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RESEARCH ARTICLE

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A synopsis of *Friesodielsia* (*Annonaceae*) in New Guinea

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Key words

Friesodielsia
liana
Melanesia
New Guinea
new species
taxonomy
Uvarieae

Abstract The lianescent genus *Friesodielsia* has been poorly documented and studied in the New Guinea region, with only a single species, *F. subaequalis*, known thus far. Three species are newly described for the island and all four are illustrated here. *Friesodielsia papuana* resembles other glaucous-leaved species from western Malesia, namely *F. glauca*, but can be distinguished through a combination of laminar and floral traits. *Friesodielsia ferralta* is described from a single montane specimen at 1400 m, representing the highest known collection for the genus; it differs from the lowland *F. papuana* in its rusty indument, longer flowering pedicels, and smaller sepals. *Friesodielsia yelaensis* is described from a single specimen from Rossel Island, representing both the southernmost and easternmost extent for the genus. It has a distinct morphology with its strongly acuminate to caudate leaf apex, subsessile flowers, large foliaceous medial bracts and sepals. A key to the species in New Guinea is provided.

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INTRODUCTION

Friesodielsia Steenis is a genus encompassing around 50 species of woody climbers in the *Annonaceae* (*Annonoideae*: *Uvarieae*) (POWO continuously updated, Satthaphorn et al. 2024). With its circumscription having been recently revised, the genus is now geographically restricted to the forests of tropical Asia, its range spanning from southern India to New Guinea. Previously, several African species were included, however their inclusion was found to render the genus polyphyletic, necessitating their transfer into the genera *Afroguatteria* Boutique, *Monanthotaxis* Baill. and *Sphaerocoryne* Scheff. ex Ridl. (Guo et al. 2017). The latter authors then re-circumscribed *Friesodielsia* based on the presence of elongated flowers with partially closed floral chambers along with unequal inner and outer petals. Additional useful distinguishing characters for the genus are provided by Leeratiwong et al. (2021) and Damthongdee et al. (2023).

Molecularly, *Friesodielsia* is most closely related to the Asian *Dasymaschalon* Dalla Torre & Harms, to which it is immediately sister, followed by the Asian *Desmos* Lour. and the Afro-Malagasy *Monanthotaxis* Baill., which are successive sisters to that clade (Guo et al. 2017). Collectively, these four genera are referred to as the *Dasymaschalon* alliance and share morphological similarities including inaperturate pollen and scalariform tertiary venation (Satthaphorn et al. 2024). While flowers of *Dasymaschalon* exhibit circadian trapping of pollinators similar to that of *Friesodielsia*, they notably differ in bearing only one whorl of petals (Guo et al. 2018a). Species of *Friesodielsia* are reported to have basal leaf glands, a feature that is rare in *Annonaceae* and otherwise only known from *Desmos* (Leeratiwong et al. 2021) and *Monanthotaxis* (Hoekstra et al. 2021). Recent fieldwork and study of *Friesodielsia* has resulted in the description of several new species, most notably from Thailand, which now boasts the highest diversity for the genus with 21 species thus far (Damthongdee et al. 2023, Leeratiwong et al. 2023, Satthaphorn et al. 2024).

The taxonomic history of this genus in New Guinea is a limited one. Although collectors have recognized certain lianescent *Annonaceae* taxa to be members of this genus, only a handful of specimens determined as *Friesodielsia* have thus far been collected from the island. The collaborative and comprehensive checklist of the New Guinea vascular plant flora by Cámara-Leret et al. (2020) originally did not include the genus *Friesodielsia* due to no prior records of it. Shortly after this checklist's publication, however, the closely related monotypic genus *Schefferomitra* Diels, which was included in the checklist and until then considered an endemic genus of New Guinea, was synonymized under *Friesodielsia* (Saunders et al. 2020). This action followed an earlier molecular study which found the former genus, represented by *S. subaequalis* (Scheff.) Diels, to be embedded in the latter, recovered in an isolated position sister to a large western Malesian clade (Guo et al. 2017). Upon its transfer to *Friesodielsia*, the species *F. subaequalis* (Scheff.) R.M.K.Saunders, X.Guo & C.C.Tang became the first and only representative of the genus in New Guinea.

However, brief examinations of herbaria collections made it clear there existed other specimens, which represented hitherto unknown taxa. Specimens of unidentified material from New Guinea believed to represent the genus were briefly noted in a taxonomic conspectus by Van Steenis (1964). On its distribution, he noted *Friesodielsia* occurring "as far as the Moluccas, but possibly also in New Guinea" (Van Steenis 1964: 357). It is possible he could have come across a few specimens at L representing *F. papuana* Ezedin, newly described here, as it is the most widespread species when the former *Schefferomitra* is excluded. Various other collections made from across the island have often been identified by authors as unknown species of *Friesodielsia*. Some specimens representing the species, here

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referred to as *F. papuana*, were found sometimes identified as *F. glauca* (Hook.f. & Thomson) Steenis, a species otherwise restricted to western Malesia, due to similarities in general appearance. In addition to the aforementioned new species, two additional species are newly described here, raising the number of *Friesodielsia* species present in New Guinea to four. This is notably fewer than the number of species recorded for other regions of Malesia: Malay Peninsula (14), Philippines (12 or 13), Borneo (11), and Sumatra (7) (Pelser et al. continuously updated, POWO continuously updated).

Indeed, the genus is noticeably less diverse east of Wallace's Line with only one other species, *F. hirta* (Miq.) Steenis, reported from Sulawesi (Turner 2018). Thus far, *Friesodielsia* remains unknown from the Bismarck Archipelago and Bougainville, but is here newly recorded from the Louisiade Archipelago, which now serves as its easternmost extent. All the species known from New Guinea are morphologically distinct and may readily be distinguished from one another even when sterile. Despite the synopsis presented here, additional collecting efforts are undoubtedly needed to better assess species diversity in the genus along with the distribution ranges of the currently known species in Papuasia and Wallacea.

MATERIALS AND METHODS

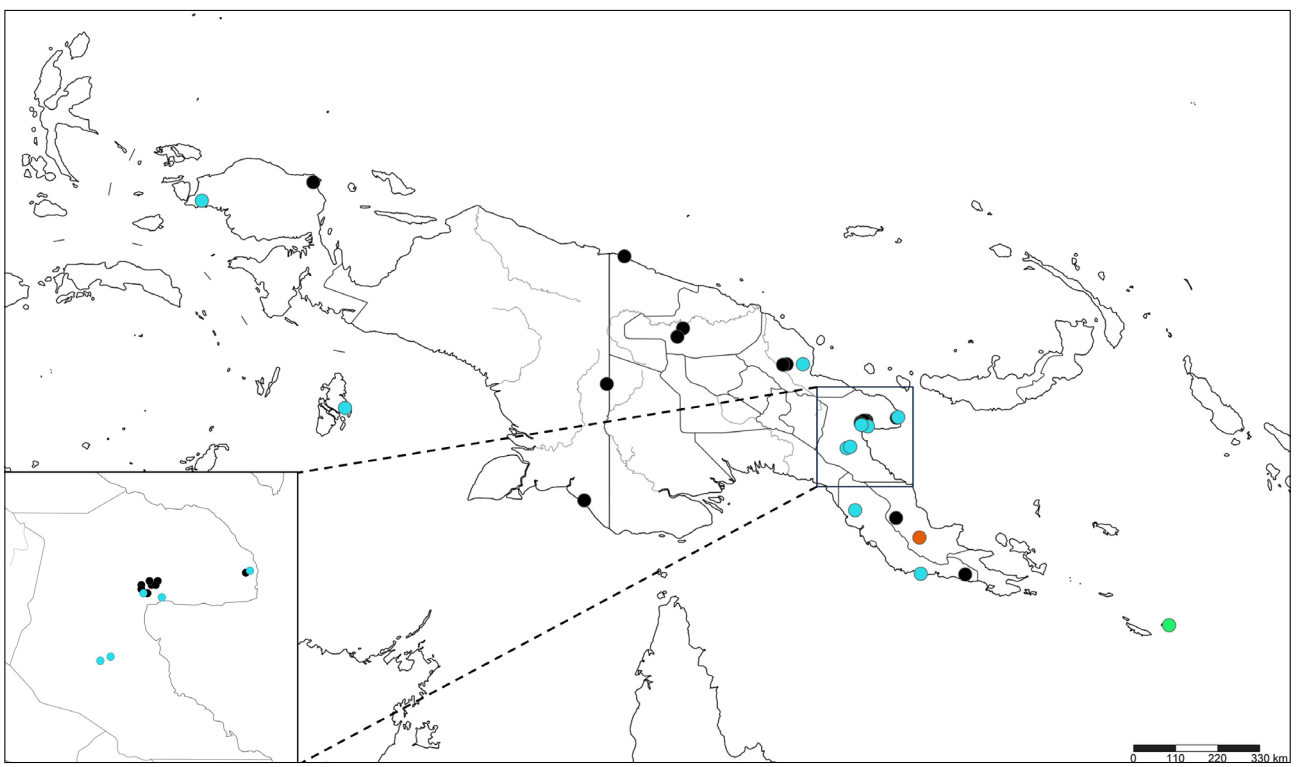
The precursor to this treatment began during the author's graduate studies at the 50-ha permanent Wanang Forest Dynamics Plot (WFDP), located in the middle Ramu basin of Madang Province (Papua New Guinea). A few sterile specimens of a rather common *Annonaceae* climber were encountered inside the plot and collected. This taxon had been colloquially referred to as '*F. glauca*' by local taxonomists, likely due to a handful of morphologically similar specimens at LAE being identified as such, a species otherwise not known from New Guinea. The enigma of its identity prompted a review of other *Friesodielsia* specimens at the LAE herbarium and others. A handful of flowering and fruiting specimens were found, which generally agreed with sterile specimens collected from Wanang. It was determined this was a widespread, yet undescribed species, here named *F. papuana*. In the process, two additional unidentified specimens representing two separate novel species were also located.

Fieldwork was conducted at the WFDP between the months of May and November 2022. Specimens of *Friesodielsia* were examined in person at BO, HUH, LAE, and SING, while specimen images were examined from BISH, K, L, MIN, RSA, and US (for herbarium abbreviation see Thiers continuously updated). All relevant material from New Guinea was examined and compared against species primarily from the Philippines and Borneo, along with specimens from the Moluccas. In addition, some collections under *Uvaria* L., another commonly collected lianescent genus, were examined for possible misidentified material, of which a few were found.

TAXONOMIC TREATMENT

Key to the New Guinea species of Friesodielsia

1. Leaves elliptic to obovate, tertiary veins conspicuous . . . 2
1. Leaves narrowly elliptic to narrowly oblong, tertiary veins usually inconspicuous 3
2. Base of leaf blade (sub)cordate, apex acuminate to caudate, indument dull brown, hairs only along veins. Flowering pedicels to 1 cm long; bracts foliaceous, 14–17 mm long; petals narrowly triangular . . . . . 4. *F. yelaensis*
2. Base of leaf blade acute to rounded, apex cuspidate to mucronate, indument ferruginous, hairs densely covering the abaxial lamina. Flowering pedicels > 1 cm long; bracts c. 6 mm long; petals broadly ovate-elliptic . . . . . 3. *F. subaequalis*
3. Young twigs, abaxial laminas, and outer petals glabrous. Petioles 3–5 mm long. Flowering pedicels 2–4.5 cm long . . . . . 2. *F. papuana*
3. Young twigs, abaxial laminas, and outer petals ferruginous. Petioles 7–10 mm long. Flowering pedicels 11–13 cm long . . . . . 1. *F. ferralta*



Map 1 Distribution of *Friesodielsia* in the New Guinea region: *F. ferralta* Ezedin (●), *F. papuana* Ezedin (●), *F. subaequalis* (Scheff.) R.M.K.Saunders, X.Guo & C.C.Tang (●), *F. yelaensis* Ezedin (●). Inset shows collections in Morobe.

Fig. 1 *Friesodielsia ferralta* Ezedin. a. Adaxial leaves; b. abaxial leaves; c. flower prior to anthesis; d. closeup of the proximal end of the unopened flower; e. calyx (all: *James 1200*, BISH). — Photos: S.A. James.

1. *Friesodielsia ferralta* Ezedin, *sp. nov.* — Fig. 1; Map 1

Similar to *F. papuana*, but differs in its rust-coloured indument covering the young twigs, abaxial veins, and petioles, longer flowering pedicels, smaller and thinner sepals, shorter outer petals, and longer inner petals. — Type: *James & Damas SAJ1200* (holo BISH [BISH1052906, BISH1052984] photo; iso L [L.3992650] photo, LAE [296518]), Papua New Guinea, Oro, Sibium Mountains, vicinity of Idoknama Camp (Camp 3), 1399 m, 21 Feb. 2013 (fl).

Etymology. From the Latin *ferrugineus* + *altus*; in reference to the rusty indument and the high altitude of the species.

Climbers or scrambling shrubs. *Indument* present on twigs, petioles, laminas, and primary veins, hairs simple, rusty orangish (brown). *Twigs* slender, terete, twining, when young densely rufous pubescent, glabrescent, when older longitudinally striate and dark greyish brown. *Leaves* narrowly elliptic to narrowly oblong, (6–)9–14(–17) by 1.5–3 cm, chartaceous, glossy dark green above and glaucous powdery blue-green below in vivo, dark brown (to blackish) above and glaucous light brown below in sicco, apex acuminate, base acute, margins entire, new leaves flushing reddish purple adaxially; petioles 7–10 by c. 1 mm, terete, broadly grooved, rusty pubescent when young, glabrescent, dark greenish grey in vivo, black in sicco; venation eucamptodromous, primary vein sharply impressed above, prominent below, number of secondary veins (11–)12–16, inconspicuous above, slightly raised below, spaced 6–13 mm apart, intersecondaries infrequent, tertiary veins inconspicuous above, weakly visible below, straight percurrent, c. 60° to nearly perpendicular to primary vein, quaternary veins straight percurrent. *Flowers* solitary, internodal, supra-axillary, green-yellow to light orange prior to anthesis; pedicel long, thin wiry, 11–13 by c. 0.1 cm; bract borne at c. 1/3 the distance from the base, narrowly triangular, c. 2 by 1 mm, outer side densely pubescent with long hairs; sepals 3, free, elongate triangular, c. 5 by 2 mm, apex acuminate, outer side pubescent with long appressed hairs, inner side glabrous, reflexed in sicco; outer petals 3, narrowly ovate-triangular, 50–70 by 6–7 mm, outer side sparsely rusty pubescent with short appressed hairs, inner side glabrous; inner petals 3, narrowly ovate, c. 1/3 as long as outer petals, c. 27 by 4 mm, glabrous; stamens, carpels, and receptacle not examined. *Fruits* unknown.

Distribution — Papua New Guinea (Oro). Only known from type collection.

Habitat & Ecology — Found growing in mossy forest at 1400 m a.s.l. Flowering: late February.

Conservation status — Data Deficient (DD). Can not be assessed due to insufficient information on extent of range. Assuming it is restricted to lowland montane forests along the Central Cordillera in the Papuan Peninsular region, there may likely be additional sites where it is present. Despite threats of logging and degradation, many areas in the highlands remain relatively intact as they often see less intense logging activities as compared to the lowlands.

Notes — 1. The type specimen was originally determined as *F.* cf. *bakeri* (Merr.) Steenis, a species otherwise only known from the Philippines and Borneo. While this species does indeed share some features with the latter, including long-tapering laminar apices, pubescent young twigs, elongated

flowering pedicels, petals, and sepals, it nonetheless markedly differs from *F. bakeri* with its shorter, broader leaves, acute leaf bases, longer petioles, narrower sepals, outer petals that are broader, shorter, and covered in a rust-coloured pubescence, and inner petals that are much longer. It may also be similarly confused with the lowland *F. papuana*, described below, but is easily differentiated by its smaller leaves and indument. The inner floral chamber could not be examined nor dissected and is thus excluded from the description here.

2. The type was collected at the elevation of 1 400 m, which appears to make this the highest occurring species of its genus. It may likely be restricted to mid-montane elevations and could perhaps be a montane relative of the lowland-restricted *F. papuana*, which it broadly resembles. Previously, the highest reported *Friesodielsia* species was *F. alpina* (J.Sinclair) Steenis, known from its type collection at 1 240 m in Peninsular Malaysia (*Yeob Forest Dept., F.M.S. 1451* [K!]). This species clearly differs from *F. alpina* in bearing a ferrugineous indument on young twigs, narrower leaves, longer flowering pedicels, and longer petals. Currently, the only other species known from above 1 000 m a.s.l. are *F. paucinervis* (Merr.) Steenis occurring from 700–1200 m in the Philippines (Pelser et al. continuously updated), *F. betongensis* Leerat. from 1000–1200 m in southern Thailand (Leeratiwong et al. 2023), *F. subaequalis* up to 1 200 m, and *F. papuana* up to 1 060 m in New Guinea (see below).

2. *Friesodielsia papuana* Ezedin, *sp. nov.* — Fig. 2, 3; Map 1

Similar to *F. glauca* but differs by its longer laminas, longer flowering pedicels, larger sepals, petals, and in the fruits generally bearing more monocarps. — Type: *Hartley 12278* (holo A [A00871713, A00871714]; iso L [L.1765022], LAE [65442], RSA [RSA0448536]), Papua New Guinea, Morobe, Bunga River about 15 miles NE of Lae, 15 m, 24 Oct. 1963 (fl).

Etymology. After the island of New Guinea.

Woody climbers when adults, upright to scrambling trees or shrubs when juvenile. *Indument* largely absent but sometimes sparsely present on young twigs and petioles, hairs simple, yellowish, appressed. *Twigs* slender, terete, upright to twining, when young glabrous green to light(-dark) brown, when older greyish brown to black, often lenticellate. *Leaves* narrowly oblong when juvenile to narrowly elliptic when mature, (7.5–)13–19(–24) by 2.9–5.5(–6) cm, chartaceous, glossy dark green above and glaucous blue-green below in vivo, (light-) dark brown above and glaucous light brown below in sicco, apex acuminate when juvenile and rounded to acute when adult, base obtuse to rounded when juvenile and rounded to subcordate when adult, margins entire, undulate in juveniles; petioles 3–5 mm long, grooved, glabrous, (light) green in vivo, black in sicco; venation eucamptodromous, primary vein sharply impressed above, prominent below, number of secondary veins (9–)11–17(–21), weakly impressed above, slightly raised below, spaced 12–21 mm apart, tertiary veins inconspicuous to weakly prominent above, straight percurrent, c. 45° to the primary vein, quaternary veins somewhat irregular, straight (to forked) percurrent. *Flowers* solitary, internodal, supra-axillary, (whitish to) light orange at anthesis; pedicel (2–)3.5–4.5 by c. 0.1 cm, sparsely appressed hairy to subglabrous; bract borne at 1/3 the distance from the base, triangular, c. 3 by 1–1.5 mm, outer side densely appressed hairy, inner side glabrous; sepals 3, free, triangular, c. 8 by 4 mm, apex acute, glabrous; outer petals 3, narrowly obovate triangular, c. 55 by 6–9 mm, glabrous; inner petals 3, c. 1/4 as long as the outer petals, 14–16 by 3–4 mm, glabrous; stamens many, in 4–5 series, 1.5–2 mm long, connective apex truncate, pentagonal, irregular, curved away from thecae towards the stigmatic center, without prominent prolongation; carpels many, in 3–4 series, 4–5 mm long, stigmas c. 2 mm long, apex hairy, ovaries c. 2 mm long, densely golden brown hairy, ovules 1 per ovary. *Fruits* consisting of (9–)13–28 monocarps, each aggregate cluster up to 4.3 cm wide; pedicel 3.5–4 by 0.1–0.2 cm, subwoody, thickened distally; stipe 6–8 mm long; monocarps subglobose to ovoid, 7–10 by 4–6 mm, apex mucronate, yellow to reddish then maturing purple, pericarp thin. *Seeds* ovoid, 6–8 by 5–6.5 mm, testa yellow brown.

Distribution — Indonesian Papua and Papua New Guinea.

Habitat & Ecology — Occurs in lowlands to lower montane forests up to 1 060 m a.s.l. Appears to be more commonly associated with ridges and steep slopes in hill forest. Thus far known from the Papuan Peninsula region on the PNG side and from the Vogelkop Peninsula and Aru Islands on the Indonesian side. The species appears to grow in a wide variety of substrates including clayey and sandy soils. Flowering: June–December;

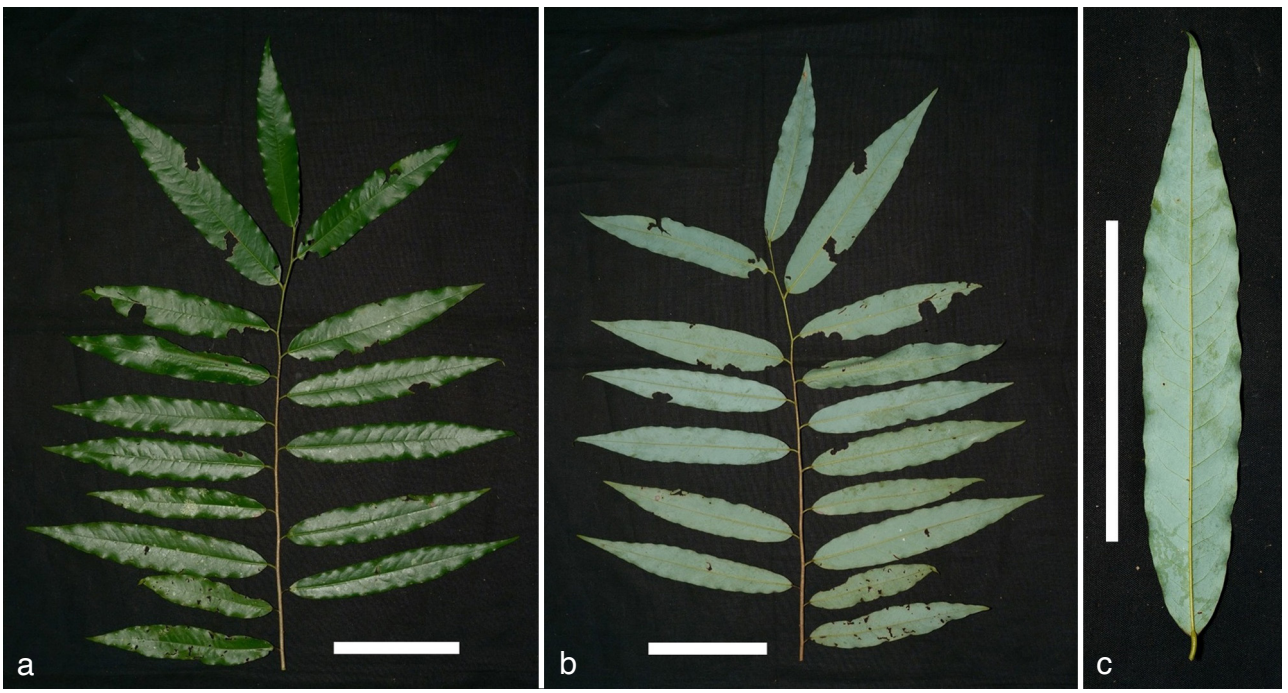


Fig. 2 *Friesodielsia papuana* Ezedin. Twigs and leaves of a juvenile upright individual from Wanang, Madang Province. a. Twig, adaxial side; b. twig, abaxial side; c. leaf, abaxial side (all: *Ezedin 1395*, MIN). — Scale bar = 10 cm. — Photos: Z. Ezedin.

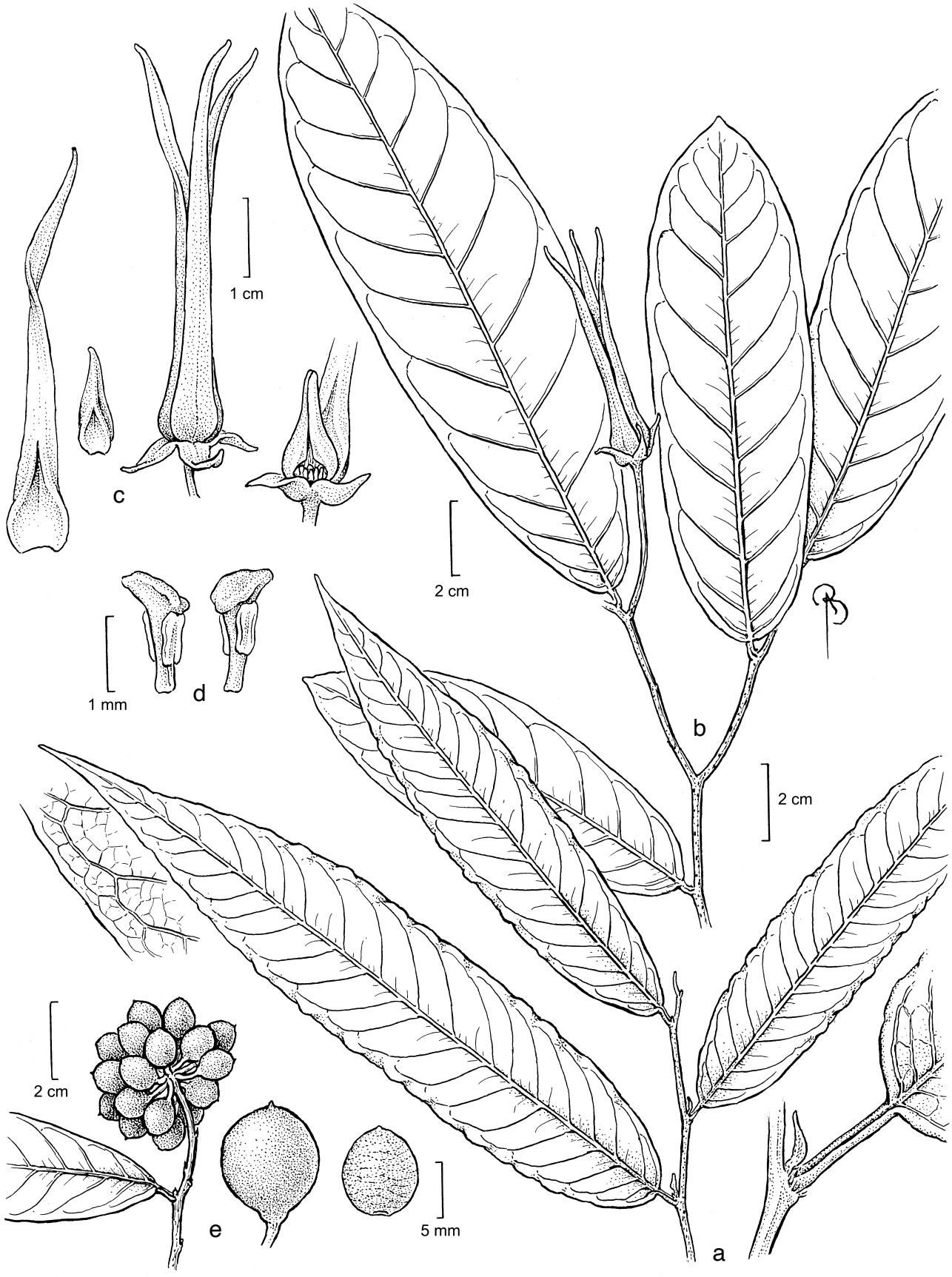


Fig. 3 *Friesodielsia papuana* Ezedin. a. Juvenile twig with leaves and closeup of petiole and leaf axils; b. adult twig with leaves and a flower; c. outer petal, inner petal, whole flower, and closeup of inner petals showing inner chamber (from left to right); d. stamen (lateral views); e. infructescence, single monocarp, and seed (from left to right) (a: *Ezedin 1395*, MIN; b–d: *Hartley 12278*, A; e: *Womersley & Jones 8815*, A). — Illustration by B. Angell.

fruiting: February–November; it likely flowers and fruits year round. In the floral chamber of the type specimen, *Hartley 12278*, several small beetles representing at least three distinct species were found. They belong to the families *Nitidulidae* and *Staphylinidae*, which have been previously recorded in *Annonaceae* and species of the latter have been recorded previously in *F. borneensis* (Miq.) Steenis as active vectors of pollen (Gottsberger & Webber 2017, Lau et al. 2017). Fruit dispersers unknown.

Vernacular name — Ipé kapé simi (Magi).

Uses — Semi-dried leaves are used as rolling paper in the making of traditional cigarettes (Wanang).

Conservation status — Least Concern (LC). This species has a broad distribution across New Guinea, including the Aru Islands. It appears to occupy various types of lowland forest habitats on various substrates, thus lessening the impacts of any potential threat. At the WFDP, this species appears to be rather infrequent with only ten juvenile individuals having been counted (mistakenly as 'trees') in the most recent plot census. However, this is an artifact since adult individuals are not counted in the census due to being lianescent. Therefore, an assessment of LC is given here (IUCN 2022).

Specimens examined (paratypes). Indonesia, Maluku, Aru Islands Regency, P. Kobroor, Kp. Kobroor, S6°15' E134°45', 10 m, 26 Mar. 1993 (fr), *van Balgooy & Mamesah 6467* (L [L.1765063, L.1765064, L.1765065, U.1072544]); ibid., 27 Mar. 1993 (fr), *van Balgooy & Mamesah 6484* (L [L.4345925]); West Papua, Sorong, behind Kp. Baroe, 28 July 1948 (fl), *Djamahari 408* (BO [1371791], L [L.1765014]). – Papua New Guinea, Central, Mori River, Abau subdist., 240 m, S10°10' E148°20', 13 Feb. 1969 (fr), *Henty & Lelean NGF 41857* (L [L.1765013], LAE [111521]); Central, between the villages of Kubuna and Baikodu on the road to Tapini, 220 m, 5 Sept. 1998 (st), *Katik & Rali 482* (LAE [272812]); Madang, S of the Gogol River near Mawan village (c. 25 km inland), 60 m, 22 June 1955 (fl), *Hoogland 4924* (LAE [8783]); Madang, near Swire Station, Usino-Bundi district, S5°13'39" E145°4'47", 80–180 m, 14 Nov. 2022 (st), *Ezedin 1395* (MIN); Morobe, Heldsbach, 212 m, S6°28' E147°48', 13 Sept. 1935 (st), *Clemens 115* (L [L.1765021]); ibid., 9 Nov. 1935 (fr), *Clemens 886* (L [L.1765020]); Morobe, Bulolo Valley, 1067 m, 6 June 1956 (fr), *Womersley & Jones NGF 8815* (A [A00871715], LAE [9009: 2 shts]); Morobe, W of Bulolo, near Bulolo-Watut divide, S7°10' E146°40', 792 m, 20 Dec. 1965 (fl), *Frodin & Hill NGF 26345* (L [L.1765015], LAE [76254]); Morobe, Mt. Susu, Bulolo, S7°10' E146°40', 910 m, 8 Aug. 1967 (fl), *Streimann & Kairo NGF 30743* (A, L [L.1760504]); Morobe, Hills near Taraka, S6°39' E146°56', 150 m, Mar. 2006 (fr), *Takeuchi & Ama 20985* (K [K001870511], L [L.3729202, L.3729203]).

Notes — 1. *Friesodielsia papuana* looks similar to *F. glauca*, which is a variable and complex species found primarily in western Malesia (Satthaphorn et al. 2024). Although there are several specimens of the latter species observed with overlapping character states, the New Guinea specimens appear to be distinct. A morphological comparison of useful traits between the two species and a couple others is provided in Table 1.

2. It should be noted that the juvenile morphology of *F. papuana* appears to differ from that of adult individuals. When juvenile, its growth is upright to scrambling and thus its habit may appear as that of a small tree or shrub (pers. obs.). During this juvenile phase, the leaves are often narrower, much longer (up to c. 38 cm long), more narrowly elliptic-oblong with the apices long-acuminate, and the margins undulate (Fig. 2, 3a). In its adult stage, its habit is that of a true woody climber and the leaves become broader and the apex not as strongly tapering (Fig. 3b). These observations are further substantiated by those made by the indigenous landowners (pers. comm.), who recognize the juvenile and adult morphologies as part of the same taxon. The flowers are described as white (*Djamahari 408*), yellow and red (*Streimann & Kairo NGF 30743*), or pale yellow and weakly fragrant (*van Balgooy & Mamesah 6467*).

3. The specimen chosen as the type was included in the phylogenetic study by Guo et al. (2018b: f. 6, S2), where it was found to resolve in clade II of the genus, sister to *F. longiflora* (Merr.) Steenis of the Philippines with questionable support. Despite this, it was still found to be nested in a well-supported subclade consisting of Filipino and Malayan species: *F. bakeri*, *F. latifolia* (Hook.f. & Thomson) Steenis, *F. paucinervis* (Merr.) Steenis. Biogeographic analyses point to the ancestor of *F. papuana* arriving from the Philippines (Guo et al. 2018b: f. S3, S4).

3. *Friesodielsia subaequalis* (Scheff.) R.M.K.Saunders, X.Guo & C.C.Tang — Fig. 4; Map 1

Friesodielsia subaequalis (Scheff.) R.M.K.Saunders, X.Guo & C.C.Tang (2020) 183. — *Mitrephora subaequalis* Scheff. (1885) 20. — *Scheffero-mitra subaequalis* (Scheff.) Diels (1912) 152. — Lectotype (designated by Diels 1912): *Beccari PN 523* (lecto FI-B [B100365083] photo; isolecto B [B 10 0365083] photo, FI-B n.v.), Indonesia, West Papua, Andai, 22 Aug. 1872 (fl).

Mitrephora subaequalis var. *macrocalyx* Scheff. (1885) 21. — Lectotype (designated by Turner 2018): *Beccari PP 863* (lecto FI-B [FI007599] photo), Indonesia, Papua, Monte Arfak a Putat, Oct. 1872 (fl).

Woody climbers or scrambling shrubs. *Indument* present on twigs, petioles, veins, and abaxial laminas, hairs simple, golden orange. *Twigs* slender, terete, upright to twining, when young orangish rusty pubescent, when older dark brown to grey, glabrous, (densely) lenticellate. *Leaves* variable, (elliptic to) oblong to obovate, (5–)10–25 by (3–)6–9 cm, chartaceous, dull mid(-dark) green above and bluish white glaucous below in vivo, light (reddish) brown above and glaucous light brown below in sicco, apex rounded (to bluntly acute) to mucronate (to subacuminate), base acute (to rounded) to subcordate, sometimes weakly asymmetric, margins entire; petioles 4–10 mm long, shallowly grooved, glabrescent, light green in vivo, dark brown in sicco; venation eucamptodromous to weakly brochidodromous, primary vein (weakly) impressed above, prominent below, pubescent above, number of secondary veins (9–)12–15, flat above, slightly raised below, spaced 1–2 cm apart, tertiary veins conspicuous below, straight percurrent, c. 45° to

Table 1 Morphological comparison between *Friesodielsia papuana* and similar species. Measurements and observations of the other three species taken from digitized specimens; juveniles not included.

	F. papuana	*F. glauca*	*F. mindorensis*	*F. paucinervis*
Distribution	New Guinea	Malay Pen., Borneo, Sumatra	Philippines	Philippines
Leaves (cm)	(7.5–)13–24 by 2.9–6	8.3–12.5 by 3.7–5	14.5–25.5 by 5–7.5	5.5–10 by 2.1–3.5
Secondary veins	9–21	7–12	16–22	5–9
Indument on twigs	Absent	Present or absent	Present	Present
Apex	Rounded to acute	Acuminate to caudate	Acuminate to caudate	Acuminate
Pedicel length (cm)	(2–)3.5–4.5	1.4–4	2.4–3	0.8–2.1
Sepals (mm)	c. 8 by 4	c. 4 by 2	c. 2.5 by 1.5	N/A
Outer petals (mm)	c. 55 by 6–9	16–26 by 2.5–4	10–23 by 4–5	N/A
Inner petals (mm)	14–16 by 3–4	7–10 by 2–2.5	c. 4 by 3.5	N/A
Monocarps	(9–)13–20(–28)	(6–)12–15(–22)	N/A	4–7

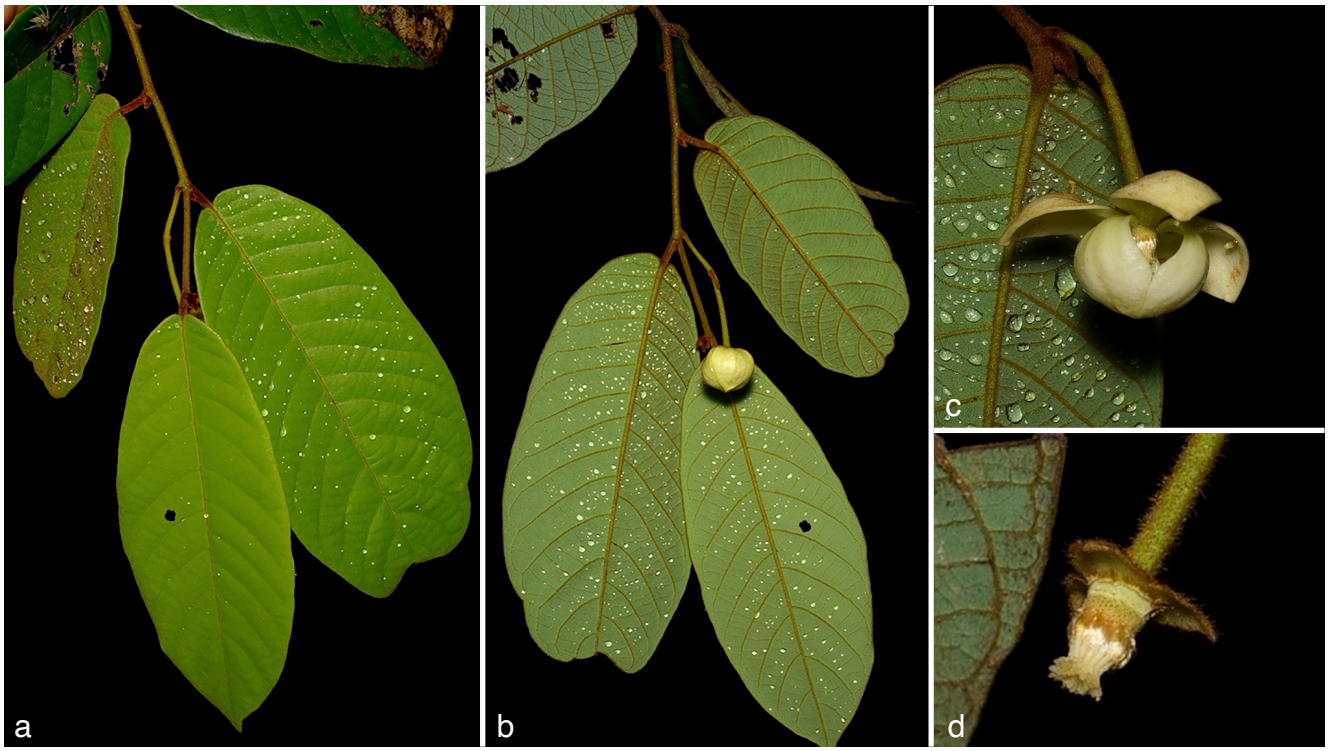


Fig. 4 *Friesodielsia subaequalis* (Scheff.) R.M.K.Saunders, X.Guo & C.C.Tang. a. Adaxial leaves; b. abaxial leaves with flower bud; c. flower at anthesis; d. spent bloom with stamens and petals fallen, revealing the carpels (all: *Ezedin 1365*, A). — Photos: Z. Ezedin.

the primary vein, quaternary veins regular, straight (to forked) percurrent. *Flowers* solitary, leaf-opposed to supra-axillary, off-white or cream at anthesis; pedicel (1–)2–4 by c. 0.2 cm, rusty brown hairy; bract borne at 1/3–1/2(–3/4) the distance from the base, triangular, 3–6 by 1–2 mm, outer side densely hairy, inner side glabrous; sepals 3, free, triangular, 3–4 by 4–5 mm, apex acute, outer side hairy, inner side subglabrous, with a continuous ring of hairs surrounding the base of the outer petals; outer petals 3, fleshy, broadly ovate-elliptic, c. 10–20 by 8–15 mm, spreading, outer side lightly rusty hairy, inner side glabrous; inner petals 3, ± equal to the outer petals, rounded, apically connivent and forming a mitriform dome, glabrous; stamens many, in 3–5 series, 2–3 mm long, connective apex rounded, dome- to tongue-shaped; carpels many, in 2–3 series, c. 3 mm long, vase-shaped, stigmas c. 2 mm long, (sub-) glabrous, apex flattened and curved outwards, ovaries c. 1 mm long, densely rusty orange hairy. *Fruits* consisting of (3–)6–14 monocarps, each aggregate cluster up to 6 cm wide; pedicel 1–3 by (0.1–)0.2 cm, subwoody, stipe (5–)8–20 mm long, hairy; monocarps (sub)globose to ovoid(–oblong), 10(–15) by 8–10 mm, apex pointed mucronate, sparsely hairy, yellowish orange (to red) when mature, pericarp thin. *Seeds* 1 or rarely 2, (sub)globose, 7–8 by 5–6 mm, testa yellowish.

Distribution — Indonesian Papua and Papua New Guinea.

Habitat & Ecology — Found growing on limestone or mafic substrates in primary lowland hill forests up to 400(–1200) m a.s.l. All specimens are known from below 400 m with the exception of one collection from Sattelberg at 900–1200 m. Often associated with ridges or crestlines. Flowering: July–August, fruiting: October–February. Pollinators and dispersers unknown.

Vernacular names — Asanaka (Waskuk), Fai (Wagu), Simed simi (Magɨ), Iekarwaar (Kebar).

Conservation status — Least Concern (LC). Very common liana found throughout the New Guinea lowlands on various substrates, including in regenerating secondary forests and along forest margins, suggesting some level of tolerance to disturbance. Due to this, it is here assessed as LC (IUCN 2022).

Specimens examined (paratypes). Indonesia, Papua, Soengei Maroka [=? Sungai Merauke [= Sungai Maro]], Apr. 1901 (fr), *Jaheri 341* (BO [1363625, 136326]); Papua, Ingenbit rd. to Opka, 8 June 1967, *Reksodihardjo 418* (L [L.1765023]). – Papua New Guinea, Central, Kokoda, 365 m, 12 Mar. 1936 (fl), *Carr 16117* (L [L.1768169], NY [NY04727934], SING); Central, Abau subdistrict c. 12 km N of Amazon Bay, N of Nunumai village across Ulumanok River, 50 m, S10°11' E149°23', 23 June 1969 (fr), *Kanis 1070* (A [A00871719], L [L.4266417], LAE [207906]); East Sepik, Sepikgebiet, [1912], *Ledermann 9831* (A, L [L.4266425]); East Sepik, near Wagu, Ambunti subdistrict, 91 m, S4°22' E142°43', 2 July 1966 (fl), *Hoogland & Craven 10431* (A [A00871722, A00871723], L [L.4266422], LAE [143742]); East Sepik, April River near confluence with the Sitipa, 200 m, S4°34' E142°35', 22 July 1995 (fl), *Takeuchi 10368* (A [A00871718], L [L.1765018, L.1765019]); East Sepik, April River, Samsai ridge near Bugabugi camp, 200 m, S4°34' E142°34', 9 Sept. 1990, *Takeuchi 6810* (A [A00871717], L [L.4266416]); Madang, Wanang village, 115 m, S5°13' E145°10', 13 Aug. 2007 (st), *Weiblen & BRC WP4B3505* (LAE [291738], MIN [912275]); Madang, near Swire Station, Usino-Bundi district, S5°13'39" E145°4'47", 80–180 m, 11 Nov. 2022 (fl), *Ezedin 1365* (A); Morobe, Sattelberg, S6°29' E147°46', 900–1200 m, 29 Nov. 1935 (fl), *Clemens 1002* (A [A00871726], BR [BR0000027842324], L [L.4266420, L.4266421]); Morobe, near the Butibum River about 7 miles N of Lae, 92 m, 19 Apr. 1963 (fl), *Hartley 11636* (A [A00871727], LAE [66618], SING); Morobe, Busu River, 15 miles from Lae, Lae subdistrict, 76 m, S6°35' E147°00', 27 Mar. 1969 (fl, fr), *Native collector for Womersley NGF 37479* (A [A00871725], BRI [AQ0351348], L [L.4266418], LAE [112176]); Morobe, Buaru Creek, Lae, 91 m, S6°35' E146°55', 6 Apr. 1972 (fl, fr), *Katik NGF 46875* (L [L.4266424], LAE [201583]); Morobe, Tributary of Busu River, above Sankwep River, Lae subdistrict, 243 m, S6°33' E147°03', 13 Apr. 1972 (fl), *Katik for Womersley NGF 43923* (A [A00871724], BRI [AQ0351327], L [L.4266423], LAE [145606], SING); Morobe, N of Busu River and E of Sankwep River, near Gwabadik village, S6°33' E146°59', 365 m, 11 Feb. 1993 (fr), *Takeuchi 8769* (A [A00871716, A00871721], BRI [AQ1042659], L [L.1754994, L.1754995, L.3728780, L.3728781], LAE [266896], NSW [NSW825923, NSW825924], NY [NY03790717]); Morobe, Lae, hills near Taraka, S6°37' E146°55', 200 m, 29 Aug. 2004 (fr), *Takeuchi & Ama 17066* (A [A00871720], K [K001870090], L [L.1767766, L.1767767, L.1767768, L.1767769, L.3728918, L.3728919], LAE [288582]); ibid., 29 Aug. 2004 (fl, fr), *Takeuchi & Ama 17066B* (L [L.1767762, L.1767763, L.1767764, L.1767765], LAE [283111]); Sandaun, Pevi, Vanimo, Vanimo subdistrict, S2°40' E141°20', 120 m, 25 Jan. 1969 (fr), *Streimann & Kairo NGF 39182* (L [L.1765017], LAE [110739], SING).

Notes — 1. First described as a species of *Mitrephora* Hook.f. & Thomson by Scheffer (1885), it was eventually moved to its

own genus, named *Schefferomitra*, by Diels (1912). Until recently this species remained treated under the monotypic *Schefferomitra*, likely due to its lianescent habit and floral morphology. In subsuming it under *Friesodielsia*, Guo et al. (2017: 11) state that their detailed morphological study of the formerly monotypic genus "failed to reveal any character that supports the continued recognition of *Schefferomitra*" and that the "only consistent difference" was the shape of the staminal connective, which is conical (vs truncate). However, the flowers generally look unlike most *Friesodielsia* which tend to have strongly unequal outer and inner petals that are narrowly triangular in shape, inner petals tightly enclosing the chamber with small apertures, and the outer petals almost never fully reflexed at anthesis. Instead, flowers of *F. subaequalis* bear subequal outer and inner petals, broadly ovate-elliptic petals, fully open and reflexed outer petals, inner petals that are only connivent at the apex forming a dome (reminiscent of the mitriform dome in some *Miliuseae* genera), and with wide apertures allowing ease of access to

Fig. 5 *Friesodielsia yelaensis* Ezedin. a. Twig with leaves and flowers; b. flower with medial bract; c. outer petals, inner petals, and sepals, with the anterior outer and inner petals removed showing inner chamber; d. closeup of inner petals and inner chamber; e. carpel (lateral view), stamen (lateral view), and stamen (abaxial view) (from left to right) (all: *Brass 28329*, A). — Illustration by B. Angell.

the inner chamber (Fig. 4c). The overall morphology of the petals recall those of the African *Monanthotaxis obovata* (Benth.) P.H.Hoekstra, a species formerly classified in *Friesodielsia*. Within the genus, as currently circumscribed, the species that most closely approaches it is the Indian *F. sahyadrica* N.V.Page & Survesw. with its near subequal outer and inner petals (Page & Surveswaran 2014). In light of the odd combination of floral traits, it is understandable as to why it had been classified separately in its own genus prior to being molecularly sampled.

2. Phylogenetically, *F. subaequalis* occupies and isolated, yet nested position within the genus, being sister to one of its two primary clades, named I and II by Guo et al. (2018a). Clade I, to which this species is sister, is composed of Malesian species whereas clade II, with *F. sahyadrica* as its sister, is primarily south Asian (Guo et al. 2017). The two clades can be differentiated primarily by the connivence of the outer petals in bud: free in clade II and connivent in clade I (Guo et al. 2018a). Another notable distinction of clade I is the near subequal petals of some species such as *F. sahyadrica* and *F. calycina* (King) Steenis. Given the ancestral positions of *F. subaequalis* and *F. sahyadrica* in clades I and II, respectively, subequal petals could represent retention of the ancestral trait at the base of crown *Friesodielsia*.

3. There is variability in laminar shape, ranging from (narrowly) elliptic to obovate and measuring 4.5 by 3 cm up to 18 by 8.5 cm in size. Specimen labels have variously reported its habit as a 'liana' (*Womersley NGF 37479*), 'shrub-treelet' (*Takeuchi 8769*) or 'treelet' (*Kanis 1070*). However, all of these specimens are fruiting, suggesting that *F. subaequalis* either has a variable habit (shrub/tree to liana) perhaps determined by local environmental factors, or an ability to flower and set fruit at a relatively young age. The flowers are reported as green (*Native collector for Womersley NGF 37479*) to white (*Katik for Womersley NGF 43923*). The specimen which deviates most prominently from the rest is *Kanis 1070*, with narrowly oblong laminas measuring 8–14 by 2.5–5 cm), twigs with longer hairs, abaxial laminas less densely hairy, fruiting pedicels not thickened, and monocarps noted as ripening red (vs orange).

4. Vegetatively, its morphology appears similar to that of *F. pubescens* (Merr.) Steenis from the Philippines, but the latter lacks the prominently raised tertiaries on the abaxial side.

5. The flowers emit no fragrance (pers. obs.).

4. *Friesodielsia yelaensis* Ezedin, *sp. nov.* — Fig. 5; Map 1

Differs from *F. subaequalis* in having caudate leaf apices, shorter pedicels, larger foliaceous medial bracts that are equal to or larger than the sepals, longer more prominent sepals. — Type: *Brass 28329* (holo A [A00871712]; iso BO [1372564], L [L.1765025] photo, LAE [29454], US [US03900190] photo), Papua New Guinea, Milne Bay, Rossel Island, Abaleti, 50 m, 5 Oct. 1956 (fl).

Etymology. After the indigenous name of Rossel Island (Yela).

Woody climbers. *Twigs* slender, terete, twining, when young densely rusty brown pubescent, when older longitudinally striate and black. *Indument* of simple hairs, dark brownish orange, covering twigs, petioles, and primary vein. *Leaves* oblong to obovate, (8.5–)10–14(–17.6) by 3–5(–6.8) cm, chartaceous, dark olivaceous to light brown above and dark olivaceous below in sicco, apex (acute to) acuminate to (strongly) caudate, base (sub)cordate, margins entire; petioles 6–11 by c. 2 mm, terete, adaxially flattened to weakly grooved, densely rusty pubescent when young then becoming glabrous, black; venation eucamptodromous to weakly brochidodromous, primary vein flat to weakly impressed above, prominent below, secondary veins 14–16(–18), ± flat above, weakly raised below, spaced 9–20 mm apart, intersecondaries absent, tertiary veins prominent below, straight percurrent, closely spaced, c. 45° to the primary vein, quaternary veins irregular, forked to straight percurrent. *Flowers* solitary, internodal, supra-axillary and nearly leaf-opposed, appearing just below the leaf axils opposite the leaves, brown prior to anthesis; pedicels 0.3–1 by c. 0.1 cm, densely brown pubescent; bracts borne at c. 1/2 the distance from the base or appearing basal when flowers are subsessile, large, narrowly triangular, foliaceous and with distinct venation to the third order, equal to or larger than the sepals, 14–17 by 2–3 mm, pubescent on both sides, with hairs more dense on the primary vein and base; sepals 3, free, triangular, 10–14 by 3–4.5 mm, apex acuminate, pubescent on both sides, with hairs more dense on outer side and towards the base; outer petals 3, narrowly ovate-triangular, 50–65 by 5–7 mm, outer side (sparsely) hairy, inner side glabrous, with a prominent midrib; inner petals 3, narrowly ovate, c. 1/4 the length of the outer petals, c. 16 by 4–5 mm, glabrous, with a small tuft of hair at the apex; stamens 50–60, in 3–4 series, 1.5–2 mm long, connective apex truncate, pentagonal, irregular, curved away from thecae towards the stigmatic center, without prominent prolongation; carpels many, in 2–3 series, 3–3.5 mm long, stigmas 1–1.5 mm long, apex hairy, broad, curving outwards, partially covering the adjacent stamen series, ovaries c. 2 mm long, with appressed long hairs, ovules 1 per ovary. *Fruits* unknown.

Distribution — Papua New Guinea (Rossel Island). Only known from the type collection.

Habitat & Ecology — Found in lowland rainforests at 50 m a.s.l. Flowering: October. Pollinators and dispersers unknown.

Conservation status — Data Deficient (DD). Thus far only known from the type collection from Rossel Island. Threats to the species are unknown, along with its true extent of occurrence. However, assuming the species is endemic to the island and given the island's small size of 292.5 km^2, likely with an even smaller area of suitable habitat in non-degraded lowland forest, it would likely qualify as either endangered or critically endangered (IUCN 2022). Whether or not this species occurs at higher elevations is also not yet known, although this may be inconsequential assuming its endemicity to the island. Unfortunately, further field assessment would be needed to confirm its extent of occurrence on the island and whether or not populations are present on any adjacent islands of the Louisiade Archipelago (i.e., Sudest, Misima).

Notes — 1. *Friesodielsia yelaensis* is unique in the genus in several respects. First, it represents both the southernmost and easternmost occurring species of the genus at 11° south and 154° east. Its morphology is equally striking with its subsessile flowers and large triangular bracts and sepals, both of which are foliaceous. While large, foliaceous bracts and sepals are found in some other species such as the Indochinese *F. affinis* (Hook.f. & Thomson) D.Das and the Peninsular Malaysian *F. calycina*, it is thus far unique for eastern Malesia. The combination of both floral and leaf traits easily distinguish this species from others in the region.

2. Being recorded from Rossel Island is also unique in itself. The island, which is the easternmost of the Louisiade Archipelago, is known to harbour an unusually high level of endemism for its small size of just under 300 km^2. There are a total of 38 endemic species recorded from the island, representing a wide array of families and even an endemic genus, *Rosselia* Forman (*Burseraceae*) (Johns et al. 2009). Given this, it is likely that there are additional endemic taxa from the island that await description.

DISCUSSION

All four species of New Guinea *Friesodieslia* are endemic to the region. The absence of *Friesodielsia* from the Bismarck Archipelago may possibly be an artifact of poor collecting or

could in fact be legitimate due to its absence from Bougainville and the Solomon Islands. *Friesodielsia subaequalis* is the most morphologically unique member as its floral plan deviates from the rest of the genus. The other three species have floral morphologies that appear to match those of other triquetrous connivent species found in Indochina and western Malesia (Leeratiwong et al. 2021). The isolated phylogenetic placement of *F. subaequalis* along with its odd morphology suggests it arrived separately from the other three species (Guo et al. 2017). Furthermore, it is known that *F. papuana* likely arrived via the Philippines (Guo et al. 2018b). Thus, it could be inferred that *Friesodielsia* independently colonized New Guinea at least twice. Given the late Miocene crown age of *Friesodielsia*, with estimates ranging from 11 Ma (Guo et al. 2018b) to 9 Ma (Pirie & Doyle 2012), these arrivals to New Guinea would have been recent, taking place during the island's active expansion. Increased molecular sampling across the genus is still needed to better examine its biogeographic expansion across Malesia.

The presence of what appears to be distinct juvenile and adult morphologies in *F. papuana* is largely undocumented for the genus and elsewhere in the family. While many woody species in New Guinea exhibit this feature, and those who work in the field are able to notice these patterns over time, it is something that is rarely documented in the literature. When young, individuals of *F. papuana* observed in the WFDP grow upright and may be easily confused for a shrub or small tree. Although not yet directly observed for *F. subaequalis*, a couple of specimens indicate the habit as a shrub or small tree. Other species of *Friesodielsia* from elsewhere have also been described as scandent shrubs, including all five species described from Thailand by Leeratiwong et al. (2021). Detailed field observations of other species will aid in better assessing the life history of the genus.

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