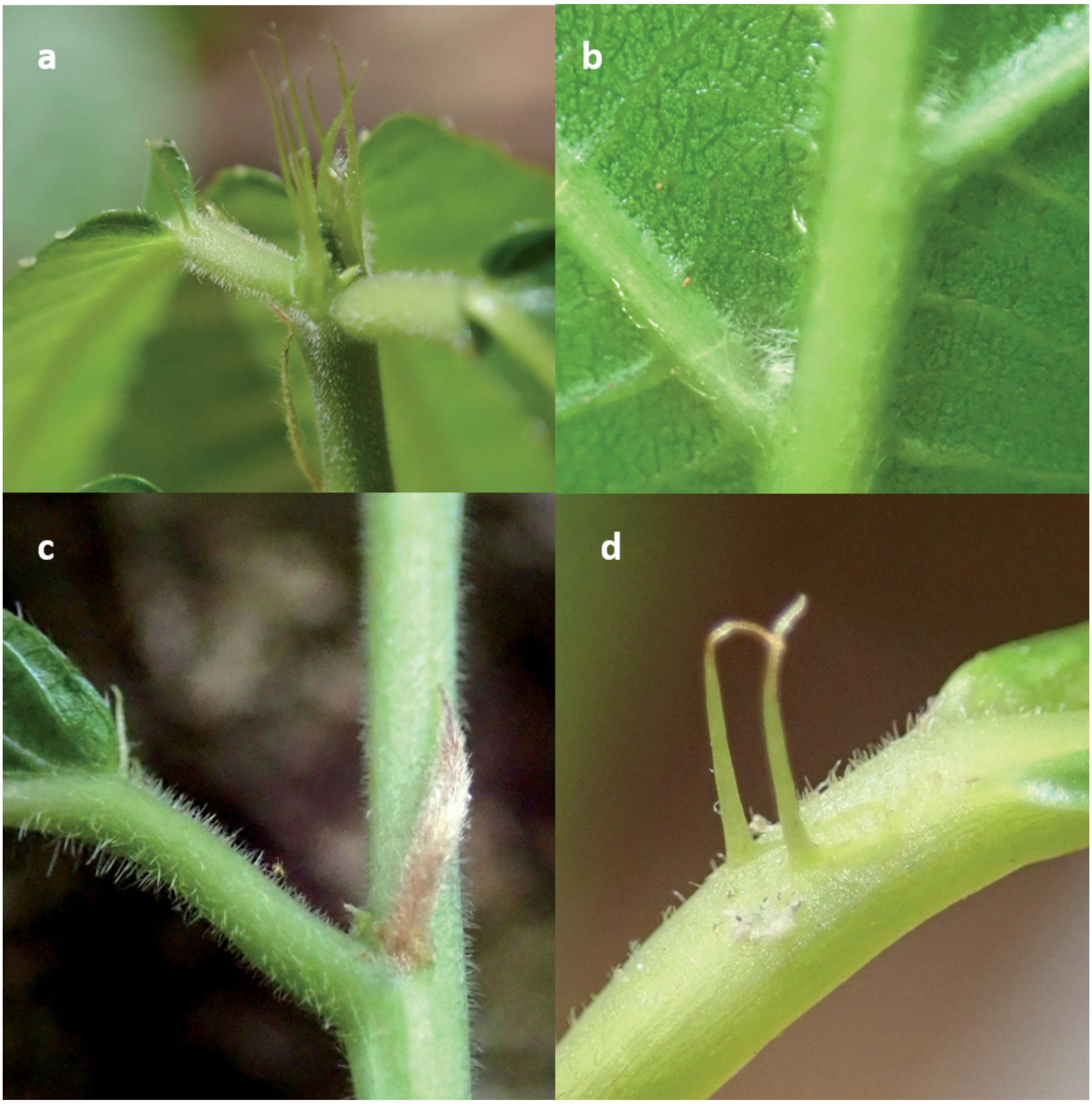

Fig. 5. Field photographs of *Paranecepsia andrafiabensis* Barberá & O.Lachenaud sp. nov. **a**. Bud. **b**. Domatial hair tufts at primary-secondary vein junctions. **c**. Leaf base and stipule. **d**. Stipels. From *Barberá et al. 2767* (a, c–d), *Barberá et al. 2765* (b). Photos by P. Barberá.

Preliminary conservation assessment

Paranecepsia andrafiabensis sp. nov. is endemic to northwestern Madagascar where it grows at the base of the western wall of the Ankarana tsingy. It is presently known from 11 herbarium specimens, two of them collected in fruit by Morat and Capuron in 1969, and recently (in 2019) several collections with

Fig. 6. Field photographs of *Paranecepsia andrafiabensis* Barberá & O.Lachenaud sp. nov. **a**. Staminate inflorescence. **b**. Pistillate inflorescence. **c**. Detail of the bract of the pistillate flower. **d**. Pistillate flower, lateral view. **e**. Pistillate flower, top view. From *Barberá et al. 2799* (a), *Barberá et al. 2765* (b–c), *Barberá et al. 2771* (d), *Barberá et al. 2772* (e). Photos by P. Antilahimena (a) and P. Barberá (b–e).

flowers and fruits were made at east of Andrafiabe village. All the collections represent seven occurrences and only one subpopulation of the species. We have verified that the species is abundant at this site with many seedlings and mature trees. Based on a 2 × 2 km cell size, the AOO is estimated as 4 km^2, which is less than the upper threshold for "Critically Endangered" status under Criterion B2. The EOO is the same as the AOO. All known occurrences are located at the limits of a protected area (Ankarana National Park), and no specific threats have been identified at the present time. However, we estimate that the population size is less than 1000 mature individuals, and that the species presumably has a low dispersal ability. For these reasons, *Paranecepsia andrafiabensis* is assigned a preliminary status of VU D1.

Notes

The stipels at the base of the leaf blade are present on some specimens and absent in others, even on very young leaves; this appears to be individual variation.

Discussion

The addition of *Paranecepsia* brings the number of native Malagasy genera of Euphorbiaceae to 40 (5 alchorneoids), which contain over 450 species (14+ alchorneoids) (Madagascar Catalogue 2022). The other genera of alchorneoids in Madagascar include *Alchornea* Sw., *Amyrea* Leandri, *Orfilea* Baill., and *Necepsia*.

Our phylogenetic reconstruction verifies the placement of the new species within the genus *Paranecepsia* and, as expected, shows similar relationships within the alchorneoids and related lineages as in Wurdack *et al.* (2005), including the paraphyletic position of the two *Alchornea* species sampled. The alchorneoids consist of 12–15 genera and ca 120 species that are currently classified in tribes Alchorneeae (Hurus.) Hutch., Agrostistachydeae (Müll.Arg.) G.L.Webster, Caryodendreae G.L.Webster, and Pycnocomeae Hutch. (Webster 2014). As suggested by Wurdack *et al.* (2005), the supported nodes of sister taxa indicate that Alchorneeae s. str. might be expanded to include the members of the alchorneoid clade. Potential synapomorphies in wood anatomy (Hayden & Hayden 2000; Wurdack *et al*. 2005) and in pollen (Nowicke & Takahashi 2002; Wurdack *et al.* 2005) have been indicated by previous authors supporting Alchorneeae s. str. within the alchorneoids. Further morphological studies and phylogenetic analyses need to be done, using more phylogenetically informative genetic regions and a broader taxon sampling within this clade, including a larger representation of its largest genus (*Alchornea*), needed to better understand the phylogenetic structure within the alchorneoids. However, our analysis expands the generic members of this clade confirming *Paranecepsia*, which, although previously sampled in Wurdack *et al.* (2005), was only represented by a single *rbcL* sequence of *Paranecepsia alchorneifolia*.

Acknowledgements

We wish to thank the botanists of the Missouri Botanical Garden's Madagascar Program for their assistance in organizing the fieldtrip and specimen management, especially Faranirina Lantoarisoa, Sylvie Andriambololonera, Patrice Antilahimena, and Christian Camara. Field work was conducted under the collaborative agreements between the Missouri Botanical Garden and the Parc Botanique et Zoologique de Tsimbazaza, and the Ministère de l'Environnement, de l'Écologie, de la Mer et des Forêts. The first author would like to express her special thanks to Patrice Antilahimena (MBG), Jacquie Razanatsoa (TAN), and Sehilany Andriazafy (our guide from Andrafiabe) for their great assistance in the field trip and specimen management. We gratefully acknowledge courtesies extended by the staff of Ankarana National Park. The fieldwork was conducted with support of the Krukoff funds from the Missouri Botanical Garden. The herbarium curators of COI, DSM, K, LISC, NHT, P, TAN and TEF are thanked for their assistance while working in their institutes. Support from project PID2019-108109GB-I00, funded by MCIN/AEI/10.13039/501100011033/ and FEDER "A way to make Europe" is also acknowledged.

References

Bachman S., Moat J., Hill A.W., de la Torre J. & Scott B. 2011. Supporting Red List threat assessments with GeoCAT: geospatial conservation assessment tool. *ZooKeys* 150: 117–126. https://doi.org/10.3897/zookeys.150.2109

Castillon J.P. & Castillon J.B. 2018. A new threatened species of *Euphorbia* sect. *Goniostema* (Euphorbiaceae) from northern Madagascar. *Candollea* 73 (2): 187–191. [In French.] https://doi.org/10.15553/c2018v732a2

Cervantes A., Fuentes S., Gutiérrez J., Magallón S. & Borsch T. 2016. Successive arrivals since the Miocene shaped the diversity of the Caribbean Acalyphoideae (Euphorbiaceae). *Journal of Biogeography* 43: 1773–1785. https://doi.org/10.1111/jbi.12790

Darriba D., Taboada G.L., Doallo R. & Posada D. 2012. jModelTest 2: more models, new heuristics and parallel computing. *Nature Methods* 9: 772. https://doi.org/10.1038/nmeth.2109

Doyle J. 1991. DNA protocols for plants. *In*: Hewitt G.M., Johnston A.W.B. & Young J.P.W. (eds) *Molecular Techniques in Taxonomy*: 283–293. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-83962-7_18

Guindon S. & Gascuel O. 2003. A simple, fast and accurate algorithm to estimate large phylogenies by maximum likelihood. *Systematic Biology* 52: 696–704. https://doi.org/10.1080/10635150390235520

Haevermans T. & Hetterscheid W.L. 2021. Taxonomic changes and new species in Malagasy *Euphorbia* (Euphorbiaceae). *Phytotaxa* 492 (1): 1–61. https://doi.org/10.11646/phytotaxa.492.1.1

Hayden W.J. & Hayden S.M. 2000. Wood anatomy of Acalyphoideae (Euphorbiaceae). *IAWA Journal* 21: 213–235. https://doi.org/10.1163/22941932-90000246

IUCN. 2019. *The IUCN Red List of Threatened Species. Ver. 2019-3*. Available from http://www.iucnredlist.org [accessed 26 Jan. 2022].

Kainulainen K., van Ee B., Razafindraibe H. & Berry P.E. 2017. A revision of the *Adenophorus* Group and other glandular-leaved species of *Croton* (Euphorbiaceae) from northern Madagascar and Mayotte, including three new species. *Candollea* 72 (2): 371–402. https://doi.org/10.15553/c2017v722a15

Kulju K.K., van der Ham R.W. & Breteler F.J. 2008. Rediscovery and phylogenetic position of the incertae sedis genus *Afrotrewia* (Euphorbiaceae): morphological, pollen and molecular evidence. *Taxon* 57 (1): 137–143.

Madagascar Catalogue. 2022. *Catalogue of the Vascular Plants of Madagascar.* Missouri Botanical Garden, St. Louis, U.S.A. & Antananarivo, Madagascar. Available from http://legacy.tropicos.org/Project/Madagascar [accessed 26 Jan. 2022].

Masa-Iranzo I., Sanmartín I., Caruzo M.B.R. & Riina R. 2021. Skipping the Dry Diagonal: spatio-temporal evolution of *Croton* section *Cleodora* (Euphorbiaceae) in the Neotropics. *Botanical Journal of the Linnean Society* 197 (1): 61–84. https://doi.org/10.1093/botlinnean/boab016

McPherson G. 2017. Six new species of *Argomuellera* (Euphorbiaceae) from Madagascar. *Novon: A Journal for Botanical Nomenclature* 25 (3): 286–297. https://doi.org/10.3417/D-16-00008

McPherson G. 2019. Two new species of Madagascan *Claoxylon* (Euphorbiaceae, Acalyphoideae) and a key to the species of Madagascar and the Comoro Islands. *Novon: A Journal for Botanical Nomenclature* 27 (3): 145-150. https://doi.org/10.3417/2019425

Montero-Muñoz I., Cardiel J.M. & Levin G.A. 2020. Discovery of three new species of *Acalypha* L. (Euphorbiaceae, Acalyphoideae) from Madagascar and their conservation status. *Systematic Botany* 45 (1): 122-130. https://doi.org/10.1600/036364420X15801369352379

Montero-Muñoz I., Levin G.A. & Cardiel J.M. 2022. Four new species of *Acalypha* L. (Euphorbiaceae, Acalyphoideae) from Madagascar, with notes about their conservation status. *South African Journal of Botany* 146: 634–642. https://doi.org/10.1016/j.sajb.2021.11.052

Nowicke J.W. & Takahashi M. 2002. Pollen morphology, exine structure and systematics of Acalyphoideae (Euphorbiaceae), part 4: tribes Acalypheae pro parte (*Erythrococca*, *Claoxylon*, *Claoxylopsis*, *Mareya*, *Mareyopsis*, *Discoclaoxylon*, *Micrococca*, *Amyrea*, *Lobanilia*, *Mallotus*, *Deuteromallotus*, *Cordemoya*, *Cococceras*, *Trewia*, *Neotrewia*, *Rockinghamia*, *Octospermum*, *Acalypha*, *Lasiococca*, *Spathiostemon*, *Homonoia*), Plukenetieae (*Haematostemon*, *Astrococcus*, *Angostyles*, *Romanoa*, *Eleutherostigma*, *Plukenetia*, *Vigia*, *Cnesmone*, *Megistostigma*, *Sphaerostylis*, *Tragiella*, *Platygyna*, *Tragia*, *Acidoton*, *Pachystylidium*, *Dalechampia*), Omphaleae (*Omphalea*), and discussion and summary of the complete subfamily. *Review of Paleobotany and Palynology* 121: 231–336. https://doi.org/10.1016/S0034-6667(02)00087-8

Radcliffe-Smith A. 1975. Notes on African Euphorbiaceae VI. *Kew Bulletin* 30: 675–687. https://doi.org/10.2307/4102909

Radcliffe-Smith A. 1987. *Euphorbiaceae* (Part I). *In:* Polhill R.M. (ed.) *Flora of Tropical East Africa*. A.A. Balkema, Rotterdam, The Netherlands & Boston, USA.

Radcliffe-Smith A. 2001. *Genera Euphorbiacearum.* Royal Botanic Gardens, Kew, UK.

Rambaut A., Suchard M.A., Xie D. & Drummond A.J. 2014. Tracer v.1.7.1. Available from http://beast.bio.ed.ac.uk/Tracer [accessed 10 Dec. 2021].

Ronquist F., Teslenko M., Van der Mark P., Ayres D., Darling A., Höhna S., Larget B., Liu L., Suchard M.A. & Huelsenbeck J.P. 2012. MrBayes 3.2: efficient Bayesian phylogenetic inference and model choice across a large model space. *Systematic Biology* 61: 539–542. https://doi.org/10.1093/sysbio/sys029

Silva O.L.M., Riina R. & Cordeiro I. 2020. Phylogeny and biogeography of *Astraea* with new insights into the evolutionary history of Crotoneae (Euphorbiaceae). *Molecular Phylogenetics and Evolution* 145: 106738. https://doi.org/10.1016/j.ympev.2020.106738

Thiers B. continuously updated. *Index Herbariorum: A Global Directory of Public Herbaria and Associated Staff.* New York Botanical Garden's Virtual Herbarium. Available from http://sweetgum.nybg.org/science/ih/ [accessed 10 Jan. 2021].

Tokuoka T. 2007. Molecular phylogenetic analysis of Euphorbiaceae sensu stricto based on plastid and nuclear DNA sequences and ovule and seed character evolution. *Journal of Plant Research* 120: 511–522. https://doi.org/10.1007/s10265-007-0090-3

Turland N.J., Wiersema J.H., Barrie F.R., Greuter W., Hawksworth D.L., Herendeen P.S., Knapp S., Kusber W.-H., Li D.-Z., Marhold K., May T.W., McNeill J., Monro A.M., Prado J., Price M.J. & Smith G.F. (eds) 2018. *International Code of Nomenclature for Algae, Fungi, and Plants (Shenzhen Code) Adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017.* Regnum Vegetabile 159. Koeltz Botanical Books, Glashütten. https://doi.org/10.12705/Code.2018

van Welzen P.C., Arias Guerrero S., Arifiani D., Bangun T.J., Bouman R.W., Eurlings M.C., Gushilman I., Phillipson P.B., Tabak I., Winkel E. & Wurdack K.J. 2020. *Weda*, a new genus with two new species of Euphorbiaceae–Crotonoideae from Halmahera (North Maluku, Indonesia) and phylogenetic relationships of the Australasian tribe Ricinocarpeae. *Journal of Systematics and Evolution* 59 (5): 1000–1017. https://doi.org/10.1111/jse.12581

Vorontsova M.S. & Hoffmann P. 2007. First record of pistillate flowers of *Paranecepsia* (Euphorbiaceae sensu stricto). *Kew Bulletin* 62 (2): 285–286.

Webster G.L. 1994. Synopsis of the genera and suprageneric taxa of Euphorbiaceae. *Annals of the Missouri Botanical Garden* 81 (1): 33–144. https://doi.org/10.2307/2399909

Webster G.L. 2014. Euphorbiaceae. *In*: Kubitzki K. (ed.) *The Families and Genera of Vascular Plants. Vol. 11: Flowering Plants, Eudicots, Malpighiales*: 51–216. Springer Verlag, Berlin, Heidelberg, Germany. https://doi.org/10.1007/978-3-642-39417-1_10

Wurdack K.J., Hoffmann P. & Chase M.W. 2005. Molecular phylogenetic analysis of uniovulate Euphorbiaceae (Euphorbiaceae sensu stricto) using plastid rbcL and trnL-F DNA sequences. *American Journal of Botany* 92 (8): 1397–1420. https://doi.org/10.3732/ajb.92.8.1397

Manuscript received: 14 March 2022
Manuscript accepted: 26 May 2022
Published on: 8 August 2022
Topic editor: Frederik Leliaert
Desk editor: Pepe Fernández

Appendix 1. GenBank accession numbers for the *rbcL*, *trnL-F* sequences used in the phylogenetic analysis. Voucher information is provided for the new generated sequences of *Paranecepsia andrafiabensis* Barberá & O.Lachenaud sp. nov.

Alchornea cordifolia (Schumach.) Müll.Arg., AY794959, AY7947. *Alchornea latifolia* Sw., HM446755, HG971812. *Alchornea laxiflora* (Benth.) Pax & K.Hoffm., AY794957, AY794795. *Alchorneopsis floribunda* (Benth.) Müll.Arg., AY794962, AY794800. *Amyrea sambiranensis* Leandri, AY794964, AY794801. *Aparisthmium cordatum* (A.Juss.) Baill., MG718406, AY794793. *Aubletiana macrostachys* (Breteler) J.Murillo, AY794960, AY794798. *Bocquillonia goniorrhachis* Airy Shaw, AY794958, AY794796. *Conceveiba guianensis* Aubl., JQ626138, AY794791. *Conceveiba martiana* Baill., AY788170, AY794798. *Conceveiba pleiostemona* Donn.Sm., JQ591422, AY794794. *Conceveiba terminalis* (Baill.) Müll.Arg., AY794953, AY794790. *Cyttaranthus congolensis* J.Léonard, AY794965, AY794803. *Discoglypremna caloneura* (Pax) Prain, AB267916, AY794802. *Mareyopsis longifolia* (Pax) Pax & K.Hoffm, AY794961, AY794799. *Moultonianthus leembruggianus* (Boerl. & Koord.) Steenis, AY794982, MT040392. *Necepsia afzelii* Prain, DQ991511, DQ991514. *Neoscortechinia kingii* (Hook.f.) Pax & K.Hoffm., AB267912, AY794806. *Paranecepsia andrafiabensis* Barberá & O.Lachenaud sp. nov., Madagascar, Diana Region, *P. Barberá 2772* (MO), ON505198, ON505201. *Paranecepsia andrafiabensis* Barberá & O.Lachenaud sp. nov., Madagascar, Diana Region, *P. Barberá 2797* (MO), ON505197, ON505200. *Paranecepsia andrafiabensis* Barberá & O.Lachenaud sp. nov., Madagascar, Diana Region, *P. Barberá 2798* (MO), ON505196, ON505199. *Syndyophyllum occidentale* (Airy Shaw) Welzen, AY794967, AY794805. *Pseudagrostistachys ugandensis* Pax & K.Hoffm., AY794966, AY794804. *Erismanthus leembruggianus* Boerl. & Koord., MF435457, HG971870. *Paranecepsia alchorneifolia* Radcl.-Sm., AB267926, —. *Cheilosa montana* Blume, MF435455, —.