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Macrosolen zamboangensis (Loranthaceae), a new mistletoe species from Zamboanga Peninsula, Philippines

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Abstract. *Macrosolen zamboangensis*, a new mistletoe species from the Zamboanga peninsula of the island of Mindanao (Philippines), is described. The new species is a member of the widespread *M. melintangensis* species complex, but differs from the previously described species in this complex in having a conspicuously papillose corolla head. It is also the only species in this complex that displays a combination of papillose pedicels, calycula and fruits, at least 3–4 inflorescence axes grouped at a node, and relatively small flowers that are clustered at the apex of a raceme (a subumbel) instead of being more evenly distributed along the inflorescence axis. The conservation status of this new species is considered Vulnerable (V).

Keywords: hemiparasitic plants, *Macrosolen melintangensis*, mistletoe, species complex, taxonomy, western Mindanao.

INTRODUCTION

Macrosolen (Blume) Rchb. (Loranthaceae; Elytranthinae) is a genus of hemiparasitic epiphytes represented by at least 25 (Vidal-Russell and Nickrent 2008), but perhaps as many as 40 (Tagane et al. 2017) species. It is recognized by having spikes or racemes with decussate pairs of 6-merous flowers that are each subtended by one bract and two bracteoles, petals that are fused to the middle or higher, reflexed corolla lobes, and 4-locular anthers (Barlow 1997, Tagane et al. 2017). *Macrosolen* is distributed in southern Asia and the Malesian region, with a center of diversity in Borneo (Barlow 1997). In the Philippines, there are seven currently recognized *Macrosolen* species, two of which are endemic (Pelsler et al. 2011 onwards). The island of Mindanao is a center of diversity for the genus as all seven Philippine species can be found there (Pelsler et al. 2011 onwards). During field work in the municipi-

pality of Leon B. Postigo, Zamboanga del Norte (Zamboanga Peninsula, Mindanao), an unknown species of *Macrosolen* was documented and collected. Initially, it was identified as *M. melintangensis* (Korth.) Miq. using Barlow's (1997) taxonomic key, but further investigation revealed several morphological differences.

Macrosolen melintangensis is a taxonomically challenging species complex with unclear species boundaries. Vegetatively, it is characterized by having opposite, petiolate, ovate, medium sized, bifacial leaves. It has few-flowered racemes with bracteoles that are nearly free, and slender corollas that are mostly 20–30 mm long and usually have weakly developed wings (Barlow 1995). Most recently Barlow (1995, 1997) used a broad delimitation of *M. melintangensis*, in which he subsumed a large number of species recognized by Danser in his taxonomic treatments of *Macrosolen* (Danser 1931, 1934, 1935, 1941): *M. bellus* Danser, *M. floridus* Danser, *M. javanus* Danser, *M. lowii* (King) Tiegh., *M. sumatranus* Danser, and *M. urceolatus* Danser. Barlow (1995) also provisionally included *M. demesae* (Merr.) Danser and *M. tenuiflorus* Danser as synonyms. As a result, *M. melintangensis* is currently circumscribed as a quite polymorphic species with a large distributional area (Borneo, Cambodia, Java, Malay Peninsula (including Singapore), Philippines, Sumatra and Thailand; Barlow 1995). Barlow interpreted the much narrower species delimitation of this complex by Danser (1931, 1934, 1935, 1941) as a segregation into “local races” (Barlow 1995: 28) and concluded that these do not merit recognition at the species level, because of the absence of “sharp morphological discontinuities” among them. However, Barlow (1995, 1997) did not present data in support of this view, nor provide a more detailed discussion. Further, our current study in search of the identity of the Zamboanga *Macrosolen* plants revealed morphological patterns that suggest that more than one species should be recognized within the *M. melintangensis* complex (see Discussion), although more detailed studies are required to determine their exact number.

In this study, we compare the *Macrosolen* plants from Zamboanga with *M. melintangensis* sensu Barlow (1995, 1997), the putative species that Danser (1931, 1934, 1935, 1941) recognized within this species complex, as well as other species that display morphological similarities. We conclude that the Zamboanga plants are best considered as a new species under the unified species concept (De Queiroz 2007), because they are morphologically different from all members of the *M. melintangensis* species complex.

MATERIALS & METHODS

A specimen of the new species (two duplicates: holotype and isotype) was collected under Wildlife Gratuitous Permit (GP) No. R-IX-03-2021 issued by Department of Environment and Natural Resources (DENR) Region 9. Morphological observations and measurements were made from fresh and dried material and photographic images *in situ* of this specimen. Photos of type and other specimens at B, BM, K, L, P, and protologues of other *Macrosolen* species were also examined. A total of 39 characters were scored (when possible) for 10 members of the *M. melintangensis* complex (including the new species) and three other *Macrosolen* species that resemble the new species in aspects of their morphology. These data are presented in Supplemental file 1. Figure 1 illustrates the terminology used to describe mature flower buds of *Macrosolen*.

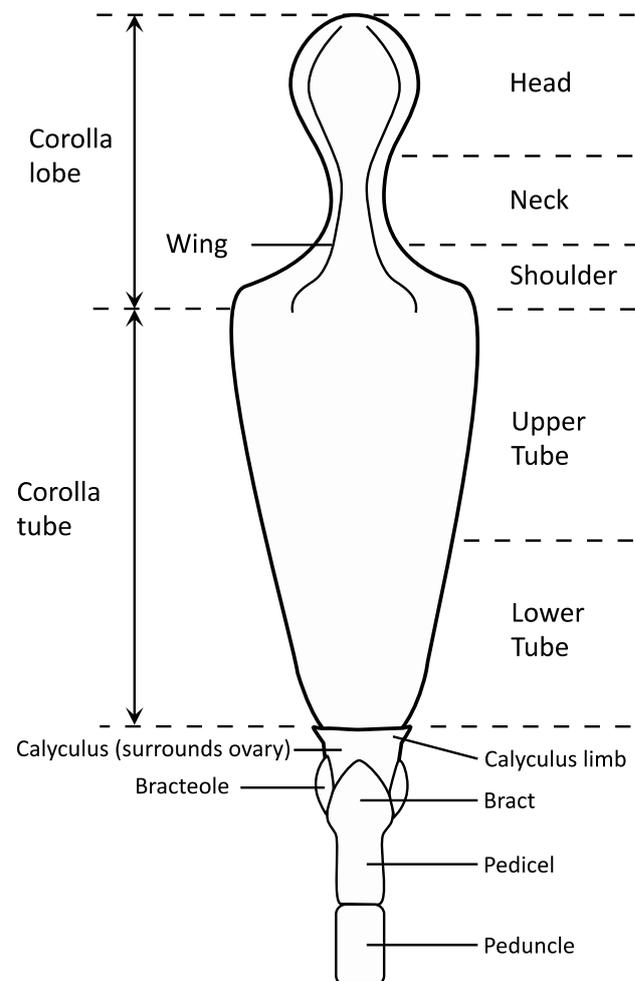


Figure 1. Terminology for describing mature flower buds.

Macrosolen zamboangensis Mazo, Nickrent & Pelsner, **sp. nov.** (Figure 2)

Type: Philippines, Mindanao, Zamboanga del Norte Province, municipality of Leon B. Postigo, barangay Tinuyop, Oro River, 8° 3' 33.19" N, 122° 55' 21.81" E, 337 m.a.s.l., 17 Mar. 2021, K.R.F. Mazo 37 (holotype PNH; isotype CMUH).

Diagnosis

Macrosolen zamboangensis is similar to species of the *M. melintangensis* complex, but unique in having conspicuously papillose flowers and fruits in combination with relatively short corollas (i.e. less than 20 mm in mature flower buds) of flowers that are clustered in subumbels. The inflorescences are generally 3–4 per axil, more numerous than in other members of the complex.

Description

Hemi-parasitic epiphyte with epicortical runners. Internodes terete, slightly flattened in the apical region when young, glabrous, light brown when mature. Nodes thickened. Leaves opposite or subopposite; petiole (7–)8–14 × 2.5–4.0 mm, flat adaxially, rounded abaxially; lamina bifacial, ovate or elliptic, 7.5–14(–15.6) × 3.3–7.7 cm, base rounded or obtuse to broadly cuneate, margin entire, apex acuminate to caudate, coriaceous, glabrous, adaxial surface somewhat shiny, abaxial surface dull, both surfaces light olive green, midrib prominent on both sides, lateral nerves 5–7 pairs, adaxially slightly prominent, abaxially prominent, brochidodromous. Inflorescences (1–)3–4(–5) per leaf axil, at older leafless nodes or on epicortical runners, subumbels (rarely racemes) of (2–)4–6 flowers crowded at the peduncle apex; prophylls caducous, ovate, c. 1 × 1.2 mm, apex mucronate; peduncles 3.2–8.0 × 1.1–1.8 mm, terete, glabrous or slightly papillose, with raised lenticels; pedicels 0.9–2.3 × c. 1 mm, slightly papillose. Central bracts broadly ovate, carinate, c. 1 × 1.2 mm, apex acute and occasionally mucronate, papillose. Bracteoles connate at base, broadly ovate, carinate, c. 1 × 1.2 mm, apex acute, papillose. Calyculus ellipsoid to slightly urceolate, 2.8–3.4 × 2.3–2.6 mm; limb cylindrical, c. 0.4 × 1.4–1.6 mm, margin shallowly crenate; conspicuously papillose, greyish green. Corolla in mature buds lageniform, straight or very slightly curved, slightly flaring from the base above calyculus limb, 15–19.2 mm long, wings prominent and symmetrical; tube 9.4–13.4 mm long, length/width ratio 2.4, tube grading from orange to red from lower to upper portion including shoulder; shoulder 2.3–2.6 mm long, wings prominent, glabrous; neck 0.8–1.3 × 1.8–2.6 mm, wings prominent, glabrous, black; head not dis-

tinctly clavate, 4.5–5.7 × 1.8–2.2 mm, wings not prominent, apex acute to obtuse, conspicuously papillose, greyish green; corolla lobes 6, reflexed but not twisting after anthesis, linear, 7.4–9.2 × 0.6–1.0 mm, adaxial surface glabrous. Stamens 6, free part of the filament 2.5–3.6 × 0.46–0.55 mm, green at base grading into yellow-orange at apex or yellow-orange throughout; anthers basifixed, 1.1–1.6 × 0.45–0.55 mm, base and apex obtuse, locules continuous, connective yellow-orange, anther sacs cream. Style 18–22 mm long, articulated above a conical base, distally not thickened, green; stigma ellipsoid to nearly globose, 0.6–0.7 mm wide, red. Fruit globose, c. 7 × 8 mm when mature, papillose but with warts that are less prominent than those on the ovary, brownish-red or purplish; calyculus limb crenate, c. 0.2 mm long, light green to almost colorless; stylar base forming a short nipple-like beak, 0.2–0.4 mm long, yellow. Seeds 1, ellipsoidal, 5–6 × 4 mm, longitudinally 6-grooved.

Etymology

The specific name refers to the Zamboanga peninsula of the island of Mindanao, Philippines, where this species was discovered.

Phenology

This new species was observed flowering and fruiting between February and June.

Distribution and habitat

Thus far, *M. zamboangensis* is only known from its type locality, which is in a disturbed lowland tropical rain forest and at 320–350 m elevation. *Macrosolen zamboangensis* was observed growing on *Mangifera* sp. (Anacardiaceae), *Palaquium* sp. (Sapotaceae), and species of Sapindaceae.

Conservation status

The number of populations and individuals, and the extent of the distribution of *M. zamboangensis* are still unknown. Nine plants were observed during the fieldwork for this study. The habitat of *M. zamboangensis* is not a protected area and threatened by small-scale mining, forest clearings for charcoal making, and illegal logging. Following the IUCN guidelines, we consider this species vulnerable under criterion VU:D2 (IUCN Standards and Petitions Committee, 2019).

Discussion

The abaxial surfaces of the corolla lobes in the floral head of *Macrosolen zamboangensis* are covered with a greyish-green papillose indumentum. This feature is par-

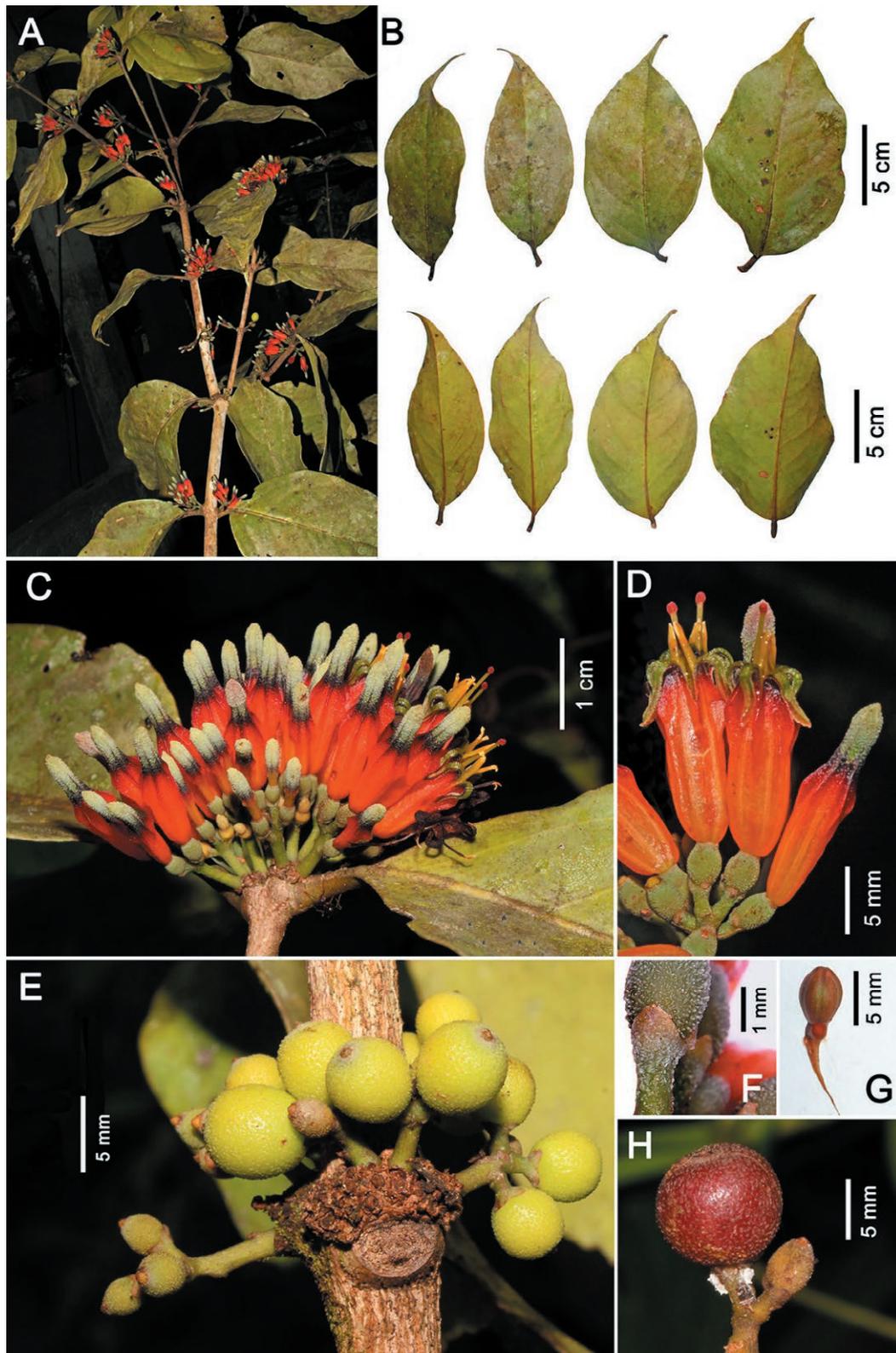


Figure 2. Morphological features of *Macrosolen zamboangensis*. A. Habit of mistletoe. B. Leaf variation, adaxial surfaces above, abaxial surfaces below. C. Inflorescence. D. Closer view of flowers in bud stage and at anthesis. E. Infructescences emerging from swollen node. F. Closer view of calyx/ovary, subtending bract, and pedicel. G. Seed removed from fruit. H. Mature fruit with scale insects on pedicel.

ticularly conspicuous when the flower buds are mature, but have not yet opened (Fig. 2c, d). It is an important diagnostic character for this species because flowers with a similar indumentum have thus far only been recorded for *M. papillosus* (Gamble) Danser from Borneo, Peninsular Malaysia, and Singapore (Gamble 1914; Barlow 1997). The protologue of *Elytranthe papillosa* Gamble describes the corolla as prominently papillose. Danser (1931) indicates the corolla is “beset with more or less numerous papillae”.

We wish to point out that three different terms for these types of excrescences have been used in Loranthaceae: papillate, tuberculate, and verrucate. The latter two are considered synonymous in Stearn (1992) and one recent plant taxonomy text synonymized all three (Simpson 2019). All describe excrescences or warts that are rounded projections, either regular or irregular in shape. Barlow (1997, p. 373) described the calyculus of *M. papillosus* as “shortly tomentose and more or less tuberculate” and later says “verrucose inflorescence parts and papillose fruits.” Both *M. papillosus* and *M. zamboangensis* have excrescences on their calycula, flower bud apices, and fruits (Fig. 2e, f, h). Those of *M. papillosus* are generally larger (c. 0.2 mm) and coarser compared with *M. zamboangensis* (0.1 mm).

Macrosolen zamboangensis can further be distinguished from *M. papillosus* by its larger leaf lamina (7.5–15.6 × 3.3–7.7 cm vs. 2.5–4.0 × 0.8–2 cm), different leaf shape (ovate or elliptic vs. obovate to spatulate), longer petioles (7–14 vs. 1–3 mm long), and the shape of its leaf apex (acuminate to caudate vs. rounded or slightly emarginate) (Fig. 2a, b). Further, *M. zamboangensis* usually has a longer mature corolla bud (15–19.2 vs. 10–15 mm; Fig. 2c, d). Finally, *M. papillosus* typically has one pair of flowers on a peduncle that is solitary in the leaf axil, whereas *M. zamboangensis* has a raceme or subumbel of usually 2–3 flower pairs with typically 3–4 peduncles per axil (Fig. 2c).

In his revision of *Macrosolen* for the Malesian region, Barlow (1997) wrote that papillose indumentum is not only found in *M. papillosus*, but that the inflorescences of *M. melintangensis* (sensu Barlow 1995) are also very rarely papillose. This description apparently applies to one component of the complex, *M. lowii*, where Danser (1931) described the inflorescences as “densely papillose hairy.” Although Barlow (2002, p. 694) mentioned that some specimens from Thailand have “tuberculate” fruits, papillose indumentum is, however, not present on the corolla of this species. Despite these differences in indumentum between *M. zamboangensis* and *M. melintangensis*, both species share similarities, particularly in leaf shape and size, length of corolla, and relative length

of the corolla tube. In fact, *M. zamboangensis* plants with three pairs of flowers per inflorescence key to *M. melintangensis* in Barlow (1997). A comparison with the descriptions of *M. melintangensis* in Barlow (1995, 1997) suggests, however, that *M. zamboangensis* generally has smaller flowers (corolla in mature flower bud 15–19.2 vs. usually 20–30 mm long) with shorter pedicels (0.9–2.3 vs. mostly 2–4 mm long) and longer calycula (2.8–3.4 vs. 1.8–2.5 mm). Also, *Macrosolen zamboangensis* typically has shorter anthers than what Barlow recorded for *M. melintangensis* (1.1–1.6 vs. 1.5–3 mm long). However, the morphological diversity of *M. melintangensis* sensu Barlow extends beyond the descriptions in his publications (Barlow 1995, 1997) because these only partially capture the morphological diversity of the following species that he included as synonyms: *M. bellus*, *M. demesae*, *M. floridus*, *M. javanus*, *M. lowii*, *M. sumatranus*, *M. tenuiflorus*, and *M. urceolatus*. We therefore also compared *M. zamboangensis* with these species individually. If this narrower delimitation of the *M. melintangensis* complex is used, differences in, amongst others, petiole length, leaf shape, inflorescence type and corolla size and shape can be used in addition to the presence of a papillose corolla to delimit *M. zamboangensis*.

Danser (1935) listed two Philippine members of the *M. melintangensis* complex: *M. bellus* and *M. demesae*. *Macrosolen zamboangensis* can be distinguished from *M. bellus* in leaf morphology. It generally has longer petioles (7–14 vs. 1.8–7.9 mm) and a rounded or obtuse to broadly cuneate instead of a decurrent or attenuate leaf base (Fig. 2b). In addition, the anthers of *M. zamboangensis* are shorter than those of *M. bellus* (1.1–1.6 vs. 2.5 mm; Danser 1935). They are also considerably shorter than the free part of the filament (2.5–3.6 mm), whereas the anthers of *M. bellus* are only slightly shorter than the free part of their filaments (3 mm; Danser 1935).

As far as we are aware, *M. demesae* is only known from descriptions by Merrill (1914) and Danser (1935) of the type material, and neither Barlow or we were able to find any surviving specimens. The holotype reported from PNH is presumed lost. This type material came from Zamboanga, the same part of Mindanao where *M. zamboangensis* grows. *Macrosolen demesae* is different from *M. zamboangensis* in leaf morphology. It has sessile or nearly sessile leaves (petiole 0–1 mm) with 10 lateral nerve pairs, whereas those of *M. zamboangensis* are clearly petiolate and have 5–7 lateral nerve pairs (Fig. 2b). In addition, the inflorescences of *M. demesae* are solitary vs. usually 3–4 per axil. The flowers are uniformly red (vs. orange-red with black neck and greyish green head) and the calyculus/ovary is smaller (2 × 1 mm vs. 2.8–3.4 × 2.3–2.6) (Fig. 2c, d).

Macrosolen lowii from Peninsular Malaysia, Thailand and possibly Cambodia (King 1887; Danser 1938; Barlow 2002) resembles *M. zamboangensis* in having puberulous (King 1887) or papillose (Danser 1931) peduncles, pedicels and bracteoles. However, it has smaller leaves ($3.6\text{--}6 \times 1.2\text{--}4$ vs. $7.5\text{--}15.6 \times 3.3\text{--}7.7$ cm) that are more strongly bifacial and have shorter petioles ($2.3\text{--}4.4$ vs. $7\text{--}14$ mm). Its flowers are larger than those of *M. zamboangensis* (mature bud corolla $24\text{--}34$ vs. $15\text{--}19.2$ mm long) and have a different shape (King 1887, Gamble 1914, Danser 1931). The corolla tube in *M. lowii* is more slender than that of *M. zamboangensis* (length/width ratio 4.2 vs. 2.4) and is pink, pinkish or white (Danser 1931) vs. orange to red (Fig. 2c, d).

Macrosolen javanus represents the *M. melintangensis* complex in Java. It differs from *M. zamboangensis* by its larger flowers (mature bud corolla $25\text{--}33$ vs. $15\text{--}19.2$ mm), which are similar in size to those of *M. lowii*. Likewise, its corolla tube is more slender (length/width ratio 5 vs. 2.4).

Danser (1931, 1934, 1941) also recognized three Bornean species and one species from Sumatra in the *M. melintangensis* complex, but expressed some doubts as to whether they are indeed taxonomically distinct from each other: *M. floridus*, *M. sumatranus*, *M. tenuiflorus*, and *M. urceolatus*. These four species have a distinctly different inflorescence morphology than *M. zamboangensis*. Whereas the flower pairs of *M. zamboangensis* are usually placed in a subumbel, i.e. with flowers crowded at the apex of the peduncle (Fig. 2c, e), those of the three Bornean taxa are in racemes with flowers more evenly distributed along the inflorescence axis (Danser 1931, 1934). Although we were not able to observe mature flowers or buds on the type material of *M. urceolatus*, the morphology of its immature buds suggests that they are more slender than those of *M. zamboangensis* and have a longer neck.

Neither Barlow (1995) or we were able to locate any surviving type material of *M. tenuiflorus* or other specimens collected and identified as this species, but Danser's (1931) illustration of *M. tenuiflorus* shows that it has flowers with dimensions similar to those of *M. zamboangensis*. It differs by its narrower leaves ($2.5\text{--}4$ vs. $3.3\text{--}7.7$), smaller calyx/ovary (1.5×1 vs. $2.8\text{--}3.4 \times 2.3\text{--}2.6$), the presence of an oviformous style base, and uniformly red flowers (Danser 1931). In contrast to *M. tenuiflorus*, type material for both *M. floridus* and *M. sumatranus* is extant, however, these sheets lack mature flower buds for analysis. For this reason we relied mostly upon descriptions. Moreover, *M. floridus* differs by having longer pedicels (i.e. $3\text{--}4$ vs. $0.9\text{--}2.3$ mm), a longer neck (c. 3.6 vs. $0.8\text{--}1.3$ mm) and shorter head (c. 2.3 vs.

$4.5\text{--}5.7$ mm) on the mature flower bud, as well as a pink vs. orange to red corolla tube (Danser 1934). *Macrosolen sumatranus* mostly stands out from the three other species in this racemose group by its yellow corolla tube and red head (Danser 1931).

Macrosolen melintangensis sensu stricto is a very poorly known species described from Sumatra. The protologue (Korthals 1839) is very brief and lacks diagnostic detail, and later authors (Miquel 1856; Danser 1931) were not able to add much more information about the morphology of this species. Walpers (1843) mentions that the corolla is 35 mm long and red, which is considerably longer than the corolla of *M. zamboangensis* (i.e. $15\text{--}19.2$ mm in mature flower buds; Fig. 2c, d). The type material at L is sparse and the single remaining inflorescence no longer bears flowers (Danser 1931; Barlow 1995), but it is evident that it is a raceme that had evenly distributed flower pairs. *Macrosolen melintangensis* s. str. is therefore also different from *M. zamboangensis* in inflorescence morphology.

In his revision of *Macrosolen* from the Malesian region, Barlow mentioned that *M. melintangensis* sensu Barlow is similar to *M. retusus* (Jack) Miq. from Borneo, Peninsular Malaysia, Singapore, and Sumatra, and to *M. robinsonii* (Gamble) Danser from China, Peninsular Malaysia and Vietnam (Danser 1931, 1938, Barlow 1997). *Macrosolen retusus* is, however, distinctly different from *M. zamboangensis* in its leaf morphology and flower color. The leaves of *M. retusus* are usually obovate and have a rounded or more rarely obtuse apex that can be retuse. In contrast, those of *M. zamboangensis* are typically ovate or elliptic, with an acuminate to caudate apex (Fig. 2b). *Macrosolen retusus* also has shorter petioles ($3\text{--}5$ vs. $7\text{--}14$ mm long) and has a leaf base that is cuneate (rarely rounded) instead of broadly cuneate, rounded or obtuse. The corolla tube of *M. retusus* is often pink or violet (vs. orange to red) and is generally larger ($18\text{--}25$ vs. $15\text{--}19.2$ mm long) (Danser 1931, Barlow 1997). *Macrosolen robinsonii* stands out from *M. zamboangensis* and other members of the *M. melintangensis* complex by its sessile inflorescences (peduncles $0.9\text{--}2.5$) but information on flower dimensions is confusing. Danser (1931) indicated that the corollas in mature buds were $11\text{--}13$ mm long but he amended that to $11\text{--}15$ (Danser 1936) and later (Danser 1938) simply to 12. Barlow (1997) extends the size considerably reporting $15\text{--}25\text{--}30$ mm long for the corolla length. Because the leaves of *M. robinsonii* are narrower than those of *M. zamboangensis* ($0.8\text{--}3.5$ vs. $3.3\text{--}7.7$ mm wide), and because it has an involucre (pairs of triangular scales, up to 2 mm long) present at the base of the inflorescence peduncle, these two taxa are distinct.

CONCLUDING REMARKS

Naming a new species in a mistletoe genus such as *Macrosolen* presents a number of challenges. These include the absence of type specimens associated with various names, variations in descriptions of the same taxa by different authors, and weighing the extent of polymorphism present within a taxon prior to considering it a species. Although photographs of herbarium specimens provide invaluable data for this type of work, the quality of specimens varies considerably and crucial details (e.g. of flowers) are not always visible. For the Philippine flora in particular, specimens (including types) were destroyed in WWII and no collections currently held in PNH and various in-country university herbaria are digitized and available for viewing on the internet. To fully explore species boundaries in *Macrosolen*, the morphological character variation should be examined in the context of a molecular phylogeny, but currently no such data exist. As discussed here, the *M. melintangensis* complex may contain as few as four and as many as 13 species. All of these taxa can be characterized, more or less, by unique combinations of characters. For the 39 morphological characters considered here, we propose that *M. zamboangensis* shows sufficient phenotypic differences from other members of the complex to be considered a distinct species.

Additional specimens examined

PHILIPPINES. *Macrosolen bellus* Danser. Catanduanes, *Bur. Sci.* 30447 Ramos (lectotype BM; isolectotype P), 14 Nov. to 11 Dec. 1917 (photos!).

MALAYSIA. *Macrosolen floridus* Danser. Borneo, Sabah, Mt. Kinabalu, *J. & M.S. Clemens 31411* (holotype B; isotypes BM, K, L), Penibukan, Spur S. of Kina Taki river, 7 Feb. 1933 (photos!); *J. & M.S. Clemens 28246* (L), Tenompok, 24 Feb. 1932 (photo!). *Macrosolen lowii* (King) Tiegh. Peninsular Malaysia, *Scortechini 861* (holotype K; isotype L), Perak (photos!). *Macrosolen robinsonii* (Gamble) Danser. Peninsular Malaysia, *Wray & Robinson 5404* (syntypes BM, K), Pahang, Gunong Tahan, 3 June 1905 (photos!).

INDONESIA. *Macrosolen javanus* Danser. Java, *Koorders 26726B* (L), Pangentjongan, 18 Jan. 1897 (photo!); *Koorders 26742B* (L), Pangentjongan, 4 Feb. 1897 (photo!); *Docters van Leeuwen 3024* (isotype L), Pateungteung, 9 Nov. 1918 (photo!). *Macrosolen melintangensis* (Korth.) Miq. Sumatra, *Korthals s.n.* (syntype L, two sheets), G. Malintang (photos!). *Macrosolen sumatranus* Danser. Sumatra, *Bünnemeijer 3335* (holotype L), Agam, Brani, 26 June 1918 (photo!). *Macrosolen urceola-*

tus Danser. Borneo, *Van Wijk 65a* (isotype L), Kahajan, Bahaoen, 25 Sept. 1938 (photo!).

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