



# A revision of *Ziziphus* (Rhamnaceae) in Borneo

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**Summary.** The genus *Ziziphus* (Rhamnaceae) is revised for Borneo. 13 species are recognised using morphological evidence, including three new endemic species: *Ziziphus cuspidata*, *Z. domatiata* and *Z. puberula*. Borneo is therefore the island with the greatest known diversity of *Ziziphus* species. The area surrounding Mount Kinabalu is particularly diverse, with nine species occurring in Ranau. Two new varieties of *Z. borneensis* are also described here, *Z. borneensis* var. *ranggam* and *Z. borneensis* var. *velutina*, five new synonyms are established, including the placement of *Z. elmeri* as a synonym of *Colubrina beccariana*. A taxonomic treatment, including a preliminary IUCN conservation status assessment, is presented for each species and variety.

**Key Words.** conservation, IUCN, Malesia, South-East Asia, systematics, taxonomy, tropical climbers.

## Introduction

*Ziziphus* Mill. is a genus in the Rhamnaceae of about 80 species of deciduous and evergreen shrubs, climbers and trees occurring throughout the Old World (OW) tropics, subtropics and warmer temperate regions (Hauenschild *et al.* 2016; Medan & Schirarend 2004; POWO 2019). Leaves are typically triplinerved, stipules spinose, inflorescences cymose and fruits drupaceous (Medan & Schirarend *loc. cit.*). The fruits of almost all species could be edible (Latiff 1991), and jujube (*Ziziphus jujuba* Mill.) and ber (*Z. mauritiana* Lam.) are grown commercially. The genus was included in the morphologically heterogeneous Zizipheae Brongn. (Brongniart 1843, as “Zizyphae”) by Hooker (1862), Weberbauer (1895) and Suessenguth (1953). Zizipheae however is predated by Paliureae Reiss. ex Endl. as noted by Schirarend & Olabi (1994), which is the currently accepted name for the tribe that includes *Ziziphus*. An analysis of *rbcL* and *trnL-F* sequence data by Richardson *et al.* (2000) confirmed the placement of *Ziziphus* into Paliureae. Morphological differences between Old World (OW) and New World (NW) species had been reported by several authors (listed by Islam & Simmons 2006) and an analysis of ITS, 26S rDNA and *trnL-F* data by Islam & Simmons (*op. cit.*) revealed that the genus was not monophyletic, with OW and NW species belonging to separate lineages. An additional analysis of *trnL-F* and ITS sequence data by Hauenschild *et al.* (2016) further supports that the genus *Ziziphus* as previously defined is not monophyletic and NW species have subsequently been reattributed to the genera *Sarcomphalus* P.Browne in Paliureae and *Pseudoziziphus* Hauenschild (*op. cit.*) in Rhamnaceae Hook.f. emend. J.E.Richardson (Richardson *et al.* 2000).

*Ziziphus* is found across diverse habitats, from savanna-adapted species such as *Z. mucronata* Willd., widely distributed in the grasslands of Africa (GBIF 2019), to rainforest endemics like most of the species studied here. The genus displays a range of morphological adaptations to these environments: spiny shrubs occurring in xeric shrublands such as *Z. spinachristii* (L.) Desf. (GBIF 2019), unarmed rainforest trees to 25 m tall such as *Z. angustifolia* (Miq.) Hatus. ex Steenis, widely distributed in South-East Asia, and armed rainforest woody climbers like most species studied here. Whether functional traits reflect habitat adaptations is part of ongoing work, in particular whether traits such as spinescence reflect a response adaptation to a biome or have facilitated entrance into the biome (Rickenback *et al.* in prep.). The centre of both the distribution and evolution of *Ziziphus* seems to be SE Asia (Liu & Cheng 1995); c. 50 species occur in Asia as opposed to c. 15 in Africa (GBIF 2019). Preliminary genus-level studies also suggest the origin of the genus may have been Asian (Rickenback *et al.* in prep.). This is consistent with the conclusions of Richardson *et al.* (2004) who also noted good representation of sister taxa in the Late Eocene-Miocene of North America and Eurasia, suggesting a Laurasian origin for this group followed by more recent migration to Africa. Despite being widely distributed, questions remain around the age, dispersal and morphological adaptations of the genus. *Ziziphus* is especially diverse in Malesia with over 25 currently accepted species (POWO 2019). Most of the c. 15 SE Asian genera of Rhamnaceae have yet to be revised, although a synopsis of *Smythea* (Cahen & Utteridge

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2018), *Gouania* (Cahen *et al.* 2020) and a key to the Bornean species of *Ventilago* (Cahen & Utteridge 2017) were recently completed.

In Borneo, no complete taxonomic treatment of *Ziziphus* has been published, although checklists for the island (Merrill 1929; Masamune 1942) and the Mount Kinabalu area (Beaman & Anderson 2004) are available, with Merrill listing five species, of which one is excluded in this revision (*Z. elmeri* Merr. established here as a synonym of *Colubrina beccariana* Warb.), Masamune listing 11 species, of which *Z. elmeri* again is excluded here, and Beaman & Anderson listing eight, of which six are accepted here (the other two, *Z. cupularis* Suess. & Overkott and “*Ziziphus indet.*” [Clemens & Clemens 27375], are synonyms of species also included in their list). The most complete overview of *Ziziphus* species occurring in Borneo was restricted to Sabah and Sarawak (Schirarend 1995). It includes a detailed account of *Z. angustifolia* and recorded seven climbing species in the key only. Borneo is the island with the greatest known diversity of *Ziziphus* species in the world with 13 species recognised in this revision. Despite this, *Ziziphus oenopolia* (L.) Mill. and *Z. mauritiana* Lam., otherwise widespread in Malesia are not known to have been reported on the island. Many of the species occurring in Borneo have a small distribution range: five are endemic to the island (*Z. borneensis* Merr., *Z. cuspidata* sp. nov., *Z. domatiata* sp. nov., *Z. puberula* sp. nov. and *Z. ridleyana* Rasingam & Karthig.) and four are restricted to the Philippines, Borneo and Sulawesi (*Z. crebrivenosa* C.B.Rob., *Z. cumingiana* Merr., *Z. havilandii* Ridl. and *Z. suluensis* Merr.). The area surrounding Mount Kinabalu is particularly diverse with nine species recorded for Ranau: *Z. angustifolia*, *Z. borneensis* (including two local endemic varieties: *Z. borneensis* var. *kinabalu* Suess. and *Z. borneensis* var. *velutina* var. nov.), *Z. calophylla* Wall., *Z. crebrivenosa*, *Z. cumingiana*, *Z. cuspidata*, *Z. havilandii*, *Z. horsfieldii* Miq. and *Z. suluensis*.

The taxonomy of *Ziziphus* for Borneo is revised here, three new species and two new varieties are described. In addition, four new synonyms are established within the genus and *Z. elmeri* a tree species with pinnate venation, is placed here as a synonym of *Colubrina beccariana*.

## Material and Methods

Herbarium specimens from K and K-W were studied. Additional specimen images from A, B, BR, BRI, C, CAS, CM, E, F, FI, GH, HBG, L, M, MEL, NY, P, PH, S, SING, U, UC, US were examined. All cited specimens or their image were seen unless specified. Most of the available material from the island was collected in Sabah by the Sandakan Forest Research Centre (SAN; c. 25% of studied sheets) and Sarawak by the Kuching Department of Forestry (SAR; c. 15%). An alphabetical index to all numbered examined collections from Borneo is given at the end of the

paper (Appendix 1). Material was examined under a Zeiss Stemi 1000 binocular microscope at magnifications of up to  $\times 350$ . Leaf anatomy terms used are from Hickey (1979). Hair density terms are defined as follows: *sparse* when hairs are scattered enough not to touch when pressed towards each other, *abundant* when hairs are close enough to touch if pressed towards each other, *dense* when hairs are so close to each other that they hide the surface of the organ they grow on. Other morphology terms follow Beentje (2010). Measurements were made on material available at K and for specimens collected in Borneo only, except for type specimens of species occurring there but collected outside the island. To facilitate species identification, average measurements are sometimes used in the Key to species. Averages were calculated by recording measurements in spreadsheets and excluded the least developed, distal leaves. Habitat, elevation, vernacular names and phenological information are also indicated here for Borneo records only; and only specimens from Borneo are listed in the specimens examined. Habitat names used are from Ecoregions 2017 (Dinerstein *et al.* 2017). Collection locality coordinates used for species distribution maps were retrieved from label information for Borneo specimens and from GBIF (2019) for specimens collected outside the island. GeoCat (Bachman *et al.* 2011) was used to calculate Extents of Occurrence (EOO) and protected areas were located using the World Database on Protected Areas online interface (IUCN & UNEP-WCMC 2019).

## Key morphological characters

### Leaves

*Ziziphus* species have triplinerved leaves, with three main veins, the outer two of which branch off the midrib at the base of the lamina and run in convergent arches to the leaf apex (“basal, perfect, acrodromous venation” *sensu* Hickey 1979) (Fig. 2B). Leaves also present  $\pm$  closely and regularly spaced, scalariform, transverse veins between the main veins (Fig. 3B). In addition, most species in Borneo have strong marginal veins branching off the outer main veins towards the leaf margin (Fig. 2B). Minute callosities c. 1 mm long are distributed along the leaf margin and when the margin is serrated each serration is topped by such a callosity (Fig. 1G). Examining leaves is enough to identify most Borneo *Ziziphus* plants to species. Particularly useful characters for identification include: leaf size (to about 30 cm long in the two tree species *Z. angustifolia* and *Z. ridleyana* vs  $< 20$  cm in the climbing species; and among climbers, usually  $> 12$  cm in *Z. crebrivenosa* and *Z. kunstleri* vs usually  $< 9$  cm in other species; the

smallest leaves are in *Z. havilandii*, usually 2.5 – 5.5 cm), the presence of many dark glands, appearing as black spots, covering the abaxial surface (present in *Z. havilandii* and *Z. suluensis*, absent in all other species), the number of strong veins branching off the outer main veins towards the leaf margin (absent in *Z. calophylla*, *Z. havilandii* and *Z. suluensis*; c. 4 on either side in *Z. domatiata*, c. 5 in *Z. cumingiana* var. *cumingiana*, c. 6 in *Z. cuspidata* and *Z. horsfieldii*, c. 8 in *Z. borneensis* except > 15 in var. *ranggam*, > 10 in *Z. puberula*, > 20 on either side in *Z. angustifolia*, *Z. crebrivenosa*, *Z. kunstleri* and *Z. ridleyana*) and the presence of hairs on the abaxial lamina surface, main veins excluded (hairy in *Z. borneensis*, *Z. cumingiana* var. *cumingiana*, *Z. cuspidata*, *Z. crebrivenosa*, *Z. kunstleri* and *Z. ridleyana* vs glabrous to subglabrous in other species). The prominence, closeness and branching of transverse veins provide additional characters for identification (e.g. clearly raised, spaced by c. 5 mm from each other and often branching in *Z. kunstleri*; barely raised, spaced by c. 1 mm from each other and unbranched in *Z. calophylla*).

#### Inflorescences and flowers

All Borneo *Ziziphus* species present a typical Rhamnaceae flower, with five valvate, adaxially keeled calyx lobes, five small hooded petals each enclosing a stamen, and a fleshy nectar disk (Fig. 2G & Fig. 4G). In the *Ziziphus* of Borneo, the disk surrounds a partially immersed ovary and is 10-pitted (Fig. 2H & Fig. 4H), except in *Z. angustifolia* and *Z. ridleyana* where the disk is rugose and appears ± 20-pitted. *Ziziphus angustifolia* and *Z. ridleyana* flowers also differ in having 2 – 4 style arms vs 2 in all other species. These flower characters, along with the unarmed tree habit (all other species in Borneo are spiny climbers), could indicate that the two species are in a separate clade. Otherwise, flowers

appear relatively consistent morphologically. They are arranged in cymes, which can either be subsessile and almost fascicle-like (in *Z. angustifolia*, *Z. borneensis*, *Z. cumingiana* and *Z. ridleyana*) or clearly pedunculate (all other species) (Fig. 2F & Fig. 4F). *Ziziphus kunstleri* is distinctive in the leaves subtending the cymes being distinctly smaller and narrower than other leaves, falling soon, and the inflorescences ultimately appearing to be arranged in panicles. Leaves subtending the cymes also tend to fall soon in *Z. calophylla* and *Z. suluensis* but they are not morphologically distinct from other leaves; the leaves subtending the cymes seem more or less persistent in all other species. Bracteoles at the base of pedicels are present and are narrowly triangular, entire to lacinate and 1 – 5 mm long (Fig. 2F).

#### Fruit

Fruits are particularly useful for the identification of *Ziziphus* species in Borneo and provide the most diagnostic characters along with the leaves. All are single-stoned and fleshy (drupes), but they vary in size, shape and pubescence. Those of *Ziziphus crebrivenosa* are unique in being covered in raised, blister-like lenticels. *Ziziphus cumingiana* is recognised in the small fruits, c. 7 mm long (vs at least 10 mm long in all other Borneo *Ziziphus* species). Only three species have glabrous fruits: *Z. cumingiana*, *Z. cuspidata* (Fig. 2L) and *Z. domatiata* (Fig. 3E). *Ziziphus horsfieldii* fruits are characteristically obovoid (wider towards apex) and c. 1.1 × 1.1 cm. Except for *Z. crebrivenosa*, which has fruits with raised lenticels, *Z. borneensis* and *Z. puberula* are the only other species of the genus in Borneo with fruits that are ellipsoid, > 1.5 × longer than wide, and > 2 cm long (vs globose to obovoid, < 1.5 × longer than wide, or, if ellipsoid, then < 2 cm long) (Fig. 4J).

## Taxonomic Treatment

### Key to *Ziziphus* species in Borneo

1. Trees, unarmed. Leaves long, to 31 cm long. Inflorescences axillary, subsessile fascicle-like cymes; style arms 2 – 4 . . . . . 2
  - Climbers, spiny. Leaves smaller, not exceeding 20 cm in length. Inflorescences axillary fascicle-like cymes, pedunculate cymes or panicles; style arms 2 [note: flowers not known for *Z. domatiata*] . . . . . 3
2. Leaves and branchlets subglabrous, calyx lobes c. 2 mm long. (Widely distributed from southern Thailand to Solomon Islands) . . . . . **1. *Z. angustifolia***
  - Leaves and branchlets with a dense reddish-brown indumentum, calyx lobes c. 4 mm long. (Only known from Kuching Division, Sarawak) . . . . . **12. *Z. ridleyana***
3. Leaves thin-chartaceous, usually hairy along the main veins abaxially only; margin widely and weakly crenate with a tooth and hairs inserted by the sinus of each crenation; venation including the smallest veins evenly dark red when dry, contrasting strongly with the paler colour of the lamina surface. Inflorescences subsessile fascicle-like cymes; pedicels and outside of flowers sparsely hairy. Fruits small, c. 0.7 cm long, obovoid (wider towards apex), glabrous . . . . . **5. *Z. cumingiana* var. *cumingiana***
  - Leaves chartaceous to subcoriaceous, glabrous to densely hairy; margin entire to finely serrate, not widely and weakly crenate; venation colour various. Inflorescences subsessile fascicle-like cymes, pedunculate cymes or

- paniculate; pedicels and outside of flowers abundantly to densely hairy. Fruits 1 – 3 cm long, globose, obovoid or ellipsoid, glabrous to densely hairy . . . . . 4
4. Leaves with usually only the three main veins clearly visible, strong veins branching off outer main veins towards the leaf margin usually lacking; intramarginal vein running along the leaf margin present, faint but distinct; transverse veins that join the main veins closely and regularly spaced by c. 1 mm from each other; longitudinal venules between the transverse veins indistinct. Fruits densely hairy . . . . . 5
- Leaves with strong veins branching off outer main veins towards the leaf margin present; intramarginal vein running along the leaf margin present or absent; transverse veins that join the main veins closely and regularly spaced or not, spaced by 1 – 5 mm from each other; longitudinal venules between the transverse veins indistinct to conspicuous. Fruits glabrous to densely hairy . . . . . 7
5. Leaves with many dark glands on abaxial surface (appearing as black spots), lamina usually asymmetric, chartaceous to subcoriaceous, usually < 8 cm long; leaf base mostly rounded to subcordate. Inflorescences with c. 8 flowers per cyme. Fruits globose-obovoid. . . . . 6
- Leaves with no to many dark glands on abaxial surface, lamina usually ± symmetric, subcoriaceous, on average c. 11 cm long; leaf base mostly wide-cuneate to rounded. Inflorescences with c. 16 flowers per cyme. Fruits usually ellipsoid-obovoid . . . . . **3. *Z. calophylla***
6. Leaves chartaceous, usually widest near base, narrow ovate, (1.0 –) 2.5 – 5.5 (– 6.5) × (0.5 –) 1.2 – 2.5 (– 3.5) cm, indumentum dense on distal branchlets at fruiting. Fruits (0.4–) 0.9 (– 1.5) × (0.3–) 0.8 (– 1.3) cm . . . . . **8. *Z. havilandii***
- Leaves chartaceous-subcoriaceous, usually widest near middle, elliptic-oblong, (4.5 –) 8 (– 13) × (1.9 –) 3.5 (– 5.2) cm, indumentum sparse to abundant on distal branchlets at fruiting. Fruits 1.2– 1.5 × 0.9– 1.5 cm . . . . . **13. *Z. suluensis***
7. Leaves usually > 12 × 6 cm, strong veins branching off outer main veins towards the leaf margin > 20 on either side, forming loops near the leaf margin . . . . . 8
- Leaves usually < 9 × 4 cm, strong veins branching off outer main veins towards the leaf margin usually < 12 on either side (except > 15 in *Z. borneensis* var. *ranggam* and often > 12 in *Z. puberula*), forming loops near the leaf margin or ascending and gradually diminishing and not forming conspicuous loops . . . . . 9
8. Fruits covered in raised, blister-like lenticels. Branchlets with conspicuous, raised lenticels. Transverse veins between main veins usually joining main veins without branching; longitudinal venules between transverse veins visible but not clearly raised. Cymes subtended by usually persistent leaves, not much smaller and narrower than other leaves, the flowers remaining arranged in pedunculate cymes subtended by leaves . . . . . **4. *Z. crebrivenosa***
- Fruits covered in reddish hairs, lenticels not present. Branchlets with superficial lenticels concealed by the dense, reddish indumentum. Transverse veins between main veins usually branching; longitudinal venules between transverse veins conspicuous, clearly raised. Cymes subtended by fugaceous leaves, distinctly smaller and narrower than other leaves, the flowers usually ultimately arranged in leafless panicles . . . . . **10. *Z. kunstleri***
9. Fruits ellipsoid, > 1.5 × longer than wide, usually > 2 cm long, densely hairy. Inflorescences sessile fascicle-like cymes or pedunculate cymes. Leaves usually > 7 × 3 cm; strong veins branching off outer main veins towards the leaf margin usually 8 or more on either side . . . . . 10
- Fruits globose to obovoid, < 1.5 × longer than wide, usually < 2 cm long, glabrous to densely hairy. Inflorescences pedunculate cymes. Leaves usually < 7 × 3 cm; strong veins branching off outer main veins towards the leaf margin usually < 8 on either side . . . . . 11
10. Inflorescences sessile fascicle-like cymes, peduncles rudimentary, < 4 mm long if developed. Indumentum on distal branchlets of hairs mostly c. 0.5 mm long, often > 1 mm long. Strong veins branching off outer main veins towards the leaf margin c. 8 on either side (except > 15 in *Z. borneensis* var. *ranggam*), rarely forming clear loops with each other, all reaching a usually well-defined intramarginal vein running along the leaf margin; lamina densely hairy abaxially, soft to touch due to the hairs, hairs c. 1 mm long . . . . . **2. *Z. borneensis***
- Inflorescences pedunculate cymes, peduncles 3 – 10 mm long. Indumentum on distal branchlets of very short hairs, 0.1 mm long. Strong veins branching off outer main veins towards the leaf margin > 10 on either side, ascending and usually forming loops near the margin, with no clear intramarginal vein running along the leaf margin; lamina subglabrous abaxially except along larger veins, hairs minute, 0.1 mm long . . . . . **11. *Z. puberula* sp. nov.**
11. Leaf lamina subglabrous abaxially except along larger veins. Fruits glabrous or densely hairy, subglobose to obovoid, usually < 1.5 cm long. Leaves widest near base, narrow ovate; apex usually acuminate; base asymmetric, usually clearly oblique . . . . . 12
- Leaf lamina with abundant hairs abaxially, rarely subglabrous. Fruits glabrous, globose to ellipsoid, usually > 1.5 cm long. Leaves usually widest near middle, elliptic; apex usually acute to attenuate, rarely acuminate; base usually symmetric . . . . . **6. *Z. cuspidata* sp. nov.**
12. Fruits glabrous, subglobose, ripening creamy-grey. Leaf strong veins branching off outer main veins towards the margin c. 4 on either side, often less . . . . . **7. *Z. domatiata* sp. nov.**

- Fruits densely hairy, obovoid, ripening yellowish-green. Leaf strong veins branching off outer main veins towards the margin c. 6 on either side, rarely < 5 . . . . . **9. *Z. horsfieldii***

**1. *Ziziphus angustifolia*** (Miq.) Hatus. ex Steenis (van Steenis 1960: 13). *Celtis angustifolia* (Miq.) Planch. (Planchon 1873: 186). *Solenostigma angustifolium* Miq. (Miquel 1861: 412). Type: Indonesia, Sumatra, Priaman, [collector unknown] HB 2501 (lectotype, selected here: L [L 0013794]; paralectotype: L [L 0931291]).

*Celtis grewoides* Warb. (Warburg 1891: 287). *Ziziphus grewoides* (Warb.) L.M.Perry (1954: 595). Type: Papua New Guinea, Hatzfeldthafen, s.d., Warburg 20810 (lectotype, selected here: B [B 10 0295710]; isolectotype: L [L 0013795]).

*Ziziphus inermis* Merr. (Merrill 1905: 37). Type: Philippines, Luzon, Rizal, Bosoboso, May 1905, *Ahern's collector* Forestry Bureau No 3075 (lectotype, selected here: NY [00415112]; isolectotype: US [00094330]).

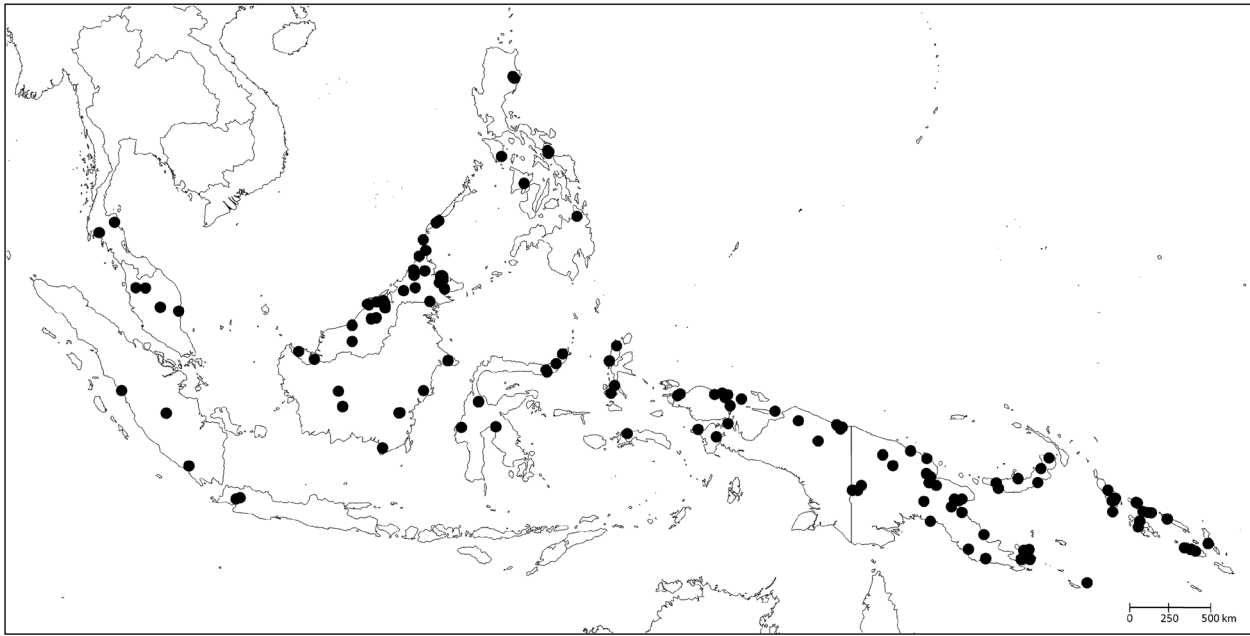
*Ziziphus forbesii* Baker f. (Baker 1923: 10). Type: Papua New Guinea, Mt Gawada, 2500 ft [750 m], *Forbes* 910 (lectotype, selected here: BM [BM000838632]; isolectotypes: BRI [BRI-AQ0317636], FI [FI008653], L [L 0013796], MEL [MEL 567838]).

*Tree*, to at least 25 m high, unarmed, girth to 1.5 m in diam.; bole  $\pm$  straight, to at least 15 m high, buttresses sometimes present, low, 1  $\times$  1 (– 1.5) m. *Bark* usually greyish-brown, smooth, not peeling, to at least 12 mm thick; lenticels visible, in longitudinal rows, yellowish-brown, inner bark yellowish or pale pink grading into orange near cambium, to at least 2.5 mm thick; cambium pink, orange or red, to at least 1.25 mm thick. Sapwood yellowish-brown, hard; heartwood dark brown, hard. *Branchlets* terete, with longitudinal striations and visible lenticels, hairs absent to sparse (– dense), hairs short, c. 0.1 mm long, appressed. *Stipules* not transformed into spines, early deciduous, narrowly triangular, c. 2 mm long, densely hairy. *Leaves* weakly discolorous, drying greenish-brown, blade  $\pm$  symmetric, (narrow) elliptic-oblong, 7.5 – 22.5  $\times$  2.5 – 8.6 cm, chartaceous to subcoriaceous, apex attenuate to acuminate, base (cuneate –) obtuse to rounded,  $\pm$  symmetric, margins usually subentire, sometimes clearly serrate, each serration topped by a minute protruding callosity that dries darker than the lamina, c. 0.1 mm long; primary veins 3, impressed adaxially, raised abaxially, hairs sparse (– abundant) along primary veins abaxially, c. 0.2 mm long,  $\pm$  appressed, reddish some whitish; strong marginal veins coming off the outside of the two outer main veins > 20 on either side, all ending in a distinct intramarginal vein running along the leaf margin, angle of divergence with outer main veins c. 65°; transverse veins between the main veins conspicuous, coming off midrib at c.

90°, raised (readily felt by touch), spaced by (2 –) 4 (– 10) mm from each other; higher order reticulations visible; lamina glabrous (– abundantly hairy) abaxially; no domatia visible; petiole subterete, 5 – 12 mm long, glabrous. *Inflorescence* of axillary short-peduncled, almost fascicle-like cymes, often branched, usually c. as long as subtending leaf's petiole, 6 – 12 flowers in each cyme; pedicels to 2 – 3 mm long, hairs dense; bracteoles entire, narrowly triangular, c. 1 mm long, hairy. *Flower* hypanthium densely hairy on the outer surface; sepals triangular, c. 2 mm long, glabrous and keeled adaxially; petals clawed, c. 1.4 mm long, obcordate; stamen filaments flat, subulate, c. 1.2 mm long, anthers c. 0.4 mm long, exceeding petals; nectary disk pentagonal, rugose, appearing  $\pm$  20-pitted, glabrous, annulus strongly raised and sheathing style; style arms (2 –) 3 (– 4), c. 0.5 mm long, diverging, not expanding at apex, glabrous ovary partially immersed. *Fruit* a drupe, ripening yellowish-green, pinkish or red, (1.3 –) 1.6 (– 1.9)  $\times$  (0.8 –) 1.1 (– 1.5) cm, obovoid [wider towards apex], glabrous; fruiting pedicels c. 3 – 6 mm long; hypanthium remains annular at base of fruit.

**DISTRIBUTION.** Brunei, Indonesia (Java, Kalimantan, Maluku, Sulawesi, Sumatra, West Papua), Malaysia (Peninsular Malaysia, Sabah, Sarawak), Myanmar, Papua New Guinea, Philippines (Biliran, Leyte, Luzon, Masbate, Mindanao, Mindoro, Palawan, Samar), Solomon Islands, Thailand. Map 1.

**ADDITIONAL SPECIMENS EXAMINED.** BRUNEI. BELAIT: Labi F.R., 29 June 1935, *Ja'amat* KEP 39641 (K); TUTONG: Upstream from Belabau on Tutong R., 20 m, 18 March 1990, *Coode et al.* 6318 (E, K, L); Rambai, Bukit Bahak Ridge. Vicinity of LP338A, 300 m, 14 Dec. 1991, *Coode et al.* 7052 (K, L); INDONESIA. BORNEO: Boekit Tjihhan [Bukit Cehan], 10 Dec. 1898, *Amdjah* 314 (K, L); EAST KALIMANTAN, P.T. ICTI, Gunung Meratus, 22 Nov. 1997, *Ambriansyah* AA 2155 (E, K, L); *ibid.*, 20 Feb. 1998, *Ambriansyah* & *Priyono* AA 2187 (E, K); E. Kutei, Sg. Menubar Region, 5 m, 7 June 1951, *Kostermans* 5032 (K, L); Loa Haur, W of Samarinda, 40 m, 13 May 1952, *Kostermans* 6917 (K, L); SOUTH KALIMANTAN, Djaru Dam. c. 10 km NE of Muara Uja, c. 1°50'S 115°40'E, 70 m, 16 Oct. 1972, *de Vogel* 1667 (K, L); *ibid.*, 6 March 1973, *de Vogel* 2196 (L); WEST KALIMANTAN, Sintang. Bukit Baka National Park. Along bank of Sungai Ella, 100 m NE of camp, 0°38'S 112°17'E, 13 Oct. 1993, *Church et al.* 14 (K, L); MALAYSIA. SABAH: BELURAN, W of Lake Sg. Namatoi,  $\pm$  1300 ft [400 m], 12 June 1978, *Madani* SAN 88843 (L); KENINGAU, Ulu Sg. Mantuluk, Witt Range area, 16 Jan. 1986, *Krispinus* SAN 113272 (K, L);



Map 1. Distribution of *Ziziphus angustifolia* (●).

**KINABATANGAN**, Supu F.R., Elopura, edge of Kaboi R., 100' [30 m], 12 Oct. 1938, *Puasa* NBF 10106 (K, L); **KOTA BELUD**, Kampung Melangkap Tomis, 2 km dari Melangkap Tomis, 8 Nov. 1995, *Lugas* 1229 (K); Len Hin Logging Area, Mile 68 Kudat-Kota Belud Road, ± 680 ft [200 m], 14 Nov. 1963, *Mikil* SAN 40341 (L); **KUDAT**, Labuan F.R., Penangsoo, 40 feet [10 m], 27 Aug. 1937, *Apostol* 7678 (K, L); Banguay [Banggi] Island, July – Sept. 1923, *Castro & Melegrito* 1468 (K); **LAHAD DATU**, Sg. Taliwas, ± 500 ft [150 m], 20 Nov. 1963, *Ambullah* 37187 (K, L); **RANAU**, Tenompok, 5000 ft [1500 m], 10 Nov. 1931, *Clemens & Clemens* 27051 (L); Kampung Bundu Tuhan, Kampung Himbaa, 19 Dec. 1993, *Soibeh* 627 (K); **SANDAKAN**, Lahad Datu road, 50 ft [15 m], 25 July 1978, *Arshid* SAN 88621 (L); Lagsikan Forest Reserve, 300 ft [90 m], 3 Jan. 1953, *Bukah* A 3418 (K, L); Mamanjang Agriculture Station, 11 July 1973, *Madani* SAN 77372 (K, L); Segaliud Lokan, 12 Oct. 1988, *Majawati et al.* SAN 102438 (K); Lungmanis Timber camp, 9 Aug. 1962, *Mikil* SAN 31565 (K, L); Sapagaya, 50 ft [15 m], 15 June 1937, *Puasa* 7201 (L); Elopura Forest Distr., Suan Lamba, 100 ft [30 m], 7 Oct. 1939, *Puasa & Enggoh* 10623 (K, L); Ladang Fico Bilit, 16 Jan. 1985, *Sundaling* SAN 107497 (K); **TAWAU**, Kalabakan prop. V.F.R., ± 250 ft [75 m], 16 Dec. 1961, *Meijer* SAN 27921 (K, L); Bukit Gemok F. Res., 11 June 1997, *Sundaling et al.* SAN 135259 (K, L); **TENOM**, Pa'al, *Gibot* SAN 64335 (K, L); **SARAWAK**, Kelintang [Kelingkang] Range, 400 m, 14 Oct. 2001, *Hazlinah et al.* S. 86696 (L); **BINTULU**, Segan Forest Reserve, 16 Sept. 1972, *Chai* S.31703 (K, L); *ibid.*, 26 Nov. 1961, *Paie* S.15569 (K, L); Sg. Bunut, Maying, Kakus, Tatau, 500 m, 6 Oct. 1985, *Paie* S.50173 (K, L); **KAPIT**, Pelagus, 50 m, 10 July 1979, *Hock*

S.40631 (K, L); **KUCHING**, Sg. Rayu, Matang, 26 March 1988, *Munting & Jugah* S.55601 (K); Sampadi F.R. (near road), 26th mile Bau-Lundu road, 650 ft [200 m], 18 June 1968, *Paie* S.26187 (L); Kubah National Park, Sg. Rayu, 75 m, 21 Sept. 1994, *Rantai & Tinjan* S.68738 (K); **MIRI**, Gunong Mulu National Park, limestone hill opposite the National Park Bungalow, 40 m, 11 Oct. 1976, *Martin* S.38200 (L); Sarawam, Gunong Api, 200 m, 16 Feb. 1966, *Chew* 1139 (L); Lambir National Park, Ashton's Ecological Plot 1, 21 June 1983, *Hock* S.46435 (L); Batu Kalulong, near Gunong Pelamau, Ulu Sg. Tutoh, 610 m, 13 April 1997, *Julaihi et al.* S.76946 (K, L); Ulu Sg. Lubang, Ulu Tinjar, Baram, 320 m, 4 March 1997, *Lai et al.* S. 75301 (K, L); Bakam, Sg. Jangkang, Lambir National Park, 100 m, 26 Oct. 1983, *Mohtar et al.* S.47160 (K, L); *ibid.*, 29 Oct. 1983, *Mohtar et al.* S.47197 (K, L); Ulu Sg. Sekiwa, Btg. Tinjam, Baram, 30 Aug. 1974, *Tong* S.34959 (L); **SAMARAHAN**, G. Buri, 18 March 1982, *Yü* S.44186 (K, L).

**HABITAT.** Borneo lowland forests; extending to montane rain forests; alt. 0 – 1500 m.

**CONSERVATION STATUS.** Least Concern (LC). *Ziziphus angustifolia* is widely distributed from southern Thailand to the Solomon Islands. It is commonly collected in lowland mixed dipterocarp forests throughout western Malesia and in the forests of New Guinea and Solomon Islands.

**PHENOLOGY.** Collected in flower June – Nov.; collected in fruit Jan. – Dec.

**VERNACULAR NAMES.** *Ensarai* (Iban, *vide* Coode *et al.* 7052); *Kayu buluh/Kayu labu* (Kedayan, *vide* Church *et al.* 14 & *Puasa* 7201); *Merjawai* (Iban, *vide* Coode

*et al.* 6318); *Mertama* (Iban, *vide* Mohtar *et al.* S.47160 & S.47197, *Haslinah et al.* S.86696); *Otoi Paseng* (Punan, *vide* Coode *et al.* 7052); *Pasil-pasil* (Bajau Labuk, *vide* Apostol 7678); *Sireh-sireh/Sirih-sirih* (Iban, *vide* Hock S.46435, *Munting & Jungah* S.55601, *Lai et al.* S.75301, *Tong* S.34959, *Julaihi et al.* S.76946); *Tanpahelaue* (Merap, Persoon & Osseweijer 2008).

**USES.** Fruits edible (*vide* Apostol 7678, Coode *et al.* 6318 and Sundaling SAN 107497).

**NOTES.** In Borneo, *Ziziphus angustifolia* is most like *Z. ridleyana*, the only other known tree species of the genus to occur on the island. Both are unarmed and their leaves have a similar oblong-elliptic to oblong-lanceolate shape that can exceed 20 cm in length. Their venation pattern is similar with three strong main veins converging at the leaf base and apex and a distinct intramarginal vein running along the leaf margin; transverse veins between the main veins are raised and usually well-spaced, by at least 3 mm; reticulations are clearly visible between the transverse veins. Both species also have axillary, subsessile fascicle-like cymes with flowers that can have 3 style arms or more (all other *Ziziphus* species from Borneo with flowers available for study have 2 style arms). *Ziziphus angustifolia* differs from *Z. ridleyana* in the subglabrous branchlet and abaxial leaf surfaces (vs densely covered in reddish-brown hairs) and in the smaller flowers (calyx lobes only 2 mm long in *Z. angustifolia* vs c. 4 mm in *Z. ridleyana*). The only other Borneo *Ziziphus* species with axillary, subsessile fascicle-like cymes and fruits are *Z. borneensis* and *Z. cumingiana* which, apart from being spiny climbers, both differ strongly from *Z. angustifolia* in leaf and fruit size and shape.

Miquel (1861) lists Priaman and Lubu-alang as localities in the protologue for *Solenostigma angustifolium* and van Steenis (1960) cites HB 758 (Lubu-alang) [L 0931291] and HB 2501 (Priaman) [L 0013794], both held at L, as syntypes. The specimens are sterile but HB 2501 is less fragmented and selected as the lectotype here. *Celtis grewioides* (basonym of *Ziziphus grewioides*), *Z. inermis* and *Z. forbesii* are all listed as synonyms of *Z. angustifolia* by van Steenis (*loc. cit.*). This view is accepted here and each is lectotypified: Warburg (1891) cited material from Hatzfeldthafen and the sheet held at Berlin, where Warburg worked in 1891, is selected as the lectotype for *Celtis grewioides*; the NY sheet of *Ahern's collector* Forestry Bureau No 3075, cited as the type of *Ziziphus inermis* by Merrill (1905), is selected as the lectotype rather than the US one because Merrill worked in NY; sheets of *Forbes* 910, the only collection mentioned by Baker (1923), are available in several institutions and the BM material is selected as the lectotype because it was the most likely to have been examined by Baker.

**2. *Ziziphus borneensis* Merr.** (Merrill 1929: 178). Type: Malaysia, Sabah, Sandakan, Oct. – Dec. 1921, *Elmer* 20149 (lectotype, selected here: UC [UC 228986]; isolectotypes: BR [5289356], CAS [0005256], CM [1372], GH [00051547, 00051548], HBG [HBG-510064], K [K000723023], L [L 0551682], M [M-0211798], P [P06790404], PH [PH00029952, PH00029953], SING [SING 0059176], U [U 1541200]).

*Woody climber* to at least 20 m long; girth to at least 6 cm in diam., spiny. *Branchlets* terete, with longitudinal striations and visible lenticels when surface not hidden by indumentum, sparsely to densely hairy on young parts and distal portions, becoming sparsely hairy to glabrous when mature, hairs variable, usually c. 0.5 mm long, often > 1 mm long, straight to curved, spreading to appressed, reddish. *Stipules* paired on very young shoots, one becoming a persistent recurved spine, (2 –) 3 (– 5) mm long, the other short-lived, entire, ovate, c. 4 × 2 mm, hairs dense. *Leaves* discolorous, drying greenish-brown, blade slightly asymmetric, narrow ovate (– elliptic-oblong), (3.6 –) 7 (– 15.0) × (1.4 –) 3 (– 5.3) cm, chartaceous to subcoriaceous, apex (acute –) attenuate (– acuminate), base (obtuse –) rounded (– subcordate), often weakly oblique, margins entire (– finely serrate), with minute callosities that dry much darker than the lamina, > 150 on either side, often protruding and c. 0.1 mm long, margin slightly thickened, hairs usually present along margin; primary veins 3, impressed adaxially, raised abaxially, hairs along primary veins dense on either side of lamina, c. 0.4 mm long, mostly antrorse, reddish; strong marginal veins coming off the outside of the two outer main veins c. 8 on either side (except > 15 in var. *ranggam*), ascending and ending in a distinct intramarginal vein running along the leaf margin (except indistinct in var. *kinabalui* and var. *velutina*), angle of divergence with outer main veins c. 45°; transverse veins between the main veins conspicuous, coming off midrib at c. 90°, raised, spaced by c. 1 mm from each other, usually unbranched, straight (scalariform); higher order reticulations between transverse veins usually barely discernible (except reticulate abaxially, with the longitudinal venules between the transverse veins that join the main veins conspicuous and raised in var. *ranggam*); lamina subglabrous to densely hairy, always at least hairy along main and transverse veins, soft to touch when densely hairy, hairs c. 1 mm long, spreading to curved-antrorse, reddish; no domatia visible; petiole slightly dorsiventrally flattened, (2 –) 4 (– 6) mm long, hairs dense, indumentum extending to widened base of main veins adaxially. *Inflorescence* of axillary, subsessile fascicle-like cymes, 2 – 8 (– 10) flowers in each cyme; peduncles rudimentary, rarely developed to 4 mm long; pedicels to 4 mm long, hairs dense, reddish, c. 0.5 mm long, mostly spreading to patent; bracteoles entire, narrowly triangular, c. 2 mm long,

hairy. *Flower* hypanthium densely hairy on the outer surface, hairs c. 1 mm long, appressed-antrorse, reddish; sepals triangular, 1.5–3 mm long, greenish when fresh, glabrous and keeled adaxially; petals clawed, c. 2.5 mm long, obcordate, white when fresh; stamen filaments flat, subulate, c. 2 mm long, pale yellow-green when fresh, anthers c. 0.5 mm long, enclosed by petals; nectary disk

pentagonal, weakly 10-pitted, glabrous, style arms 2, free for c. 1 mm long, strongly diverging, glabrous; ovary partially immersed, hairs dense. *Fruit* a drupe, ripening greenish-yellow to red, c. 2.2 × 1.5 cm, ellipsoid, surface wrinkly when dry, covered in minute reddish hairs < 0.1 mm long; fruiting pedicels curved, c. 5 mm long, hypanthium remains caving in at base of fruit.

### Key to varieties of *Ziziphus borneensis*

1. Leaves long, to 15 cm; strong marginal veins coming off the outside of the two outer main veins > 15 on either side; venation reticulate abaxially, with the longitudinal venules between the transverse veins that join the main veins conspicuous and raised; intramarginal vein running along the leaf margin very distinct . . . . . **2c. *Z. borneensis* var. ranggam var. nov.**
  - Leaves shorter, < 11.5 cm; strong marginal veins coming off the outside of the two outer main veins c. 8 on either side; venation not clearly reticulate, transverse veins that join the main veins much stronger than the longitudinal venules between them; intramarginal vein running along the leaf margin indistinct or distinct . . . . . 2
2. Leaves to > 10 cm long; callosities protruding off a margin that is usually entire in outline; intramarginal vein running along the leaf margin distinct. Branchlet hairs sparse to dense on young parts and distal portions, variable, usually c. 0.5 mm long and appressed to spreading . . . . . **2a. *Z. borneensis* var. borneensis**
  - Leaves < 7.5 cm long; callosities protruding off a margin that is finely serrate in outline; intramarginal vein running along the leaf margin indistinct. Branchlet hairs dense on young parts and distal portions, longer, c. 1 mm long and mostly ± spreading . . . . . 3
3. Leaf lamina subglabrous abaxially except along larger veins, marginal veins and transverse veins between the main veins; serrations clearly visible all along leaf margin . . . . . **2b. *Z. borneensis* var. kinabalu**
  - Leaf lamina densely hairy abaxially on its entire surface; leaf margin serrations clearly visible near leaf apex only . . . . . **2d. *Z. borneensis* var. velutina var. nov.**

### 2a. *Ziziphus borneensis* Merr. var. *borneensis*

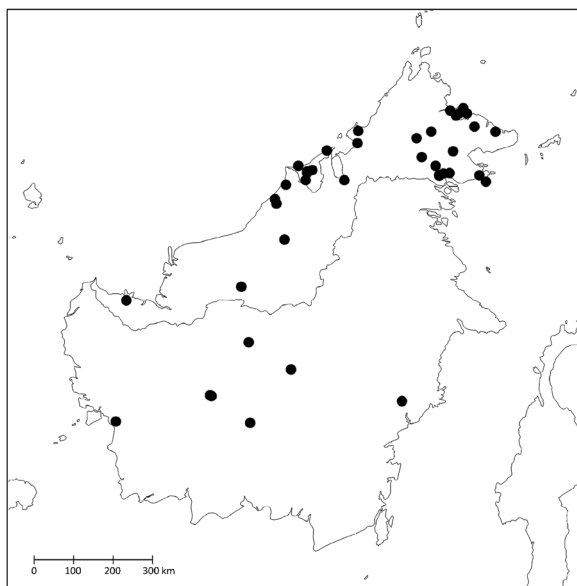
*Branchlets* sparsely to densely hairy on young parts and distal portions, hairs variable, usually c. 0.5 mm long, spreading to appressed. *Leaves* narrow ovate (– elliptic-oblong), (3.6 –) 7 (– 11.4) × (1.4 –) 3 (– 4.9) cm; callosities protruding off a margin that is usually entire in outline; strong marginal veins coming off the outside of the two outer main veins c. 8 on either side, ascending and ending in a distinct intramarginal vein running along the leaf margin. Higher order reticulations between transverse veins barely discernible; lamina densely hairy abaxially on its entire surface. Fig. 1A – E.

**DISTRIBUTION.** Borneo (Brunei, Kalimantan, Sabah, Sarawak), Endemic. Map 2.

**ADDITIONAL SPECIMENS EXAMINED. BRUNEI. BELAIT:** Bukit Teraja, path above Rest-house, 4°18'N 114°26'E, 310 m, 4 Dec. 1991, *Coode et al.* 6900 (K, L); Bukit Sawat, Merangking Buau, 4°32'N 114°35'E, 40 m, *Coode et al.* 7688 (K); along edges of unsurfaced road, 20 km S along Labi, open road from Sungai Liang, on logging track, 4°28'N 114°28'E, 90 m, 26 Sept. 1994, *Davis et al.* 453 (K); Labi Hill Forest Reserve. Compartment 8, next to Sungei Peti, along

Labi Road, 4°30'N 114°28'E, 40 m, 13 Oct. 1989, *Forman & Blewett* 862 (K, L); **BRUNEI-MUARA:** Berakas F.R., 50 ft [15 m], *Ashton* S.7817 (K, L); **TUTONG:** Telisai, Bukit Basong along old logging road, 11 Sept. 1996, *Kalat et al.* BRUN 17809 (K); Ladan Hills Forest Reserve, 125 m, 30 March 1991, *Sands et al.* 5717 (K, L); **INDONESIA. BORNEO: CENTRAL KALIMANTAN, P.T.** Pamenang logging concession rd. c. Km 20, 0°02'S 114°06'E, 23 June 1990, *Sidiyasa* PBU609 (L); KTC Trumbang Sah Km 96 Katingan R., 1°15'S 113°10'E, 100 m, 4 Feb. 1983, *Wiradinata* 3539 (K); **EAST KALIMANTAN, P.T. ITCI,** Permanent plot 72-8, 50 m, 2 March 1995, *Kessler et al.* 775 (K, L); **WEST KALIMANTAN,** Sintang. Bukit Baka National Park. Panjung butung, 250 m N of camp down Sungai Ella, along bank and near environs, 0°38'S 112°17'E, 315 m, *Church et al.* 127 (K, L); *ibid.*, E of camp along bank of Sungai Ella and environs, 0°37'S 112°15'E, 290 m, *Church et al.* 544 (E, L); Amai Ambit, 1893 – 1894, *Hallier* 3209 (L); Ketapang, Gunung Palung National Park, Cabang Panti Research Site, Trail UB2w20, 1°13'S 110°06'E, 50 m, 25 Oct. 1996, *Laman et al.* 142 (E, K, L); **MALAYSIA. SABAH:** Mount Kinabalu, 16 March 1932, *Clemens & Clemens* 30376 (K); E Coast, s.d., *Creagh* s.n. (K); Brar Manit, 25 ft [5 m], 12





**Map 2.** Distribution of *Ziziphus borneensis* var. *borneensis* (●).

Nov. 1931, *Maidi* 1534 (K); N Borneo, s.d., *Wood* 1961 (K), **BEAUFORT**, Klias, 27 July 1976, *Bidin* SAN 80728 (K, L); Weston, Sunggau Hill, 20 Feb. 1973, *Jumatim* 77406 (K, L); **BELURAN**, Sungai Tahid, 18 Jan. 1985, *Amin et al.* SAN 67312 (K, L); Sungai Monduring, 28 Oct. 1985, *Amin & Donggop* SAN 113622 (K, L); **KALABAKAN**, Block 8 Sabah Foundation unlogged area Seranum, 14 Sept. 1983, *Krispinus & Suali* SAN 101212 (K, L); Benaword logged areas last 2 years, 18 April 1980, *Krispinus & Jimpin* SAN 91809 (K, L); Mile 12 Luasong Road, NBT logged area, 23 Sept. 1980, *Krispinus & Jimpin* SAN 91877 (K, L); Km 28 NBT logged area Kuasong, 22 Aug. 1983, *Suali & Pikkoh* SAN 96499 (K, L); **KINABATANGAN**, Keruak, 19 Feb. 1985, *Amin & Maidil* SAN 108127 (K); **LAHAD DATU**, Palum Tambun, c. 150 m, 10 March 1987, *Argent et al.* 451987 (E); Danum valley and environs, May 1989, *Ridsdale et al.* CEROL 18 (K, L); Sg. Urik Ulu Tabin, 750 m, 15 Jan. 1990, *Sundaling* SAN 129538 (E, K); **SANDAKAN**, Myburgh Province, Sandakan, Oct. – Dec. 1921, *Elmer* 20361 (K, L, P, U); Bettokan near Sandakan, 5 Aug. 1927, *Kloss* SFN 19064 (K); Mile 8, top of hill, 13 Jan. 1934, *Radin* 4191 (K); Sandakan and vicinity, Sept. – Dec. 1920, *Ramos* 1462 (K, L); Along Jalan Batu 6, Cpt 13, Circle path, Sepilok F.R., ± 30 ft [10 m], 29 March 1965, *Sam* SAN 49929 (K, L); Sg. Mannil, 30 ft [10 m], 17 Feb. 1963, *Elleh* SAN 34357 (K, L); Tangkulap F.R., 9 Dec. 1985, *Gambukas et al.* SAN 108026 (K, L); **SEMPORNA**, Mt Pock F.R., 360 ft (100 m), 28 Nov. 1965, *Gansau* SAN 54499 (K); **TAWAU**, E of M. 15, Apas Rd., 80 ft [25 m], 4 Feb. 1964, *Gibot* SAN 40901 (K, L); Mile 12, Hap Seng road, 28 March 1979, *Krispinus* SAN 89801 (K, L); Umas umas, 14 Sept. 1934, *Orolfo* 4153 (K); **TONGOD**,

Labuk Sugut, Sungai Tongod, 20 Sept. 1984, *Amin et al.* SAN 67632 (K, L); **SARAWAK: KAPIT**, N Tiemai, Ulu Mujong, Balleh, c. 250 m, 20 March 1964, *Ashton* S.12143 (K); Batu Laga Plateau, Ulu Sungei Benalui, Batang Balui, 960 m, 19 March 1989, *Yii* S.56905 (K); *ibid.*, 20 March 1989, *Yii* S.56911 (K); **KUCHING**, 8 km near Kuching, 19 Sept. 1892, *Haviland* 1765 (K); **LIMBANG**, Sg. Sipayan, Bkt. Pagon, 540 m, 3 Aug. 1984, *Awa & Lee* S.47643 (K, L); **MIRI**, Foot of Lambir Hills, Lambir Hills N.P., 20th mile, 1400 m, 9 Nov. 1976, *Paie* S.38463 (K, L); Niah F.R., 16 Sept. 1982, *Paie & Dami* S.43778 (K, L); Kuala Sungai Sekaloh, Niah National Park, c. 50 ft [15 m], 3 April 1979, *Yii* S.40106, (K, L).

**HABITAT.** Borneo lowland and montane rain forests; alt. 0 – 1400 m.

**CONSERVATION STATUS.** Least Concern (LC). Although this taxon is endemic and likely declining given the widespread destruction of rainforests in Borneo (Gaveau *et al.* 2014), it was collected in, or very close to, several protected areas, and its EOO is greater than 450,000 km<sup>2</sup>. With *Ziziphus angustifolia*, it is the most collected taxon of *Ziziphus* in Borneo and is known to have been collected in the following protected areas: Labi Hills (Bukit Teraja) Forest Reserve (IUCN Category Ia), Labi Hills (Luagan Lalak) Forest Reserve (IUCN Category V), Ulu Temburong National Park (IUCN Category II) in Brunei; Bukit Baka - Bukit Raya National Park (IUCN Category II) and Gunung Palung National Park (IUCN Category II) in Kalimantan; Kabili Sepilok Virgin Jungle Reserve (IUCN Category not reported), Mount Pock Protection Forest Reserve (IUCN Category Ia), Siaungau Virgin Jungle Reserve (IUCN Category Ia) in Sabah; Lambir Hills National Park (IUCN Category II) and Niah National Park (IUCN Category II) in Sarawak.

**PHENOLOGY.** Collected in flower in June and Aug. – Oct.; collected in fruit Aug. – May.

**VERNACULAR NAMES.** *Kangam Sopuan/Sapuan* (Akar *fide Maidi* 1534 & *Elleh* SAN 34357).

**USES.** Fruits edible, sweet (*fide Church et al.* 544).

**NOTES.** *Ziziphus borneensis*, including all four varieties, is recognised in its cymes being few-flowered, subsessile and fascicle-like (Fig. 1A) and its fruits being hairy and ellipsoid, c. 2.2 × 1.5 cm. *Ziziphus borneensis* var. *borneensis* is most like *Z. borneensis* var. *velutina* in the branchlets, leaves and flowers most often having a dense reddish indumentum (Fig. 1E) and with the abaxial leaf surface being soft to the touch on account of the dense, soft hairs (Fig. 1D) but differs in the distinct intramarginal vein running along the leaf margin (vs indistinct) (Fig. 1B), the outline of the margin, which is entire (vs serrate near the apex) (Fig. 1C), and the hairs on

the young parts and distal portions of branchlets usually c. 0.5 mm long and appressed to spreading (vs c. 1 mm long and mostly  $\pm$  spreading) (Fig. 1E). When compared with other species, this variety is most like *Z. kunstleri* and *Z. puberula* in having hairy, ellipsoid fruits > 2 cm long but differs from both in the sessile fascicle-like cymes and fruits. Vegetatively, it differs from *Z. kunstleri* in the transverse veins that join the main veins usually unbranched and closely spaced, by c. 1 mm from each other and the higher order reticulations between the transverse scalariform veins that join the main veins are barely visible (vs transverse veins usually branched, spaced by c. 5 mm and with conspicuous, raised longitudinal venules between them) (Fig. 1D). It differs from *Z. puberula* in the conspicuous indumentum of dense hairs > 0.5 mm long on branchlets, leaves and flowers (vs minute, scarcely visible to the naked eye in *Z. puberula*). It differs from both *Z. kunstleri* and *Z. puberula* in the c. 8 strong marginal veins on either side rarely forming clear loops with each other but all reaching a usually well-defined intramarginal vein running along the leaf margin (vs > 10 strong marginal veins on either side in *Z. puberula* and > 20 in *Z. kunstleri*, consistently forming clear loops with each other and not joining a well-defined intramarginal vein (Fig. 1A & B). The strong marginal veins in *Z. borneensis* var. *borneensis* are reminiscent of *Z. horsfieldii* but the axillary flowers, reddish indumentum and large ellipsoid fruit clearly distinguish the species. *Ziziphus cumingiana* var. *cumingiana* also has axillary, fascicle-like cymes but differs in the leaves being thin-chartaceous, with crenate margins, higher order reticulations and well-developed areoles, clearly visible with a hand lens, drying dark red and contrasting strongly with the lamina colour, and the fruits being smaller, c. 7  $\times$  6 mm, obovoid and glabrous.

*Elmer* 20149, indicated as the type in the protologue (Merrill 1929), is widely distributed with duplicates available in at least 12 herbaria. The specimen from UC, where Merrill worked from 1924 – 1929, and which is in flower, is selected here as the lectotype.

**2b. *Ziziphus borneensis* var. *kinabalui* Suess.** (Suessenguth 1950). Type: Malaysia, Sabah, Ranau, Tenompok, 5000 ft [1500 m], 14 March 1932, *Clemens & Clemens* 30376 (lectotype, selected here: M [M-0211795]; isolectotypes: K [sheet 2, K000723017], L [L 0013798], M [M-0211796]).

*Branchlets* densely hairy on young parts and distal portions, hairs c. 1 mm long and mostly  $\pm$

spreading. *Leaves* narrow ovate (– elliptic), (4.2 –) 5.5 (– 7.5)  $\times$  (1.8 –) 2.4 (– 3.1) cm; callosities protruding off a margin that is finely serrate in outline, serrations clearly visible all along leaf margin; strong marginal veins coming off the outside of the two outer main veins c. 8 on either side, intramarginal vein running along the leaf margin indistinct; venation not clearly reticulate, transverse veins that join the main veins much stronger than the longitudinal venules between them; lamina subglabrous abaxially except along larger veins, marginal veins and transverse veins between the main veins. Fig. 1F – K.

**DISTRIBUTION.** Borneo (Mount Kinabalu), Endemic. Map 3.

**ADDITIONAL SPECIMENS EXAMINED. MALAYSIA. SABAH: RANAU,** Tenompok, 5000 ft [1500 m], 14 March 1932, *Clemens & Clemens* 28839 (K, L).

**HABITAT.** Borneo montane rain forests; alt. c. 1500 m.

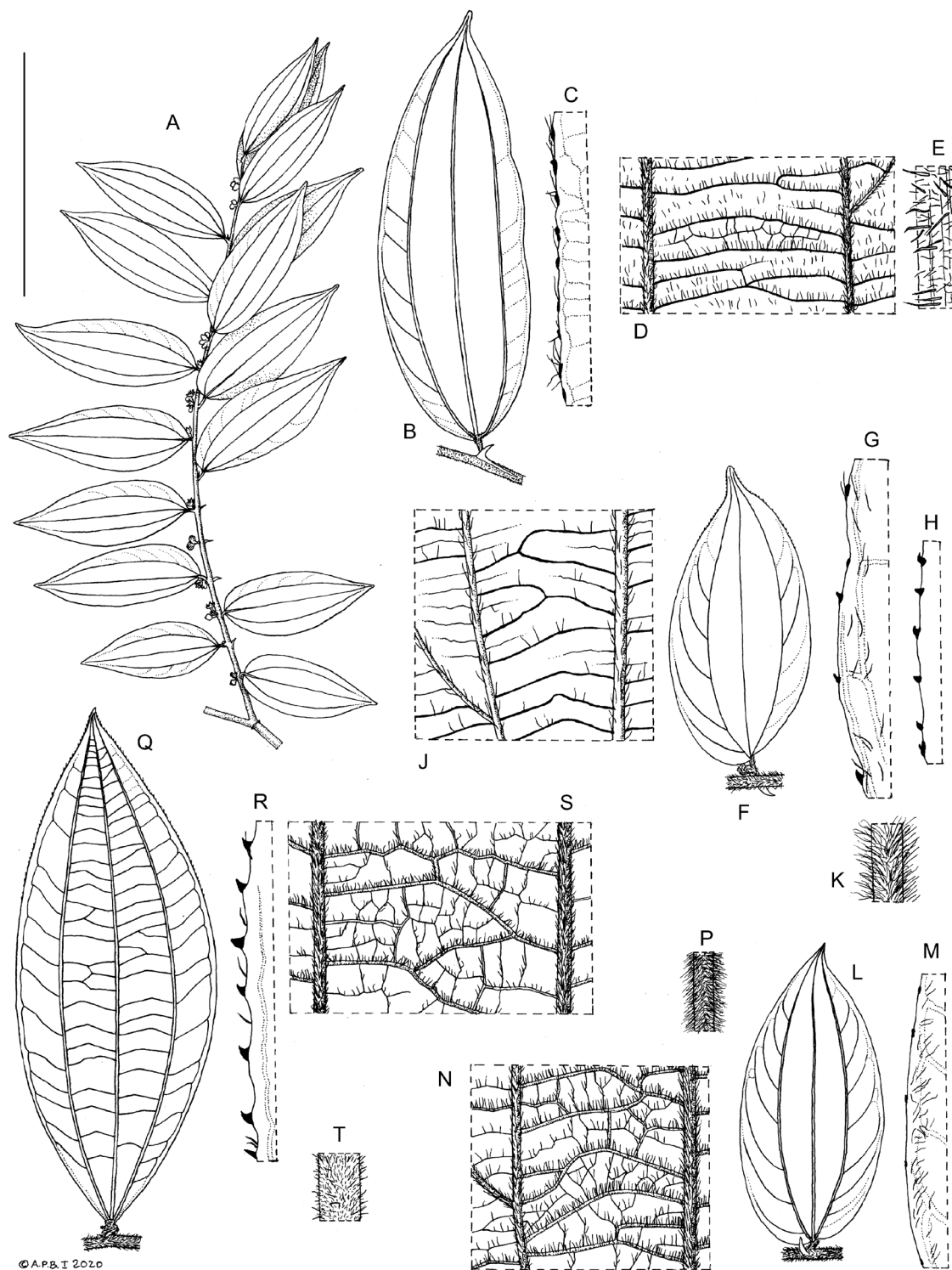
**CONSERVATION STATUS.** Data Deficient (DD). The variety is only known from a single locality. It thus meets the IUCN B1a criterion for Critically Endangered, but a decline or fluctuation of the population cannot be estimated or inferred. The specimens may have been collected within the Tenompok Protection Forest Reserve (IUCN Category Ia) or Kinabalu National Park and ASEAN Heritage Park (IUCN Category II) where forests appear well preserved in satellite images. The variety is considered here to be Data Deficient because the data are so uncertain that both LC and CR are plausible categories.

**PHENOLOGY.** Collected in flower in March.

**NOTES.** *Ziziphus borneensis* var. *kinabalui* is most like *Z. borneensis* var. *velutina* in the dense reddish indumentum on branchlets, the c. 8 strong marginal veins on either side and the indistinct intramarginal vein running along the leaf margin but differs in the lamina being subglabrous except along main and transverse veins (vs all lamina surface densely hairy) (Fig. 1J) and in the serrations clearly visible all along leaf margin (Fig. 1G & H).

A sheet of *Clemens & Clemens* 30376 from M is marked as the holotype, and while this collection is cited in the protologue (Suessenguth 1950), additional material is available at M and other herbaria. The sheet marked as the holotype is therefore designated here as the lectotype because no specific sheet was indicated in the protologue.

Two sheets of *Clemens & Clemens* 30376 are also available at K, but this is a mixed collection: only Sheet 2 (marked “Sheet II”) is of this variety of *Ziziphus borneensis*. Sheet 1 [K000723017] is a specimen of *Z. havilandii*.



**Fig. 1.** *Ziziphus borneensis*. A – E *Z. borneensis* var. *borneensis*: A habit; B leaf, abaxial view; C leaf margin, adaxial view; D leaf lamina surface, abaxial view; E detail of branchlet indumentum; F – K *Z. borneensis* var. *kinabalui*: F leaf, adaxial view; G leaf margin, mid-margin, abaxial view; H leaf margin, distal margin, abaxial view; J leaf lamina surface, abaxial view; K detail of branchlet indumentum; L – P: *Z. borneensis* var. *velutina*: L leaf, abaxial view; M leaf margin, abaxial view; N leaf lamina surface, abaxial view; P detail of branchlet indumentum; Q – T *Z. borneensis* var. *ranggam*: Q leaf, abaxial view; R leaf margin, adaxial view; S leaf lamina surface, abaxial view; T detail of branchlet indumentum. Scale bar: A = 10 cm; B, F, L, Q = 5 cm; C, G, H, M, R = 5 mm; D, J, K, N, P, S, T = 1 cm; E = 2.5 mm. A, C from Forman & Blewett 862; B, D, E from Elmer 20149; F – K from Clemens & Clemens 30376; L – P from Tikau SAN 28913; Q – T from Church *et al.* 96. DRAWN BY ANDREW BROWN.

**2c. *Ziziphus borneensis* var. *ranggam*** Cahen & Utteridge **var. nov.** Type: Indonesia, Borneo, West Kalimantan, Sintang, Bukit Baka National Park. Panjung butung, 250 m N of camp down Sungai Ella, along bank and near environs, 0°38'S 112°17'E, 315 m, Church *et al.* 96 (holotype: K [K001420126], isotypes: E [E00781015], L [L.4197610]).

<http://www.ipni.org/urn:lsid:ipni.org:names:77218841-1>

*Branchlets* densely hairy on young parts and distal portions, hairs variable, usually c. 0.5 mm long, spreading to appressed. *Leaves* narrow ovate (– elliptic-oblong), (7.2 –) 10.6 (– 15.0) × (3.0 –) 4.3 (– 5.3) cm; callosities protruding off a margin that is finely serrate in outline, serrations visible all along leaf margin but especially clearly near apex; strong marginal veins coming off the outside of the two outer main veins > 15 on either side, intramarginal vein running along the leaf margin very distinct; venation reticulate abaxially, with the longitudinal venules between the transverse veins that join the main veins conspicuous and raised; lamina densely hairy abaxially on its entire surface. Fig. 1Q – T.

**RECOGNITION.** This variety is recognised in the longer leaves, to 15 cm, with the margins distinctly finely serrate, the numerous strong marginal veins, > 15, coming off the outside of the two outer main veins, and the longitudinal venules clearly visible between the transverse veins that join the main veins.

**DISTRIBUTION.** Borneo (Kalimantan, Sarawak), endemic. Map 3.

**ADDITIONAL SPECIMENS EXAMINED. MALAYSIA. SARAWAK:** KAPIT, Bukit Salong, Ulu Sampuran, Melinau, 900 m, 26 March 1980, Paie S.41581 (K, L); MIRI, Block No. 17, Bintulu Lumber Co. area, Suai, 450 ft [150 m], 24 July 1977, Paie S.39200 (K, L).

**HABITAT.** Borneo rain forests; alt. 150 – 900 m.

**CONSERVATION STATUS.** Vulnerable (VU). The variety is only known from three collections within an EOO of c. 18,000 km<sup>2</sup> and Borneo rainforests are subjected to a decline in extent and quality. It thus meets the Blab(iii) criteria for VU. The type specimen was collected in Bukit Baka - Bukit Raya National Park (IUCN Category II).

**PHENOLOGY.** Collected in flower in Oct.; collected in fruit in March and July.

**ETYMOLOGY.** The varietal epithet is the local name indicated on the label of the type specimens (West Kalimantan, language unknown).

**VERNACULAR NAMES.** *Ranggam* (West Kalimantan, language not specified, *vide* Church *et al.* 96).

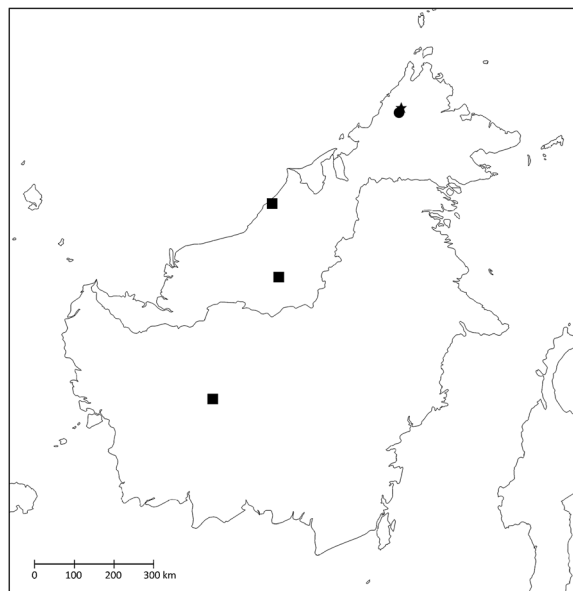
**NOTES.** The leaf venation in this variety is strikingly different from other *Ziziphus borneensis* varieties, with > 15 strong marginal veins on either side (Fig. 1R) and the reticulations of finer venules clearly visible (Fig. 1S). It is like *Z. puberula* in the marginal veins > 15 (although sometimes < 15 in *Z. puberula*) and the big, > 2 cm, ellipsoid fruit, but differs in the dense indumentum of longer hairs on the branchlets and leaves (Fig. 1S & T), reticulation of leaf veinlets clearly visible, the presence of a distinct intramarginal vein running along the leaf margin (Fig. 1Q), subsessile fascicle-like cymes and subsessile fruit.

The variety is only known from three localities each at least 200 km apart from one another. Specimens of the Sarawak collections have a more reddish indumentum, but all share the same characteristic venation pattern.

**2d. *Ziziphus borneensis* var. *velutina*** Cahen & Utteridge **var. nov.** Type: Malaysia, Sabah, Ranau, Kundasang above Sosopodon, 11 April 1962, [the date on the label is 31 April 1962, which does not exist; 11 April was inferred from other collections above Sosopodon by Tikau in 1962] Tikau SAN 28913 (holotype: K [K001420127]; isotype: L [L.2336619]).

<http://www.ipni.org/urn:lsid:ipni.org:names:77218842-1>

*Branchlets* densely hairy on young parts and distal portions, hairs c. 1 mm long and mostly ± spreading. *Leaves* narrow ovate, (4.6 –) 6.4 (– 7.5) × (1.9 –) 2.8 (– 3.5) cm; callosities protruding off a margin that is finely serrate in outline, serrations



**Map 3.** Distribution of *Ziziphus borneensis* var. *kinabalu* (●), *borneensis* var. *ranggam* (■), *borneensis* var. *velutina* (★).

clearly visible near leaf apex only; strong marginal veins coming off the outside of the two outer main veins c. 8 on either side, intramarginal vein running along the leaf margin indistinct; venation not clearly reticulate, transverse veins that join the main veins much stronger than the longitudinal venules between them; lamina densely hairy abaxially on its entire surface. Fig. 1L – P.

**RECOGNITION.** This variety is most like *Ziziphus borneensis* var. *kinabalu* in the densely hairy branchlets with c. 1 mm long hairs that are mostly  $\pm$  spreading and in the absence of a clearly visible intramarginal vein but differs in the abaxial lamina surface being entirely hairy (vs along major veins and transverse veins between the main veins only) and the leaf margin serrations clearly visible near the leaf apex only (vs clearly visible all along the leaf margin).

**DISTRIBUTION.** Borneo (Mount Kinabalu), Endemic. Map 3.

**ADDITIONAL SPECIMENS EXAMINED. MALAYSIA. SABAH: RANAU,** Kinabalu near Kundasang, Sopodon, c. 4350 ft [1300 m], 11 July 1963, *Madani* SAN 36786 (K, L).

**HABITAT.** Borneo montane rain forests; alt. c. 1300 m.

**CONSERVATION STATUS.** Data Deficient (DD). The variety is only known from the Kundasang-Sosopodon area near Mount Kinabalu. It thus meets the IUCN B1a criterion for Critically Endangered, but a decline or fluctuation of the population cannot be estimated or inferred. The specimens may have been collected within the Sosopodon Forest Reserve (IUCN Category Ia) where despite some fragmentation, forests seem well preserved overall in satellite images. The variety is considered here to be Data Deficient because the data is so uncertain that both LC and CR are plausible categories.

**PHENOLOGY.** Collected in fruit in April and July.

**ETYMOLOGY.** The varietal epithet derives from the Italian *velluto*, velvet, itself derived from the Latin *villus*, hair, and refers to the dense indumentum of hairs on the abaxial surface of leaves making them soft to touch.

**VERNACULAR NAMES.** *Kangom sapuon* (Ranau *vide Tikau* SAN 28913).

**NOTES.** This variety differs from the other *Ziziphus borneensis* varieties in the combination of branchlets having dense, long, reddish, mostly spreading hairs, c. 1 mm long (Fig. 1P), strong marginal veins coming off outer main veins c. 8 on either side (Fig. 1L) and the abaxial lamina surface being completely covered in hairs (Fig. 1N).

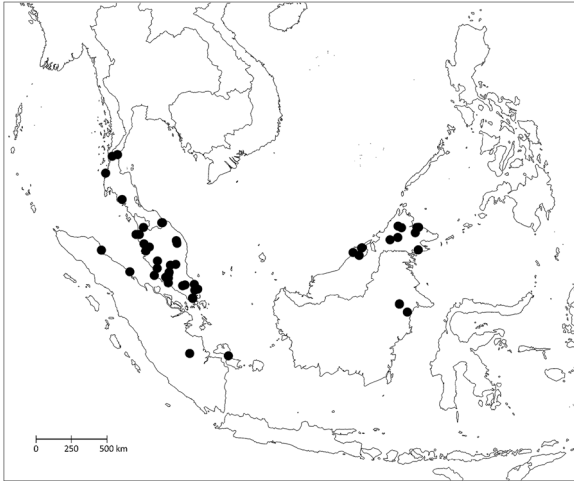
**3. *Ziziphus calophylla* Wall.** (Wallich in Roxburgh 1824: 366). *Berchemia calophylla* (Wall.) G. Don (1832: 28). Type: Malaysia, Penang, *Porter* EICH 4230 (lectotype, selected here: K-W [K001038440]; isolectotypes: K-W [K001038441], K [2 barcodes on same sheet: K000723029, K000723030], M [M-0211794]).

*Ziziphus ornata* Miq. (Miquel 1856: 642) **synon. nov.**

Type: Indonesia, Bangka Island, 1802 – 1818, *Horsfield* s.n. (lectotype, selected here: K [K001420128]).

*Ziziphus horsfieldii* sensu Beaman & Anderson (2004: 276), pro parte, non Miq.

*Woody climber* to at least 25 m long; girth to at least 20 cm in diam., spiny. *Branchlets* terete, with conspicuous longitudinal striations, lenticels raised, densely hairy on young parts and distal portions, becoming sparsely hairy to glabrous when mature, hairs < 0.1 mm long, reddish. *Stipules* paired, one becoming a recurved spine, c. 4 mm long, the other one fugaceous, persistent on some flowering branchlets, entire, wide ovate, c. 3 × 2 mm, hairs dense, spines on distal branchlets often closely spaced, by c. 1 cm. *Leaves* weakly discoloured, drying greenish-brown, blade  $\pm$  symmetric, (narrow ovate –) elliptic (– narrow elliptic), (5.3 –) 11 (– 15) × (1.9 –) 4.5 (– 6) cm, subcoriaceous, apex attenuate to acuminate, base wide cuneate to rounded, usually symmetric, margins subentire to finely denticulate, > 100 serrations on either side, each serration topped by a protruding callosity that dries darker than the lamina, c. 0.1 mm long; primary veins 3, impressed adaxially, raised abaxially, hairs sparse to dense along primary veins on either side of lamina, hairs c. 0.2 mm long; strong marginal veins coming off the outside of the two outer main veins usually absent (only 3 main veins conspicuous), sometimes visible, > 20, faint intramarginal vein running along the leaf margin present; transverse veins between the main veins weak but discernible, coming off midrib at c. 90°, barely raised (not readily felt by touch), tightly spaced, usually < 1 mm from each other,  $\pm$  straight; higher order reticulations and areoles well-developed, visible with a hand lens; lamina subglabrous, with no to very few glands, mostly visible abaxially, drying darker than rest of lamina surface, slightly pitted,  $\pm$  0.1 mm in diam.; tufts of hairs rarely present in the axils at the base of the 3 main veins; petiole slightly dorsiventrally flattened, 5 – 11 mm long, hairs sparse to dense. *Inflorescence* of axillary pedunculate cymes, usually arranged in a panicle, c. 16 flowers in each cyme, cymes consisting of loose dichasia visibly branching 2 – 3 times; peduncles dorsiventrally flattened (0.2 –) 1.2 (– 2.0) cm long, hairs abundant to dense, appressed to spreading, c. 0.1 mm long; pedicels (1 –) 3 (– 5) mm long, straight to curved; bracteoles entire, narrowly triangular, c. 2 mm long, hairs dense. *Flower* hypanthium densely hairy on the outer surface, c. 0.1 mm long, appressed-antrorse, reddish; sepals triangular, c. 1.5 mm long, yellowish-green when fresh, glabrous and keeled adaxially; petals clawed, c. 1.4 mm long, obcordate; stamen filaments flat, subulate, c. 1.0 mm long,



Map 4. Distribution of *Ziziphus calophylla* (●).

anthers c. 0.3 mm long, enclosed by petals; nectary disk pentagonal, 10-pitted, glabrous, slightly rugose; style arms 2, well-developed, c. 0.7 mm long, terminating in an expanded, almost flat stigmatic surface; ovary partially immersed, hairs dense. *Fruit* a drupe, ripening yellow-brown, 1.2 – 2.4 × 0.9 – 1.7 cm, (globose to ellipsoid) obovoid [wider towards apex], indumentum dense, hairs drying reddish, < 0.1 mm long; fruiting pedicels 3 – 5 × 1 mm; hypanthium remains sometimes saucer-shaped, usually caving in at base of fruit.

**DISTRIBUTION.** Brunei, Indonesia (Bangka, Kalimantan, Sumatra), Malaysia (Peninsular Malaysia, Sabah, Sarawak). Singapore, Thailand. Map 4.

**ADDITIONAL SPECIMENS EXAMINED. BRUNEI. BELAIT:** Bukit Sawat, Sungai Mau, 4.33N 114.29E [4°19'48"N 114°17'24"E], Along Sg Belait downstream from village, 20 m, 15 Oct. 1991, *Simpson & Marsh* 2006 (K, L); c. 0.5 mile above Bukit Puan, Sungai Belait, 31 Aug. 1960, *Sinclair* 10520 (E, L); **INDONESIA. EAST KALIMANTAN:** W. Koetai, no. 19, near L. Poehoes, c. 80 m, 15 Nov. 1995, *Endert* 4946 (K); East Kutai Reserve, vicinity of Sengata and Mentoko Rs, below 300 m, 8 Jan. 1978, *Leighton* 77 (L); **MALAYSIA. SABAH: KENINGAU,** Ulu Sg, Pingas pingas, 10 March 1988, *Mantor* SAN 122037 (K); **KINABATANGAN,** 0.5 mile N of Kinabatangan R. at Bukit Garam (1 mile E of Lamag), B.B.T.co. concession, 50 ft [15 m], 19 June 1954, *Wood* A 4674 (L); **NABAWAN,** Syt. Benawood, logged area, Sg. Maadun, 22 June 1987, *Jimpin* SAN 118831 (K); **RANAU,** Tompurungan, 7 Aug. 1987, *Amin & Francis* SAN 119814 (K); Kampung liposu. Kampung Napung, 7 Dec. 1994, *Sambuling* 524 (K); **SANDAKAN,** Sibuga jeep track,

200 ft [60 m], 15 May 1961, *Burgess* SAN 25151 (K); Kabili-Sepilok F.R., Elopura, 300 ft [90 m], 20 April 1939, *Enggoh* 10522 (K, L); **TAWAU,** Mile 15 1/2 Quoin Hill Road, 12 May 1962, *Gibot & Singh* SAN 30014 (K, L); **SARAWAK:** 1865 – 68, *Beccari* 1631 (K); **MIRI,** Baram. Mata Kuching, S of Dulit Range, Ulu Tinjar, c. 1500 ft [450 m], 11 Aug. 1974, *Chai* S.34788 (K, L); Marudi. Pulong Tau National Park (Western part). Ulu Sungai Baong, 3°39'56"N 115°16'40"E, 9 May 2007, *Julia et al.* S.98021 (K); *ibid.*, 971 m, 15 May 2007, *Eryani et al.* S.98444 (K); **SRI AMAN,** Lubok Antu Distr., 112°10'N 1°20'E, 15 m, R. Delok, secondary forest near Nanga Sumpa, 6 June 1993, *Christensen* 1446 (K).

**HABITAT.** Borneo lowland rain forests; alt. 0 – 1000 m.

**CONSERVATION STATUS.** Least Concern (LC). *Ziziphus calophylla* is widely distributed in much of western Malesia and does not appear to be threatened. In Borneo, it is likely that the taxon is declining and severely fragmented given the widespread destruction of rainforests. However, the species was collected in protected areas: Sepilok Virgin Jungle Reserve (IUCN Category not reported) in Sabah and Lambir Hills National Park (IUCN Category II) in Sarawak.

**PHENOLOGY.** Collected in flower in March – May and Oct.; collected in fruit in May, June, Aug., Nov. and Dec.

**VERNACULAR NAMES.** *Menaul Daun Besai* (Iban, *vide Christensen* 1446); *Surunit duru* (Dusun, *vide Sambuling* 524).

**USES.** Fruit edible (*vide Chai* S.34788 and *Christensen* 1446). Fibres used to frame top part of baskets (*vide Christensen* 1446); medicinally used “against Rabus (white in the mouth) probably fungal attack” (*vide Christensen* 1446); sap drinkable (*vide Christensen* 1446).

**NOTES.** *Ziziphus calophylla* is recognised by the leaves being long, usually > 10 cm, leathery, usually elliptic, ± symmetric, with only the three main veins conspicuous and a faint but distinct intramarginal vein running along the leaf margin. The species is morphologically similar to *Z. subuensis*, as noted by Merrill (1929), but differs in the abaxial leaf surface having no to few glands (vs many) and leaf shape usually elliptic and ± symmetric (vs elliptic-oblong and asymmetric). Other differences include leaves that are more coriaceous, on average longer (c. 11 cm vs 8 cm) with the leaf base wide-cuneate to rounded (vs frequently subcordate), inflorescences more branching and with more flowers (flowers c. 16 per cyme vs 8) and fruit often more ellipsoid-obovoid (vs globose-obovoid). *Ziziphus calophylla* and *Z. havilandii* could represent two ends of a spectrum in leaf size and leaf gland abundance with *Z. subuensis* covering some of the middle range.

In the protologue for *Ziziphus calophylla*, Wallich (in Roxburgh 1824) cites material “discovered on the hill of Pulo Pinang [Penang Island] by Mr.

George Porter". Four sheets collected by Porter in Penang were located, and a K-W sheet is selected as lectotype here because it is in the East India Company Herbarium (EICH) and can be considered the 'top set' upon which Wallich worked, and the sheet selected [K001038440] has fruits, whereas the the second EICH specimen [K001038440] is sterile.

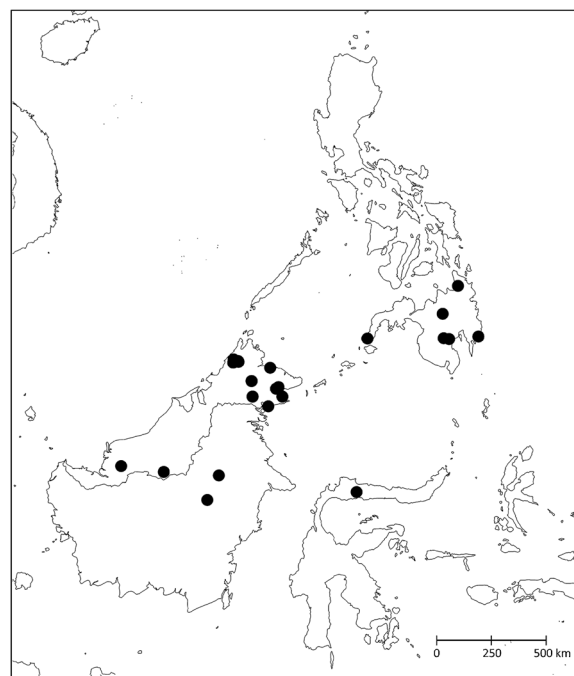
*Ziziphus ornata* Miq. is placed as a synonym here. As noted by King (1896), no apparent morphological character seems to separate it from *Z. calophylla*. In the protologue for *Z. suluensis*, Merrill (1926) noted the similarity between *Z. suluensis* and *Z. ornata* (= *Z. calophylla*), noting that "except in leaf size the characters of *Ziziphus ornata* Miq., ex descr., apply closely to the present species". In the protologue for *Z. ornata* Miquel (1856) cites material collected by Horsfield in Banka [Bangka]. A specimen identified as *Z. ornata*, possibly from Miquel's private herbarium, is available at U [U.1541152], but the collector is not specified and the collection locality (illegible) is not Bangka. However, a sheet labelled as collected in Bangka Island by Horsfield is available at K and designated as the lectotype here.

**4. *Ziziphus crebrivenosa* C.B.Rob.** (Robinson 1908: 201). Type: Philippines, Mindanao, Zamboanga, Sax River, 21 Feb. 1905, Williams 2335 (lectotype, selected here: NY [00415108]; isolotypes: K [K001420129], NY [00415109], US [00094321]).

*Ziziphus lenticellata* Merr. (Merrill 1922: 532) **synon. nov.** Type: Malaysia, Sabah, Aug. 1920, Agama 1018 (lectotype, selected here: A [00051552]).

*Woody climber* to at least 15 m long; girth to at least 5 cm in diam., spiny. *Branchlets* terete, with longitudinal striations and many conspicuous, raised lenticels, densely hairy on young parts and distal portions, more sparsely hairy when mature, hairs c. 0.1 mm long, mostly appressed-antrorse, reddish, some whitish. *Stipules* modified into spines, forming clusters at the tip of developing shoots, single or 3 per node, 2 lateral and one below point of insertion of leaf or branchlet, often some deciduous and 1 or 2 remaining, spines recurved, c. 5 mm long, hairy. *Leaves* weakly discolorous, drying greenish-brown, paler abaxially, blade symmetric, elliptic (– wide elliptic), 6.5 – 17.5 × 2.5 – 9.5 cm, chartaceous, apex acute (– acuminate), base (obtuse –) cordate, usually symmetric, margins serrate, c. 70 serrations on either side, each serration topped by a minute protruding callosity that dries darker than the lamina, c. 0.1 mm long; primary veins 3, impressed adaxially, raised abaxially, hairs sparse to abundant along primary veins on both sides of lamina, hairs c. 0.2 mm long, straight to tortuous, mostly appressed, antrorse; strong marginal veins coming off

the outside of the two outer main veins c. 25 on either side, ± equally strong, ascending and usually forming loops near the margin but no clear intramarginal vein running along the leaf margin present, angle of divergence with outer main veins wide, c. 70°; transverse veins between the main veins conspicuous, coming off midrib at c. 90°, raised (readily felt by touch), spaced by c. 4 mm from each other, ± straight, often branching; higher order reticulations discernible; lamina sparsely hairy abaxially (more densely along bigger veins), hairs c. 0.3 mm long, mostly appressed; domatia present in the axils at the base of the 3 main veins, pocket-like; petiole slightly dorsiventrally flattened, c. 4 mm long, hairs dense, indumentum extending to widened base of main veins adaxially. *Inflorescence* of axillary pedunculate cymes, < ½ as long as subtending leaves, sometimes arranged in panicles when subtending leaves caducous, c. 12 flowers in each cyme, cymes loose dichasia visibly branching at least 3 times; peduncles 0 – 15 mm long, hairs dense; bracteoles entire to deeply bifid, narrowly triangular, c. 1 mm long, hairy. *Flower* hypanthium densely hairy abaxially; sepals triangular, c. 2 mm long, glabrous and keeled adaxially; petals clawed, c. 1.5 mm long, obcordate; stamen filaments flat, subulate, c. 1 mm long, anthers brownish, c. 0.4 mm long, enclosed by petals; nectary disk, pentagonal, 10-pitted, glabrous; style c. 1 mm long, flattened, arms 2, c. 0.1 mm long, glabrous; ovary partially immersed, hairs dense. *Fruit* a drupe, ripening reddish-brown, globose to ellipsoid, to 3 cm long, surface covered in raised, blister-like lenticels; fruiting pedicels to 1.5 cm long, c.



**Map 5.** Distribution of *Ziziphus crebrivenosa* (●).

2 mm wide, covered in lenticels, hypanthium remains at base of fruit usually indistinct.

**DISTRIBUTION.** Borneo (Kalimantan, Sabah, Sarawak), Mindanao and Sulawesi. Map 5.

**ADDITIONAL SPECIMENS EXAMINED. INDONESIA. BORNEO:**

**EAST KALIMANTAN,** Berau, Mt Njapa on Kelai R., 100 m, 14 Oct. 1963, *Kostermans* 21286 (K, L); PT ACTR Camp Lebangan, km 42 from Batu Kenalung, 17 Jan. 1982, *Kramadibrata* 202 (K, L); **MALAYSIA. SABAH:** **KOTA BELUD,** Dallas [6°02'N 116°28'E], 3000 ft [900 m], 2 Dec. 1931, *Clemens & Clemens* 27375 (K); Delupid. Kampung Melangkap Tomis, 3 km dari Melangkap Tomis, 8 June 1996, *Lugas* 2310 (K); Nohutu, Kampung Melangkap Tomis, 4 km dari Melangkap Tomis, 11 July 1996, *Lugas* 2495 (K); **LAHAD DATU,** Silam [4°58'N 118°13'E], ± 200 ft [50 m], 21 Sept. 1963, *Ambullah* 36090 (K, L); Mile 3 on Kennedy Bay Timber Co.'s road, 15 miles ESE of Lahad Datu, 75 ft [20 m], 17 March 1955, *Wood* SAN 16070 (L); **RANAU,** Sungai Kolumpisahon. Kampung Nalumad, 5 batu dari kampung Nalumad, 10 m dari sungai Mokodou [6°6'N 116°40'E], 13 Sept. 1996, *Andau* 654 (K); Langan Falls c. 3.6 km NW of Poring Hot Springs, 6°4'N 116°41'E, 1200 m, 16 Aug. 1990, *Beaman* 10988 (K); **SANDAKAN,** s.l., Aug. 1918, *Castillo* 644 (K, P, US); **SEMPORNA,** Timbun Mata F.R., 15 Aug. 1938, *Agama* 9466 (K, L); **TAWAU,** Tawao [Tawau], Oct. 1922 – March 1923, *Elmer* 20880 (K, L, P, U); *ibid.*, *Elmer* 21813 (L, U); Hap Seng logging area, Sri Usukan, ± 400 ft [100 m], 13 Sept. 1978, *Madani & Krispinus* SAN 88461 (K, L); **TONGOD,** Lamag, Sungai Korong, Karamuak, 500 ft [150 m], 5 Sept. 1973, *Madani* SAN 76313 (K); Ulu Sg Malung, Keramuak, 100 m, 15 June 1983, *Sundaling* SAN 97021 (K, L). **SARAWAK: KAPIT,** Naanga Sringin, Ulu Sungai Entuloh, Baleh, 18 Sept. 1989, *Othman et al.* S.57735 (K, L); **SARIKEI,** Ulu Mayeng, Kakus, c. 200 m, 14 July 1964, *Luang* S.21735 (K, L).

**HABITAT.** Borneo lowland and montane rain forests; alt. 0 – 1200 m.

**CONSERVATION STATUS.** Near Threatened (NT). It is likely that the taxon is declining and severely fragmented given the widespread destruction of rainforests in Borneo (Gaveau *et al.* 2014), Mindanao (Viloria *et al.* 2005) and Sulawesi (Cannon *et al.* 2007). However, the taxon is distributed with an EOO greater than 200,000 km<sup>2</sup>. Also, the species occurs in montane forests possibly less exposed to heavy exploitation. Some specimens were collected in the following protected areas: Kinabalu National Park and ASEAN Heritage Park (IUCN Category II) in Borneo, Mount

Apo Natural Park (IUCN Category II) and Cabadbaran Watershed Forest Reserve (IUCN Category VI) in Mindanao.

**PHENOLOGY.** Collected in flower Feb. – April; collected in fruit in March (*Wood* 16070) but mostly June – Oct.

**VERNACULAR NAMES.** *Akar Menaul* (Iban, *fide Luang* 21735); *Aurinip* (Kedayan, *fide Agama* 9466); *Batang berduri* (not specified, *fide Kramadibrata* 202); *Kuku alang* (Banjar, *fide Agama* 9466); *Kuku menayul* (not specified, *fide Othman et al.* 57735).

**USES.** Fruits edible (*fide Madani* SAN 76313 and *Othman et al.* S.57735).

**NOTES.** *Ziziphus crebrivenosa* is recognised in being the only species with numerous blister-like raised lenticels on its long, to 3 cm, often ellipsoid fruits. It is most like *Z. kunstleri* in having leaves at least 10 cm long with clearly raised transverse veins that join the main veins on the abaxial surface and in having mature fruits to at least 2 cm in length. However, finer vein reticulations are not clearly raised in *Z. crebrivenosa* and transverse veins tend to join the main veins without branching (vs reticulations raised and transverse veins tending to branch in *Z. kunstleri*). In addition, branchlets of *Z. crebrivenosa* have raised lenticels whereas those of *Z. kunstleri* are superficial and tend to be concealed on the younger parts by the dense reddish indumentum.

*Williams* 2335 is designated as the type in the protologue for *Ziziphus crebrivenosa* (Robinson 1908) and a sheet of this material from NY where Robinson worked from 1903 to 1908 is selected here as the lectotype.

Merrill (1922) highlighted the “ellipsoid, not globose, entirely glabrous, conspicuously lenticellate fruits” in his protologue of *Ziziphus lenticellata* but compared vegetative characters of this species to those of *Z. horsfieldii*. He did not consider *Z. crebrivenosa* in this publication despite listing it in his *An Enumeration of Philippine Plants* the following year (Merrill 1923). No morphological character seems to separate *Z. lenticellata* from *Z. crebrivenosa* and it is placed as a synonym here. Merrill (1922) mentions *Castillo* 644 and *Agama* 1018 in the protologue for *Z. lenticellata* and the sheet of *Agama* 1018 from A is selected as the lectotype because it is in flower unlike those of *Castillo* 644 and may have been examined by Merrill.

**5. *Ziziphus cumingiana* Merr. var. *cumingiana*** (Merrill 1906: 206). Type: Philippines, Luzon, Laguna, Calawang [Calauan], 1836 – 1840, *Cuming* 453 (lectotype, selected here: L [L0550597]; isolectotypes: L [L0550985, L0551582], MEL [MEL 2441734]).



*Ziziphus buhusanensis* Elmer ex Merr. (Merrill 1923: 522), nom. inval. pro syn.

*Ziziphus borneensis* sensu Beaman & Anderson (2004: 275), pro parte, non Merr.

*Ziziphus havilandii* sensu Beaman & Anderson (2004: 276), pro parte, non Ridl.

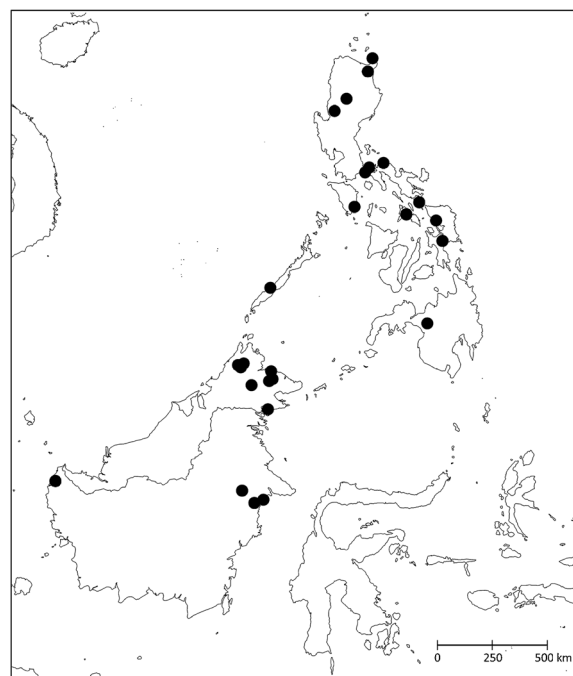
*Ziziphus horsfieldii* sensu Beaman & Anderson (2004: 276), pro parte, non Miq.

*Woody climber*, to at least 20 m long, girth not recorded, spiny. *Branchlets* terete, with longitudinal striations and visible lenticels, sparsely to densely hairy on young parts and distal portions, becoming sparsely hairy to glabrous when mature, hairs c. 0.2 mm long, mostly appressed-antrorse, reddish. *Stipules* modified into spines, single, recurved, c. 3 mm long on distal branchlets, often hairy. *Leaves* weakly discolorous, drying greenish-brown, paler abaxially, blade asymmetric, ovate to narrow ovate (– narrow elliptic), 3.0 – 10.0 × 1.8 – 4.0 cm, thin-chartaceous, apex attenuate to acuminate, base (cuneate –) rounded (– cordate), usually clearly oblique, margins crenate, crenations weak but distinct, spaced by c. 3 mm at middle of margin, c. 25 on either side, each serration topped by a tuft of hairs along with a protruding callosity that dries darker than the lamina, c. 0.1 mm long; primary veins 3, (lowest marginal veins are strong, making it sometimes appear like there are 4 or 5 primary veins), impressed adaxially, raised abaxially, hairs sparse to abundant along primary veins on either side of lamina, often more densely adaxially, hairs c. 0.2 mm long; strong marginal veins coming off the outside of the two outer main veins c. 5 on either side, ascending and gradually diminishing, not forming conspicuous loops near margin, no clear intramarginal vein running along the leaf margin present, angle of divergence with outer main veins c. 35°; transverse veins between the main veins distinct, coming off midrib at c. 90°, barely raised (not readily felt by touch), spaced by c. 1 mm from each other, ± straight; higher order reticulations and areoles well-developed, clearly visible with a hand lens, drying dark red and contrasting strongly with the lamina colour; lamina sparsely hairy; domatia often present in the axils at the base of the 3 main veins and at the junction between the marginal veins and the outer main veins, pocket-like and often with tufts of hairs, swelling sometimes visible adaxially just above junction between 3 main veins, drying darker than rest of lamina; petiole slightly dorsiventrally flattened, c. 5 mm long, hairs dense, with glands and foliaceous appendages, especially along edges of channel and near junction with leaf blade. *Inflorescence* of axillary short-peduncled, almost fascicle-like cymes, usually shorter than the subtending leaf's petiole, c. 10 flowers in each cyme, cymes dichasia with usually only peduncle and first 2 branches distinguishable; peduncles dorsiventrally

flattened c. 2 mm long, hairs abundant, c. 0.1 mm long; pedicels c. 2 mm long, straight to slightly curved, sparsely hairy; bracteoles entire to deeply bifid, narrowly triangular, c. 1 mm long, hairy. *Flower* hypanthium sparsely hairy abaxially, hairs < 0.1 mm long, appressed, reddish to white; sepals triangular, c. 1.2 mm long, pale green when fresh, glabrous and keeled adaxially; petals clawed, c. 1.2 mm long, obcordate; stamen filaments flat, subulate, c. 1.0 mm long, anthers c. 0.2 mm long, enclosed by petals; nectary disk pentagonal, 10-pitted, glabrous, no distinguishable annulus surrounding ovary; style c. 1 mm long, flattened, arms 2, rudimentary, free for 0.1 mm; ovary partially immersed, glabrous. *Fruit* a drupe, ripening yellow then black, c. 7 × 6 mm, obovoid [wider towards apex], glabrous; fruiting pedicels c. 3 mm long; hypanthium remains annular at base of fruit.

**DISTRIBUTION.** Borneo (Kalimantan, Sabah) and the Philippines (Alabat, Leyte, Luzon, Mindanao, Mindoro, Palawan, Visayas). Map 6.

**ADDITIONAL SPECIMENS EXAMINED. INDONESIA. BORNEO: EAST KALIMANTAN**, W Koetai, no.18, near L. Poehoes, c. 70 m, 8 Aug. 1925, *Endert* 2411 (K, L); East Kutai Reserve, vicinity of Sengata and Mentoko Rs, 0°30'N 117°20'E, below 300 m, 1 Feb. 1979, *Leighton* 487 (L); pr. Fluv. Boengaloen [Sungai Bengalon], 24 Nov. 1912, *Rutten* 754 (U); **WEST KALIMANTAN**, Soengei Sambas, 1893 – 1894, *Hallier* 1112 (L); **MALAYSIA. SABAH: KINABATANGAN**, Gomatong Fr. [Gomantong F.R.], 30 Jan. 1988, *Joseph et al.* SAN 123657 (E, K); Supu F.R. [Hutan Simpan Supu], Elopura, 160 feet [50 m], 21 Oct. 1938, *Puasa* 10098 (K, L); **RANAU**,



**Map 6.** Distribution of *Ziziphus cumingiana* var. *cumingiana* (●).

Sungai Kepuakan, 18 June 1985, *Amin et al.* SAN 109777 (K, L); Narawang [6°00'24"N 116°46'44"E], 12 Aug. 1987, *Amin & Francis* SAN 119847 (K); Langsat [6°03'02"N 116°47'53"E], 8 Sept. 1987, *Amin et al.* SAN 121074 (K); Kpg. Nalumad to Kpg. Pinawantai, 20 Oct. 1968, *Ogata* 11380 (L); Kampung Takutan. Tepi jalan raya ke SMK Timbua, 30 April 1995, *Tadong* 247 (K); **SANDAKAN**, Sibuga Road, Kebun China, 15 Sept. 1972, *Kumin* SAN 75600 (K, L); **TAWAU**, Tawao [Tawau], Oct. 1922 – March 1923, *Elmer* 21383 (K, U); **TONGOD**; Bintang Mas logging area Karamuak, 14 June 1975, *Madani* SAN 81174 (K, L).

**HABITAT.** Borneo lowland rain forests; alt. 0 – 300 m.

**CONSERVATION STATUS.** Least Concern (LC). The species has a wide distribution with collections in lowland forests across Borneo and in many islands of the Philippines (Alabat, Leyte, Luzon, Mindanao, Mindoro, Palawan, Visayas). In Borneo, it is likely that the taxon is declining and severely fragmented given the widespread destruction of rainforests. However, the species was collected in protected areas, e.g. Gomantong Protection Forest Reserve (IUCN Category Ia) in Sabah.

**PHENOLOGY.** Collected in flower in Nov. – Feb., April, June and Sept.; collected in fruit in April, June, Aug. – Oct.

**VERNACULAR NAMES.** *Sandulanghani* (Sungei Kinabatangan, *fide* Puasa 10098); *Surinit* (Dusun, *fide* *Tadong* 247).

**USES.** No recorded uses found.

**NOTES.** *Ziziphus cumingiana* var. *cumingiana* is recognised by the small glabrous fruits (< 0.9 cm in diam.) inserted in subsessile fascicle-like cymes. The only other species on Borneo known to have glabrous fruits are *Z. cuspidata* and *Z. domatiata*. The fruits of *Z. cuspidata* are bigger, on average 2.0 × 1.5 cm, and arranged in pedunculate cymes; those of *Z. domatiata* slightly bigger, c. 1.0 × 0.8 cm, also arranged in pedunculate cymes. The dark red venation when dry, including the smallest venules, is unique among *Ziziphus* species in Borneo, as is the sparse indumentum on the pedicels and flowers and the weakly and distantly crenate margin with a tooth and hairs inserted by the sinus of each crenation.

*Ziziphus cumingiana* var. *cumingiana* shares many morphological characters with *Z. oenopolia* (L.) Mill. which, despite being widely distributed from India to Australia (GBIF 2019), has apparently not yet been recorded in Borneo. Both species have leaves obliquely ovate, < 10 cm in length, with strong marginal veins, subsessile fascicle-like cymes and fruits small, c. 1 cm in diam., glabrous, globose to obovoid. *Ziziphus oenopolia* differs from *Z. cumingiana* var. *cumingiana* in the transverse veins between the main veins strong and ascending, and the leaves densely hairy abaxially. The widespread, cultivated and sometimes naturalised

*Z. mauritiana* and *Z. jujuba* also have subsessile fascicle-like cymes and globose fruits but the leaf apex is usually rounded or notched as opposed to attenuate. Lectotypes for both *Z. mauritiana* and *Z. oenopolia* were recently selected in a review of the nomenclature of the species of *Ziziphus* occurring in Australia (Kellermann 2020).

*Ziziphus cumingiana* var. *pilosa* Merr. (Merrill 1923: 522) differs from *Z. cumingiana* var. *cumingiana* in the more densely hairy leaf surface abaxially. The difference is marked and while specimens of this variety collected in the Philippines are available in herbaria, it is not known to have been found in Borneo. Vernacular names of *Z. cumingiana* in the Philippines are listed by Merrill (*loc. cit.*).

Merrill (1906) did not designate a type specimen in the protologue for *Ziziphus cumingiana* but lists *Cuming* 453 as illustrative and a sheet of this material, which is in flower, is selected here as the lectotype.

*Ziziphus bulusanensis* is listed as a synonym of *Z. cumingiana* by Merrill (1923) but because there is no retrievable diagnosis or description associated with it, the name seems to have not been validly published.

**6. *Ziziphus cuspidata* Cahen & Utteridge sp. nov.** Type: Malaysia, Sabah, Sandakan, Mile 75.5 Telupid Road, 15 Aug. 1979, *Gibot* SAN 91255 (holotype: K [K001420131]; isotypes: KEP-not seen, L [L.2328612], SAR-not seen).

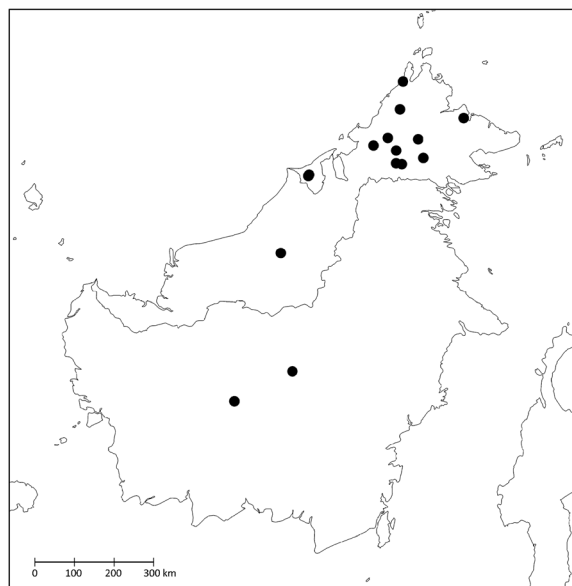
<http://www.ipni.org/urn:lsid:ipni.org:names:77218843-1>

*Ziziphus horsfieldii* sensu Beaman & Anderson (2004: 276), pro parte, non Miq.

Woody climber to at least 15 m long; girth to at least 6 cm in diam., spiny. *Branchlets* terete, with longitudinal striations and visible lenticels, densely hairy on young parts and distal portions, more sparsely hairy on mature parts, hairs mostly 0.5 – 1 mm long, curved to tortuous, spreading to appressed-antrorse, reddish, some whitish. *Stipules* modified into spines, forming clusters at the tip of developing shoots, usually single at maturity, occasionally 3-whorled at branching nodes, spines recurved, c. 3 mm long, hairy when developing, glabrous at maturity. *Leaves* weakly discolorous, drying yellowish-green to brown adaxially, paler abaxially, blade variable in size and shape between individuals, usually asymmetric, (narrow oblong –) elliptic (– ovate), 2.5 – 8.0 × 1.0 – 4.5 cm, subcoriaceous, apex (acute –) attenuate (– acuminate), base (obtuse –) rounded (– subcordate), usually symmetric, only rarely clearly oblique, margins weakly serrate, c. 50 serrations on either side, each serration topped by a minute protruding

callosity that dries darker than the lamina, c. 0.1 mm long, margin slightly thickened, glabrous; primary veins 3, impressed adaxially, raised abaxially, hairs abundant along primary veins on both sides of lamina, hairs c. 0.5 mm long, straight to tortuous, mostly appressed, antrorse; marginal veins coming off the outside of the two outer main veins 3 – 15, usually c. 6, strong, ascending and forming loops near the margin but no clear intramarginal vein running along the leaf margin, angle of divergence with outer main veins 20 – 40°; transverse veins between the main veins conspicuous, coming off midrib at c. 90°, barely raised (not readily felt by touch), spaced by 1 – 2 mm from each other, more often slightly zigzagging than straight, often branching; higher order reticulations discernible; lamina abundantly hairy abaxially to more rarely subglabrous, hairs c. 0.5 mm long, reddish, mostly spreading; domatia present in the axils at the base of the 3 main veins, pocket-like; petiole slightly dorsiventrally flattened, 3 – 7 mm long, hairs dense, indumentum extending to widened base of main veins adaxially. *Inflorescence* of axillary pedunculate cymes, < ½ as long as subtending leaves, c. 8 flowers in each cyme, cymes loose dichasia with usually 2 terminal elongate branches visible; peduncles c. 6 mm long with dense indumentum of hairs shorter and more whitish than on branchlets, hairs mostly spreading, < 0.1 mm long; pedicels to 3 mm long, hairs dense, straight to sometimes curved; bracteoles variously laciniate, often deeply bifid, c. 1 mm long, hairy, especially on margins, subglabrous abaxially. *Flower* fragrant (*vide Jacobs 5328*); hypanthium densely hairy abaxially, hairs paler and much shorter than on branchlets, < 0.1 mm long, appressed-antrorse to spreading; sepals triangular, c. 2 mm long, yellowish-green when fresh, glabrous and keeled adaxially; petals clawed, c. 1.5 mm long, obcordate, whitish; stamen filaments flat, subulate, c. 1 mm long, anthers brownish, c. 0.5 mm long, enclosed by petals; nectary disk orange, pentagonal, 10-pitted, glabrous; style arms 2, free to at least 1.2 mm long, glabrous; ovary partially immersed, glabrous. *Fruit* a drupe, ripening yellow-orange, globose to ellipsoid, (1.5 –) 2.0 (– 2.2) × (1 –) 1.5 (– 1.8) cm, usually with a rigid point at the apex, c. 1 mm long, surface smooth, glabrous; fruiting pedicels c. 5 × 2 mm, hypanthium remains at base of fruit saucer-shaped, c. 5 mm in diam. Fig. 2.

**RECOGNITION.** Most like *Ziziphus horsfieldii* and *Z. domatiata* in having pedunculate cymes, fruits < 1.5 × longer than wide, leaves usually < 7 × 3 cm with strong marginal veins coming off the outer main veins usually < 8 on either side. It differs



**Map 7.** Distribution of *Ziziphus cuspidata* (●).

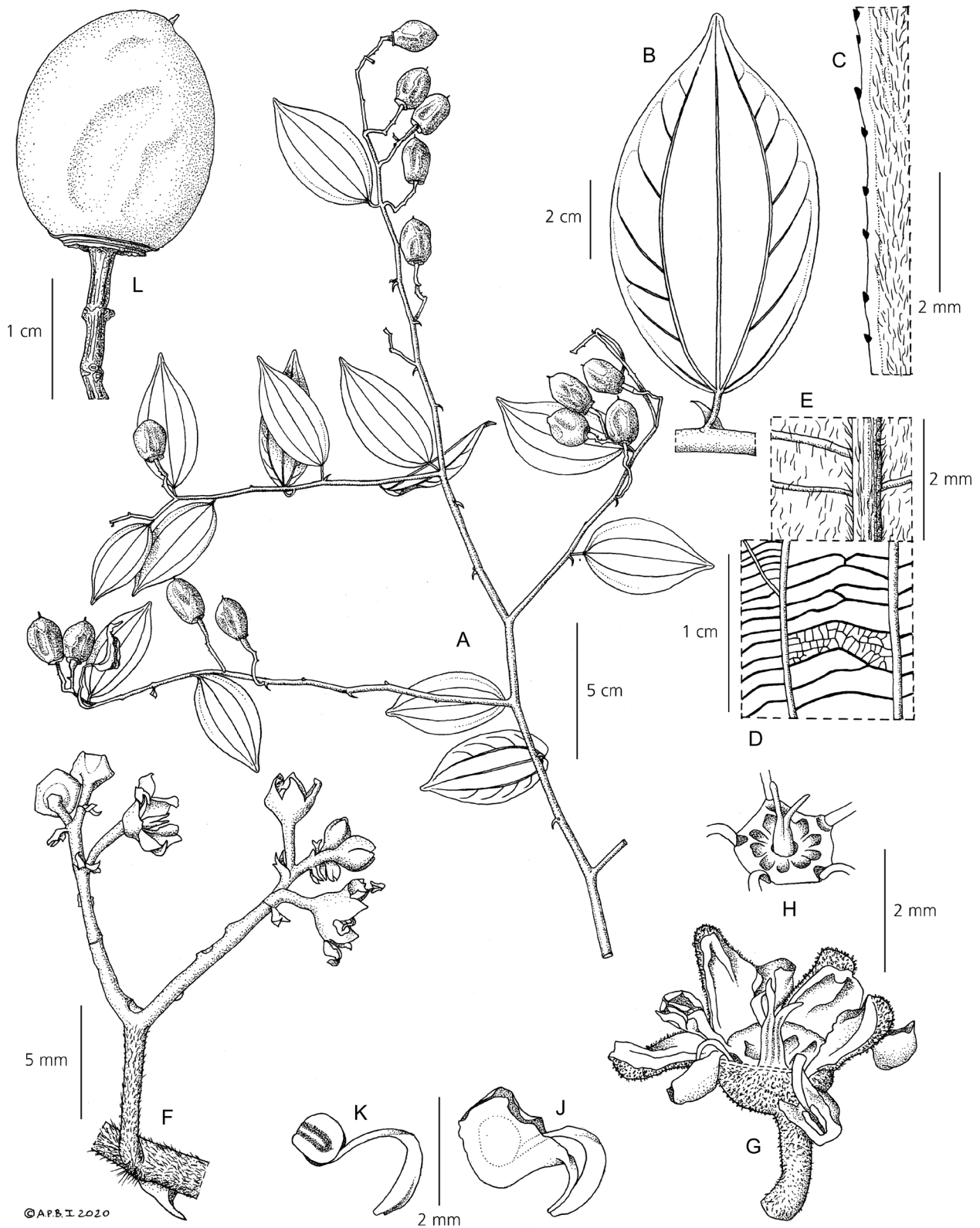
from both species in having bigger fruits, c. 2 × 1.5 cm (vs c. 1.1 × 1.1 cm in *Z. horsfieldii* and c. 1.0 × 0.8 cm in *Z. domatiata*) and the leaf lamina usually being hairy abaxially (vs subglabrous). It also differs from *Z. horsfieldii* in having glabrous, globose to ellipsoid fruits (vs densely hairy, ob-ovoid), shorter petioles, 3 – 7 mm (vs usually c. 10 mm) and a more often symmetric lamina base, and from *Z. domatiata* in having fruits with the style remains forming a rigid point (vs muticous) and leaves with c. 6 strong marginal veins on either side (vs c. 4).

**DISTRIBUTION.** Borneo (Brunei, Kalimantan, Sabah, Sarawak), possibly endemic. Map 7.

**ADDITIONAL SPECIMENS EXAMINED. BRUNEI. BELAIT:** Kg. Tenajor, Labi, 2 Nov. 1994, *Nangkhat et al.* BRUN 15775 (K); Labi Forest Reserve, compartment 13, 4°27'N 114°29'E, 60 m, *Osman et al.* BRUN 16491 (K);

**INDONESIA. BORNEO: CENTRAL KALIMANTAN,** Kalteng, Samba, Sungai Samba, 0°42'56.6"S 112°46'46.5"E, 350 m, 19 Feb. 1995, *Jarvie & Ruskandi* 6235 (K, L); P.T. Pamenang logging concession Rd c. km 20, 0°25'N 114°6'E, 23 June 1990, *Ridsdale* PBU 628 (E, K, L);

**MALAYSIA. SABAH: BELURAN,** Ulu Tongod, 2 Aug. 1983, *Han et al.* SAN 99846 (K, L); **KENINGAU,** Sungai Siliawan, Sepulut F.Res., 22 March 1986, *Krispinus & Sumbing* SAN 113903 (K, L); Ulu Sg. Sambuaa, 27 Sept. 1988, *Krispinus* SAN 125205 (K, L); **KOTA BELUD,** Mt Templer F. Reserve, 1500 ft [450 m], 10 Feb. 1966, *Kanis & Kuripin* SAN 54380 (K, L); **NABAWAN,** Labang, Sepulut fr, 22 Oct. 1988, *Krispinus* SAN 125255 (K); Syrikat Undan Sd. Bh. Logging Area KM18 Jalan Nabawan/Pandewan, 27 March 1990,



**Fig. 2.** *Ziziphus cuspidata*. A habit; B leaf, abaxial view; C leaf margin, abaxial view; D leaf lamina surface (indumentum omitted), abaxial view; E detail of leaf lamina surface, abaxial view; F inflorescence; G flower with a sepal removed (rehydrated); H flower centre (dry), viewed from above; J petal and stamen, side view; K stamen; L fruit. A – E from *Gibot* 91255; F – K from *Sumbing* SAN 128564; L from *Osman et al.* BRUN 16491. DRAWN BY ANDREW BROWN.

*Sumbing* SAN 128564 (E, K, L); **RANAU**, Kampung Bundu Tuhan, Buntui, Kg. Himbaan, 5°56'58"N 116°32'46"E, 28 Dec. 1993, *Soibeh* 642 (K); **SANDAKAN**, Mile 75.5 Telupid Road, 15 Aug. 1979, *Gibot* SAN 91255 (K, L); **TENOM**, 15 Aug. 1992, *Meijer* SAN 136518 (K, US); **TONGOD**, Block 8, Sabah Foundation Unlogged area, Seranum, 13 Sept. 1983, *Embun* SAN 101239 (K, L); **SARAWAK: KAPIT**, left bank of Rajang R., c. 10 km below Belaga, Segaham range, near Belaga airfield, approx. 2°40'N 113°50'E, below 500 m, 27 Aug. 1958, *Jacobs* 5328 (K, L).

**HABITAT.** Borneo lowland rain forest; alt. 60 – 450 m.

**CONSERVATION STATUS.** Near Threatened (NT). It is likely that the taxon is declining and severely fragmented given the widespread destruction of rainforests in Borneo. However, the taxon is distributed with an EOO greater than 150,000 km<sup>2</sup> and some specimens were collected in or close to protected areas, e.g. Bukit Baka - Bukit Raya National Park (IUCN Category II) in Kalimantan, Maliau Basin Protection Forest Reserve (IUCN Category Ia) and Tenompok Protection Forest Reserve (IUCN Category Ia) in Sabah.

**PHENOLOGY.** Collected in flower in March and Aug. – Sept.; collected in fruit in Feb., March, May, June and Aug. – Oct.

**ETYMOLOGY.** The specific epithet is derived from the Latin *cuspidatus*, pointy, and refers to the style remains forming a distinctive, conspicuous, rigid point at the apex of the fruit.

**VERNACULAR NAMES.** *Kuku menaul* (Iban, *vide Osman et al.* BRUN 16491); *Mata kuling puru* (Dusun, *vide Soibeh* 642).

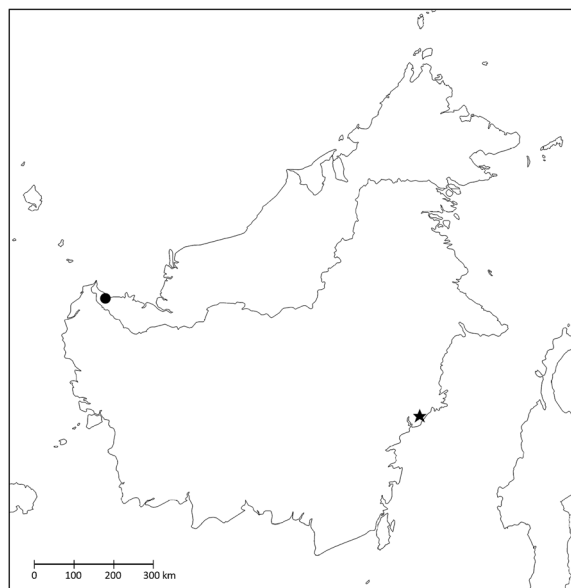
**USES.** No recorded uses found.

**NOTES.** *Ziziphus cuspidata* had mostly been identified as *Z. sp.* and *Z. horsfieldii* in herbaria. It superficially resembles *Z. horsfieldii* but is easily distinguished in the fruits being glabrous (vs densely hairy) (Fig. 2L) and leaves being hairy with a petiole 3 – 7 mm long (vs subglabrous leaves and petiole c. 1 cm long) (Fig. 2B). The species characteristically dries yellowish. A point formed by the style remains at the apex of the fruits is visible in all *Ziziphus* species in Borneo except perhaps *Z. domatiata*, but is particularly conspicuous and rigid in this species (Fig. 2A & L).

### 7. *Ziziphus domatiata* Cahen & Utteridge sp. nov.

Type: Indonesia, East Kalimantan, Wanariset research area, Rintis Baru, Km 2, 1°S 117°E, 50 m, 3 April 1991, *Ambriansyah & Arifin* W702 (holotype: K [K001420132]; isotype: L [L.2332322]).

<http://www.ipni.org/urn:lsid:ipni.org:names:77218844-1>



**Map 8.** Distribution of *Ziziphus domatiata* (★) and *Z. ridleyana* (●).

*Woody climber*; girth to at least 3 cm in diam., spiny. *Branchlets* terete, with longitudinal striations and conspicuous, raised lenticels, hairs sparse, c. 0.5 mm long mixed with shorter hairs < 0.1 mm long, spreading to appressed-antrorse. *Stipules* modified into spines, single, slightly recurved, c. 2 mm long, subglabrous. *Leaves* weakly discolorous, drying greenish-brown, blade asymmetric, narrow ovate (–ovate), 3.5 – 5.5 × 1.7 – 3.1 cm, chartaceous to subcoriaceous, apex attenuate to acuminate, base cuneate to subcordate, usually clearly oblique, margins weakly crenate-serrate, c. 60 serrations on either side, each serration topped by a protruding callosity that dries darker than the lamina, c. 0.1 mm long; primary veins 3, impressed adaxially, raised abaxially, hairs sparse to dense along primary veins on either side of lamina, hairs c. 0.3 mm long; strong marginal veins coming off the outside of the two outer main veins (2 –) 4 (– 8) on either side, ascending and gradually diminishing, rarely forming conspicuous loops near margin, no clear intramarginal vein running along the leaf margin present, angle of divergence with outer main veins c. 45°; transverse veins between the main veins weak but discernible, coming off midrib at c. 90°, barely raised (not readily felt by touch), spaced by c. 1 mm from each other, more often slightly zigzagging than straight; higher order reticulations barely discernible; lamina subglabrous; domatia present at the junction between the marginal veins and the outer main veins, pocket-like and with tufts

of hairs; petiole slightly dorsiventrally flattened, c. 5 mm long, hairs dense, indumentum extending to widened base of main veins adaxially. *Inflorescence* of axillary pedunculate cymes, cymes loose dichasia (inferred from fruiting material) with usually peduncle and first 2 branches clearly elongate and next branches short and less distinct; peduncles c. 5 mm long; bracteoles not seen. *Flower* unknown. *Fruit* a drupe, ripening creamy-grey, c. 1.0 × 0.8 cm, subglobose to obovoid, glabrous, smooth; fruiting pedicels c. 3 mm × 1 mm; hypanthium remains saucer-shaped at base of fruit. Fig. 3.

**RECOGNITION.** Most like *Ziziphus horsfieldii* in having pedunculate cymes, narrow ovate leaves, which are subglabrous abaxially except along larger veins and with tufts of hairs at the junction between the marginal and outer main veins. It differs in the glabrous, subglobose fruit, ripening creamy-grey, c. 1.0 × 0.8 cm (vs fruit densely covered in reddish hairs, obovoid, ripening yellowish-green, c. 1.1 × 1.1 cm). Vegetatively, it differs in the smaller leaves, 3.5 – 5.5 × 1.7 – 3.1 cm (vs 3.5 – 10.0 × 1.2 – 4.5 cm), weakly crenate-serrate margin with c. 60 serrations on either side (vs finely denticulate and c. 100 serrations on either side) and fewer strong marginal veins, c. 4 on either side but often less (vs c. 6 and rarely < 5).

**DISTRIBUTION.** Borneo (East Kalimantan). Endemic. Map 8.

**HABITAT.** Borneo lowland forests; alt. c. 50 m.

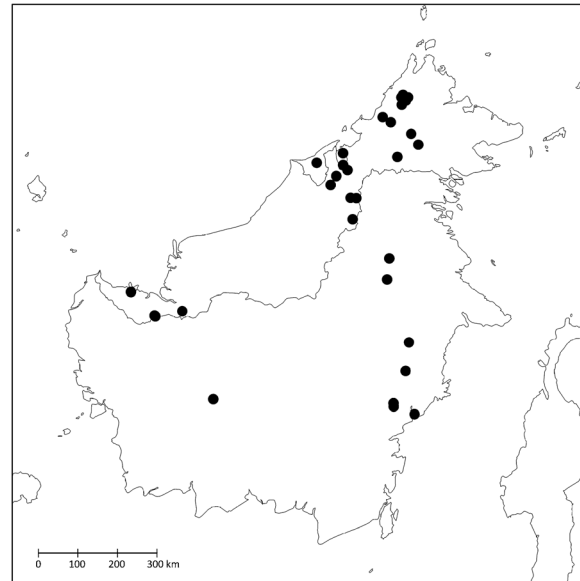
**CONSERVATION STATUS.** Critically Endangered (CR). *Ziziphus domatiata* is known from a single collection in the Wanariset Tropical Forest Research Station area, about 38 km north of Balikpapan, East Kalimantan. It was collected in 1991 in a Mixed Dipterocarp Forest, a habitat that has been subject to extensive logging in East Kalimantan (Kartawinata 2008). Because it is known from a single location and its potential EOO is inferred to be declining, it meets the B1ab(iii) criteria for CR.

**PHENOLOGY.** Collected in fruit in April.

**ETYMOLOGY.** Named for the presence of domatia in the axils at the junction between the marginal veins and the outer main veins, pocket-like and with tufts of hairs.

**USES.** Fruits edible (*vide* Ambriansyah & Arifin W702).

**NOTES.** This species is only known from a single collection. Vegetatively it closely resembles *Ziziphus horsfieldii* in the leaves being subglabrous abaxially with tufts of hairs at the junction between the marginal veins and the outer main veins (Fig. 3D). The only other known *Ziziphus* species of Borneo with glabrous fruits are *Z. cuspidata* and



Map 9. Distribution of *Ziziphus havilandii* (●).

*Z. cumingiana*. It differs from *Z. cuspidata* in having abaxially glabrous leaves except along the main and marginal veins (vs usually hairy) (Fig. 3D) with c. 4 or less strong marginal veins on either side (vs c. 6) (Fig. 3A & B), in the tufts of hairs at the junction between the marginal veins and the outer main veins (vs sometimes in the axils at the base of the 3 main veins only) (Fig. 3D), and the fruits c. 1.0 × 0.8 cm and muticous (vs c. 2 × 1.5 cm and style remains forming a rigid point) (Fig. 3E). *Z. cumingiana* has smaller fruits (c. 7 × 6 mm in diam.) inserted in subsessile fascicle-like cymes (vs pedunculate cymes) and leaves thin-chartaceous (vs chartaceous to subcoriaceous), with a visibly reticulate venation drying darker than lamina surface (vs reticulation indistinct and veins drying paler than lamina surface).

**8. *Ziziphus havilandii* Ridl.** (Ridley 1931: 495). Type: Malaysia, Sarawak, Kuching, Feb. 1893, *Haviland* 2134 (lectotype, selected here: K [K000723019]).

*Ziziphus borneensis* sensu Beaman & Anderson (2004: 275), pro parte, non Merr.

Woody climber to at least 30 m long; girth to at least 20 cm in diam., spiny. *Branchlets* terete, with longitudinal striations and visible lenticels, densely hairy on young parts and distal portions, becoming sparsely hairy to



**Fig. 3.** *Ziziphus domatiata*. A habit; B leaf showing part of scalariform venation (indumentum shown only on petiole and branchlet), abaxial view; C leaf margin, abaxial view; D detail of domatium at junction between outer main vein and marginal vein, abaxial view; E fruit. A – E from Ambriansyah & Arifin W702. DRAWN BY ANDREW BROWN.

glabrous when mature, hairs straight to curved, spreading to appressed-antrorse. *Stipules* paired, one becoming a recurved spine, c. 3 mm long, the other one fugaceous, persistent on some flowering branchlets, entire, wide ovate, c. 3 × 2 mm, hairs dense, spines on distal branchlets often closely spaced, by c. 1 cm. *Leaves* weakly discoloured, drying greenish-brown, blade asymmetric, narrow ovate to elliptic-oblong, (1.0 –) 2.5 – 5.5 (– 6.5) × (0.5 –) 1.2 – 2.5 (– 3.5) cm, chartaceous, apex attenuate to acuminate, base rounded, usually symmetric, margins subentire to finely denticulate, c. 75 serrations on either side, each serration topped by a protruding callosity that dries darker than the lamina, c. 0.1 mm long; primary veins 3, impressed adaxially, raised abaxially, hairs sparse to dense along primary veins on either side of lamina, hairs c. 0.2 mm long; strong marginal veins coming off the outside of the two outer main absent (only 3 main veins conspicuous), faint intramarginal vein running along the leaf margin present; transverse veins between the main veins weak but discernible, coming off midrib at c. 90°, barely raised (not readily felt by touch), tightly spaced, usually < 1 mm from each other, more often slightly zigzagging than straight; higher order reticulations and areoles well-developed, visible with a hand lens; lamina subglabrous, with many glands, mostly visible abaxially, drying darker than rest of lamina surface, slightly pitted, ± 0.1 mm in diam.; tufts of hairs present in the axils at the base of the 3 main veins; petiole slightly dorsiventrally flattened, (1 –) 2 – 5 mm long, hairs dense, indumentum extending to widened base of main veins adaxially. *Inflorescence* of axillary pedunculate cymes, c. 7 flowers in each cyme, cymes loose dichasia visibly branching 1 – 2 times; peduncles dorsiventrally flattened (2 –) 5 (– 10) mm long, hairs dense, spreading, c. 0.1 mm long; pedicels c. 1 mm long, straight; bracteoles entire, narrowly triangular, c. 1 mm long, hairs dense. *Flower* hypanthium densely hairy abaxially, c. 0.1 mm long, appressed-antrorse, whitish; sepals triangular, c. 1.2 mm long, yellowish-green when fresh, glabrous and keeled adaxially; petals clawed, c. 1.2 mm long, obcordate; stamen filaments flat, subulate, c. 1.0 mm long, anthers c. 0.3 mm long, enclosed by petals; nectary disk pentagonal, 10-pitted, glabrous; style arms 2, well-developed, c. 0.7 mm long, terminating in an expanded, almost flat stigmatic surface; ovary partially immersed, hairs dense. *Fruit* a drupe, ripening yellowish, flushed reddish, (0.4 –) 0.9 (– 1.5) × (0.3 –) 0.8 (– 1.3) cm, (globose –) obovoid [wider towards apex], indumentum dense, hairs drying reddish, < 0.1 mm long; fruiting pedicels c. 3 × 1 mm; hypanthium remains saucer-shaped at base of fruit.

**DISTRIBUTION.** Borneo (Brunei, Kalimantan, Sabah, Sarawak), Sulawesi. Map 9.

**ADDITIONAL SPECIMENS EXAMINED. BRUNEI. BELAIT:** Bukit Sawat Jalan Merangking-Buau, 27 July 1996, *Kalat et al.* BRUN 17692 (K); **TEMBURONG:** Bukit Belalong, 4°29'N 115°11'E, 900 m, 22 Feb. 1992, *Dransfield et al.* JD 7157 (K, L); Bukit Belalong, 23 July 1989, *Joffre s.n.* (K); Headwaters of Temburong R. to the NE of Gunong Retak, 4°22'N 115°17'E, 900 m, 13 March 1991, *Sands et al.* 5369 (K, L); Bukit Patoi, 29 Oct. 1989, *Wong WKM* 1598 (K); **TUTONG:** Telisai, Bukit Basong, 11 Sept. 1996, *Kalat et al.* BRUN 17810 (K); **INDONESIA. BORNEO: CENTRAL KALIMANTAN,** Sintang. HPH 70, W of camp off main road; along new log road and surrounding environs towards Km 71, 0°51'53.6"S 112°13'29.9"E, 150 m, 11 April 1994, *Church et al.* 834 (E, K, L); 10 km along side road at Km 57 from Sangai (S. Mentaya), Kab. Kotawaringin Timur, 1°29'S 112°31'E, c. 50 m, 20 Oct. 1994, *Wilkie* 94312 (E); **EAST KALIMANTAN,** foot of Gunung Beratus, W of Balikpapan, c. 300 m, 26 Jan. 1979, *Murata B* 2759 (L); near Gunung Meratus, Orang Utan release site, 0°57'29"S 116°19'43"E, 166 m, 12 Jan. 2005, *Slik* MEPRI 4529 (L); W Koetai, no. 37, near Mt Kemoel, 27 Sept. 1925, *Endert* 3607 (K); Sg. Wain, NE of Balikpapan, 90 m, Oct. 1950, *Kostermans* 4041 (K, L); W Kutei, Kelindjau R. region near Melan, 28 June 1954, *Kostermans* 9688; Central Kutei, Belajan R. near Long Bleh, 25 March 1955, *Kostermans* 10234 (K, L); **NORTH KALIMANTAN,** W Koetai, no. 36, near L. Petah, c. 550 m, 9 Sept. 1925, *Endert* 3114 (K, L); **MALAYSIA. SABAH:** Crocker Range F. Res., 25 May 1977, *Abas* SAN 85693; Mount Kinabalu, Upper Kinabalu, 6000 – 16500 ft [1800 – 5000 m], 27 Jan. 1932, *Clemens & Clemens* 29324 (L); Penibukan, 4000 ft [1200 m], 10 Nov. 1931, *Clemens & Clemens* 32195 (L); *ibid.*, Marai Parai, 5000 ft [1500 m], 7 May 1933, *Clemens & Clemens* 33096 (K); *ibid.*, Penibukan ridge, 4000 ft [1200 m], 23 Sept. 1933, *Clemens & Clemens* 40420 (K); *ibid.*, Gurulau Spur, 5000 ft [1500 m], 9 Dec. 1933, *Clemens & Clemens* 50854 (K, L); **KENINGAU,** Mile 55 on path from Tenom to Ranau (near Apin-Apin), 2000 ft [600 m], 2 Sept. 1954, *Wood & Wyatt-Smith* A 4387 (L); **NABAWAN,** Pensiangan, Ponontomon FR, 17 Aug. 1994, *Krispinus* SAN 136978 (K); **RANAU,** Mesilau R., 5000 ft [1500 m], 11 April 1964, *Chew & Corner* RSNB 4894 (K, L); Tenompok, toward Bundu T., 5500 ft [1700 m]; 27 Jan. 1932, *Clemens & Clemens* 28129 (K); Mount Kinabalu, Tenompok, 5000 ft [1500 m]; 16 March 1932, *Clemens & Clemens* 28874 (K, L); *ibid.*, *Clemens & Clemens* 30376 (K, sheet 1); Kinabalu National Park, along Sg. Mamut, 1200 – 1400 m, 15 Feb. 1969, *Kokawa & Hotta* 5781 (L); Mesilau Camp, 1964, *Poore* H 441 (K); Kampung Bundu Tuhan. Notoki, Kg. Himbaan, 5°57'4" N 116°33'43"E, 14 April 1993, *Soibeh* 201 (K); **TONGOD,** Lamag, S. side of



Gunong Lotung Inarat, 3200 ft [1000 m], 17 May 1976, *Gibot* SAN 83221 (K); Ulu Sg. Pingas, 14 March 1985, *Krispinus & Sumbing* SAN 110913 (K, L); **SARAWAK**: 1865 – 68, *Beccari* 2493 (K); Gat, Upper Rejang [Rajang] R., 1929, *Clemens & Clemens* 21688 (K); Rejang [Rajang R.], s.d., *Haviland* 807 (K); **KUCHING**, 30 Jan. 1893, *Haviland* 2134 (K); **LIMBANG**, Bukit Binula Lawas, 1200 m, 2 Aug. 1895, *Rena et al.* S.60744 (K); **MIRI**, Sg. Mentawai, G. Mulu N.P., 6 Oct. 1977, *Chai* S.39697 (K, L); Kalabit Highlands, Pa Ukat 3 miles E of Bario, 1000 m, 20 April 1970, *Nooteboom & Chai* 2170 (K, L); Pulong Tau National Park (Western part). Trail to Bukit Tenidan from Napun Kederi (Kern B), 9 May 2007, *Suzana et al.* S.97545 (K); Sg. Kelapang, Ramudu, Bario, 24 March 1997, *Wat et al.* S.76303 (K); **MUKAH**, Bkt. Iju, Ulu Sg. Arip, Balingian, 700 ft [200 m], 3 Aug. 1965, *Kudi* S.23703 (K, L); **SAMARAHAN**, Gunong Gaharu, Ulu Sg. Sabal Aping, 70th Mile, Serian/Simanggang Rd., Simunjan, 1300 ft [400 m], 12 Oct. 1974, *Paie* S.35742 (K, L); Sabal F.R., 70th Mile, Serian Road, 13 May 1974, *Tong et al.* S.34293 (K, L).

**HABITAT.** Borneo lowland and montane rain forests; alt. 30 – 1800 m.

**CONSERVATION STATUS.** Near Threatened (NT). It is likely that the taxon is declining and severely fragmented given the widespread destruction of rainforests in Borneo. However, the taxon is distributed with an EOO greater than 300,000 km<sup>2</sup>. Also, the species occurs in hilly and montane habitats possibly less exposed to heavy exploitation. Some specimens were collected in the following protected areas: Ulu Temburong National Park (IUCN Category II) in Brunei; Kinabalu National Park and ASEAN Heritage Park (IUCN Category II) in Sabah; Mulu National Park and ASEAN Heritage Park (IUCN Category II) in Sarawak.

**PHENOLOGY.** Collected in flower in Jan., Feb. and May – Oct.; collected in fruit March – May and July – Dec.

**VERNACULAR NAMES.** *Akar kuku menaul/manayul/menawal* (Iban, *vide Chai* S.39697, *Rena et al.* S.60744, *Suzana et al.* S.97545, *Tong et al.* S.34293); *Akar-sema'it* (Berawan, *vide Chai* S.39697); *Kukulang* (Iban and Malay, *vide Kalat et al.* BRUN 17810, *Sands et al.* 5369); *Mensimou* (Dusun, *vide Soibeh* 201).

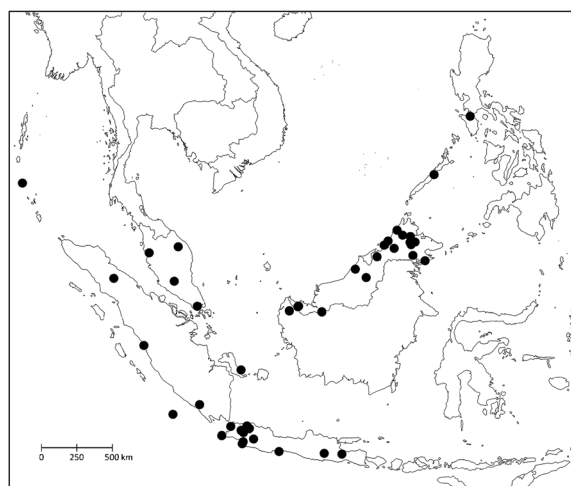
**USES.** Fruits edible, sweet (*vide Chai* S.39697, *Soibeh* 201 and *Suzana et al.* S.97545).

**NOTES.** *Ziziphus havilandii* is recognised by leaves having abundant dark glands (appearing as black spots) on the abaxial lamina. Only the three main veins are clearly visible and a faint but distinct intramarginal vein running along the leaf margin is present. It is also recognised by the presence of wide ovate, fugaceous stipules c. 3 × 2 mm and the

spines of distal branchlets spaced by c. 1 cm, closer to each other than in most other species. It most resembles *Z. suluensis* in the black spot, venation and stipule characters. *Ziziphus havilandii* differs from *Z. suluensis* in the leaves being smaller, usually 2.5 – 5.5 × 1.2 – 2.5 cm, (vs usually 8 × 3.5 cm), chartaceous (vs chartaceous-subcoriaceous), usually more asymmetric and widest near base (vs widest near middle), often denser indumentum on distal branchlets and usually smaller fruits, on average 0.9 × 0.8 cm (vs 1.2 – 1.5 × 0.9 – 1.5 cm). The difference between the two species is slight, they could represent a single species on the same morphological variability continuum. *Ziziphus suluensis* was originally described based on material collected in Tawi-tawi, close to Borneo and the species is not known to occur on more northern islands of the Philippines, also suggesting that *Z. havilandii* and *Z. suluensis* could be a single lineage restricted to Borneo's near vicinity (Sulawesi and southern Philippines). Schirarend (1995) used the character of the intramarginal vein to distinguish the two species (present in *Z. havilandii*, absent in *Z. suluensis*), but this could not be observed on all available specimens previously identified as *Z. suluensis*, including the type material.

Ridley (1931) cited *Beccari* 2493 and *Haviland* 2134 in his protologue for *Ziziphus havilandii*, and he indicated that the latter specimen is the “type”. A sheet of the Haviland 2134 collection is selected here as the lectotype.

**9. *Ziziphus horsfieldii* Miq.** (Miquel 1856: 643). Type: Indonesia, Java, 1802 – 1818, *Horsfield* s.n. (lectotype, selected here: K [K000723025]).



**Map 10.** Distribution of *Ziziphus horsfieldii* (●).

*Ziziphus palawanensis* Elmer (1913: 1828) **synon. nov.**

Type: Philippines, Palawan, Puerto Princesa (Mt. Pulgar), March 1911, *Elmer* 12891 (lectotype selected here: A [00051556]; isolectotypes: F [V0068187F], GH [00051555], L [L 0550937], NY [00415113], P [P06790454], U [U 0115267], US [00094337]).

Woody climber to at least 30 m long; girth to at least 10 cm in diam., spiny. *Branchlets* terete, with longitudinal striations and conspicuous, raised lenticels, hairs sparse, c. 0.5 mm long mixed with shorter hairs 0.1 mm long, mostly appressed-antrorse, reddish to whitish. *Stipules* modified into spines, single, recurved, c. 2.5 mm long, subglabrous. *Leaves* weakly discoloured, drying greenish-brown, blade asymmetric, (lanceolate –) narrow ovate (– ovate), 3.5 – 10.0 × 1.2 – 4.5 cm, chartaceous to subcoriaceous, apex attenuate to acuminate, base cuneate to subcordate, usually clearly oblique, margins finely denticulate, c. 100 serrations on either side, each serration topped by a protruding callosity that dries darker than the lamina, c. 0.1 mm long; primary veins 3, impressed adaxially, raised abaxially, hairs sparse along primary veins on either side of lamina, often more densely adaxially, hairs c. 0.2 mm long; strong marginal veins coming off the outside of the two outer main veins c. 6 on either side, rarely < 5, ascending and gradually diminishing, not forming conspicuous loops near margin, no clear intramarginal vein running along the leaf margin present, angle of divergence with outer main veins c. 45°; transverse veins between the main veins weak but discernible, especially adaxially, coming off midrib at c. 90°, barely raised (not readily felt by touch), spaced by c. 1 mm from each other, more often slightly zigzagging than straight; higher order reticulations barely discernible; lamina subglabrous; domatia present in the axils at the base of the 3 main veins and at the junction between the marginal veins and the outer main veins, pocket-like and often with tufts of hairs, swelling often visible adaxially just above junction between 3 main veins; petiole slightly dorsiventrally flattened, c. 7 mm long, hairs dense, indumentum extending to widened base of main veins adaxially. *Inflorescence* of axillary pedunculate cymes, < ½ as long as subtending leaves, c. 12 flowers in each cyme, cymes loose dichasia with usually peduncle and first 2 branches clearly elongate and next 4 branches short but distinct; peduncles dorsiventrally flattened (5 –) 10 (– 15) mm long, hairs abundant, mostly < 0.1 mm long; pedicels c. 2 mm long, straight to slightly curved; bracteoles entire, narrowly triangular, c. 1 mm long, hairy. *Flower* faintly scented; hypanthium densely hairy on the outer

surface, hairs 0.1 mm long, appressed-antrorse, greyish; sepals triangular, c. 1.2 mm long, pale greenish when fresh, glabrous and keeled adaxially; petals clawed, c. 1 mm long, obcordate, white; stamen filaments flat, subulate, c. 0.7 mm long, anthers c. 0.3 mm long, enclosed by petals; nectary disk yellow, pentagonal, 10-pitted, glabrous, annulus surrounding ovary barely raised; style arms 2, free for c. 1 mm, glabrous; ovary partially immersed, hairs dense. *Fruit* a drupe, ripening yellowish-green, (0.9 –) 1.1 (– 1.5) × (0.7 –) 1.1 (– 1.5) cm, obovoid [wider towards apex], indumentum dense, hairs drying reddish, < 0.1 mm long; fruiting pedicels c. 5 × 1 mm; hypanthium remains annular at base of fruit.

**DISTRIBUTION.** Brunei, Indonesia (Java, Kalimantan, Sumatra), Malaysia (Malay Peninsula, Sabah, Sarawak), Philippines (Mindoro, Palawan), Singapore. Map 10.

**ADDITIONAL SPECIMENS EXAMINED. BRUNEI. TEMBURONG:** Temburong R. just downstream from Kuala Belalong, 25 June 1989, *Wong* WKM 1281 (K, L); **INDONESIA. BORNEO: WEST KALIMANTAN,** Sanggouw, 1893 – 1894, *Hallier* 811 (L); **MALAYSIA. SABAH:** Hills about Bumi, 1857, *Lobb* s.n. (K); **BEAUFORT,** Kampong Suasa Kota Klias, 29 July 1969, *Gibot* SAN 64377 (K, L); Klias F. Res., 20 July 1973, *Sundaling & Karim* SAN 77793 (K, L); **BELURAN,** Bidu-bidu hill, 31 July 1990, *Maikin et al.* SAN 130679 (E, K); **KENINGAU,** Kg. Bah Mula Jalan Karamatoi, 19 Oct. 1978, *Abas* SAN 86009 (K, L); **KOTA BELUD,** HS. Purak mato, 19 Aug. 1987, *Mansus & Amin* SAN 106660 (K); **PAPAR,** Ulu Bongawan, 9 Sept. 1976, *Bidin* SAN 84401 (K, L); **RANAU,** Tompurungon, 17 Oct. 1986, *Amin & Jarius* SAN 116444 (K, L); **SANDAKAN,** H.S. Sagaliud Lokan, 24 Aug. 1989, *Bousi et al.* SAN 124340 (E, K, L); Pembangunan Sabariah Sdn Bhd, Sg Kun-Kun, 7 June 1983, *Gibot* SAN 96929 (L); HS. Segaliud-Lokan, 30 June 1986, *Pikkoh* SAN 116849 (K); **TAWAU,** Mile 26, Imbak Rd., Luasong, 11 Dec. 1979, *Krispinus & Sumbing* SAN 91399 (K, L); 3 Miles N of Balong Estate, 5 Dec. 1963, *Meijer* 41042 (K, L); **TENOM,** Sungai Kaang, 25 March 1987, *Mantor* SAN 120247 (K); **TONGOD,** Sg Tangkulap, 25 June 1983, *Amin* SAN 97402 (K, L); **SARAWAK: KAPIT,** Belaga, Ulu Sg, Berangan, Batang Balui, Bakun HEP, 520 m, 23 Aug. 1995, *Yii et al.* S.72598 (L); **KUCHING,** Jambusan, 300 ft [10 m], 24 July 1960, *Anderson* 12585 (K, L); Seburan, 100 ft [30 m], 29 May 1960, *Anderson* 12908 (K, L); Bkt. Tabai, Tai Ton Bau, 400 ft [100 m], 16 Dec. 1965, *Chai* S.22874 (K, L); **MIRI,** Ulu Sungei Sekaloh, Niah R., 1 Dec. 1966, *Anderson* S.27284 (K, L); Baram, Dec. 1894, *Hose* 169 (E, K, P); *ibid.*, 12 April 1895, *Hose* 698 (E, K);

Long Dam, Ulu Dapoi, Tinjar, Marudi, 1000 ft [300 m], 10 April 1965, *Luang* S.23451 (K, L).

**HABITAT.** Borneo lowland rain forests; alt. 30 – 520 m.

**CONSERVATION STATUS.** Least Concern (LC). *Ziziphus horsfieldii* is widely distributed in western Malesia and extends to the Philippines. It does not appear to be threatened. In Borneo, it could be declining and severely fragmented given recent widespread destruction of rainforests but was collected in the following protected areas in Sabah: Bidu-Bidu Protection Forest Reserve (IUCN Category Ia), Klias Protection Forest Reserve (IUCN Category not reported) and SG. Kinabatangan Valley Bird Sanctuary (IUCN Category not reported).

**PHENOLOGY.** Collected in flower in April, June, Oct. and Dec.; collected in fruit in March, June – Oct. and Dec.

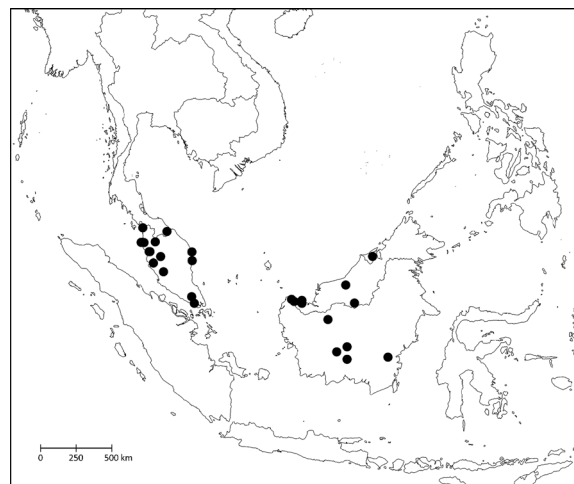
**VERNACULAR NAMES.** *Kanggom sopuan* (Sandakan, *vide Bousi et al.* SAN 124340); *Kuku manual* (Iban, *vide Luang* S.23451); *Unak Manual* (Iban, *vide Wong* WKM 1281).

**USES.** No recorded uses found.

**NOTES.** In Borneo, *Ziziphus horsfieldii* is most like *Z. cuspidata* and *Z. domatiata* in having pedunculate cymes, fruits < 1.5 × longer than wide, leaves usually < 7 × 3 cm with usually < 8 strong marginal veins coming off the outer main veins on either side. It differs from both species in the densely hairy fruits (vs glabrous). It also differs from *Z. cuspidata* in the smaller fruits, c. 1.1 × 1.1 cm (vs c. 2 × 1.5 cm), the leaf lamina being subglabrous abaxially except along larger veins (vs usually hairy), the longer petioles, c. 10 mm (vs 3 – 7 mm) and the often clear presence of tufts of hairs at the junction between the outer main veins and the marginal veins. It further differs from *Z. domatiata* in the obovoid fruits (vs subglobose) and leaves with c. 6 strong marginal veins on either side (vs. c. 4).

The type material from Java is unusual in having almost sessile fruits but does not appear to differ in any other morphological character from material recognised here as *Ziziphus horsfieldii*. A lectotype is selected here among the Horsfield material collected in Java. Two additional sheets of *Z. horsfieldii* from Java marked as belonging to Horsfield's herbarium are available at K (K000723024, K000723026) but whether these are islectotypes, i.e. from the same collection event as the lectotype, is unsure.

*Ziziphus palawanensis* Elmer is placed as a synonym here because no apparent morphological character from the type material or protologue description seems to separate it from *Z. horsfieldii*. Elmer (1913) described the climber as forming “dense hanging masses over the open creek bed”. Elmer 12891, indicated as the type in the protologue for *Z. palawanensis* (Elmer *op. cit.*), is widely distributed with duplicates available in at least seven herbaria and the sheet at A, where much of Elmer's herbar-



Map 11. Distribution of *Ziziphus kunstleri* (●).

ium collections are kept, is selected here as the lectotype.

**10. *Ziziphus kunstleri* King (1896: 373).** Type: Malaysia, Penang, Province Wellesley [Seberang Perai], April 1881, *King's Collector* [Kunstler] 1607 (lectotype, selected here: K [K001420133]; islectotype: CAL [24069]). Lectoparatypes: Malaysia, Perak, May 1888, *Wray* 1911 (CAL [24072], P [P06784156]); *Wray* 3281 (not seen); Perak, s.d., *Wray* 3285 (L [L.2328519]); *ibid.*, Larut [Taiping], Jan. 1883, *King's Collector* [Kunstler] 3772 (CAL [24070], P [P06784154, P06784155], US [3364315]); *ibid.*, Nov. 1881, *King's Collector* [Kunstler] 6853 (CAL [24071]).

*Ziziphus cupularis* Suess. & Overkott (Suessenguth & Overkott 1941: 330) **synon. nov.** Type: Malaysia, Sarawak, s.d., *Native collector* 113 (lectotype, selected here: K [K000723022]; islectotypes: A [00051549], L [L 0013799]).

Woody climber to at least 9 m long; girth to at least 10 cm in diam., spiny. Branchlets terete, with longitudinal striations and superficial lenticels concealed by indumentum, densely hairy on young parts and distal portions, more sparsely hairy when mature, hairs c. 0.5 mm long mixed with shorter hairs, mostly spreading on inflorescence rachis, reddish, some whitish. Stipules 1 or 2 per node, forming clusters at the tip of developing shoots, 1 stipule modified into a spine, recurved, c. 4 mm long, other stipule erect, not spine-like, c. 4 mm long [Wilkie 94133]. Leaves weakly discolorous, drying greenish-brown, paler abaxially, chartaceous, dimorphic: first type type of leaf proximal to inflorescences, blade symmetric, (wide) ovate-elliptic, 6.0 – 17.7 × 4.7 – 9.8 cm,

apex rounded to acuminate, base rounded to cordate, symmetric, margins entire to serrate, c. 70 serrations on either side, each serration topped by a minute protruding callosity that dries darker than the lamina, c. 0.1 mm long; primary veins 3, impressed adaxially, raised abaxially, hairs abundant along primary veins abaxially, hairs c. 0.7 mm long,  $\pm$  straight,  $\pm$  spreading; strong marginal veins coming off the outside of the two outer main veins  $> 20$  on either side,  $\pm$  equally strong, ascending and forming loops near the margin but no clear intramarginal vein running along the leaf margin, angle of divergence with outer main veins  $40 - 70^\circ$ ; transverse veins between the main veins conspicuous, coming off midrib at  $50 - 90^\circ$ , raised (readily felt by touch), spaced by c. 5 mm from each other, slightly zigzagging, often branching; higher order reticulations discernible, slightly raised; lamina sparsely hairy abaxially (more densely along bigger veins), hairs c. 0.3 mm long, mostly spreading; domatia present in the axils at bigger veins with main veins, pocket-like; petiole slightly dorsiventrally flattened, (2 –) 4 (– 10) mm long, hairs dense, indumentum extending to widened base of main veins adaxially. Second type of leaf smaller, at the base of cymes, fugaceous, narrowly ovate, c.  $5 \times 2$  cm, apex acute to attenuate. *Inflorescence* of axillary pedunculate cymes subtended by fugaceous leaves, ultimately arranged in a panicle,  $< \frac{1}{2}$  as long as subtending leaves, c. 7 flowers in each cyme, cymes contracted dichasia not or only once visibly branching; peduncles 2 – 10 mm long, hairs dense, reddish, spreading; bracteoles entire to deeply bifid, narrowly triangular, c. 3 mm long, hairy. *Flower* hypanthium densely hairy on the outer surface; sepals triangular, pale yellow, c. 2 mm long, glabrous and keeled adaxially; petals clawed, c. 2.5 mm long, obcordate; stamen filaments flat, subulate, c. 2 mm long, anthers c. 0.4 mm long, enclosed by petals; nectary disk, pentagonal, 10-pitted, glabrous; style arms 2, well-developed, c. 0.8 mm long, diverging, not expanding at apex, glabrous ovary partially immersed, hairs dense. *Fruit* a drupe, ripening with a velvety brown tinge, ellipsoid, often with a flattened base, c. (2 –) 3  $\times$  (1.5 –) 1.8 cm, indumentum dense, hairs drying reddish-brown, hypanthium remains at base of fruit visible, saucer-like, calyx lobes often persistent and reflexed.

**DISTRIBUTION.** Borneo (Brunei, Kalimantan, Sarawak), Peninsular Malaysia, Thailand (Narathiwat, Yala). Map 11.

**ADDITIONAL SPECIMENS EXAMINED.** **BRUNEI. TUTONG:** Ulu Supon, 40 ft [10 m], 10 Jan. 1958, *Ashton* BRUN 867 (K, L); **INDONESIA. CENTRAL KALIMANTAN:** Km 15 on road from camp 48. Sangai, S. Mentaya, Kab. Kotawaringin Timur,  $1^\circ 29'S$   $112^\circ 31'E$ , c. 50 m, 30 March 1995, *Latupeirissa* 95006 (E, K); km 4 from Sangai, S. Mentaya, Kab. Kotawaringin Timur,  $1^\circ 29'S$   $112^\circ 31'E$ , c. 50 m, 10 March 1994, *Wilkie* 94133 (E, K); Bukit Raya, Tumbang Riang, 8 Jan. 1983, *Wiradinata* 3199 (L); **EAST KALIMANTAN:** P.T. ITCI, road Kenangan to G. Meratus, km 54, 400 m, 27 March 1995, *Kessler et al.* 911 (K, L); **WEST KALIMANTAN:** Smittouw, 1893 – 94, *Hallier* 1351 (L, U); **MALAYSIA. SARAWAK:** Nov. 1871, *Beccari* 3377 (K); **BINTULU,** Sungei Mayeng, Tau Range, 500 ft [150 m], 7 June 1956, *Purseglove* P.5407 (K, L); **KAPIT,** Naanga Sringin, Ulu Sungai Entuloh, Baleh, 2 Aug. 1995, *Othman et al.* S.57743 (K); **KUCHING,** Gunung Pueh, 200 m, 5 March 1992, *Ching et al.* S.64312 (K); Mount Poi base, 5 Oct. 1929, *Clemens & Clemens* 7253 (K); Garai, 4 Dec. 1892, *Haviland* 884 (K); Near base of Santubong, 23 Feb. 1949, *Sinclair* Singapore Field No. 38323 (E, K, L).

**HABITAT.** Borneo lowland rain forests; alt. 10 – 400 m.

**CONSERVATION STATUS.** Near Threatened (NT). It is likely that the taxon is declining and severely fragmented given the widespread destruction of rainforests in Borneo and the Malay Peninsula. However, the taxon is distributed with an EOO greater than 350,000 km<sup>2</sup>. Some specimens were collected in or near the following protected areas: Gunong Gading National Park (IUCN Category II) and Santubong National Park (IUCN Category not reported) in Sarawak, and Budo-Sungai Padi National Park (IUCN Category II) in Thailand.

**PHENOLOGY.** Collected in flower in June; collected in fruit in Jan. – March, Aug., Nov. and Dec.

**VERNACULAR NAMES.** *Akar duri menawal* (Iban, *vide Ashton* BRUN 867); *Duri* (Indonesian, *vide Wilkie* 94133).

**USES.** Fruits edible (*vide Ching et al.* S.64312 and *Othman et al.* S.57743).

**NOTES.** *Ziziphus kunstleri* is recognised in the dense reddish indumentum on the branchlets and inflorescence, large ovate leaves, to  $17.7 \times 9.8$  cm, densely hairy abaxially, pedunculate cymes and big fruits, c.  $3 \times 1.8$  cm, ellipsoid, brownish. *Ziziphus kunstleri* is most easily confused vegetatively with *Z. crebrivenosa* because of the similar leaf size and marginal veins coming off the outside of the two outer main veins forming several loops near the margin. However, leaves of *Z. kunstleri* have raised veins, including in smaller reticulations, and the transverse veins between the main veins tend to branch (vs finer reticulations not clearly raised

and transverse veins tend to join the main veins without branching in *Z. crebrivenosa*). In addition, branchlets of *Z. kunstleri* have superficial lenticels concealed on younger parts by the dense reddish indumentum (vs lenticels conspicuous and raised in *Z. crebrivenosa*). Both species occur in Borneo, but their distribution is not known to overlap elsewhere.

King (1896) specified naming the species "in memory of its first collector, H. H. Kunstler, who sent it from Province Wellesley in 1881" and lists *King's Collector* [Kunstler] 1607 as illustrative material in his protologue for *Ziziphus kunstleri*. A sheet of this material is available at K, which holds King's main sets, and is selected here as the lectotype.

*Ziziphus cupularis* type material does not appear to differ from *Z. kunstleri*. In the protologue notes for *Z. cupularis*, Suessenguth & Overkott (1941) indicated that both species are similar but that *Z. kunstleri* differs in having axillary inflorescences and a hypanthium that is not cup-shaped. In *Z. kunstleri*, inflorescences are indeed subtended by leaves at an early stage, but these leaves, which are distinctly smaller than more proximal leaves, soon fall and inflorescences then are paniculate as in the type material for *Z. cupularis*. The hypanthium appears cup-shaped on most *Z. kunstleri* material as it does in the type material for *Z. cupularis*, but this is no longer obvious in specimens with fully open flowers, such as *King's Collector* 1607. Suessenguth & Overkott cited *Native Collector* 113 in the protologue for *Z. cupularis*. Suessenguth worked in M and a sheet with a drawing of the flower of this collection, but no plant material, and referring to material in B, is available at M [M0211790]. Suessenguth & Overkott (*op. cit.*) also specified that the material they studied was provided by B. The type therefore used to be there and it is most likely that it was destroyed in the 1943 fire (Merrill 1943). The sheet at K, which includes open flowers, is selected here as the lectotype.

Surprisingly, *Ziziphus kunstleri* was not included in the list of *Ziziphus* species occurring in Sabah and Sarawak by Schirarend (1995), despite being cited by Beaman & Anderson (2004), Masamune (1942) and Ridley (1931).

**11. *Ziziphus puberula* Cahen & Utteridge sp. nov.** Type: Brunei, Temburong District, Sungai Temburong at Kuala Belalong, 4°32'N 115°9'E, 25 m, 22 June 1989, *Dransfield & Boyce* 6667 (holotype: K [K001420134]).

<http://www.ipni.org/urn:lsid:ipni.org:names:77218845-1>

*Ziziphus borneensis* sensu Beaman & Anderson (2004: 275), pro parte, non Merr.

*Woody climber* to at least 8 m long; girth to at least 30 cm in diam., spiny. *Branchlets* terete, with longitudinal striations and visible lenticels, abundantly hairy on young parts and distal portions, more sparsely hairy when mature, hairs very short, < 0.1 mm long, mostly appressed-antrorse, reddish, some whitish. *Stipules* modified into spines, single, recurved, c. 5 mm long, conspicuously decurrent for c. 8 mm along branchlets, with very short hairs except at tip. *Leaves* weakly discolorous, drying greenish-brown, blade usually asymmetric, narrow ovate, 4.5 – 13.5 × 1.5 – 6.0 cm, chartaceous to subcoriaceous, apex attenuate to acuminate, base (obtuse –) rounded (– subcordate), symmetric, sometimes weakly oblique, margins entire, with minute callosities that dry much darker than the lamina, occasionally protruding and c. 0.1 mm long, margin slightly thickened, glabrous; primary veins 3, impressed adaxially, raised abaxially, hairs minute, 0.1 mm long, abundant along primary veins abaxially, mostly antrorse, reddish; strong marginal veins coming off the outside of the two outer main veins > 10 on either side (rarely > 12), ascending and forming loops near the margin but no clear intramarginal vein running along the leaf margin, angle of divergence with outer main veins c. 45°; transverse veins between the main veins conspicuous, coming off midrib at c. 90°, raised (readily felt by touch), spaced by 1 – 2 mm from each other, more often slightly zigzagging than straight, often branching; higher order reticulations discernible; lamina subglabrous abaxially except along larger veins, hairs minute, < 0.1 mm long, reddish; domatia present in the axils at the base of the 3 main veins, pocket-like; petiole slightly dorsiventrally flattened, (2 –) 4 (– 6) mm long, hairs dense, indumentum extending to widened base of main veins adaxially. *Inflorescence* of axillary pedunculate cymes, < ½ as long as subtending leaves, c. 15 flowers in each cyme, cymes loose dichasia with usually 4 terminal elongate branches visible; peduncles 3 – 10 mm long, hairs abundant, < 0.1 mm long; pedicels to 5 mm long, often curved; bracteoles entire, narrowly triangular, c. 1 mm long, hairy. *Flower* fragrant (*vide de Vogel* 1774 and *Dransfield & Boyce* 6667); hypanthium densely hairy on the outer surface, hairs < 0.1 mm long, appressed-antrorse; sepals triangular, c. 1.5 mm long, greenish when fresh, glabrous and keeled adaxially; petals clawed, c. 2 mm long, obcordate, with a dark medial line; stamen filaments flat, subulate, c. 1.2 mm long, anthers c. 0.5 mm long, enclosed by petals; nectary disk yellowish, pentagonal, 10-pitted, glabrous, annulus surrounding ovary strongly raised; style arms 2, free for c. 1 mm, glabrous; ovary partially immersed, hairs dense. *Fruit* a drupe, ripening yellow, c. 3 × 1.7

cm, ellipsoid, with flattened base and acuminate apex, surface wrinkly when dry, covered in minute reddish hairs, < 0.1 mm long; fruiting pedicels curved, c. 5 × 2 mm, hypanthium remains caving in at base of fruit. Fig. 4.

**RECOGNITION.** The species resembles *Ziziphus kunstleri* and *Z. borneensis* in the ellipsoid fruits, c. 3 cm long, but differs in having pedunculate cymes, subtended by leaves that are morphologically indistinct from other leaves (in *Z. borneensis* cymes are few-flowered, subsessile and fascicle-like, and in *Z. kunstleri* cymes are ultimately arranged in panicles, earlier subtended by fugaceous leaves that are distinctly smaller and narrower than other leaves); it also differs in the indumentum of minute hairs, < 0.1 mm long, scarcely visible to the naked eye on branchlets, leaf veins and inflorescences (vs conspicuous in *Z. borneensis* and *Z. kunstleri*). Unlike *Z. kunstleri*, there are no prominent raised longitudinal venules between the transverse veins that join the main veins.

**DISTRIBUTION.** Borneo (Brunei, Kalimantan, Sabah, Sarawak), possibly endemic. Map 12.

**ADDITIONAL SPECIMENS EXAMINED. BRUNEI.**

**TEMBURONG:** Below junction of Temburong and Belalong Rs, 4°34'N 115°09'E, 75 m, 23 March 1991, *Johns et al.* 6967 (K, L); Sungai Temburong at Kuala Belalong, 4°32'N 115°09'E, 25 m, 22 June 1989, *Dransfield & Boyce* 6667 (K, L); **INDONESIA. BORNEO:**

**EAST KALIMANTAN,** Wanariset Research, Inhutani Road Semoi, km 11, 70 m, 2 Feb. 1991, *Ambriansyah & Arifin* W639 (K, L); Valley between limestone hills, N part of Meratus Mts, 1°49'S 115°44'E, 400 m, 22 Oct. 1972, *de Vogel* 1774 (K, L); W Koetai, no. 33/34, near L. Petah, c. 400 m, 6 Sept. 1925, *Endert* 4061 (K, L); **MALAYSIA, SABAH:** Upper Kinabalu, 6000 – 13500 ft [1800 – 4100 m], 1931 – 1932, *Clemens & Clemens* 26722 (K); **KALABAKAN,** Mile 44 Luason Yen Foh Rd., 6 Aug. 1983, *Simbut* SAN 100309 (K, L); **KENINGAU,** Sg. Tumpason, 11 Sept. 1982, *Amin* SAN 95475 (K, L); **KINABATANGAN,** Beside Bot Tai Fr., 1 Feb. 1988, *Joseph et al.* SAN 123665 (K); Pin Supu FR, 5°29'30"N 117°58'00"E, 30 Oct. 2007, *Pius et al.* SAN 149351 (K); **MOSTYN,** Sapang Ayer Forest Reserve, June 1966, *Simanggul* SAN 57017 (L); **PITAS,** Paitan FR., 19 May 1987, *George & Amin* SAN 121297 (K); **SARAWAK: MIRI,** Baram, 2 Nov. 1914, *Moulton* 46 (K); Melinau Gorge, Mulu National Park, 100 m, 23 March 1990, *Yii & Talib* S.58894 (K).

**HABITAT.** Borneo lowland and montane rain forests; alt. 25 – 1800 m.

**CONSERVATION STATUS.** Near Threatened (NT). It is likely that the taxon is declining and severely fragmented given the widespread destruction of rainforests in Borneo. However, the taxon is distributed with an EOO greater than 200,000

km<sup>2</sup>. Also, the species occurs in montane forests possibly less exposed to heavy exploitation. Some specimens were collected in or near the following protected areas: Ulu Temburong National Park (IUCN Category II) in Brunei; Bukit Soeharto Grand Forest Park (IUCN Category VI) in Kalimantan; Kinabalu National Park and ASEAN Heritage Park (IUCN Category II) in Sabah; Mulu National Park and ASEAN Heritage Park (IUCN Category II) in Sarawak.

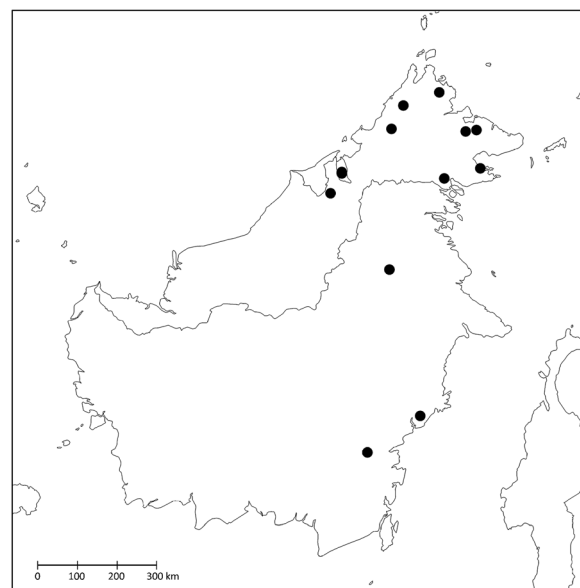
**PHENOLOGY.** Collected in flower in Feb., March, May, June and Sept. – Nov.; collected in fruit in Feb., March, June, Aug. and Sept.

**ETYMOLOGY.** Named *puberula* for its minute hairs, scarcely visible to the naked eye, especially along the main veins on the abaxial side of leaves and on fruits.

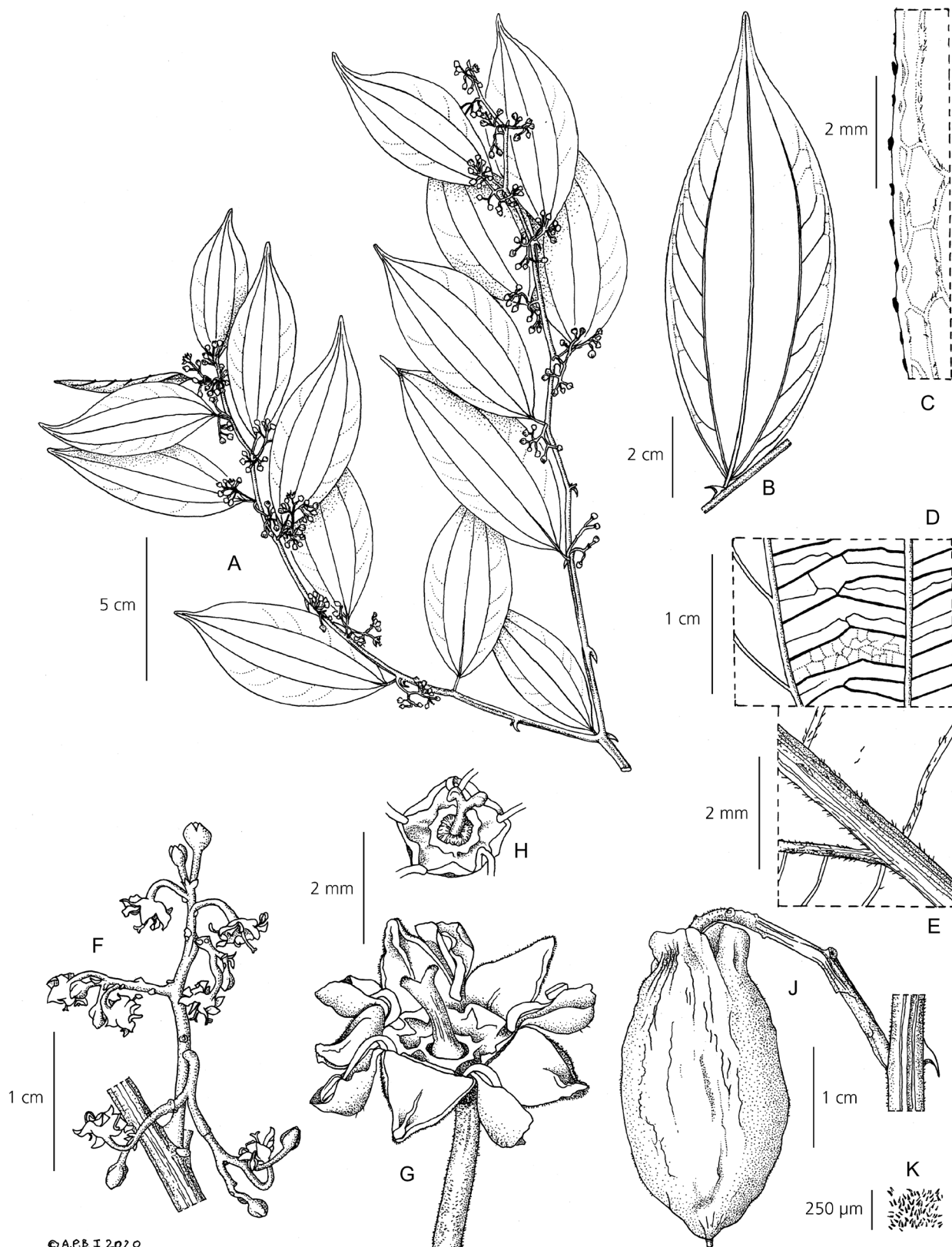
**VERNACULAR NAMES.** *Kukulan* (Iban, *vide Dransfield & Boyce* 6667).

**USES.** No recorded uses found.

**NOTES.** *Ziziphus puberula* is not known to occur outside Borneo, where it had hitherto been identified as *Z. borneensis* and *Z. horsfieldii* in herbaria. The fruits are similar in size and shape to those of *Z. borneensis*, but in addition to the pedunculate cymes (vs few-flowered, subsessile and fascicle-like cymes) (Fig. 4F), the discreet puberulent indumentum on the branchlets and leaves of *Z. puberula* (Fig. 4E) contrasts strongly with the conspicuous dense ferruginous indumentum of *Z. borneensis* (Fig. 1D & E). *Ziziphus horsfieldii* also has pedunculate cymes, but *Z. puberula* differs in the leaves having > 10 strong marginal veins coming off the outside of the two outer main veins on either side, forming loops near the



Map 12. Distribution of *Ziziphus puberula* (●).



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**Fig. 4.** *Ziziphus puberula*. A habit; B leaf (scalariform venation omitted), abaxial view; C leaf margin, abaxial view; D leaf lamina surface, abaxial view; E detail of indumentum on leaf lamina surface, abaxial view; F inflorescence (dry); G flower (rehydrated); H flower centre, viewed from above; J fruit; K detail of indumentum of fruit surface. A from *Ender* 4061; B – H from *Dransfield & Boyce* 6667; J, K from *Simbut* SAN 100309. DRAWN BY ANDREW BROWN.

margin (vs c. 6, ascending and gradually diminishing, not forming conspicuous loops near margin) (Fig. 4B) and the ellipsoid and bigger fruits, c. 3 × 1.7 cm (vs obovoid fruits c. 1.1 × 1.1 cm) (Fig. 4J).

**12. *Ziziphus ridleyana*** Rasingam & Karthig. (Rasingam & Karthigeyan 2020: 71). Type: Malaysia, Sarawak, Lundu, s.d. Garai [Haviland's collector] 881 (holotype: K [K000723014], isotype: K [K000723013]).

≡ *Ziziphus macrophylla* Ridl. (Ridley 1931: 494),

**nom. illeg.** Type: Malaysia: Sarawak, Lundu, s.d., Garai [Haviland's collector] 881 (lectotype, selected here: K [K000723014]; isolectotype: K [K000723013]).

*Tree*, small [height not measured but plant described as “small tree” on lectotype label], unarmed. Crown, bole, bark, sapwood and heartwood features unknown. *Branchlets* terete, with longitudinal striations and visible lenticels, densely hairy on young parts and distal portions, more sparsely hairy when mature, hairs c. 0.3 mm long, mostly spreading, curved, reddish-brown. *Stipules* not transformed into spines, early deciduous, narrowly triangular, c. 7 mm long, densely hairy. *Leaves* weakly discolourous, drying greenish-brown, blade ± symmetric, elliptic-oblong, 14 – 31 × 3.5 – 11 cm, chartaceous to subcoriaceous, apex attenuate to acuminate, base obtuse to rounded, ± symmetric, margins subentire, obscurely serrate, each serration topped by a minute protruding callosity that dries darker than the lamina, c. 0.1 mm long; primary veins 3, impressed adaxially, raised abaxially, hairs dense along primary veins abaxially, hairs c. 1 mm long curved to tortuous, spreading to antrorse, reddish some whitish; strong marginal veins coming off the outside of the two outer main veins 30 on either side, all ending in a distinct intramarginal vein running along the leaf margin, angle of divergence with outer main veins c. 65°; transverse veins between the main veins conspicuous, also coming off midrib at c. 65°, raised (readily felt by touch), spaced by c. 5 (– 15) mm from each other; higher order reticulations visible; lamina hairy abaxially, hairs abundant; no domatia visible; petiole subterete, 5 – 15 mm long, hairs dense, indumentum extending to widened base of main veins adaxially. *Inflorescence* of axillary short-peduncled, almost fascicle-like cymes, usually c. as long as subtending leaf's petiole, 6 – 12 flowers in each cyme; pedicels to 4 mm, hairs dense; bracteoles entire, narrowly triangular, c. 5 mm long, hairy. *Flower* hypanthium densely hairy on the outer surface; sepals triangular, c. 4 mm long, glabrous and keeled adaxially; petals

clawed, c. 2 mm long, obcordate; stamen filaments flat, subulate, c. 2 mm long, anthers c. 0.4 mm long, exceeding petals; nectary disk pentagonal, rugose, appearing ± 20-pitted, glabrous, annulus strongly raised and sheathing style; style arms 3, c. 0.5 mm long, diverging, not expanding at apex, glabrous; ovary partially immersed. *Fruit* unknown.

**DISTRIBUTION.** Borneo (Sarawak), only known from vicinity of Mount Pueh. Map 8.

**ADDITIONAL SPECIMENS EXAMINED. MALAYSIA. SARAWAK: KUCHING**, Mount Poi [Mount Pueh], 2000 ft [600 m], 4 Oct. 1929, Clemens & Clemens 7229 [20144] (K, 2 sheets).

**HABITAT.** Borneo rain forest; alt. c. 600 m.

**CONSERVATION STATUS.** Endangered (EN). *Ziziphus ridleyana* is only known from 2 collections in the Mount Pueh, Lundu area (the most recent from 1929) and Borneo rainforests have been declining in extent and quality. The species thus meets the Blab(iii) criteria for EN status. Mount Pueh forests seem relatively well preserved on satellite imagery and Haviland's collection may have been within Gunong Gading, an IUCN Category II (National Park) area.

**PHENOLOGY.** Collected in flower in Oct.

**NOTES.** *Ziziphus ridleyana* is most like *Z. angustifolia* in being a tree without spines but differs in the dense reddish-brown indumentum, covering the branchlets and abaxial surface of leaves (vs glabrous to sparsely hairy leaves, hairy on the main veins only) and bigger flowers, the sepals being c. 4 mm long (vs c. 2 mm long).

This species was originally published by Ridley as *Ziziphus macrophylla* (1931), but the name is an illegitimate later homonym of the fossil name *Z. macrophylla* (Ettingsh.) Schimp. (Schimper 1874: 224), following Art. 53.1 of the ICN (Shenzhen Code) (Turland *et al.* 2018). The matter was addressed by Rasingam & Karthigeyan (2020) who published the new name *Z. ridleyana* to replace the illegitimate combination. Two sheets of the same collection by Garai are available at K (K000723013 and K000723014) but only one of them, the holotype, is mentioned in the *Z. ridleyana* protologue (K0007230134). The date of collection of the holotype is indicated to be August 1892 in the protologue, but its label does not specify a date. The label of the isotype (K000723013) reads ‘Rec<sup>d</sup>. aug 1892’, which is the date the specimen was received rather than collected. Ridley (*op. cit.*) surprisingly compares it to the much different *Z. borneensis*, which is a spiny climber rather than *Z. inermis* (= *Z. angustifolia*). *Ziziphus macrophylla* (= *Z. ridleyana*) is not cited in the *Tree Flora of Sabah and Sarawak* (Schirarend 1995).



**13. *Ziziphus suluensis* Merr.** (Merrill 1926: 408). Type: Philippines, Sulu Archipelago, Tawi-Tawi, 5 Aug. 1924, Ramos & Edaña Bur. Sci. 44295 (lectotype, selected here: UC [UC257342]; isolectotypes: A [00051557], K [K000723019], P [P06790382], US [00094345]).

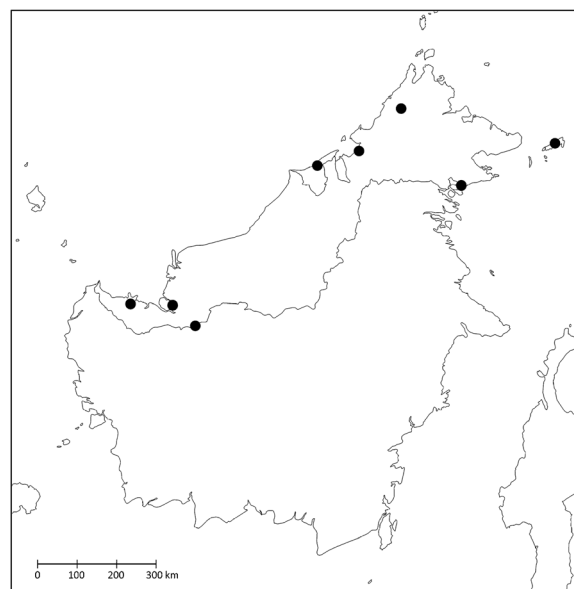
*Ziziphus havilandii* sensu Beaman & Anderson (2004: 276), pro parte, non Ridl.

Woody climber to at least 15 m long, girth not recorded, spiny. Branchlets terete, with longitudinal striations and visible lenticels, sparsely to abundantly hairy on young parts and distal portions, becoming sparsely hairy to glabrous when mature, hairs straight to curved, spreading to appressed-antrorse. Stipules paired, one becoming a recurved spine, c. 3 mm long, the other one fugaceous, persistent on some flowering branchlets, entire, wide ovate, c. 3 × 2 mm, hairs dense, spines on distal branchlets often closely spaced, by c. 1 cm. Leaves weakly discoloured, drying greenish-brown, blade asymmetric, (ovate –) elliptic-oblong, (4.5 –) 8 (– 13) × (1.9 –) 3.5 (– 5.2) cm, chartaceous-subcoriaceous, apex attenuate to acuminate, base wide cuneate to subcordate, usually symmetric, margins subentire to finely denticulate, > 100 serrations on either side, each serration topped by a protruding callosity that dries darker than the lamina, c. 0.1 mm long; primary veins 3, impressed adaxially, raised abaxially, hairs sparse to dense along primary veins on either side of lamina, hairs c. 0.2 mm long; strong marginal veins coming off the outside of the two outer main absent (only 3 main veins conspicuous), faint intramarginal vein running along the leaf margin present; transverse veins between the main veins weak but discernible, coming off midrib at c. 90°, barely raised (not readily felt by touch), tightly spaced, usually < 1 mm from each other, more often slightly zigzagging than straight; higher order reticulations and areoles well-developed, visible with a hand lens; lamina subglabrous, with many glands, mostly visible abaxially, drying darker than rest of lamina surface, slightly pitted, ± 0.1 mm in diam.; tufts of hairs present in the axils at the base of the 3 main veins; petiole slightly dorsiventrally flattened, 3 – 7 mm long, hairs dense, indumentum extending to widened base of main veins adaxially. Inflorescence of axillary pedunculate cymes, sometimes arranged in a panicle, c. 8 flowers in each cyme, cymes loose dichasia visibly branching 1 – 2 times; peduncles dorsiventrally flattened (0.5 –) 1.2 (– 2) cm long, hairs abundant to dense, appressed to spreading, c. 0.1 mm long; pedicels (1 –) 3 (– 5) mm long, straight to curved; bracteoles entire, narrowly triangular, c. 1 mm long, hairs dense. Flower hypanthium densely hairy on the outer surface, c. 0.1 mm long, appressed-antrorse, reddish; sepals triangular, c. 1.5 mm long, glabrous and keeled adaxially; petals clawed, c. 1.4 mm long,

obcordate; stamen filaments flat, subulate, c. 1.0 mm long, anthers c. 0.3 mm long, enclosed by petals; nectary disk pentagonal, 10-pitted, glabrous; style arms 2, well-developed, c. 0.7 mm long, terminating in an expanded, almost flat stigmatic surface; ovary partially immersed, hairs dense. Fruit a drupe, ripening yellow-orange, 1.2 – 1.5 × 0.9 – 1.5 cm, (globose –) obovoid [wider towards apex], indumentum dense, hairs drying reddish, < 0.1 mm long; fruiting pedicels 2 – 6 × 1 mm; hypanthium remains saucer-shaped at base of fruit.

**DISTRIBUTION.** Borneo (Brunei, Sabah, Sarawak), Philippines (Sulu). Map 13.

**ADDITIONAL SPECIMENS EXAMINED. BRUNEI. TUTONG:** Tanjong Maya Bukit Udal Bukit Kukup 4°42'N 114°37'E, 100 m, 22 Dec. 1994, Osman et al. BRUN 16474 (K), **MALAYSIA. SABAH: RANAU,** Mount Kinabalu, Tenompok, 5000 ft [1500 m], 24 Feb. 1932, Clemens & Clemens 28560 (K, L); **SIPITANG,** HS Merintaman, 19 Oct. 1988, Amin SAN 125954 (K); **TAWAU,** Oct. 1922 – March 1923, Elmer 21895 (K, L, U); **TONGOD,** South Meliau Basin, Kuamut Highlands, 600 m, 16 April 1988, Campbell 18/4/2 (E); ibid., 17 April 1988, Campbell 19/4/1 (E); **SARAWAK:** s.d., Native collector 1107 (K, L); 1865 – 68, Beccari 1200 (K); **BETONG,** Tanjong Keranji, Batang Saribas, 13 June 1971, Nudong & Kudi S.30050 (E, K, L); **KUCHING,** Path to Matang, 20 ft [5 m], Haviland 648; near Kuching, 3 March 1893, Haviland 2237 (K, L); ibid., 27 March 1893, Haviland 2237 (K, L); 26 Jan. 1893, Haviland 2862 (K); s.d., Haviland 2862 bis (K); **SRI**



**Map 13.** Distribution of *Ziziphus suluensis* (●).

**AMAN**, Rh. Wong Pandak, Lubok Antu, Bk. Binjai, 5 March 1985, *Awa & Paie* 44126 (K, L).

**HABITAT**. Borneo lowland and montane rain forests; alt. 5 – 1500 m.

**CONSERVATION STATUS**. Near Threatened (NT). It is likely that the taxon is declining and severely fragmented given the widespread destruction of rainforests in Borneo. However, the taxon is distributed with an EOO greater than 150,000 km<sup>2</sup>. Also, the species occurs in montane forests possibly less exposed to heavy exploitation. Some specimens were collected in or near the following protected areas: Tenompok Protection Forest Reserve (IUCN Category Ia) in Sabah; Kubah National Park (IUCN Category II) and Maludam National Park (IUCN Category II) in Sarawak.

**PHENOLOGY**. Collected in flower in Jan. and Oct.; collected in fruit in Feb., March, June and Dec.

**VERNACULAR NAMES**. *Akar menaul* (Iban, fide *Nudong & Kudi* S.30050); *Kuku Helang* (Kedayan, Iban, fide *Osman et al.* BRUN 16474).

**USES**. “For ulcer in mouth or tongue. Method: water drain from the stem of *Zypus* taken and drink” [sic], fide *Awa & Paie* 44126. Fruits edible (fide *Osman et al.* BRUN 16474).

**NOTES**. *Ziziphus suluensis* is recognised by the presence of abundant dark glands (appearing as black spots) black spots on the leaf lamina, the origin and function of which have not yet been studied. It only shares this character with *Ziziphus havilandii* from which it differs in having bigger leaves, on average 8 × 3.5 cm (vs 2.5 – 5.5 × 1.2 – 2.5 cm), widest near the middle (vs usually widest near the base), with more serrations on either side of the margin (>100 vs c. 75) and bigger fruits, 1.2 – 1.5 × 0.9 – 1.5 cm (vs on average 0.9 × 0.8 cm). Both species are similar and could represent a single species on the same morphological variability continuum (see Notes for *Z. havilandii*).

Merrill (1926) cites a *Ramos & Edaño* collection with the Philippine Bureau of Science number 44295 in the protologue for *Ziziphus suluensis* and the specimen from UC, where Merrill worked from 1924 – 1929, and which has open flowers, is selected here as the lectotype.

### Excluded name

***Ziziphus elmeri* Merr.** (Merrill 1929: 178) **synon. nov.** Type: Malaysia, Sabah, Tawao [Tawau], Oct. 1922 – March 1923, *Elmer* 20889 (lectotype, selected here: K [K000723021]; isolectotypes: A [00051551], BR [0000005269235], C [C10017781], CAS [0005255], CM [1373], HBG [HBG-510065], M [M-0211789], P [P06788950, P06790386], PH [00029954], S [S-G-6507], SING [SING 0059172], U [U 0115268], UC [UC 290481]). = *Colubrina beccariana* Warb.

Merrill did not have access to fruits on the material used for his original description of *Ziziphus elmeri* and therefore did not have capsules as evidence pointing towards a genus other than *Ziziphus*. Examination of type material of *Z. elmeri* revealed that it was incorrectly identified material of *Colubrina beccariana*, a species illustrated and described in detail in the *Tree Flora of Sabah and Sarawak* (Schirarend 1995).

Merrill (1929) cited *Elmer* 20889 in the protologue for *Ziziphus elmeri* and the specimen from UC, where Merrill worked from 1924 – 1929, and which has open flowers, is selected here as the lectotype.

### Acknowledgements

The authors thank Jürgen Kellermann and Ian Turner whose comments and suggestions helped improve and clarify this revision, P. Lakshminarasimhan, V. P. Prasad and Avishek Bhattacharjee for their help retrieving type material of *Ziziphus kunstleri*, and Andrew Brown for his excellent illustrations.

### Appendix 1: Alphabetical index to numbered collections examined

7Abas SAN 85693 (*Ziziphus havilandii*); Abas SAN 86009 (*Z. horsfieldii*); Agama 9466 (*Z. crebrivenosa*); Ambriansyah AA 2155 (*Z. angustifolia*); Ambriansyah & Arifin W639 (*Z. puberula*); Ambriansyah & Priyono AA 2187 (*Z. angustifolia*); Ambriansyah AA 2155 (*Z. angustifolia*); Ambullah 36090 (*Z. crebrivenosa*); Ambullah 37187 (*Z. angustifolia*); Amdjah 314 (*Z. angustifolia*); Amin et al. SAN 67632 (*Z. borneensis* var. *borneensis*); Amin SAN 95475 (*Z. puberula*); Amin SAN 97402 (*Z. horsfieldii*); Amin SAN 125954 (*Z. suluensis*); Amin & Donggop SAN 113622 (*Z. borneensis* var. *borneensis*); Amin & Francis SAN 119814 (*Z. calophylla*); Amin & Francis SAN 119847 (*Z. cumingiana* var. *cumingiana*); Amin & Jarius SAN 116444 (*Z. horsfieldii*); Amin & Maidil SAN 108127 (*Z. borneensis* var. *borneensis*); Amin et al. SAN 67312 (*Z. borneensis* var. *borneensis*); Amin et al. SAN 109777 (*Z. cumingiana* var. *cumingiana*); Amin et al. SAN 121074 (*Z. cumingiana* var. *cumingiana*); Andau 654 (*Z. crebrivenosa*); Anderson 12585 (*Z. horsfieldii*); Anderson 12908 (*Z. horsfieldii*); Anderson S.27284 (*Z. horsfieldii*); Apostol 7678 (*Z. angustifolia*); Argent et al. 451987 (*Z. borneensis* var. *borneensis*); Arshid SAN 88621 (*Z. angustifolia*); Ashton BRUN 867 (*Z. kunstleri*); Ashton S.7817 (*Z. borneensis* var. *borneensis*); Ashton S.12143 (*Z. borneensis* var. *borneensis*); Awa & Lee S.47643 (*Z. borneensis* var. *borneensis*); Awa & Paie 44126 (*Z. suluensis*).

Beaman 10988 (*Z. crebrivenosa*); Beccari 1200 (*Z. suluensis*); Beccari 1631 (*Z. calophylla*); Beccari 2493 (*Z. havilandii*); Beccari 3377 (*Z. kunstleri*); Bidin SAN 80728 (*Z. borneensis* var. *borneensis*); Bidin SAN 84401 (*Z. horsfieldii*); Bousi et al. SAN 124340 (*Z. horsfieldii*); Bukah A 3418 (*Z. angustifolia*); Burgess SAN 25151 (*Z. calophylla*).

Campbell 18/4/2 (*Z. suluensis*); Campbell 19/4/1 (*Z. suluensis*); Castillo 644 (*Z. crebrivenosa*); Castro & Melegrito 1468 (*Z. angustifolia*); Chai S.22874 (*Z. horsfieldii*); Chai S.31703 (*Z. angustifolia*); Chai S.34788 (*Z. calophylla*); Chai S.39697 (*Z. havilandii*); Chew & Corner RSNB 4894 (*Z. havilandii*); Chew 1139 (*Z. angustifolia*); Ching et al. S.64312 (*Z. kunstleri*); Christensen 1446 (*Z. calophylla*); Church et al. 14 (*Z. angustifolia*); Church et al. 96 (*Z. borneensis* var. *ranggam*); Church et al. 127 (*Z. borneensis* var. *borneensis*); Church et al. 544 (*Z. borneensis* var. *borneensis*); Church et al. 834 (*Z. havilandii*); Clemens & Clemens 7253 (*Z. kunstleri*); Clemens & Clemens 21688 (*Z. havilandii*); Clemens & Clemens 26722 (*Z. puberula*); Clemens 27051 (*Z. angustifolia*); Clemens & Clemens 27375 (*Z. crebrivenosa*); Clemens & Clemens 28129 (*Z. havilandii*); Clemens & Clemens 28560 (*Z. suluensis*); Clemens & Clemens 28839 (*Z. borneensis* var. *kinabalui*); Clemens & Clemens 28874 (*Z. havilandii*); Clemens & Clemens 29324 (*Z. havilandii*); Clemens & Clemens 30376 (K-sheet 1, *Z. havilandii*); Clemens & Clemens 30376 (K-sheet 2, *Z. borneensis* var. *kinabalui*); Clemens & Clemens 32195 (*Z. havilandii*); Clemens & Clemens 33096 (*Z. havilandii*); Clemens & Clemens 40420 (*Z. havilandii*); Clemens & Clemens 50854 (*Z. havilandii*); Clemens & Clemens 7229 [20144] (*Z. ridleyana*); Coode et al. 6318 (*Z. angustifolia*); Coode et al. 6900 (*Z. borneensis* var. *borneensis*); Coode et al. 7052 (*Z. angustifolia*); Coode et al. 7688 (*Z. borneensis* var. *borneensis*).

Davis et al. 453 (*Z. borneensis* var. *borneensis*); Dransfield & Boyce 6667 (*Z. puberula*); Dransfield et al. JD 7157 (*Z. havilandii*).

Elleh SAN 34357 (*Z. borneensis* var. *borneensis*); Elmer 20149 (*Z. borneensis* var. *borneensis*); Elmer 20361 (*Z. borneensis* var. *borneensis*); Elmer 20880 (*Z. crebrivenosa*); Elmer 21383 (*Z. cumingiana* var. *cumingiana*); Elmer 21813 (*Z. crebrivenosa*); Elmer 21895 (*Z. suluensis*); Embun SAN 101239 (*Z. cuspidata*); Endert 2411 (*Z. cumingiana* var. *cumingiana*); Endert 3114 (*Z. havilandii*); Endert 3607 (*Z. havilandii*); Endert 4061 (*Z. puberula*); Endert 4946 (*Z. calophylla*); Enggoh 10522 (*Z. calophylla*); Eryani et al. S.98444 (*Z. calophylla*).

Forman & Blewett 862 (*Z. borneensis* var. *borneensis*).

Gambukas et al. SAN 108026 (*Z. borneensis* var. *borneensis*); Gansau SAN 54499 (*Z. borneensis* var. *borneensis*); George & Amin SAN 121297 (*Z. puberula*);

Gibot SAN 40901 (*Z. borneensis* var. *borneensis*); Gibot SAN 64335 (*Z. angustifolia*); Gibot SAN 64377 (*Z. horsfieldii*); Gibot SAN 83221 (*Z. havilandii*); Gibot SAN 91255 (*Z. cuspidata*); Gibot SAN 96929 (*Z. horsfieldii*); Gibot & Singh SAN 30014 (*Z. calophylla*).

Hallier 811 (*Z. horsfieldii*); Hallier 1112 (*Z. cumingiana* var. *cumingiana*); Hallier 1351 (*Z. kunstleri*); Hallier 3209 (*Z. borneensis* var. *borneensis*); Han et al. SAN 99846 (*Z. cuspidata*); Haviland 648 (*Z. suluensis*); Haviland 807 (*Z. havilandii*); Haviland 881 (*Z. ridleyana*); Haviland 884 (*Z. kunstleri*); Haviland 1765 (*Z. borneensis* var. *borneensis*); Haviland 2134 (*Z. havilandii*); Haviland 2237 (*Z. suluensis*); Haviland 2862 (*Z. suluensis*); Hazlinah et al. S.86696 (*Z. angustifolia*); Hock S.40631 (*Z. angustifolia*); Hock S.46435 (*Z. angustifolia*); Hose 169 (*Z. horsfieldii*); Hose 698 (*Z. horsfieldii*).

Ja'amat KEP 39641 (*Z. angustifolia*); Jacobs 5328 (*Z. cuspidata*); Jarvie & Ruskandi 6235 (*Z. cuspidata*); Jimpin SAN 118831 (*Z. calophylla*); Johns et al. 6967 (*Z. puberula*); Joseph et al. SAN 123657 (*Z. cumingiana* var. *cumingiana*); Joseph et al. SAN 123665 (*Z. puberula*); Julaihi et al. S.76946 (*Z. angustifolia*); Julia et al. S.98021 (*Z. calophylla*); Jumatin 77406 (*Z. borneensis* var. *borneensis*).

Kalat et al. BRUN 17692 (*Z. havilandii*); Kalat et al. BRUN 17809 (*Z. borneensis* var. *borneensis*); Kalat et al. BRUN 17810 (*Z. havilandii*); Kanis & Kuripin SAN 54380 (*Z. cuspidata*); Kessler et al. 775 (*Z. borneensis* var. *borneensis*); Kessler et al. 911 (*Z. kunstleri*); Kloss SFN 19064 (*Z. borneensis* var. *borneensis*); Kokawa & Hotta 5781 (*Z. havilandii*); Kostermans 4041 (*Z. havilandii*); Kostermans 4205 (*Z. havilandii*); Kostermans 5032 (*Z. angustifolia*); Kostermans 6917 (*Z. angustifolia*); Kostermans 9688 (*Z. havilandii*); Kostermans 10234 (*Z. havilandii*); Kostermans 21286 (*Z. crebrivenosa*); Kramadibrata 202 (*Z. crebrivenosa*); Krispinus SAN 89801 (*Z. borneensis* var. *borneensis*); Krispinus SAN 113272 (*Z. angustifolia*); Krispinus SAN 125205 (*Z. cuspidata*); Krispinus SAN 125255 (*Z. cuspidata*); Krispinus SAN 136978 (*Z. havilandii*); Krispinus & Jimpin SAN 91809 (*Z. borneensis* var. *borneensis*); Krispinus & Jimpin SAN 91877 (*Z. borneensis* var. *borneensis*); Krispinus & Suali SAN 101212 (*Z. borneensis* var. *borneensis*); Krispinus & Sumbing SAN 91399 (*Z. horsfieldii*); Krispinus & Sumbing SAN 110913 (*Z. havilandii*); Krispinus & Sumbing SAN 113903 (*Z. cuspidata*); Kudi S.23703 (*Z. havilandii*); Kumin SAN 75600 (*Z. cumingiana* var. *cumingiana*).

Laman et al. 142 (*Z. borneensis* var. *borneensis*); Lai et al. S.75301 (*Z. angustifolia*); Latupeirissa 95006 (*Z. kunstleri*); Leighton 77 (*Z. calophylla*); Leighton 361 (*Z. calophylla*); Leighton 487 (*Z. cumingiana* var. *cumingiana*); Luang S. 21735 (*Z. crebrivenosa*); Luang S.23451 (*Z. horsfieldii*); Lugas 1229 (*Z. angustifolia*);

*Lugas* 2310 (*Z. crebrivenosa*); *Lugas* 2495 (*Z. crebrivenosa*).

*Madani* SAN 36786 (*Z. borneensis* var. *velutina*); *Madani* SAN 76313 (*Z. crebrivenosa*); *Madani* SAN 77372 (*Z. angustifolia*); *Madani* SAN 81174 (*Z. cumingiana* var. *cumingiana*); *Madani* SAN 88843 (*Z. angustifolia*); *Madani* & *Krispinus* SAN 88461 (*Z. crebrivenosa*); *Maidi* 1534 (*Z. borneensis* var. *borneensis*); *Maikin et al.* SAN 30679 (*Z. horsfieldii*); *Majawat et al.* SAN 102438 (*Z. angustifolia*); *Mansus & Amin* SAN 106660 (*Z. horsfieldii*); *Mantor* SAN 120247 (*Z. horsfieldii*); *Mantor* SAN 122037 (*Z. calophylla*); *Martin* S.38200 (*Z. angustifolia*); *Meijer* 41042 (*Z. horsfieldii*); *Meijer* SAN 27921 (*Z. angustifolia*); *Meijer* SAN 136518 (*Z. cuspidata*); *Mikil* SAN 31565 (*Z. angustifolia*); *Mikil* SAN 40341 (*Z. angustifolia*); *Mohtar et al.* S.47160 (*Z. angustifolia*); *Mohtar et al.* S.47197 (*Z. angustifolia*); *Moulton* 46 (*Z. puberula*); *Munting & Jugah* S.55601 (*Z. angustifolia*); *Murata* B 2759 (*Z. havilandii*).

*Nangkat et al.* BRUN 15775 (*Z. cuspidata*); *Native collector* 1107 (*Z. suluensis*); *Native collector* 113 (*Z. kunstleri*); *Nooteboom & Chai* 2170 (*Z. havilandii*); *Nudong & Kudi* S.30050 (*Z. suluensis*).

*Ogata* 11380 (*Z. cumingiana* var. *cumingiana*); *Orolfo* 4153 (*Z. borneensis* var. *borneensis*); *Osman et al.* BRUN 16474 (*Z. suluensis*); *Osman et al.* BRUN 16491 (*Z. cuspidata*); *Othman et al.* S.57735 (*Z. crebrivenosa*); *Othman et al.* S.57743 (*Z. kunstleri*).

*Paie & Dami* S.43778 (*Z. borneensis* var. *borneensis*); *Paie* S.15569 (*Z. angustifolia*); *Paie* S.26187 (*Z. angustifolia*); *Paie* S.35742 (*Z. havilandii*); *Paie* S.38463 (*Z. borneensis* var. *borneensis*); *Paie* S.39200 (*Z. borneensis* var. *ranggam*); *Paie* S.41581 (*Z. borneensis* var. *ranggam*); *Paie* S.50173 (*Z. angustifolia*); *Pikkoh* SAN 116849 (*Z. horsfieldii*); *Pius et al.* SAN 149351 (*Z. puberula*); *Poore* H 441 (*Z. havilandii*); *Puasa & Enggoh* 10623 (*Z. angustifolia*); *Puasa* 7201 (*Z. angustifolia*); *Puasa* 10098 (*Z. cumingiana* var. *cumingiana*); *Puasa* NBF 10106 (*Z. angustifolia*); *Purseglove* P.5407 (*Z. kunstleri*).

*Radin* 4191 (*Z. borneensis* var. *borneensis*); *Ramos* 1462 (*Z. borneensis* var. *borneensis*); *Rantai & Tinjan* S. 68738 (*Z. angustifolia*); *Rena et al.* S. 60744 (*Z. havilandii*); *Ridsdale et al.* CEROL 18 (*Z. borneensis* var. *borneensis*); *Ridsdale* PBU 628 (*Z. cuspidata*); *Rutten* 754 (*Z. cumingiana* var. *cumingiana*).

*Sam* SAN 49929 (*Z. borneensis* var. *borneensis*); *Sambuling* 524 (*Z. calophylla*); *Sands et al.* 5369 (*Z. havilandii*); *Sands et al.* 5717 (*Z. borneensis* var. *borneensis*); *Sidiyasa* PBU 609 (*Z. borneensis* var. *borneensis*); *Simbut* SAN 100309 (*Z. puberula*); *Simpson & Marsh* 2006 (*Z. calophylla*); *Simanggul* SAN 57017 (*Z. puberula*); *Sinclair* 10520 (*Z. calophylla*); *Sinclair*

Singapore Field No. 38323 (*Z. kunstleri*); *Slik* MEPRI 4529 (*Z. havilandii*); *Soibeh* 201 (*Z. havilandii*); *Soibeh* 627 (*Z. angustifolia*); *Soibeh* 642 (*Z. cuspidata*); *Suali & Pikkoh* SAN 96499 (*Z. borneensis* var. *borneensis*); *Sumbing* SAN 128564 (*Z. cuspidata*); *Sundaling* SAN 97021 (*Z. crebrivenosa*); *Sundaling* SAN 107497 (*Z. angustifolia*); *Sundaling* SAN 129538 (*Z. borneensis* var. *borneensis*); *Sundaling & Karim* SAN 77793 (*Z. horsfieldii*); *Sundaling et al.* SAN 135259 (*Z. angustifolia*); *Suzana et al.* S.97545 (*Z. havilandii*).

*Tadong* 247 (*Z. cumingiana* var. *cumingiana*); *Tikau* SAN 28913 (*Z. borneensis* var. *velutina*); *Tong et al.* S.34293 (*Z. havilandii*); *Tong* S.34959 (*Z. angustifolia*)  
*de Vogel* 1667 (*Z. angustifolia*); *de Vogel* 1774 (*Z. puberula*); *de Vogel* 2196 (*Z. angustifolia*).

*Wat et al.* S.76303 (*Z. havilandii*); *Wilkie* 94133 (*Z. kunstleri*); *Wilkie* 94312 (*Z. havilandii*); *Wiradinata* 3199 (*Z. kunstleri*); *Wiradinata* 3539 (*Z. borneensis* var. *borneensis*); *Wong* WKM 1281 (*Z. horsfieldii*); *Wong* WKM 1598 (*Z. havilandii*); *Wood & Wyatt-Smith* A 4387 (*Z. havilandii*); *Wood* 1961 (*Z. borneensis* var. *borneensis*); *Wood* A 4674 (*Z. calophylla*); *Wood* SAN 16070 (*Z. crebrivenosa*).

*Yü* S.56905 (*Z. borneensis* var. *borneensis*); *Yü* S.56911 (*Z. borneensis* var. *borneensis*); *Yü* S.40106 (*Z. borneensis* var. *borneensis*); *Yü* S.44186 (*Z. angustifolia*); *Yü & Talib* S.58894 (*Z. puberula*); *Yü et al.* S.72598 (*Z. horsfieldii*).

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