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Four new species of *Matelea* (Apocynaceae: Asclepiadoideae) endemic to Mexico

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Summary. Four new species of *Matelea*, endemic to Mexico, are proposed and described: *M. balrog, M. cornuta, M. jaimesiae* and *M. lokii*. These taxa differ from each other and *M. gonoloboides*, *M. medusae* and *M. porphyrantha* (the *Matelea gonoloboides* species complex) in their corolla shapes and gynostegial corona ornamentation. Descriptions, illustrations, morphological comparisons and geographic distributions of these species, as well as their conservation status, are provided. A lectotypification for the name *M. gonoloboides* is also included. These discoveries highlight Mexico as a centre of diversity and endemism for the genus, with 69 species currently known from the country, of which 66% are restricted to it.

Key Words. Endemism, *Gonolobus*, gynostegium, *Matelea gonoloboides*, *Matelea medusae*, *Matelea porphyrantha*.

Introduction

Matelea Aubl. is a member of the Gonolobinae Liede (Apocynaceae: Asclepiadoideae: Gonolobeae) and is an endemic American genus of vines and shrubs. *Matelea* s.l. stands out as the genus with the most remarkable morphological heterogeneity within Gonolobinae (Krings *et al.* 2008; Endress *et al.* 2018). Woodson (1941) subordinated 27 genera of Asclepiadoideae to 16 subgenera of *Matelea*, comprising over 200 species, and retained *Gonolobus* Michx. and *Fischeria* DC. as distinct genera (Stevens 2009). Recent phylogenetic studies have recovered *Matelea* s.l. as a paraphyletic group, with several monophyletic and morphologically cohesive groups nested within it (Krings *et al.* 2008; McDonnell *et al.* 2018). Some authors have resurrected genera including *Polystemma* Decne. (sensu Stevens 2001, 2009), *Ibatia* Decne. and *Lachnostoma* Kunth (sensu Morillo 2012), or established new genera (Morillo 2012, 2013, 2015, 2016; Morillo *et al.* 2013, 2016; Mangelsdorff *et al.* 2016; Morillo & Keller 2016; Keller & Liede-Schumann 2020).

It has been suggested that *Matelea* s.s. (sensu Krings & Morillo 2015; Morillo 2015; Morillo *et al.* 2017) comprises around 20 species morphologically consistent with the type species *M. palustris* Aubl. (Stevens 2001; Krings & Morillo 2015). However, generic circumscriptions are far from settled and several alternative proposals have been suggested, such as Stevens (2009), Morillo (2015) and Endress *et al.* (2018). We adopted the latter's circumscription of the genera, as it represents a review of the phylogenetic work to date and the most recent proposal for the classification of the entire family.

Matelea has its centre of diversity in Mexico, with 65 species and endemism above 60% (Alvarado-Cárdenas *et al.* 2020). During a revision of *Matelea* for the country, four new species were discovered and are described here. These species are part of the *M. gonoloboides* (B.L.Rob. & Greenm.) Woodson species complex (Figs 1 and 2), which includes *M. medusae* Woodson, and *M. porphyrantha* (Standl.) Woodson (Stevens 2009). This species complex shares rotated corollas, arachnoid trichomes of the adaxial corolla, a cyathiform corona adnate to the base of the column, a distal edge of the corona with five interstaminal bifid and filiform (horn-like) lobes, and five oblong-spatulate staminal corona lobes resting on the anthers.

Specimens associated with the proposed new species have until now been erroneously identified as *M. gonoloboides*, however, these specimens differ in the shape and components of the gynostegial corona, as well as in their geographic distributions. Thus, we were unable to confidently assign them to any of the named species of the *M. gonoloboides* complex and have, therefore, described and illustrated them here, as four new species of *Matelea* for Mexico. We propose conservation status assessments, provide a distribution map of the new species and include a dichotomous key to the species complex. We have also provided a lectotypification of *M. gonoloboides* s.s.

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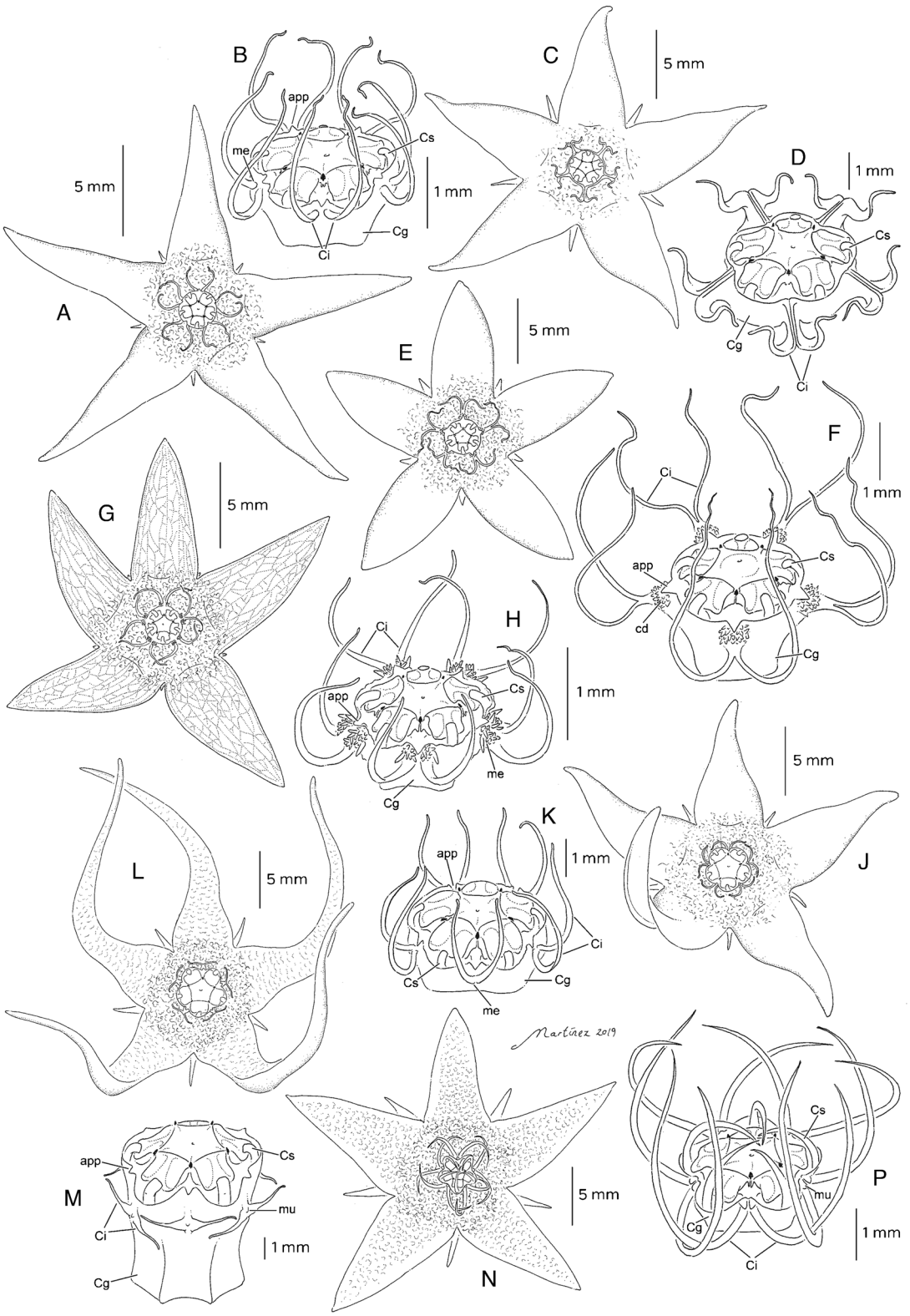

Fig. 1. Flowers and gynostegial coronas of *Matelea* species (*M. gonoloboides* species complex). **A, B** *M. balrog:* **A** flower, **B** corona; **C, D** *M. cornuta:* **C** flower, **D** corona; **E, F** *M. gonoloboides:* **E** flower, **F** corona; **G, H** *M. jaimesiae:* **G** flower, **H** corona; **J, K** *M. lokii:* **J** flower, **K** corona; **L, M** *M. medusae:* **L** flower, **M** corona; **N, P** *M. porphyrantha:* **N** flower, **P** corona. app – appendage of the interstaminal corona; cd – crested dome; Cg – gynostegial corona; Ci – interstaminal corona; Cs – staminal corona; me – membrane; mu – mucron. DRAWN BY CÉSAR A. GONZÁLEZ-MARTÍNEZ.

Fig. 2. Floral and follicle diversity of selected *Matelea* species. **A, B** *M. gonoloboides:* **A** yellow corolla, grey inset box shows pollinarium, **B** brownish corolla; **C – E** *M. jaimesiae:* **C** yellowish-brown corolla, **D** pale brown corolla, **E** fruit; **F, G** *M. lokii,* red corolla; **H**, **J** *M. medusae,* purple corolla; **K – M** *M. porphyrantha:* **K** purple corolla, **L** yellow-reddish corolla, **M** fruit. Scalebars **A**, **B** 0.25 mm; **M** 0.5 cm. PHOTOS: **E** VERÓNICA JUÁREZ JAIMES; **F**,**G** JORGE MARTÍNEZ MELÉNDEZ; **H**, **J** NEPTALÍ RAMÍREZ MARCIAL; **K**, **L**, **M** KATYA ROMERO SOLER.

Material and Methods

We consulted c. 1000 *Matelea* specimens from CHAPA, ENCB, FCME, HUMO, INIF, MEXU, UAMIZ and XAL, herbarium abbreviations follow Thiers (2019, continuously updated). In addition, we consulted the databases of the virtual herbaria of CAS (https://www.calacademy.org), F (http://emuweb.fieldmuseum.org), GH (http://kiki.huh.harvard.edu), K (http://apps.kew.org), NY (http://sweetgum.nybg.org) and US (https://collections.nmnh.si.edu). We examined digital images of type specimens of *Matelea gonoloboides*, *M. medusae*, *M. porphyrantha* and related species via JSTOR Global Plants (2018, continuously updated). Physical specimens were measured with a digital calliper and measurements from specimens reviewed digitally were suitably calibrated. Taxonomic works of Mesoamerican species of *Matelea*, Standley & Williams (1969) and Stevens (2001, 2005, 2009), were consulted. The classifications proposed by Liede & Kunze (1993) and Kunze (1995) were used for the description of the gynostegial corona, where Ci = interstaminal corona and Cs = staminal corona. The cohesion species concept (Templeton 1989) for the delimitation and recognition of new taxa, which relies on phenotypic, ecological and genetic cohesion, was followed.

QGIS software (QGIS Development Team 2019) was used to generate distribution maps based on the geographic and ecological information gathered from the consulted herbaria and the protologues of the previously published species. We complemented the distribution information for *Matelea gonoloboides*, *M. medusae* and *M. porphyrantha* with data from GBIF (GBIF 2019) and Naturalista (Naturalista 2019), see Appendix 1. Duplicate records or those without geographic coordinates were omitted. Mapping followed the proposed regionalisation of the Neotropics of Morrone (2014a, b) and used outlines of the Neotropical regions (Löwenberg-Neto 2014) as background.

To assess the state of conservation (extinction risk) of the species, we used the Geospatial Conservation Assessment Tool (GeoCAT) (geocat.kew.org; Bachman *et al.* 2011) to calculate the extent of occurrence (EOO) and area of occupancy (AOO) with a cell width of 2 km^2, according to the IUCN (2022) guidance. In addition to EOO and AOO data, we included herbarium label information, about habitat and population density, as well as field observations, to provide more substantiated risk category proposals.

Taxonomic Treatment

1. Matelea balrog *Gonz.-Martínez, Lozada-Pérez & L.O.Alvarado*, **sp. nov.** Type: Mexico, Morelos, Mun. Cuernavaca, Buenavista del Monte a 2.5 km de la entrada a los viveros de Otongo, 18°57'12.3''N, 99°17'0.4''W, 1871 m, 7 Oct. 2009, *A. Flores Morales* 151 (holotype MEXU!, isotype HUMO!).

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Twining plants with white latex. *Stems* cylindrical, suberose basally, young stems with mixed indumentum, becoming glabrescent with age: short trichomes 0.3 – 0.5 mm long, sparsely to densely pubescent, distributed evenly, erect; long trichomes 0.7 – 1.1 mm long, sparsely to densely pubescent, distributed more or less in two lines, yellowish to translucent, erect or adpressed; glandular trichomes 0.1 mm long, sparse, distributed evenly, yellowish, reddish to translucent, erect. *Leaves* opposite. *Petiole* 1.6 – 2.4 cm long, indumentum mixed: short trichomes less than 0.2 mm long; long trichomes 0.7 – 1.2 mm long, dispersed to dense, yellowish to translucent, erect or adpressed; glandular trichomes 0.08 – 0.1 mm long, dense, yellowish, reddish to translucent. *Leaf blade* 4.9 – 7.8 × 2.6 – 4.2 cm, ovate, base cordate, lobes 1.4 – 3.8 (– 4.7) mm long, apex acute to acuminate, membranaceous, indumentum mixed: abaxially long trichomes dense on the midveins and secondary veins, glandular trichomes scarce; adaxially long, scarce glandular trichomes. Brochidodromous venation, 6 – 7 secondary veins; adaxial colleters at the base of the midvein 4 – 5. *Leaf margin* hirsute, with long trichomes. *Inflorescence* extra-axillary, one per node, 4 – 6 flowers, sub-umbelliform; *peduncles* 3.1 – 3.8 mm long, pendulous, indumentum mixed similar to the petiole; *bracts* 2 – 4 mm long, lanceolate to linear-lanceolate, indumentum mixed; *pedicels* 3 – 4.4 mm long, indumentum mixed similar to the peduncles. *Calyx* lobes green, sometimes become reddish to brown, divided near the base, with one ovoid colleter between each lobe. *Sepals* 2.1 – 2.5 × 0.7 – 0.8 mm, lanceolate to narrowly ovate, green, with long trichomes abaxially, glabrous adaxially. *Corolla* c. 2.2 cm diam., rotate, green, purple-greenish, or purple, indumentum mixed: abaxially with long trichomes 0.6 – 0.8 mm long, dispersed, yellowish to translucent, adpressed, glandular trichomes less than 0.1 mm, scarce, yellowish, reddish to translucent; adaxially with arachnoid trichomes on the tube mouth and base of the lobes. *Corolla tube* 1.7 – 2 mm long; lobes 8.6 – 9.6 × 2 – 3.7 mm, lanceolate, patent, surface smooth, apex acute. *Gynostegial corona* cyathiform, adnate basally to gynostegium, orange or purple to black, 0.4 – 0.6 mm long; *staminal corona* (Cs) with 5 lobes 0.1 – 0.2 mm long, oblong, apex rounded, resting on the anthers; *interstaminal corona* (Ci) with a cymbiform appendage at the apex, 5 lobes, 1.7 – 1.8 mm long, ligulate, erect, free at the base, the base of the lobes with a smooth membrane. *Style* head apex c. 1.2 mm wide, flattened. *Pollinarium* 0.45 × 0.5 – 0.6 mm wide, corpuscle brown, slightly sagittate to rhombic;

lamellar caudicle 0.15 – 0.2 mm long; pollinia 0.32 × 0.18 – 0.22 mm, ovate to elliptic, apically excavated. *Follicle* and *seeds* not seen. Fig. 1A,B.

RECOGNITION. *Matelea balrog* resembles *M. gonoloboides*, but differs by the corolla lobes lanceolate (vs ovate); gynostegial corona 0.4 – 0.6 mm long (vs 0.8 – 1 mm); Ci with smooth membrane without appendages (vs dome crested in the axil of each lobe) and with ligulate lobes 1.7 – 1.8 mm long (vs linear lobes 2.6 – 3.1 mm), free (vs joined).

DISTRIBUTION. *Matelea balrog* is endemic to Mexico. The species has been collected only to the south and east of the state of Morelos, in the Balsas Basin province. Map 1.

SPECIMENS EXAMINED. MEXICO: Morelos State: Mun. Cuernavaca, barranca de Lomas de Tzompantle, 12 Aug. 2009, *A. Flores-Morales & R. C. Tlatilpa* 123 (MEXU); Lomas de Tetela, June – July 1953, *Hno. E. Lyonnet* 530300011, 530600011 (MEXU); Tetela del Monte, Aug. 1955, *Hno. E. Lyonnet* 550800014 (MEXU); Mun. Tepotzotlán, Tepotzotlán, 12 Oct. 1971, *L. W. Boege* 1985 (MEXU); Mun. Tlayacapan, cerro El Sombrerito, 12 Sept. 1991, *G. Serrano & R. C. Tlatilpa* 75 (MEXU).

HABITAT. Individuals of this species are restricted to seasonally dry forest and secondary vegetation derived from it, growing at altitudes of 1630 – 1870 (– 2050) m.

CONSERVATION STATUS. There are few collections of this species, so its representation in herbaria is poor. It has been reported as scarce in the places where it is found. The EOO is 75,427 km^2 (CR), and the AOO is 16 km^2 (EN). As a result of the insufficiency of specimens and information, we propose assigning this species to the threat category: Data Deficient (DD) (IUCN 2022).

PHENOLOGY. Collected with flowers from August to October.

ETYMOLOGY. The specific epithet refers to the balrog, a fantasy creature from the literature of J. R. R. Tolkien. The interstaminal corona of the new species has lobes that resemble the horns of the balrog.

NOTES. *Matelea balrog* differs morphologically from all other species within the *Matelea gonoloboides* complex by having Ci without appendages and fused lobes at the base that arise from smooth membranes (Fig. 1A, B). The studied specimens of the new species had previously been determined as *M. gonoloboides* (Figs 1E, F, 2A, B), but are distinguished by having corollas with lanceolate lobes (vs ovate lobes in *M. gonoloboides*), gynostegial corona 0.4 – 0.6 mm long (vs 0.8 – 1 mm long); Ci without appendages (vs dome crested in the axil of each lobe) and by Ci with ligulate lobes 1.7 – 1.8 mm long (vs linear lobes 2.6 – 3.1 mm), free (vs joined). Furthermore, *M. balrog* is endemic to Morelos state, Mexico, in the Balsas Basin biogeographic province (vs Oaxaca state, Mexico, in the Sierra Madre del Sur province) (Map 1).

2. Matelea cornuta *Gonz.-Martínez, Lozada-Pérez & L.O.Alvarado*, **sp. nov.** Type: Mexico, Chiapas, Mun. Siltepec, Cascada, 5 Aug. 1937, *E. Matuda* 1613 (holotype MEXU!, isotype MO).

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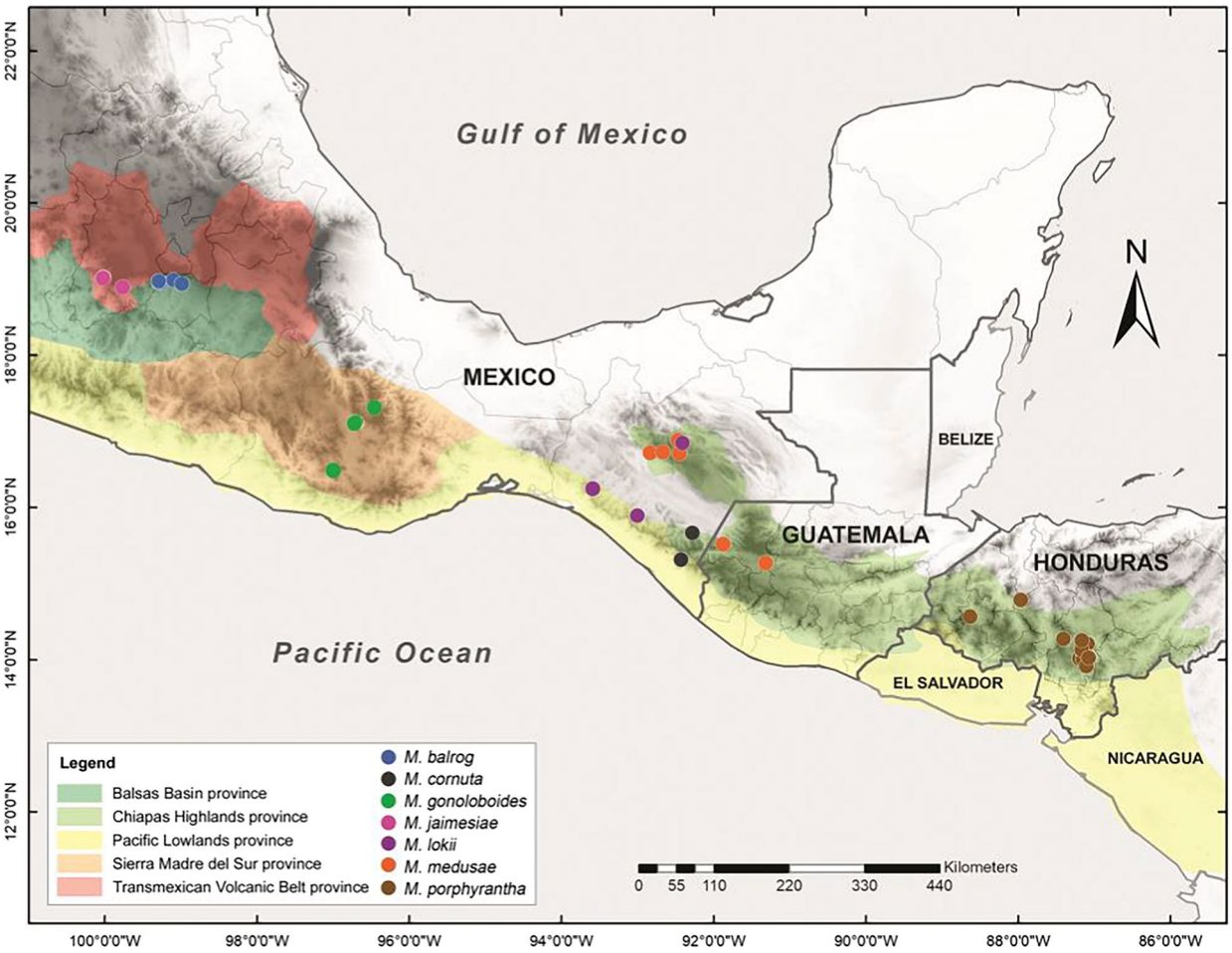
Twining plants with white latex. *Stems* cylindrical, herbaceous, young stems with mixed indumentum, becoming glabrescent with age: short trichomes 0.2 – 0.3 mm long, sparsely to densely pubescent, distributed evenly, erect; long trichomes 0.6 – 1.1 mm long, sparsely to densely pubescent, distributed more or less in two lines, yellowish to translucent, erect or adpressed; glandular trichomes less than 0.1 mm long, sparse, evenly distributed, yellowish, reddish to translucent, erect. *Leaves* opposite. *Petiole* 0.6 – 1.8 cm long, indumentum mixed: short trichomes 0.08 – 0.1 mm long; long trichomes 0.8 – 1.1 mm long, dispersed to dense, yellowish to translucent, erect or adpressed; glandular trichomes 0.08 – 0.1 mm, dense, yellowish, reddish to translucent. *Leaf blade* 3.2 – 5.3 × 1 – 2.1 cm, ovate-lanceolate, base cordate, lobes 1.7 – 4.1 (– 9) mm long, apex acuminate, membranaceous, pubescent, indumentum mixed: glandular trichomes scarce; abaxially long trichomes dense on the midveins and secondary veins, adaxially pubescent, with long and glandular trichomes. Brochidodromous venation, 5 – 7 secondary veins; adaxial colleters at the base of the midvein 3 – 4. *Leaf margin* hirsute, with long trichomes. *Inflorescence* extra-axillary, one per node, (3 –) 4 – 6 flowers sub-umbelliform; peduncles 2.9 – 5.8 mm long, erect, indumentum mixed similar to the petiole; *bracts* (1.8 –) 2.3 – 5.7 mm long, lanceolate to linear-lanceolate, indumentum mixed; *pedicels* 5 – 9 mm long, indumentum mixed similar to the peduncles. *Calyx* green sometimes becoming reddish, divided near the base, with one ovoid colleter between each lobe. *Sepals* 3.2 – 5.4 × 0.9 – 1.1 mm, narrowly ovate, green, with long trichomes abaxially, glabrous adaxially. *Corolla* 2 cm in diam., rotate, reddish-brown, indumentum mixed: abaxially with long trichomes 0.6 – 0.8 mm long, dispersed, yellowish to translucent, adpressed, glandular trichomes less than 0.1 mm, scarce, yellowish, reddish to translucent; adaxially with scarce arachnoid trichomes on the tube. *Corolla tube* 1.3 – 1.5 (– 4.3) mm long; lobes 5.2 – 9 × (1.4 –) 2 – 5.1 mm, lanceolate, ovate, patent or erect, surface smooth, apex acute or rounded. *Gynostegial corona* c. 0.2 mm long, orange or black; *staminal corona* with lobes 0.2 mm long, oblong, apex spatulate, resting on the anthers; *interstaminal corona* without appendages or membranes, 5 lobes 1.7 – 2.5 mm long, laminar, flattened laterally, patent, distally bifid with both projections perpendicular to the axis and erect at the apex, joined at the base. *Style* head apex 1.8 – 1.9 mm wide, flattened. *Pollinarium* 0.4 – 0.45 × 0.75 – 0.8 mm wide, corpuscle brown, slightly sagittate to rhombic; lamellar caudicle 0.2



Map 1. Geographic distribution of the *Matelea gonoloboides* species complex including the new species.

mm long; pollinia 0.32 × 0.24 – 0.28 mm, ovate, apically excavated. *Follicle* immature, green-olive with straight and glandular trichomes; *seeds* not seen. Fig. 1C, D.

RECOGNITION. *Matelea cornuta* resembles *M. gonoloboides* (Figs 1E, F, 2A, B), but can be distinguished by its ovate-lanceolate leaf blades (vs ovate to broadly ovate in *M. gonoloboides*); corolla tube with few arachnoid trichomes (vs arachnoid-pubescent); Ci with 5 laminar lobes, flattened laterally, patent, distally bifid with both projections perpendicular to the axis and erect towards the apex (vs linear lobes, erect, distally bifid, with erect, linear projections, twisted).
DISTRIBUTION. Endemic to Mexico. Only collected in southern Chiapas, in the Chiapas Highlands and Pacific Lowlands provinces. Map 1.
SPECIMEN EXAMINED. MEXICO. Chiapas State: Mun Motozintla, road SW along ridge from Summit of Huiztla-Motozintla highway, 7 km from highway, 15°18'36''N, 92°24'36''W, 1950 m, 17 Sept. 1988, *W. D. Stevens & E. Martínez S.* 25699 (MEX).
HABITAT. Grows on open grassy slopes with clumps of shrubs and trees derived from evergreen and subdeciduous forests, at 1650 – 1950 m elevation.
CONSERVATION STATUS. *Matelea cornuta* is known only from two locations in the south of the Sierra Madre of Chiapas (Map 1). There is no population abundance data, but it may constitute a rare species. The EOO cannot be calculated, due to lack of specimens, and the known AOO is 8 km^2 (CR). As a result of the insufficiency of specimens and information, we propose assigning this species to the threat category: Data Deficient (DD) (IUCN 2022).
PHENOLOGY. Collected with flowers in August and September.
ETYMOLOGY. The specific epithet is given because the interstaminal corona resembles the horns of a bovid.
NOTES. *Matelea cornuta* differs from other species of the genus by having Ci with 5 laminar lobes patent and distally bifid with ascendant projections (Fig. 1C, D). This species is like *M. gonoloboides* (Figs 1E, F, 2A, B), both have Ci lobes fused at the base, but the

lobes of *M. cornuta* differ in shape and orientation, they are flattened laterally with two erect projections (vs dorsoventrally flattened with two erect, twisted projections). The new species occurs in Chiapas state, Mexico, in the Chiapas Highlands and Pacific Lowlands biogeographic provinces (vs Oaxaca state, Mexico, in the Sierra Madre del Sur province) (Map 1).

3. Matelea gonoloboides (*B.L.Rob. & Greenm.*) Woodson (1941: 222) ≡ *Urostephanus gonoloboides* B.L.Rob. & Greenm. (Robinson & Greenman 1895: 159). Lectotype (designated here): Mexico, Oaxaca, hills above Oaxaca, 6 Aug. 1894, *C. G. Pringle* 4753 (GH! [barcode GH00076876]; isolectotypes: AC!, BKL!, BR!, C!, CM!, E, ENCB!, G!, GOET!, JE!, K!, M!, MIN!, MEXU!, MSC!, NDG!, NY!, P!, PH!, RSA!, S!, US!, VT!). Figs 1E, F, 2A, B.

NOTES. In the original description of the species (Robinson & Greenman 1895), the specimen *C. G. Pringle* 4753 is cited but not explicitly designated as the type. We consider that the authors, in writing the protologue, reviewed all the material of the original collection, as evidenced by the name given to the specimens and the notes and drawings that can be found in some of them. Therefore, following Art. 9.1. (Turland *et al.* 2018) and the suggestions of McNeill (2014), from among the many syntypes we designate here a lectotype. We selected the specimen in the herbarium of Harvard University (GH) as the lectotype, because it presents all the diagnostic structures and includes notes and drawings of its morphology. Besides, the GH Herbarium was where Robinson & Greenman worked, Robinson was curator there (Fishbein pers. comm.).

4. Matelea jaimesiae *Gonz.-Martínez, Lozada-Pérez & L.O.Alvarado,* **sp. nov.** Type: México, Estado de México, Mun. San Simón de Guerrero, cerca de Ranchería Cucha alrededor del panteón, 19°0'30"N, 100°1'4"W, 1900 m, 20 Aug. 2005, *V. Juárez J. et al.* 762 (holotype MEXU!).

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Twining plants with white latex. *Stems* cylindrical, suberose, young stems with mixed indumentum, becoming glabrescent with age: short trichomes 0.1 – 0.2 mm long, sparsely to densely pubescent, distributed evenly, erect; long trichomes 0.7 – 1.2 mm long, sparsely to densely pubescent, distributed more or less in two lines, yellowish to translucent, erect or adpressed; glandular trichomes less than 0.1 mm long, sparse, distributed evenly, yellowish, reddish to translucent, erect. *Leaves* opposite. *Petiole* 1 – 2.4 cm long, indumentum mixed: short trichomes 0.1 – 0.15 mm long; long trichomes 0.8 – 1.2 mm long, dispersed to dense, yellowish to translucent, erect or adpressed; glandular trichomes 0.08 – 0.1 mm, dense, yellowish, reddish to translucent. *Leaf blade* 3.1 – 5.2 × 1.2 – 2.7 cm, ovate, narrowly ovate, base cordate, lobes 0.7 – 4.4 mm long, apex acuminate, membranaceous, indumentum mixed: glandular trichomes scarce; abaxially, long trichomes dense on the midveins and secondary veins; adaxially, long trichomes and glandular trichomes. Brochidodromous venation, 6 – 7 secondary veins; adaxial colleters at the base of the midvein 4 – 5. *Leaf margin* hirsute, with long trichomes. *Inflorescence* extra-axillary, one per node, 6 – 8 (– 9) flowers, sub-umbelliform; *peduncles* 2.8 – 6.7 – (7.6) mm long, pendulous, indumentum mixed similar to the petiole; *bracts* (2 –) 2.5 – 3.5 mm long, lanceolate to linear-lanceolate, indumentum mixed; *pedicels* 2.7 – 3.6 mm long, indumentum mixed similar to the peduncles. *Calyx* green, sometimes becomes reddish to brown, divided near the base, with one ovoid colleter between each lobe. *Sepals* 2.5 – 3.7 × 0.8 – 1.3 mm, lanceolate to narrowly ovate, green, adaxially glabrous, abaxially with long trichomes. *Corolla* 2 cm in diam., rotate, green, yellowish or brown-green with dark reticulation, indumentum mixed: abaxially with long trichomes 0.5 – 0.8 mm long, dispersed, yellowish to translucent, adpressed; glandular trichomes 0.06 – 0.08 mm, scarce, yellowish, reddish to translucent; adaxially with arachnoid trichomes on the tube. *Corolla tube* 1.6 – 2 mm long; *lobes* (6.4 –) 7 – 8.4 × 2.2 – 3.6 mm, lanceolate, patent, surface smooth, apex acute. *Gynostegial corona* 0.8 – 0.9 mm long, black; *staminal corona* with lobes 0.1 – 0.3 mm long, narrowly oblong, apex spatulate, resting on the anthers; *interstaminal corona* with cymbiform appendages at the apex, 5 lobes 1.3 – 1.5 mm long, ligulate, erect, curved, free at the base, the base of the lobes with warty membranes with protuberances. *Style* apex c. 1.2 mm wide, flattened. *Pollinarium* 0.45 × 0.5 – 0.6 mm wide, corpuscle brown, slightly sagittate to rhombic; lamellar caudicle 0.15 – 0.22 mm long; pollinia 0.35 × 0.2 – 0.22 mm, ovate to elliptic, apically excavated. *Follicle* 6.5 – 7 cm long, fusiform, pale green and purple, puberulent, with inconspicuous stinging trichomes, conical and slightly elongate; *seeds* not seen. Figs 1G, H, 2C, D, E.

RECOGNITION. *Matelea jaimesiae* is morphologically close to *M. babrog*, but differs in having narrowly ovate blades 1.2 – 2.7 cm wide (vs ovate 2.6 – 4.2 cm); sepals 2.5 – 3.7 × 0.8 – 1.3 mm (vs 2.1 – 2.5 × 0.7 – 0.8 mm); corolla with reticulation (vs not reticulate), corolla lobes (6.4 –) 7 – 8.4 mm long, triangular (vs 8.6 – 9.6 mm long, lanceolate); gynostegial corona 0.8 – 0.9 mm long (vs 0.4 – 0.6 mm); Cs with narrowly oblong lobes, with apex spatulate (vs oblong lobes, with apex rounded); base of the Ci lobes with warty membranes with protuberances (vs smooth membranes), lobes of the Ci 1.3 – 1.5 mm long (vs 1.7 – 1.8 mm).
DISTRIBUTION. Endemic to Mexico. Known only from the south of the state of Mexico, in the Transmexican Volcanic Belt province. Map 1.

SPECIMENS EXAMINED. MEXICO: Mexico State: Mun. Coatepec Harinas, carretera San Luis, 17 June 2011, *F. D. Dorantes-Hernández et al.* 231 (MEXU); Mun. San Simón de Guerrero, ranchería Cucha alrededores del Campo Santo, 1 Aug. 1997, *T. Prinzie et al.* 206 (MEXU); cerca de la ranchería de Cucha, rancho de Olivia Jaimes, 20 July 1996, *V. Juárez J. & M. Ortiz O.* 658 (MEXU); cerca del arroyo "La Peña", 20 July 1996, *V. Juárez J. & M. Ortiz O.* 659 (MEXU); Ranchería Cucha sobre la ladera S del terreno campo santo, 17 Aug. 2019, *C. A. González-Martínez et al.* 2001 (MEXU); 2 km al SW de San Simón de Guerrero, Ranchería Cucha sobre la ladera S del terrero del Campo Santo, 28 Sept. 2019, *V. Juárez J. et al.* 1162, 1162-A (MEXU)
HABITAT. *Matelea jamesiae* occurs in the pine-oak forest, oak forest and disturbed areas derived from these types of vegetation, at altitudes of between 1900 – 2140 m.
CONSERVATION STATUS. Recorded as scarce in the sites where it has been collected, it is known only to the S and SE of the Nevado de Toluca volcano. The EOO is 18,689 km^2 (CR), and the AOO is 12 km^2 (EN). The populations seem to tolerate disturbance, but since they have a very restricted distribution, we propose to assign this species to the category: Endangered (EN B2a, b iv) (IUCN 2022).
PHENOLOGY. Collected with flowers from June to August and with fruit in September.
ETYMOLOGY. The specific epithet honours Verónica Juárez Jaimes of the National Herbarium of Mexico (MEXU) who is a specialist in the Asclepiadoideae subfamily in Mexico, particularly of the genus *Marsdenia* R.Br. (now *Ruehssia* H.Karst.). Mrs Jaimes found and collected specimens of this species for the first time.
NOTES. The specimens of *Matelea jaimesiae* (Figs 1G, H, 2C, D) have previously been identified as *M. gonoloboides* (Figs 1E, F, 2A, B), but it is distinguished by having a corolla with triangular lobes (vs ovate lobes); Cs with oblong lobes, apex spatulate (vs oblong lobes, apex rounded); Ci with ligulate, erect, curved lobes, 1.3 – 1.5 mm long (vs linear, erect, twisted lobes, 2.6 – 3.1 mm), free at the base (vs joined), base of the lobes with a warty membrane with protuberances (vs dome crested in the axil of each lobe). The new species occurs in the state of Mexico in the Transmexican Volcanic Belt biogeographic province (vs Oaxaca state, in the Sierra Madre del Sur province) (Map 1).

5. Matelea lokii *Gonz.-Martínez, Lozada-Pérez & L.O.Alvarado*, **sp. nov.** Type: Mexico, Chiapas, Mun. Villacorzo, ejido Sierra Morena al O del poblado, 16°14'33"N, 93°35'32"W, 1140 m, 6 Aug. 2002, *L. Alvarado C. et al.* 341 (holotype MEXU!, isotype MO).

http://www.ipni.org//urn:lsid:ipni.org:names:77324869-1

Twining plants with white latex. *Stems* cylindrical, suberose, young stems with mixed indumentum, becoming glabrescent with age: short trichomes 0.1 – 0.15 mm long, sparsely to densely pubescent, distributed evenly, erect; long trichomes 0.7 – 1.2 mm long, sparsely to densely pubescent, distributed more or less in two lines, yellowish to translucent, erect or adpressed; glandular trichomes 0.07 – 0.09 mm long, sparse, distributed evenly, yellowish, reddish to translucent, erect. *Leaves* opposite. *Petiole* 1 – 2.6 cm long, indumentum mixed: short trichomes 0.08 mm long; long trichomes 0.8 – 1.3 mm long, dispersed to dense, yellowish to translucent, erected or adpressed; glandular trichomes 0.07 – 0.09 mm, dense, yellowish, reddish to translucent. *Leaf blade* (2.9 –) 3.8 – 6.8 (– 9.4) × (1.1 –) 1.6 – 2.9 (– 4.7) cm, elliptic or ovate, base cordate, lobes 1.1 – 3.3 (– 4.3) mm long, apex acuminate, membranaceous, indumentum mixed: glandular trichomes, scarce; abaxially long trichomes dense on the midveins and secondary veins; adaxially with long trichomes and glandular trichomes. Brochidodromous venation, 6 – 8 secondary veins; adaxial colleters at the base of the midvein 4. *Leaf margin* hirsute, with long trichomes. *Inflorescence* extra-axillary, one per node, 4 – 8 flowers, sub-umbelliform; *peduncles* 2.6 – 5 mm long, pendulous, indumentum mixed similar to the petiole; *bracts* 1 – 3 (– 5.1) mm long, lanceolate, indumentum mixed; *pedicels* (3.2 –) 4 – 6.6 mm long, indumentum mixed similar to the peduncles. *Calyx* green, sometimes becomes reddish to brown, divided near the base, with one ovoid colleter between each lobe. *Sepals* 2 – 4.3 × 0.4 – 0.9 mm, lanceolate to narrowly ovate, green, abaxially with long trichomes, adaxially glabrous. *Corolla* 1.7 – 1.8 cm in diam., rotate, purple, red or brown, indumentum mixed: abaxially with long trichomes 0.5 – 0.7 mm long, dispersed, yellowish to translucent, adpressed, glandular trichomes 0.05 mm, scarce, yellowish, reddish to translucent; adaxially with arachnoid trichomes on the tube. *Corolla tube* c. 1.2 mm long; *lobes* 5.2 – 10 × 1.1 – 3 (– 3.5) mm, lanceolate, patent, surface smooth, apex acute. *Gynostegial corona* 0.7 – 0.8 mm long, reddish-black; *staminal corona* with lobes c. 1 mm long, oblong, apex spatulate, resting on the anthers; *interstaminal corona* with "v" shaped cleft appendage, 5 lobes 1.1 – 2.3 mm long, ligulate, erect, curved, free at the base, base of the lobes with corrugated membranes, free at the base. *Style* head apex c. 1.2 mm wide, flattened. *Pollinarium* 0.4 × 0.5 – 0.6 mm wide, corpuscle brown, slightly sagittate to rhombic; lamellar caudicle 0.12 mm long; pollinia 0.3 × 0.2 mm, ovate to elliptic, apically excavated. *Follicle* and *seeds* not seen. Figs 1J, K; 2F, G.

RECOGNITION. *Matelea lokii* resembles *M. medusae* (Figs 1L, M; 2H, J), but differs in the peduncle 2.6 – 5 mm long (vs (3.5 –) 7 – 11.6 mm); corolla tube c. 1 mm

long (vs 2.5 – 2.8 mm), corolla lobes 5.2 – 10 mm long (vs 10 – 21 mm); gynostegial corona 0.7 – 0.8 mm long (vs 1.4 – 1.5 mm); Ci with "v" shaped, cleft appendage (vs appendage cymbiform), lobes ligulate, erect, curved (vs lobes linear, patent to slightly reclined), free at the base (vs joined), the base of the lobes with corrugated margin (vs mucronate).

DISTRIBUTION. *Matelea lokii* is endemic to Mexico. It is known only from central and southern Chiapas in the Chiapas Highlands and Pacific Lowlands biogeographic provinces. Map 1.

SPECIMENS EXAMINED. MEXICO: Chiapas State: Mun. La Concordia, tramo Independencia-Finca Cuxtepeques, pasando el rancho La Selva, 6 May 2007, *J. Martínez M.* 1830 (HEM); Mun. Oxchuc, 1 km al NW hacia Lelenchij, 5 July 1999, *R. Torres C. & A. Campos V.* 15418 (MEXU).

HABITAT. *Matelea lokii* grows in pine-oak forest and oak forest, between 1140 – 2020 m.

CONSERVATION STATUS. *Matelea lokii* is only known from three locations in Chiapas state: La Sepultura Biosphere Reserve, near El Triunfo Biosphere Reserve and in the municipality of Oxchuc in the northeast (Map 1). Known populations are few. The EOO (IUCN 2022) is 4,551,248 km^2 (EN), and the AOO is 12 km^2 (EN). Due to the insufficiency of collections and restricted distribution, we propose assigning this species to the threat category: Data Deficient (DD).

PHENOLOGY. Collected with flowers from July to August.

ETYMOLOGY. The specific epithet refers to the interstaminal corona that resembles the horns of the helmet used in the fictional representation in the Marvel Cinematic Universe, created by Stan Lee, of the mythical character Loki.

NOTES. The specimens of *Matelea lokii* (Figs 1J, K, 2F, G) had been identified as *M. gonoloboides* (Figs 1E, F, 2A, B) because of the similarities in floral morphology, but differ from that species in having erect inflorescences (vs pendulous); corolla tube c. 1 mm long, lobes lanceolate (vs 1.8 – 2.5 mm, lobes ovate); Cs with lobes of c. 1 mm long, with spatulate apex (vs 0.2 – 0.3 mm, apex rounded); Ci with "v" shaped, cleft appendage (vs cymbiform appendage), and with ligulate, erect, curved lobes, 1.1 – 2.3 mm long (vs linear, erect, twisted lobes, 2.6 – 3.1 mm), free (vs joined). Furthermore, *M. lokii* is distributed in Chiapas, Mexico, in the Chiapas Highlands and Pacific Lowlands biogeographic provinces (vs Oaxaca, Mexico, in the Sierra Madre del Sur province). The images that appear in Tropicos (http://www.tropicos.org) as *Matelea gonoloboides* (*Martínez Meléndez* 1830 (HEM)), correspond to *M. lokii*, which it is possible to distinguish by the small corona, with an apical cleft, lobes of the Ci emerging below the middle of the corona and Cs lobes reduced (Fig. 1J, K).

Discussion

Matelea has morphologically diverse corollas and gynostegial coronas and the group is a continuous source of species-level novelties (Cortez *et al.* 2018; Juárez-Jaimes *et al.* 2021; Lozada-Pérez & Alvarado-Cárdenas 2016). Our findings corroborate the recognition that *Matelea* has a high level of diversity in Mexico, with 69 species and it is the second most diverse group of Apocynaceae in the country, after *Asclepias* with 72 species (Alvarado-Cárdenas *et al.* 2020). Likewise, the genus shows a high degree of endemism in Mexico, with 46 species (66.6%) restricted to the country.

The species proposed here are tentatively assigned to the genus *Matelea*. The phylogenetic relationships in *Matelea* remain inconclusive until further taxonomic sampling and more robust genetic data provide taxonomic stability (McDonnell *et al.* 2018). Species of the *M. gonoloboides* complex have a sister relationship with the genera *Dictyanthus* Decne. and *Polystemma* (Krings *et al.* 2008; McDonnell *et al.* 2018) but cannot be placed within those genera because *Polystemma* has a campanulate corolla, usually glabrous, complex and usually in two series; and the whole plant has glandular trichomes with crystalline white inclusions (Stevens 2009). By comparison, species of the *M. gonoloboides* complex have rotate corollas with arachnoid trichomes, the corona is in one series and, although they share filamentous appendages (Figs 1 and 2) with *Polystemma*, these arise from the interstaminal region and not the staminal portion. The *M. gonoloboides* complex also lacks trichomes with crystalline white inclusions. In *Dictyanthus,* the corona has undivided lobes fused to the corolla and the corolla is campanulate-sacciform (Stevens 2009; Endress *et al.* 2018) compared to the *M. gonoloboides* complex in which species have a divided corona and lack the rotate corolla. In addition, *M. gonoloboides* has been recovered as a sister taxon to *Dictyanthus* but not to *Polystemma* (Krings *et al.* 2008; McDonnell *et al.* 2018; Keller & Liede-Schumann 2020). Based on these characteristics, the species described here should most probably be circumscribed within *Matelea.*

The new species described here are an important contribution to our knowledge of Mexican Gonolobinae and of its *Matelea* species, since they went unnoticed or were incorrectly identified for such a long time. The specimens examined (Figs 1A – D, G – K; 2C – G) were mistakenly identified as belonging to published species of the *Matelea gonoloboides* species complex because of apparent similarities in floral morphology and a lack of detailed analyses of their morphology (Standley & Williams 1969; Stevens 2009). Taxonomic descriptions made previously in this group did not detail coronal attributes, such as fusion of the Ci lobes, nor the arrangements of any appendages or membranes that were present: these characteristics are taxonomically important and are cohesive for

each defined group of specimens studied. Likewise, the geographical distributions of the proposed species (Map 1) show disparities: the species occupy different biogeographic provinces which further helps to delineate and identify them.

A future integration of these new taxa into a phylogenetic analysis may enable us to hypothesise ancestry-descent relationships between the members of the *Matelea gonoloboides* complex. It would also allow us to contrast their phylogenetic relationships with other clades or taxa recovered previously which are phylogenetically close to *M. gonoloboides*, such as species of *Dictyanthus* and other *Matelea species* (McDonnell *et al.* 2018).

Identification key to the *Matelea gonoloboides* species complex

1. Staminal corona (Cs) with 5 curved, ascendant, subulate lobes. Honduras…………………….. **M. porphyrantha**
– Cs with 5 oblong lobes resting on the anthers. Mexico and Guatemala……..……………………………………..**2**
2. Lobes of the interstaminal corona (Ci) free, base with membranes with different ornamentation, rarely with cymbiform appendages………………………………………………………………………………………**3**
– Lobes of the Ci fused at the base, often with appendages……..……..……..………………………………………. **5**
3. Gynostegial corona 0.4 – 0.6 mm long; lobes of the Ci with smooth membranes at the base. Endemic to Morelos, Mexico……..………………………………………………………………………..……..……..…….. **M. balrog**
– Gynostegial corona 0.7 – 0.9 mm long; lobes of the Ci with ornamented membranes at the base. Endemic to Estado de Mexico and Chiapas, Mexico……..……..…..……..……..……..………………………..…….. **4**
4. Inflorescences erect; corolla tube c. 1 mm long, lobes lanceolate; gynostegial corona 0.7 – 0.8 mm long; Ci with the cleft apex in the form "v", lobes with two slightly corrugated membranes at the base. Endemic to Chiapas, Mexico……..……………………………………………………………………..……..……..…….. **M. lokii**
– Inflorescences pendulous; corolla tube 1.6 – 2 mm long, lobes triangular; gynostegial corona 0.8 – 0.9 mm long; Ci with a cymbiform appendage, lobes with two warty membranes with protuberances at the base. Endemic to Estado de Mexico, Mexico ……..………..……..……………………………………..……..…….. **M. jaimesiae**
5. Ci without appendages, 5 lobes, laminar, laterally flattened, patent……..……..……..……..……..…….. **M. cornuta**
– Ci with cymbiform appendages at the apex, 5 lobes, linear, erect, or reclined……..……..……..………..……..…….**6**
6. Inflorescences pendulous; corolla tube 1.8 – 2.5 mm long, lobes ovate, patent or slightly erect, smooth; gynostegial corona 0.8 – 1 mm long; Ci lobes linear, erect, 2.6 – 3.1 mm long. Endemic to Oaxaca, Mexico……..……..… …..……..……………………………………………………………………………..…**M. gonoloboides**
– Inflorescences erect, corolla tube 2.5 – 2.8 mm long, lobes lanceolate-elongate, erect; slightly pustulated; gynostegial corona 1.4 – 1.5 mm long; Ci lobes linear, patent or slightly reclined, c. 2 mm long. Distributed in Mexico (Chiapas) to northwestern Guatemala (Huehuetenango) …………………………………..**M. medusae**

Appendix 1. Additional Specimens Examined

Matelea gonoloboides. MEXICO. Oaxaca State: Mun. Capulalpam de Méndez, SE del río Molinos en tierra caliente cerca del Puente que va a Yahuiche, 8 Aug. 2002, *S. Figueroa Brito & F. Y. Guzmán Rivera* 50 (ENCB, MEXU); Mun. Oaxaca de Juárez, 20 June 2006, *M. Fishbein* s.n. (record from Naturalista: 11419835); 1.5 km al NE de la agencia municipal de Donaji, 6 July 2003, *S. H. Salas & A. Sánchez* 5018 (MEXU); cerro San Felipe, 30 June 2006, *V. Juárez J. et al.* 787 (MEXU); cerro San Felipe al N de Oaxaca, 9 July 1976, *J. A. S. Magallanes* 146 (MEXU), San Felipe del Agua a 1 km de libramiento N, 15 June 2016, *E. B. Cortez & S. Islas* 4 (FCME); Mun. Villa Sola de Vega, about 4.9 mi SW of Sola de Vega along Hwy 131, 26 July 1971, *W. D. Stevens* 1349 (ENCB).

Matelea medusae. MEXICO. Chiapas State: Mun. San Cristóbal de las Casas, 21 Oct. 2018, 1 Nov. 2018, 14 July 2019, 15 Aug. 2019, 22 Sept. 2019, 20 Oct. 2019, *N. Ramírez-Marcial* s.n. (records from Naturalista: 17723351, 18340126, 29953488, 30906039, 33560945, 34850496); Tenejapa, below Huistan (Huixtán), Aug. 1981, *D. E. Breedlove* 52466 (CAS); near paraje Kulak'tik, 27 Sept. 1981, *D. E. Breedlove* 53052 (CAS); Mun. Zinacantán, along mexican highway in paraje Granadilla, 14 Aug. 1965, *D. E. Breedlove* 11752 (F, INIF). **GUATEMALA.** Huehuetenango: Mun. Malacatancito, Malacatancito and Chixoy river, 17 Sept. 1971, *A. Molina R. & A. R. Molina* 26591 (F).

Matelea porphyrantha. HONDURAS. Francisco Morazán Department: Mun. Tatumbla, montaña de Azacualpa, 6 June 1996, *J. L. Linares* 3357 (MEXU); falda de Mt Uyuca, área de nubes entre Quebrada Granadillo y Las Flores, 27 July 1950, *A. Molina R* 2745 (F); Dpt. Lempira: Mun. Gracias, 18 Sept. 2014, *Hermes Vega* s.n. (record from Naturalista: 8015986).

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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