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THE CONFUSING TAXONOMY AND NOMENCLATURE OF *SYZYGIUM CONFUSUM* COMPLEX (MYRTACEAE)

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ABSTRACT
WIDODO, P. & VELDKAMP, J. F. 2021. The confusing taxonomy and nomenclature of *Syzygiun confusum* complex (Myrtaceae). *Reinwardtia* 20(2): 43–49. — The taxonomic and nomenclatural confusions surrounding the *Syzygium confusum* complex are elucidated. For that purpose, type specimens are designated and circumscriptions are presented for each species. Typifications, newly characterized descriptions and illustrations are presented for *Syzygium korthalsii* Widodo, *S. confusum* (Blume) Bakh.f., *S. blumei* (Steudel) Merr. & L.M.Perry, *S. insigne* (Blume) Merr. & L.M.Perry. The new species *Syzygium sipirokense* Widodo & Veldkamp is described.

Key words: *Jambosa*, Malesia, Myrtaceae, Southeast Asia, *Syzygium*.

ABSTRAK
WIDODO, P. & VELDKAMP, J. F. 2020. Kekusutan taksonomi dan tata nama kompleks *Syzygium confusum* (Myrtaceae). *Reinwardtia* 20(2): 43–49. — Kekusutan taksonomi dan tata nama jenis seputar kompleks *Syzygium confusum* dicoba diuraikan dengan pemantapan penunjukan spesimen-spesimen tipenya. Selanjutnya perapian batasan takson yang termasuk jenis kompleks juga telah dilakukan. Oleh karena itu pemantapan nama dan pertelaan serta ilustrasi *Syzygium korthalsii* Widodo, *S. confusum* (Blume) Bakh.f., *S. blumei* (Steudel) Merr. & L.M.Perry, *S. insigne* (Blume) Merr. & L.M.Perry dan jenis baru *Syzygium sipirokense* Widodo & Veldkamp disajikan.

Kata kunci: Asia Tenggara, *Jambosa*, Malesia, Myrtaceae, *Syzygium.*

INTRODUCTION

In studying the Sumatran free petalled species of *Syzygium* one may have difficulty in identifying the species with narrow leaves, especially because some of their representatives are rare and hence poorly known (Backer & Bakhuizen van den Brink Jr., 1963:343). In April 1972, for the Flora Malesiana project, Bakhuizen van den Brink Jr. & van Steenis tentatively identified and annotated two specimens preserved in L (namely HLB no. 898.203-342 part of Herb *Blume s.n*. collected in Java without definite locality and HLB no. 898.203-344 collected around Bogor, Java by an unknown collector) as *Syzygium confusum* (Blume) Bakh.f. Another specimen (HLB no 898.203-345 collected in Mount Malintang, West Sumatra by Korthals) was tentatively identified by them as *Syzygium* cf. *confusum* (Blume) Bakh.f.

In 1846 Korthals had already identified his collection (HLB 898.203-345) as *Jambosa lanceolata* Korthals. Confusion arose when Blume (1849) proposed the name *Jambosa confusa* Blume for other material from Java and Sumatra, inferring that Korthals's name was superfluous, as *Jambosa lanceolaria* was an earlier name for Korthals's material, based on *Eugenia lanceolaria* Roxb. (1832). To rectify this, Blume (1850) proposed *Jambosa korthalsii* Blume as a new name for *Jambosa lanceolata* Korthals. Although these specific epithets are similar, they do not mean exactly the same thing because *lanceolarius* (= small tip of a spear) and *lanceolatus* (= lancet-shaped) and they are not confusable under the ICNafp (Turland *et al*., 2018). In this case, what is the nomenclatural status of Blume's proposed new name *Jambosa korthalsii* Blume? Is it a superfluous name? Korthals' specific epithet *lanceolatum* cannot be transferred to *Syzygium* because it is pre-empted by the combination *S. lanceolatum* (Lam.) Wight & Arn. (1834). It is clear, therefore, that there is a need to clarify this nomenclaturally confused situation.

In revising the taxonomy of the narrow leaves *Syzygium* in Sumatra (Widodo, 2011) we found that twigs, leaf shape, leaf base and apex more often than not offer valuable characters for deli miting species. Consequently, morphological variation in these characters in the *Syzygium confusum* complex will be given special attention.

During the course of this study, in BO we found specimens from Sumatra with characteristics very much like *Syzygium insigne* (Blume) Merr. & L.M.Perry and *S. blumei* (Steudel) Merr. & L.M.Perry (species also related to the *Syzygium confusum* complex) but with consistently varying characteristics. We take this opportunity to describe these specimens and propose a species new to science.

MATERIALS AND METHODS

Materials used in this research are herbarium specimens from Sumatra, Java, and Borneo preserved in the herbaria of BO, L and K. Procedures and methods of observations used in this study mostly followed those elaborated by Rifai (1976), de Vogel (1987), Widodo (2011) and Widodo (2012).

RESULTS AND DISCUSSION

Results of our renewed observations of morphological characters of *Syzygium confusum* complex are presented in Table 1. We found that combinations of these characters are of assistance for delimiting closely related species as can be observed in Table 1.

1. SYZYGIUM KORTHALSII Widodo. — Fig. 1.
Jambosa lanceolata Korth. Ned. Kruidk. Arch. 1: 199. 1846. [non *Syzygium lanceolatum* (Lam.) Wight & Arn., 1834]. – *Jambosa korthalsii* Blume, Mus. Bot. Lugd.-Bat. 1: 101. 1849 [1850], nom. superfl. – *Syzygium korthalsii* Widodo, Reinw. 13(3): 235–240 (2012). — TYPE: INDONESIA, West Sumatra, Gunung Malintang, *Korthals s.n.* (Holotype L! HLB no. 898.203-345), designated by Widodo (2012).

Tree diameter unknown. *Twigs* usually 4-angled to 4-winged, with smooth and whitish pale brown bark. *Leaves* relatively long compared to width, the leaf form very narrowly ovate, 30–45 cm by 2.5–5 cm, brown above and milky brown below when dry; leaf base cordate, leaf apex long narrowly acuminate; petiole *ca*. 3 mm long, swollen and corky, drying pale brown; midrib channelled on the upper surface and raised on the lower surface, pale brown when dry; major lateral veins consists of *ca*. 25 pairs, 1–1.5 cm apart, at an angle of 60°–70°, sometimes curved near the midrib and straight near the intramarginal veins; minor lateral veins absent or present, oil dots between 2 major lateral veins less than 20 per cm^2; intramarginal vein 1 or 2, faint, 1–3 mm from margin. *Inflorescence* a terminal cyme, but the flower with a pseudostipe 5–7 mm long, hypanthial cup funnel-shaped; sepals triangular, 5–6 mm long, 5 mm wide; petals unknown; style 35 mm long. *Fruits* unknown.

Distribution. *Syzygium korthalsii* is known from a limited area in West Sumatra, namely in Pariaman and in Gunung Malintang.

Notes. *Syzygium korthalsii* can be readily distinguished from other Sumatran species by its leaf form which is very narrowly ovate and almost linear, reaching approximately 45 cm long and only around 3.5 cm wide on average.

2. SYZYGIUM CONFUSUM (Blume) Bakh.f. – — Fig. 2.
Jambosa confusa Blume, Mus. Bot. Lugd.-Bat. 1: 101. 1849 (non *J. confusa* Blume ex Miq., Anal. Bot. Ind. 1: 27. 1850, *nom. inval*., in syn. sub *E. microbotrya* Miq., non pert.). *Syzygium confusum* (Blume) Bakh.f. in Bakhuizen v/d Brink Jr. & Koster, Blumea 12: 61. 1963. – *Eugenia dolichophylla* Koord. & Valeton, Meded. Lands Plantentuin 40: 78. 1900, "*doligophylla*" non *Eugenia dolichophylla* Kiaersk., En. Myrt. Bras. 157. 1893, nec *Syzygium dolichophyllum* (Laut. & K.Schum.) Merr. & L.M.Perry, J. Arn. Arb. 23: 249. 1942. – *Eugenia malayana* Gagnep. in Lecomte, Fl. Indo-China 2: 838. 1921. *Syzygium malayanum* (Gagnep.) I.M.Turner, Gard. Bull. Singapore 47: 378. Jul 1997 ("Dec 1995"); Singapore Natl. Acad. Sci. 22–24: 21. Aug 1997 ("1996"), *nom. superfl.* – *Syzygium amshoffianum* Merr., Philipp. J. Sci. 79: 366. 1951 ("1950"), nom. superfl. — TYPE: INDONESIA, Java without definite locality. Herb. *Blume s.n.* (Holotype L! HLB no. 898.203-342), tentatively identified/annotated as *Syzygium confusum* (Blume) Bakh.f. in April 1972 by Bakhuizen van den Brink Jr. & van Steenis.

Tree to 8 m tall. *Twigs* terete and slightly compressed near the nodes. Leaves narrowly lanceolate, 20–30 cm by 3–5 cm tapered gradually from the middle to apex; upper surface blackish brown, lower surface reddish brown when dry; leaf base

Table 1. Morphological differences between species of *Syzygium confusum* complex

No	Character	*S. korthalsii*	*S. confusum*	*S. blumei*	*S. insigne*	*S. sipirokense*
1	Twigs	4-angled to 4-winged	Terete and slightly compressed near nodes	Terete	Terete and 4-angled near nodes	4-winged
2	Leaf form	Very narrowly ovate	Narrowly lanceolate	Quite narrowly ovate	Narrowly ovate	Quite narrowly ovate to almost oblong ovate
3	Leaf apex	Long narrowly acuminate	Acute to acuminate	Acute to acuminate	Acute	Acuminate to apiculate
4	Leaf size	30–45 cm by 2.5–5 cm	20–44 cm by 3–5 cm	15–20 cm by 2–3 cm	4–10 cm by 1–2.75 cm	10–15 cm by 3–5.5 cm
5	Leaf base	cordate	Almost narrowly cuneate	Rounded or subcordate	Subcordate or almost rounded	Rounded or subcordate
6	Inflorescence	Peduncle unknown	Peduncle unknown	Peduncle very short 2–5 mm or sessile	Peduncle unknown	Peduncle 4-angled, drying black
7	Locality	Sumatra, Mount Malintang	Java	Java	Borneo, Martapura	Aceh, North Sumatra

narrowly cuneate, apex long acute to acuminate; petiole 10–13 mm long, slender or swollen, scaly, peeling off; midrib rounded below, pale brown when dry; lateral veins very faint on both the upper and lower surfaces *ca*. 30 pairs, 1–2 cm apart, at an angle of 60°–70°, oil dots a few per cm^2; intramarginal vein 1, very faint 1–2 mm from margin. *Inflorescence* simple or paniculate to 5 cm long, terminal, up to 21 flowers per inflorescence. Rachis terete and 4-angled, drying dark brown. Flowers with short ultimate inflorescence axis, pseudostipe and hypanthial cup 8–15 mm long, trumpet-shaped to turbinate. Sepals 4 free, semiorbicular, 3.5 mm long *ca*. 4 mm wide. Petals semiorbicular *ca.* 5.5 mm long and wide, a few gland dots. Stamens *ca*. 10 mm long. Style *ca*. 20 mm long. Ovary 2-locular. *Fruits* campanulate (immature).

Distribution. Java. In Sumatra, *Syzygium confusum* is known only from Batam Island.

Notes. Koorders & Valeton (1900) realised that Blume's specific epithet *confusa* could not be combined with *Eugenia* because it was pre-empted by *E. confusa* DC. (1828), so that he proposed the new combination *E. doligophylla*. This, however, is an orthographic variant of the earlier *E. dolichophylla* Kiaersk. (1893) as can be seen when Koorders himself corrected it (1912). It is not a misprint as was suggested by Henderson (1949: 50), as the spelling is consequently used throughout in the 1900 paper. This combination is therefore also a later homonym and illegitimate.

Gagnepain (1921) proposed the new name *E. malayana* for this species (Govaerts *et al.*, 2008), which Turner (1997a, b) used in *Syzygium*, overlooking the fact that *S. confusum* was required, and that this combination had already been made by Bakhuizen van den Brink Jr. & Koster (1963). Gagnepain's specimens (*Dussaud s.n., Harmand 1314* and *Thorel s.n.*) and his description based on them actually refer to *Syzygium megacarpum* (Craib) Rathakr. & N.C.Nair (Wuu Kuang Soh, TCD, *in litt.*).

Unaware of Gagnepain's action Merrill (1951) proposed yet another name: *Syzygium amshoffianum*, which is superfluous.

3. SYZYGIUM BLUMEI (Steud.) Merr. & L.M.Perry. — Fig. 3.
Eugenia angustifolia Blume, Flora 7(1): 291 (1824), [*nom. illeg*., non *Eugenia angustifolia* Lam., Encycl. 3: 203 (1789)]. – *Myrtus*

hypericifolia Blume, Bijdr. Fl. Ned. Ind.: 1082 (1826) [*nom. illeg*., non *Myrtus hypericifolia* Salisb., Prodr. Stirp. Chap. Allerton: 354 (1796)]. *Jambosa hypericifolia* (Blume) DC., Prodr. [A. P. de Candolle] 3: 287 (1828), *nom. illeg. Eugenia hypericifolia* (Blume) Koord. & Valeton, Meded. Lands Plantentuin 40, Bijdr. 6: 69 (1900) [nom. Illeg.] – *Eugenia blumei* Steudel, Nomencl. Bot. ed. 2. 1: 601 (1840). *Syzygium blumei* (Steudel) Merr. & L.M.Perry, Mem. Amer. Acad. Arts 18: 164 (1939). — TYPE: INDONESIA, Jawa, Bogor. (Holotype L! HLB no. 898.203-344). labelled as *Jambosa confusa*, and preidentified/ annotated as *Syzygium* cf. *confusum* (Blume) Bakh.f. by Bakhuizen van den Brink f. & van Steenis in April 1972.

Habit unknown. *Twigs* terete, glabrous, drying yellowish. *Leaves* sessile, glabrous, narrowly ovate, 6–19 cm long by 1.5–3 cm wide; leaf base rounded to subcordate, leaf apex acute to acuminate; major lateral veins 6–9 pairs, very faint on both surfaces; leaves drying greyish above and yellowish below. *Inflorescence* terminal and in leaf axil. Pedicel terminally solitary, 1 flower with shorter petals. Calyx 4 lobed, base attenuate. *Fruit* unknown.

Distribution. West Java, Mt. Salak.

Habitat & Ecology. Tropical rain forest.

4. SYZYGIUM INSIGNE (Blume) Merr. & L.M.Perry — Fig. 4.
Jambosa insignis Blume, Mus. Bot. Lugd.-Bat. 1: 100. 1849. *Syzygium insigne* (Blume) Merr. & L.M. Perry, Mem. Acad. Arts & Sci. 18: 163. 1939. Mem. Gray Herb. Harvard Univ. 4: 163. 1939; Masam., Enum. Phan. Born.: 530. 1942. – *Jambosa lancifolia* Miq., Anal. Ind. 1: 17. 1850; Fl. Ned. Ind. 1, 1: 427. 1855, nom. superfl. —TYPE: INDONESIA, Borneo, Martapoera. *Korthals s.n*. (Holotype L! HLB no. 898.203-347), accepted by Merrill (1921), Merrill & Perry (1939), and Masamune (1942).

Tree, height and diameter unknown. *Twigs* 4-angled. *Leaves* opposite, very shortly petiolate nearly two-ranked, narrowly ovate, leaf apex acute, base subcordate or almost rounded, 4–10 cm by 1–2.75 cm, transverse veins confluent in the inframarginal nerve, coriaceous, shiny above, and often impressed with inconspicuous dots, paler below. Racemes 1–3, terminal and solitary in the axils, short, few-flowered. *Flowers* showy, rather longly pedicellated, pink. Calyx about 2.5 cm, tube of the calyx turbinate, widened above, the limb with sort rounded flaps of 6–8-fid, lobes unequal, the outermost shorter, deciduous.

Distribution. Borneo.

Notes. Not to be confused with *Eugenia insignis* Thwaites from Sri Lanka, a "true" *Eugenia*. Miquel (1850: 17) did not mention *Eugenia insignis* Blume, but described *E. lancifolia* as new based on the same material, so that the name is superfluous. Though he realised it in 1855 (p. 427), he still retained his own epithet. Merrill (1921: 429) regarded *Jambosa insignis* and *J. lancifolia* as distinct species, repeating Blume's suggestion that more than one collection would be involved. Merrill & Perry (1939: 163) joined the two, but did not mention *Jambosa lanceolata* at all, probably because they were aware that this was a Sumatran species, whereas they were dealing with Bornean material.

5. **Syzygium sipirokense** Widodo & Veldkamp *spec. nov.* — Fig. 5.
— TYPE: INDONESIA, Sumatra, Tapanuli Selatan, Cagar Alam Sipirok, Nagurguran. *EA Widjaja 2012,* 19 March 1983 (Holotype BO!).

Small tree or shrub. *Twigs* winged near the nodes. *Leaves* sessile, opposite, lanceolate, 10–15 cm by 3–5.5 cm, leaves upper surface dark brown, lower surface brown when dry. Major lateral veins 10–14; leaf base rounded or cordate; leaf apex acuminate to apiculate; intramarginal veins one, 1–2 mm from margin, channelled above, raised below. Inflorescence arises from the leaf axil, peduncle four-angled, slightly winged, slender, black when dry. *Flower* unknown. *Fruit* ovoid to oval, 8–12 mm long, 5–7 mm diameter, green-red.

Distribution. Aceh Province, Aceh Tenggara Regency. North Sumatra, Tapanuli Selatan, Cagar Alam Sipirok, Nagurguran.

Habitat & Ecology. Primary forest 700 m alt.

Etymology. The epithet *sipirokense* came from one of the areas where this specimen was collected.

Conservation Status. This species is known from two locations, namely Sipirok Nature Reserve in North Sumatra and Ketambe Research Station in Aceh. The IUCN Assessment (IUCN, 2020) is categorized as Critically Endangered (CR).

Fig. 1. *Syzygium korthalsii*. Leafy twig.

Fig. 2. *Syzygium confusum.* Leafy twig.

Fig. 3. A. *Syzygium blumei.* B. *Syzygium insigne.* C. *Syzygium sipirokense* Widodo & Veldkamp *spec. nov.*

Specimen Examined. Sumatra, Aceh, Ketambe Research Station. *Kramadibrata K 329, K 333*, 11 March 1982.

Notes. *Syzygium sipirokense* resembles *S. blumei*. However, the leaves of *Syzygium sipirokense* dry dark brown above and pale brown below, instead of drying greyish above and yellowish below as in *S. blumei*. Twigs of *Syzygium sipirokense* are 4-winged, while the twigs of *S. blumei* are terete.

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VANILLA YERSINIANA (ORCHIDACEAE), A NEW RECORD FOR PENINSULAR MALAYSIA

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ABSTRACT
MAT ESA, M. I., NORDIN, F. A., GO, R. & RAFFI, A. 2021. *Vanilla yersiniana* (Orchidaceae), a new record for Peninsular Malaysia. *Reinwardtia* 20(2): 51−55. — The genus *Vanilla* Plum. ex Mill. from Peninsular Malaysia is now enriched with the discovery of a newly recorded species, *Vanilla yersiniana* that made up its regional diversity to eight taxa. This species was documented from two adjacent secondary lowland forests in Perak; further south to the southern tail of Thailand. This paper describes the first record of *V. yersiniana* in Peninsular Malaysia with some highlights of its morphology and ecology. The data presented will add to the present state of knowledge on the species botanical profile.

Key words: Checklist, Malaysia, Orchidaceae, *Vanilla*.

ABSTRAK
MAT ESA, M. I., NORDIN, F. A., GO, R. & RAFFI, A. 2021. *Vanilla yersiniana* (Orchidaceae), rekaman baru dari Semenanjung Malaya. *Reinwardtia* 20(2): 51−55. — Marga *Vanilla* Plum. ex Mill. dari Semenanjung Malaya kini diperkaya dengan penemuan jenis baru yang tercatat, *Vanilla yersiniana* yang membentuk keragaman regionalnya menjadi delapan taksa. Jenis ini didokumentasikan di dua hutan dataran rendah sekunder yang berdekatan di Perak; lebih jauh ke selatan ke ekor selatan Thailand. Makalah ini menjelaskan catatan pertama *V. yersiniana* di Semenanjung Malaysia dengan beberapa sorotan morfologi dan ekologinya. Data yang disajikan akan menambah pengetahuan tentang profil botani terkini dari jenis ini.

Kata kunci: Daftar jenis, Malaysia, Orchidaceae, *Vanilla.*

INTRODUCTION

Orchidaceae is a fascinating plant family that allures researchers globally to study their systematics, ecophysiology and economical values. The current research trend on orchids in Malaysia focuses largely on the enumeration of the family composition. It is a never-ending task; with a relatively vast and unexplored forested land, Malaysian orchid's inventory is most likely far from being complete. To date, there are approximately 3000 orchid species recorded throughout Malaysia (Ong *et al*., 2017; Juiling *et al*., 2020; Forest Department Sarawak, 2021). This figure is contributed by the series of novo discovery as well as the documentation of new regional record, which is also modelled by the local genus *Vanilla* – the subject matter of this paper. Generally, the genus *Vanilla* of Malaysia is represented by ten species of which seven of them can be found in Peninsular Malaysia (Ong, 2018; Raffi, 2019). However, the genus account in the peninsula is now enriched with the discovery of a species with distinct morphological characters from two adjacent localities in the state of Perak. Its initial population was spotted in January 2021 with individuals bearing short sterile inflorescences (indicators of post-anthesis and unsuccessful fertilization) and the species identity was revealed two months later when three individuals were found flowering. This species was preliminary referred as *V. albida* Blume due to its high morphological resemblance but is later confirmed as *V. yersiniana* Guillaumin & Sigaldi based on the taxonomic description and drawing by Averyanov (2011) as well as its matched distribution pattern that is centred in Indochina. In this paper, we present the new record of *Vanilla* species for Peninsular Malaysia, amended its morphological descriptions and provide important notes on the botanical profile. These data will add to the current knowledge on the genus from Malaysia, particularly from the peninsular region.

MATERIALS AND METHODS

In situ observations were conducted on the individuals of *Vanilla* from two localities in Lenggong, a valley located in the northern part of Perak, from January to July 2021. Flowering specimens were collected, dissected, preserved using the standard herbarium technique of Bridson and Foreman (1998) and deposited in the Herbarium of School of Biological Sciences, Universiti Sains Malaysia (USMP) (Thiers, 2021). Morphological characteristics of plants parts of the *Vanilla* were diagnosed and compared with the descriptions by Soto-Arenas & Cribb (2010) and Averyanov (2011). The morphological characters of *Vanilla yersiniana* were described based on the Peninsular Malaysian specimen and its botanical drawing is provided.

RESULTS AND DISCUSSION

TAXONOMIC TREATMENT

VANILLA YERSINIANA Guillaumin & Sigaldi, Bull. Mus. Nat. Hist. sér. 2, 36: 162. 1964. Figs. 1 & 2. — Type: VIETNAM (Hon Ba), 26.03.1963, *de Sigaldi 362, de Sigaldi 309* (Syntype P).

Hemiepiphytic, large creeping vine. Roots up to 4 m long. *Stem* to 10 m long or more; internodes 8.5 –10 cm long, 8–9 mm in diam. *Leaves* 10–12 × 4–6 cm, narrowly ovate or broadly lanceolate, apex shortly acuminate, glossy green; petiole *ca*. 1.5 cm long. *Inflorescence* 2–5.5 cm long in total, bearing 4–10 flowers; peduncle 0.5–1.5 cm long; rachis 1–3 cm long; floral bract *ca*. 2 mm long, broadly triangular. Pedicel-with-ovary 2.8–3.2 cm long, terete, slightly curved, green. Flowers in succession, wide-opening, 6–8 cm across; sepals and petals white with greenish-yellow tint. Sepals broadly oblanceolate, *ca*. 5.5 cm long, 1.5 cm wide; petals a little smaller, *ca*. 5 cm long with adaxial keel along the median vein. Lip *ca*. 5 cm long, trumpet-shaped, forms a narrow tube at base, adnate to column margins for about 3/4 of its length; base light yellow; apex white, rounded, 4 cm wide when spread out, margin slightly undulate to undulate; disc with an imbricate brush *ca*. 0.7 cm high by 0.5 cm wide, the apex with longitudinal rows of sparsely and shortly papillate hairs, 1–2.5 mm long, tinted red. Column *ca*. 4.5 cm long, slender, slightly curved, glabrous, whitish; lateral sides of clinandrium slightly undulate, reddish; rostellum *ca*. 0.5 cm long, rectangular; stigma 0.5 cm wide, transversely oblong to rectangular; apex irregularly incised with reddish margin, whitish yellow; anther-cap *ca*. 0.4 cm long, helmet-shaped, glabrous, greenish; pollinia granular. *Fruit* 12 cm long, cylindrical.

Distribution. Vietnam, Thailand and Peninsular Malaysia. In Peninsular Malaysia found in Perak.

Ecology. Climbing on trees, close to streams in secondary evergreen lowland forests.

Phenology. Flowering from March to May. Fruiting in March.

Notes. *Vanilla yersiniana* is a new record to Peninsular Malaysia. The lanceolate, long-acuminate leaves, whitish flowers and its scarcely developed papillae on lip apex distinguished this species from its closest ally, the *V. albida.* Tepals of *V. albida* are greener, and the lip is white with conspicuous trichomes at the apex of the lip (Cribb, 2014).

Specimen examined. *Ikhwanuddin* 11871 (USMP), Malaysia, Perak, Lenggong, 120 m elevation, 3 March 2021, flowering vine.

Key to *Vanilla* species from Peninsular Malaysia

1a. Leaves reduced to small scales ………….…………………………..……………………...… *V. aphylla*

1b. Leaves not reduced to small scales, of various sizes ………………….……………………..….……… 2

2a. Leaves ≥ 30 cm long ……...…………………………...…………….………..……………..…….…. 3

2b. Leaves ≤ 20 cm long ……………...…………………….……………………………………..……... 4

3a. Lip with veins blood-red forked or branched, midlobe with with tuft of hairs ..…….…….. *V. sumatrana*

3b. Lip with purple-marked veins, midlobe with red-purple papillae at the apex ……..…... *V. kinabaluensis*

4a. Lip apex deeply bilobed ……………………...…...……………………….……..………...……..….. 5

4b. Lip apex entire ....……………….…………….. 6

5a. Lip midlobe with dense horseshoe-shaped callus at the emarginated apex ………….......... *V. griffithii*

5b. Lip midlobe with single individual hairs arranged vertically towards the intersection of apical split …....
……………………..…………………………………………...……….…... *V. norashikiniana*

6a. Lip with dense group of hairs at the apex …………………..………..…….……….……..… *V. pilifera*

6b. Lip with sparsely arranged hairs at the apex ……………….…………………….……………………7

7a. Lip with single individual trichomes arranged in rows at the apex ……………………..…… *V. montana*

7b. Lip with sparse short papillate hairs at the apex …………………………….……….………. *V. yersiniana*

Fig. 1. *Vanilla yersiniana* in situ, Lenggong, Perak. A. Flower, front view. B. Vines with inflorescences at different flowering stages. C. Fruit. Photos by Ikhwanuddin.

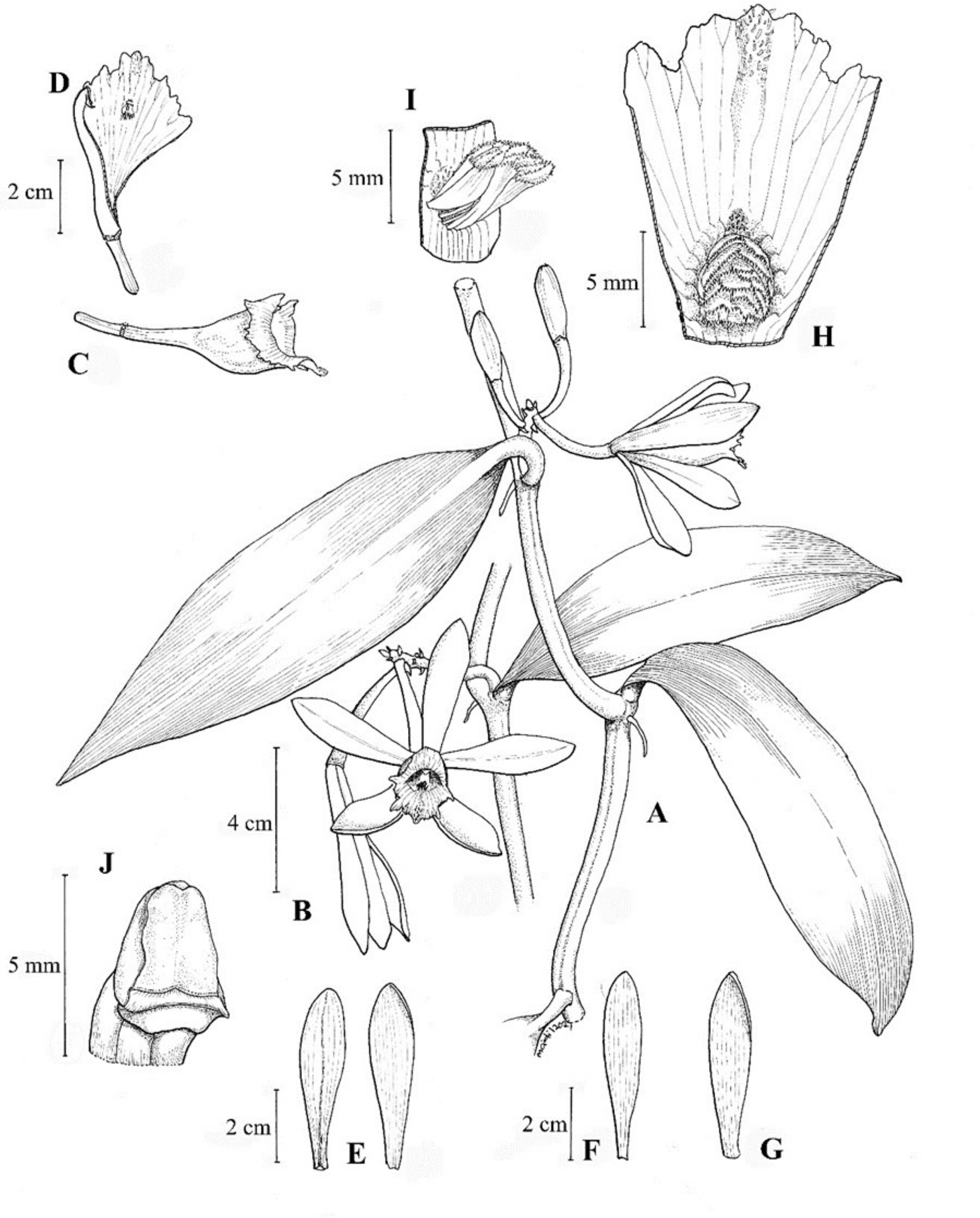

Fig. 2. *Vanilla yersiniana*. A. Part of flowering plant. B. Inflorescence with frontal view of flower. C. Lip, side view. D. Column with lip spread out. E. Petal, adaxial (left) & abaxial (right). F. Dorsal sepal. G. Lateral sepal. H. Apical half of the lip disc showing the brush in the middle of the lip disc and hairs on apex. I. Imbricate brush on the lip disc. J. Column apex. From the herbarium specimen, *Ikhwanuddin 11871* (USMP). Drawn by Mohamad Aidil Noordin.

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A NEW SPECIES OF *DEPARIA* FROM NEW GUINEA

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ABSTRACT
WARDANI, W., JAENUDIN, APANDI, I., KUSUMAWATY, A. & SANTOSO, W. 2021. A new species of *Deparia* from New Guinea. *Reinwardtia* 20(2): 57−61. — *Deparia stellata* is a new species of highland in Eastern New Guinea, described from a specimen found among unidentified piles of New Guinean Expedition in 1975. Its distinctive stellate-hairs on all axis and occasionally on rachis-scale margin are the main character that differentiate the species to other *Deparia*.

Key words: *Deparia*, highland, New Guinea, stellate-hairs.

ABSTRAK
WARDANI, W., JAENUDIN, APANDI, I., KUSUMAWATY, A. & SANTOSO, W. 2021. Jenis baru *Deparia* dari Papua Nugini. *Reinwardtia* 20(2): 57−61. — *Deparia stellata* adalah jenis baru dari dataran tinggi Papua Nugini bagian timur, dideskripsikan dari satu spesimen yang tidak teridentifikasi dalam tumpukan hasil ekspedisi di Papua Nugini pada tahun 1975. Karakter utama yang membedakannya dari jenis lain pada marga *Deparia* adalah tutupan rambut-rambut bintang di semua sumbu (rakis, kosta kostul dan vena) dan terkadang pada tepian sisik di bagian rakis.

Kata kunci: Dataran tinggi, *Deparia*, Papua Nugini, rambut bintang.

INTRODUCTION

Among specimens of Athyriaceae from New Guinea stored in BM, we found an interesting specimen that could not be convincingly identified. The pinnate oblong-lanceolate leaf with pinnae deeply incised, gradually reduced to pinnae with serrated margin toward apex, groovy and hairy-look axis, and linear indusium that mostly not reaching margin are some of the main features of a common species, *Deparia petersenii*, that immediately observed in our specimen. It was collected on the Star Mountains Expedition in 1975, a collaborative trip between Papua New Guinea National Herbarium (LAE) and Rijksherbarium Leiden (L). After a closer examination, we found the lamina axes of this specimen are densely covered with distinctive indumentum of darkly-pigmented stellate hairs, rather than multicellular septate hairs as commonly found in other *Deparia* species. Moreover, their scales are different from some hairs on margin that are not present in most of *Deparia*. This character is unusual for the genus and suggest that this specimen represented an undescribed species.

Deparia is a wide spread genus in the family *Athyriaceae*, distributed in tropical Africa, Madagascar, Reunion, South India, Ceylon, Himalayas, East and South East Asia, Oceania, East Australia and East North America (Kato, 1984). This terrestrial fern includes several other previously recognized genera *i.e. Dryoathyrium* Ching, *Lunathyrium* Koidz., *Parathyrium* Holttum, *Athyriopsis* Ching (Kato, 1984; Sano *et al.,* 2000; Wang *et al.,* 2013), *Triblemma* (J.Sm.) Ching and *Dictyodrama* Ching (Sano *et al.,* 2000; Wang *et al.*, 2003). *Deparia* differs from other genera in the Athyriaceae in its discontinued groove at the junction of costae and rachis (Kato, 1984) combined with the presence of multicellular (septate) hairs (Sundue & Rothfels, 2014; Rothfels *et al.*, 2012).

MATERIALS AND METHODS

Herbarium specimen of *Deparia* stored in BO and a loan from BM were gathered for observation and sorted based on morphology. Detail examination were carried using Olympus stereo microscope SZ61 equipped with long arm, calibrated eyepiece and camera (Fig. 1).

RESULTS AND DISCUSSION

Kuo *et al.* (2018) recognized five sections with three subsections in its infrageneric classification, *i.e. Dryoathyrium*, *Lunathyrium*, *Erectus*, *Dictyodrama*, *Deparia* with sub sections *Deparia, Caespites* and *Athyriopsis*. This classification is in line with grouping presented in Kato (1984) for Pacific species. Following the key to section provided in Kato (1984) this presented new species is in between the Sect. *Deparia* and Sect. *Athyriopsis* since it has entire indusia but slender rhizome.

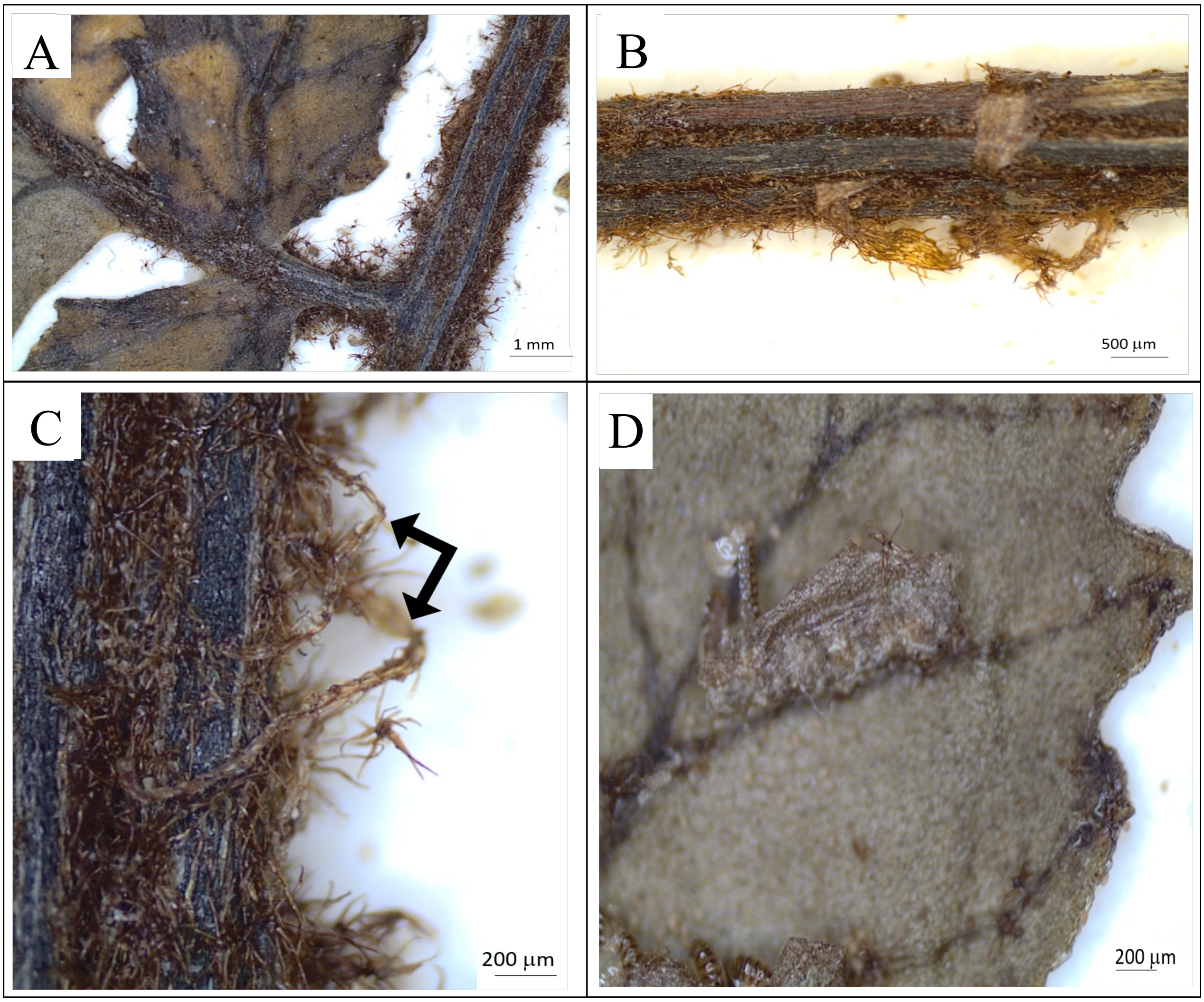

Fig. 1. A. Rachis densely covered with dark-stellate hair. Also showing the discontinued groove at the junction of costae and rachis. B. Stipe scale with irregular stiff hair on its margin. C. Two pieces of septate hair on rachis, appear among stellate hair. D. Indusium with stiff hairs radiate from one point on the margin. From *W. R. Barker 67491*. Photos by W. Wardani.

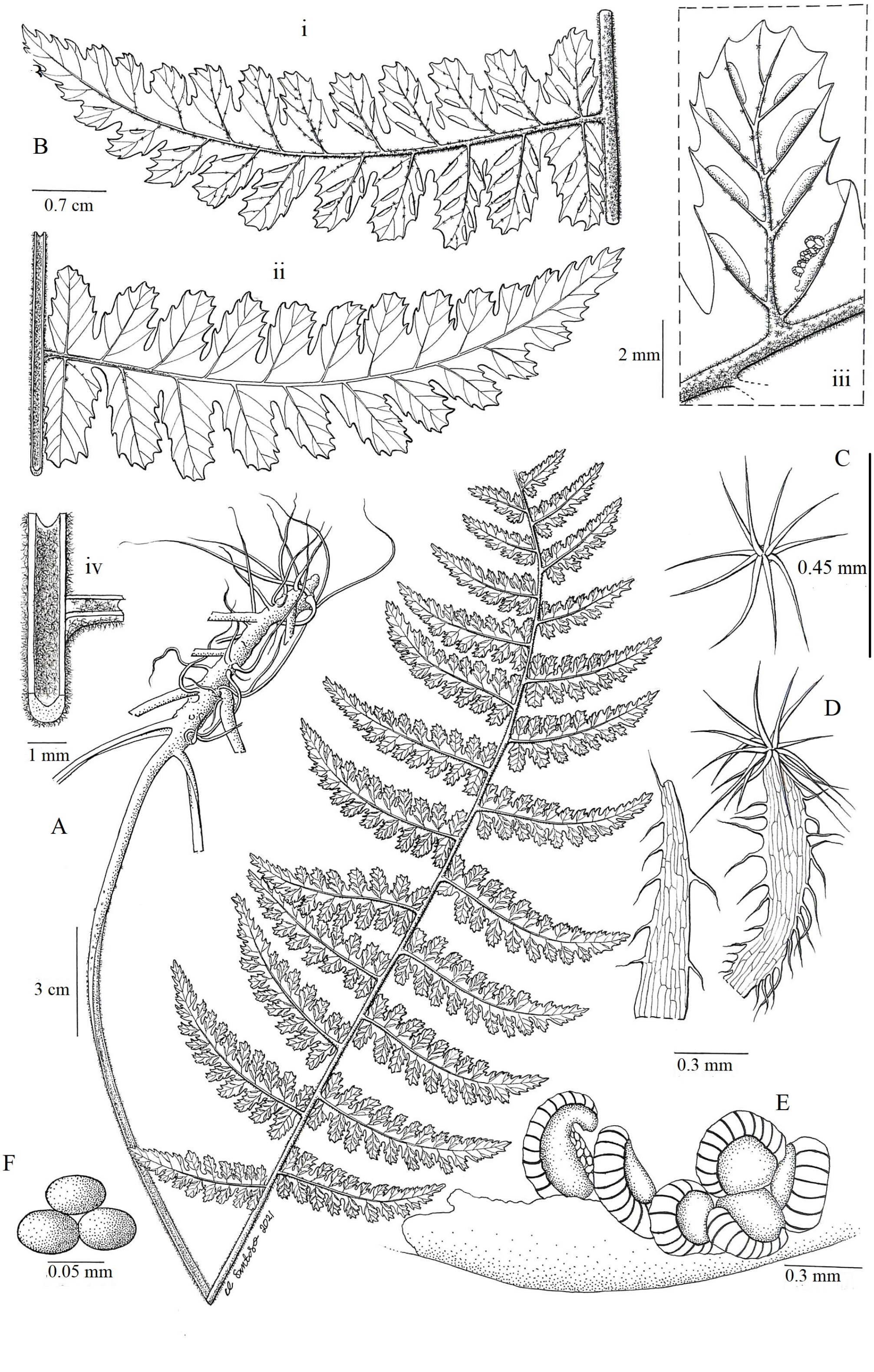

Fig. 2. *Deparia stellata* Wardani *spec. nov.* A. Habit. B. Portion of pinnae of abaxial (i) and adaxial (ii) side, detail of indusium underneath (iii) and groove at the junction of rachis and costae (iv). C. Stellate hair. D. Scale with stiff hairs on margin and stellate hair at apex. E. Detail of sporangium below indusium. F. Bilateral spore. From *W. R. Barker 67491*. Drawn by W. Santoso.

Fig. 3. Scanned holotype specimen of *Deparia stellata* Wardani *spec. nov.* From *W. R. Barker 67491*. Scanned by Jaenudin.

Deparia stellata Wardani *spec. nov.* Figs. 1–3. — TYPE: PAPUA NEW GUINEA. District West Sepik, Subdist. Telefomin, 5°00'S 141°05'E, 2,100 m asl near the border with Indonesia, 21 April 1975, *W. R. Barker 67491* (Holotype BM! Isotype L).

Pinnate-pinnatifid leaf, groovy axis, discontinue at the junctions. Rachis, costae and costules covered with darkly-pigmented stellate hair, while the multicellular septate hair as commonly occur in *Deparia* is sparsely present. Scale margin ornamented with hairs.

Rhizome creeping, slightly ascending, 4.6 mm thick. Stipe blackish, 18.5 cm long, scales caducous, brown, about 0.3 mm wide and 2 mm long, irregularly with stiff hairs on margin, unlike the entire margin in most of *Deparia* species. *Lamina* lanceolate, gradually acuminate, slightly reduced downward, herbaceous, 23–33.5 cm long, 11 cm wide, pinnate-pinnatifid, one or two basal pinnae pairs with separated acroscopic basal segment. Pinnae 1.7–2.4 cm apart, deeply pinnatifid and serrated lobes, up to 6 cm long and 1.62 cm wide with 1.45 mm stalks, acuminate, acroscopic basal segment 8 mm long and 4.3 mm wide, 3 mm apart. All axes of both sides bearing dark stellate hairs 0.45–0.9 mm in diameter, especially dense on the rachis and pinnae stalks, replace the septate hairs that commonly occur in other *Deparia* species. The long septate hairs only sparsely present on rachis. Smaller scales as on stipe also present on rachis, with hairs on margin. *Sori* linear on veins, indusia thin, 1.85–3 mm long, entire, sometimes ornamented with few ±0.12 mm long stiff hair on margin, radiating from a point impressing an abraded stellate hair.

Distribution. Known only from the type location.

Habitat. In a pristine forest at high altitude of New Guinea, 2,100 m asl.

Etymology. The epithet refers to the distinctive stellate hair covering rachis and basal pinnae-stalk, and also alludes to the type locality, the Star Mountains.

Note. The duplicate specimen in L were stored under *Diplazium stellatopilosum* (Brause) Holttum (L.3525651) which is a very different species that has similar unusual hair covering (Holttum & Roy, 1965).

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ETLINGERA COMOSA, A NEW SPECIES (ZINGIBERACEAE: ALPINIOIDEAE) FROM CENTRAL SULAWESI

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ABSTRACT
ARDIYANI, M., ARDI, W. H., HUTABARAT, P. W. K. & POULSEN, A. D. 2021. *Etlingera comosa,* a new species (Zingiberaceae: Alpinioideae) from Central Sulawesi. *Reinwardtia* 20(2): 63−68. — *Etlingera comosa* Ardiyani & Ardi, a new and unusual species from Tentena, Central Sulawesi exhibiting terrestrial as well as epiphytic habit is described here. It is compared to the morphologically closest *Etlingera sublimata* A.D.Poulsen, but differs in having tufted sheath, bilobed and asymmetric ligule, loose peduncular bracts, densely pubescent fertile bracts and longer filament. Colour plates, notes on its conservation status and DNA barcode data for the new species are also provided.

Key words: Acanthodes group, DNA barcode, epiphytic, *Etlingera sublimata,* Indonesia, Zingiberales.

ABSTRAK
ARDIYANI, M., ARDI, W. H., HUTABARAT, P. W. K. & POULSEN, A. D. 2021. *Etlingera comosa,* satu jenis baru (Zingiberaceae: Alpinioideae) dari Sulawesi Tengah. *Reinwardtia* 20(2): 63−68. — *Etlingera comosa* Ardiyani & Ardi merupakan sebuah jenis baru dan unik yang berasal dari Tentena, Sulawesi Tengah dengan perawakan terestrial sekaligus epifit. Jenis ini dibandingkan dengan jenis yang mempunyai kedekatan morfologi yaitu *Etlingera sublimata* A.D.Poulsen, namun berbeda dalam karakter pelepah yang berumbai, ligula yang bercuping dua dan asimetrik, daun gagang longgar, daun gagang fertil berbulu balig rapat dan tangkai sari lebih panjang. Foto berwarna dan catatan mengenai status konservasi dan data kode batang DNA untuk jenis baru ini juga disajikan.

Kata kunci: Epifitik, *Etlingera sublimata,* grup Acanthodes, Indonesia, kode batang DNA, Zingiberales.

INTRODUCTION

Etlingera Giseke (Zingiberaceae) is a genus with more than 100 species worldwide. The number of species have increased significantly in recent years, especially in Sulawesi, Indonesia, as more explorations of the island were done. The genus is distributed from India, Indo-China throughout Malesia to the Pacific Islands (Poulsen, 2012; Poulsen & Docot, 2018). A revision of the genus was carried out by Poulsen for *Etlingera* of Borneo (Poulsen, 2006), Java (Poulsen, 2007) and Sulawesi (Poulsen, 2012). Poulsen (2012) included 46 species of *Etlingera* in Sulawesi. Seven years later, a new species, *E. mamasarum* A.D.Poulsen & Ardiyani, was discovered from Mamasa, West Sulawesi (Ardiyani & Poulsen, 2019). The following year, *Etlingera tjiasmantoi* Ardiyani & Ardi was found in Central Sulawesi (Ardiyani *et al*., 2020). Thus, 48 species of *Etlingera* are currently known in Sulawesi.

During the expedition carried out in early 2020 by the first three authors to Central Sulawesi an interesting species of *Etlingera* was found on mossy logs and epiphytically on a tree trunk. At first, this looked very similar to *E. sublimata*, but a more thorough examinations revealed that it differs from it in several important characters, and furthermore does not match any other *Etlingera* species. Therefore, it is here described as a new species. A colour plate, notes on its conservation status and the DNA barcode of this new species are provided.

MATERIALS AND METHODS

The fieldwork was carried out in March 2020 in Central Sulawesi. The locality can be seen in Fig. 1. Herbarium specimens were prepared in the field including pickling flowers and inflorescence in 70% alcohol and photos of the floral dissection. Leaf tissue material was dried in silica gel for the purpose of molecular analyses (Wilkie *et al.,* 2013). Morphological characters were noted from the living plant in the wild as well as from the herbarium specimens in BO. Measurements were made using a ruler and a calibrated eyepiece under a dissecting microscope. DNA barcoding was done using rbcL, matK, the Intergenic Spacers between trnH and psbA (Kress & Erickson, 2007), and the Internal Transcribed Spacers (ITS) (Kress *et al*., 2005). The barcode protocols followed Kress & Erickson (2012). DNA sequencing was done in the 1stBase company, and the sequences obtained were deposited in the NCBI GenBank (Table 2).

RESULTS AND DISCUSSION

Etlingera comosa Ardiyani & Ardi *spec. nov.* Fig. 2. — TYPE: INDONESIA, Central Sulawesi Province, Tentena Regency, roadside between Tentena and Bada, elevation 1,700 m, 01.80429S, 120.47046E, flowering and fruiting, 7 March 2020, *M. Ardiyani, Wisnu H. Ardi, Prima Hutabarat, Zulfadli, Roland Putra, Ofin MAR1004* (Holotype BO!).

Similar to *Etlingera sublimata* A.D.Poulsen by the spiny bracts and thecae dehiscent through their entire length but *E. comosa* differs from *E. sublimata* in having tufted sheath (*vs*. not tufted), bilobed, asymmetric ligule (*vs*. entire), peduncular bracts only loosely enclosing base of spike and partly exposed the axis (*vs*. peduncular bracts

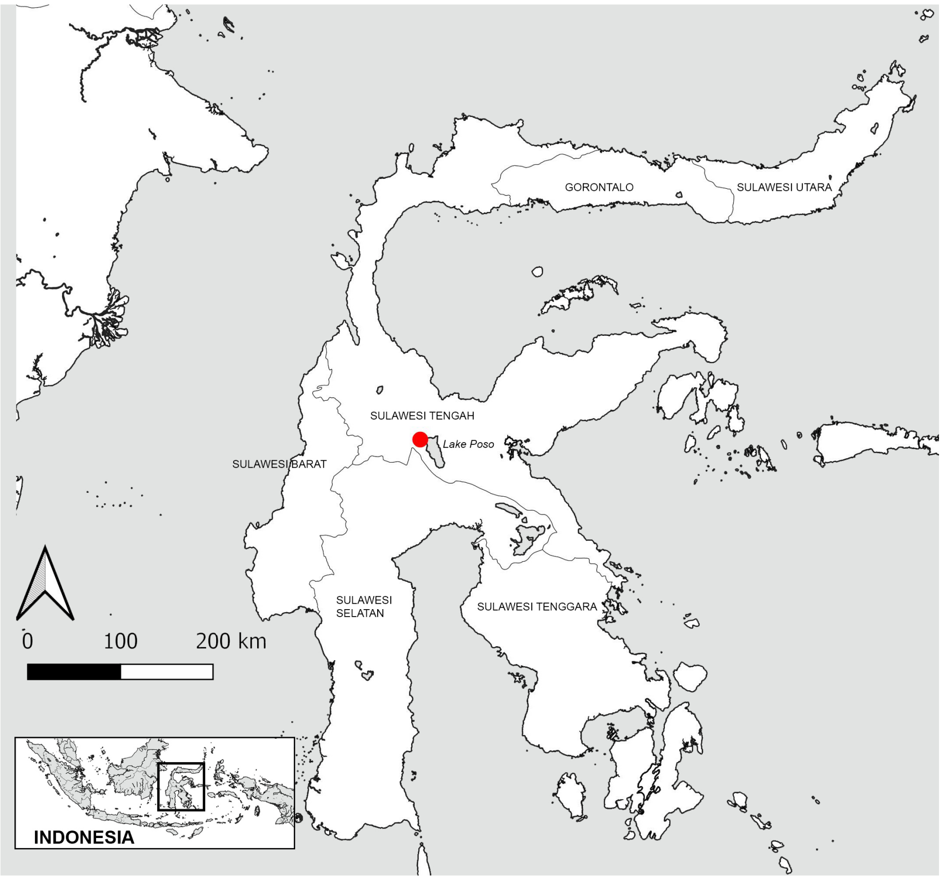

Fig. 1. The type locality of *Etlingera comosa* in Tentena, Central Sulawesi.

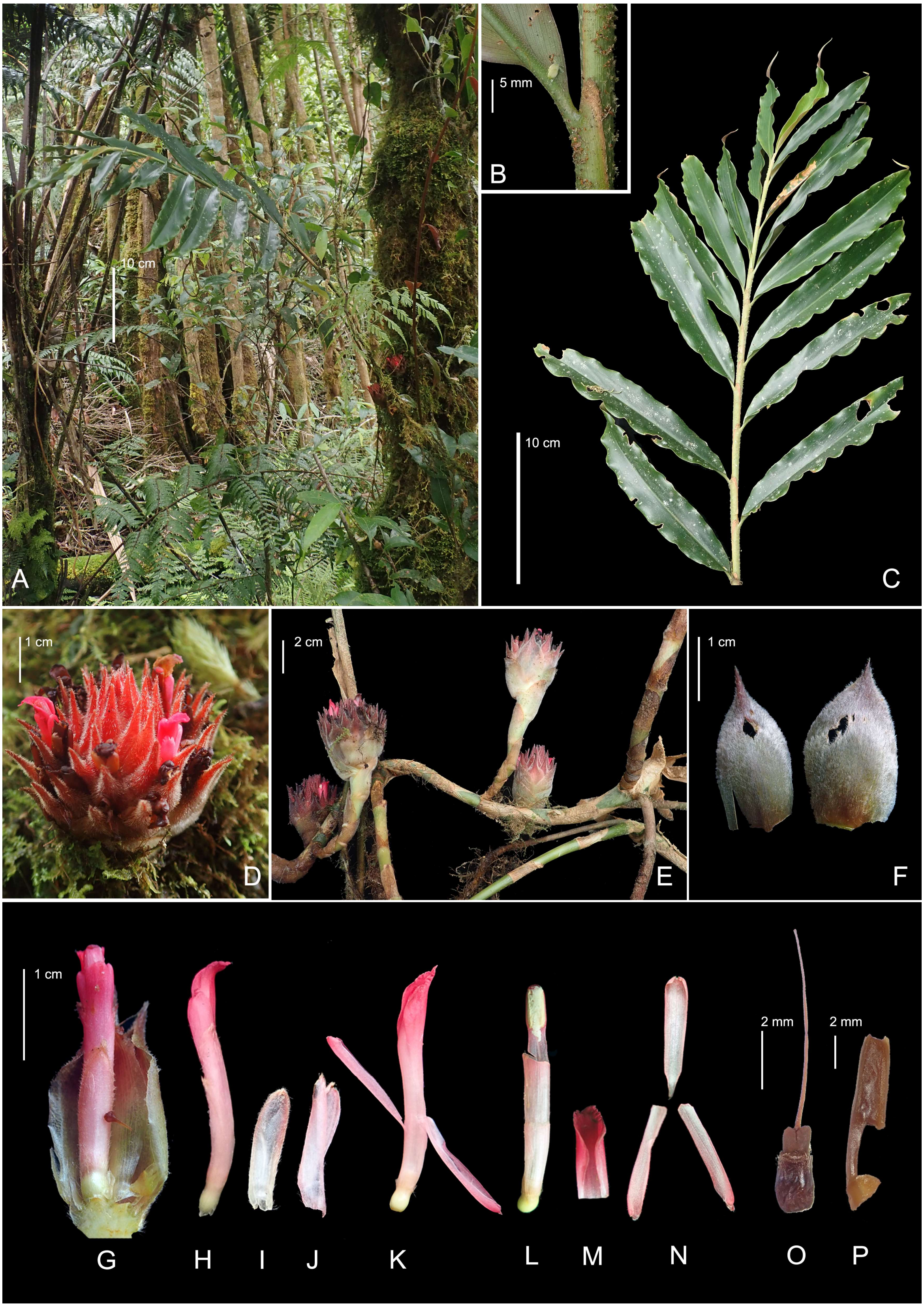

Fig. 2. *Etlingera comosa* Ardiyani & Ardi *spec. nov*. A. Habit. B. Pseudostem, ligule and petiole. C. Leaves (upper surface). D. Inflorescence with three freshly opened flowers (semi-lateral view). E. Base of leafy shoot and inflorescence arising from the rhizome. F. Sterile bracts. G. Fertile bract, bracteole and flower. H. Flower. I. Bracteole. J. Calyx. K. Flower with brateole and calyx removed. L. Flower with calyx, corolla lobes and labellum removed. M. Labellum. N. Corolla lobes. O. Ovary, epigynous glands, style and stigma. P. Filament, anther and part of staminal tube (lateral view). From *M. Ardiyani et al. 1004*. Photos by Marlina Ardiyani & Wisnu H. Ardi.

enclosing base of spike, peduncle axis not exposed), fertile bracts densely pubescent (*vs*. glabrous with ciliate margin), longer stamen (9 mm *vs*. 5 mm), longer filament (3.5–4.5 mm *vs*. 0.5 mm) and shorter anther (4 mm *vs*. 5–5.5 mm).

Terrestrial or epiphytic herb. Rhizome 0.5 cm diam. when dried, densely pubescent, green, scales 1.3–2.8 cm long, velvety; stilt roots 3 mm diameter when dried, brown, raising the rhizome to about 25 cm above ground. *Leafy shoots* to 70 cm long, 15–20 cm apart; base to 1.5 cm diameter, light green covered with dry scales; sheath greenish yellow with brown margin, tufted, margin fimbriate; ligule 3–4 mm long, bilobed, asymmetric, greenish yellow with brown dry edge, puberulous, margin ciliate; petiole 2–4 mm long, yellowish green, puberulous, some tufted; lamina 15–19 × 2.7–3.3 cm, length to width ratio 5.6–5.7, dark green above, light green with reddish brown tinge beneath, glabrous above and beneath, midrib puberulous beneath; base cuneate; apex caudate; margin glabrous, undulate. *Flowering shoot* 9.5–10 cm long, arising from rhizome, erect, receptacle with ± 50 flowers, flowers open at a time; peduncle 5.5 cm long, ascending, sericeous, peduncular bracts 0.7–2 × 0.6–1.1 cm, loosely adhering, not fully enclosing base of spike exposing the axis, greenish yellow towards base, pale brown towards apex when young, pale brown when old, densely sericeous above, glabrous beneath, obovoid, flowers reaching 0.3 cm longer than the bracts; sterile bracts 2.4–3 × 2–3 cm, broadly obovate, boat-shaped, mucronate (mucro 3–4 mm long), apex acute, green, densely pubescent above, glabrous beneath; fertile bracts 2.6–3.2 × 1.2–2.2 cm, obovate, boat-shaped, apex aristate, with 4–5 mm long mucro, green, densely pubescent above, glabrous beneath; pedicel absent; bracteole 1.6–1.8 cm long, membranous, pale pink, 1 fissure, sericeous, apex 1-lobed, mucronate. *Flower* 2.6–2.9 cm long; calyx 1.7 cm long, contracted at base, reaching to base of stamen and 3–4 mm short of apex of corolla lobes, pale pink, with 2 fissures of 0.3–0.4 cm, moderately hairy, apex 3-toothed, apices finely mucronate and ciliate; corolla tube 1.5–1.6 cm long, pale pink, glabrous, with a few scattered hairs inside; lobes pale pink at base, pink towards apex, narrowly ovate, glabrous with scattered hair at apex, apex slightly cucullate, dorsal lobe 11–18 × 3–4 mm long (reaching 2 mm short to 3 mm beyond apex of anther), lateral lobes 17 × 3–3.5 mm; staminal tube 7 mm long, pale pink; labellum ovate, 9–11 × 6 mm when flattened, red, glabrous, lateral lobe margin involute or erect ± covering the stamen, central lobe entire, slightly recurved, extending 3 mm beyond anther when flattened; stamen 6 mm long, pale pink; filament 2 × 2 mm; anther 4 × 2 mm, parallel-sided, spurred, angled 165°–170°, anther crest emarginate; thecae completely dehiscent (slit *ca*. 4 mm), sericeous along slits and apex; ovary 3 × 2 mm, barrel-shaped, pale greenish yellow, glabrous at base, ciliate towards apex; epigynous gland 1.5–2 mm long, split to base adaxially, emarginate, glabrous; style 2.2–2.5 cm long, white, papillose especially towards apex; stigma 1 mm wide, pink, club-shaped, ostiole transverse-elliptic less than 1 mm, facing downwards, puberulous. *Infructescence* not seen.

Distribution. Only known from the type locality in Tentena, Central Sulawesi, Indonesia.

Habitat. Slopes in secondary, upper montane, very humid forest with open canopy less than 10 m. Most tree trunks were covered with mosses, open areas with many ferns and ericaceous shrubs, such as species of *Rhododendron*, *Vaccinium* and *Gaultheria*.

Etlingera comosa was quite common in this vegetation and many individuals were encountered (in one spot > 25, including juveniles) most of which grew on moss-covered dead tree trunks, or on bases of trees. The single flowering individual found was epiphytic. In this moist and open forest type, it is not surprising to see species occurring both terrestrially and as epiphytes.

Etymology. The epithet *comosa* refers to the tufted hairs of the sheath.

Phenology. Flowering in March.

Local name & uses. Not available.

Conservation status. This species is currently only known from the type locality, which is not in a conserved area and close to the main road between Tentena and Bada. There is a possibility that the population will decline in the future if the area is not conserved. The conservation status is therefore tentatively assigned as Vulnerable D2 (IUCN, 2021).

Notes. With its montane habit, sessile and barrel-shaped ovary, pink and glabrous labellum, and the anther dehiscing for its entire length, *Etlingera comosa* clearly belongs to the Acanthodes group, which up till now consists of 15 species in

Table 1. Morphological characters of *Etlingera sublimata* and *E. comosa.*

No	Characters	*Etlingera sublimata* (Poulsen 2012)	*Etlingera comosa*
1	Indumentum of sheath	Puberulous	Tufted
2	Ligule shape	Entire	Bilobed, asymmetric
3	Petiole length	Sessile	2–4 mm
4	Position of peduncular bracts	Enclosing base of spike, uppermost the longest; imbricate, peduncle not exposed	Not fully enclosing base of spike; loose, peduncle is partly exposed
5	Colour of peduncular bracts	Pale brown	Greenish yellow towards base, pale brown towards apex when young, pale brown when old
6	Indumentum of fertile bracts	Glabrous, margin ciliate	Densely pubescent, margin ciliate
7	Stamen length (mm)	5	9
8	Filament dimensions (mm) size	0.5 × 2–2.5 mm	3.5–4.5 × 2 mm
9	Anther dimensions (mm)	5–5.5 × 2.3–3 mm	4 × 2 mm

Table 2. DNA barcoding of *Etlingera comosa*

Species	NCBI GenBank Accession No.			
	rbcL	ITS	*trnH-psbA*	*mat*K
Etlingera comosa	OL631135	OL711629	OL752579	OL770275

Sulawesi (Poulsen, 2012). Of these, the following species have spiny bracts: *Etlingera acanthodes* A.D.Poulsen*, E. chlorodonta* A.D.Poulsen*, E. doliiformis* A.D.Poulsen*, E. mucronata* A.D.Poulsen*, E. spinulosa* A.D.Poulsen and *E. sublimata* A.D.Poulsen. The latter is most similar, but *E. comosa* differs from it by the striking tufted indumentum on the sheath, the hairy bracts, ligule shape, stamen length as well as other morphological differences (Table 1).

The original description of *E. sublimata* mentions the tessellate pattern of the leaf sheath but omitted that the sheath is more or less uniformly puberulous, which is clearly observed on the neotype (*Poulsen et al. 2647*, BO!, E!). It is, in any case, strikingly different to the tufted sheath of *E. comosa*. This character has, however, also been described in other species of the Acanthodes Group, such as *E. spinulosa* and *E. steringophora*. *Etlingera comosa* is morphologically dissimilar to these species and can be distinguished by multiple characters such as the bilobed and asymmetric ligule with puberulous hairs *vs*. 19–21 mm, emarginate ligule with vilose hairs (*E. steringophora*) and 22–26 mm long, inflated, bilobed ligule and laterally extended to clasp the pseudostem (*E. spinulosa*); smaller lamina (15–19 × 2.7–3.3 cm) *vs*. 35–35 × 4.5–6 cm in *E. steringophora* and 63 × 16 cm in *E. spinulosa*). The shape of fertile bract and anther size are further differences. In *E. comosa,* the fertile bracts are obovate with aristate apex *vs*. broadly spatulate with mucronate apex (*E. steringophora*) and ovate with long acute apex (*E. spinulosa*). The *E. comosa* anther size is *ca*. 4 × 2 mm, while it is 6 × 3 mm in *E. spinulosa* and 5.5 × 3 mm in *E. steringophora.*

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EVALUATING THE ECOPHYSIOLOGY OF SURVIVAL FOR *MAPANIA CUSPIDATA* (MIQ.) UITTIEN (CYPERACEAE) TRANSPLANTATION

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ABSTRACT
SHABDIN, Z., NORI, H., MEEKIONG, K. & FAIZ, M. F. M. 2021. Evaluating the ecophysiology of survival for *Mapania cuspidata* (Miq.) Uittien (Cyperaceae) transplantation. *Reinwardtia* 20(2): 69–75. — This study aimed to investigate the ecology of the sedge *Mapania cuspidata* at three different locations in East Malaysia, namely Gunung Gading, Matang and Bengoh, and the survival of *M. cuspidata* transplanted in pots exposed to different light intensities in Universiti Malaysia Sarawak, East Malaysia. The highest species density was recorded in Matang with a total density of 1.98 individuals/ha followed by Bengoh (1.42) and Gunung Gading (0.96). In these locations, the soil pH ranged from 4.9 in Bengoh to 5.7 in Matang where as soil organic matter content was between 3.47% in Bengoh and 8.68% in Gunung Gading. The highest light intensity was recorded in Matang with 0.94 kLux, and produced plants with the highest chorophyll content (64.8 SPAD value). This study found that the transplanted *M. cuspidata* had 90% survival over a four month experiment, produced ~ 8 new leaves, took an average of 15.8 days to produce a new leaf and had a chlorophyll content of ~30.3 SPAD value regardless of the intensity of light where the plants were exposed to. The findings of this study suggests that *M. cuspidata* can grow well in any light conditions and therefore it is also possible to transplant and re-establish other *Mapania* species in new location. It is hoped that the initiative to relocate other *Mapania* species of concervation concern will be effective if adequate post-harvest handling methods are practiced.

Key words: Ecophysiology, light intensity, *Mapania*, vegetative propagation.

ABSTRAK
SHABDIN, Z., NORI, H., MEEKIONG, K. & FAIZ, M. F. M. 2021. Evaluasi ekofisiologi ketahanan transplantasi *Mapania cuspidata* (Miq.) Uittien (Cyperaceae). *Reinwardtia* 20(2): 69–75. — Tujuan penelitian ini adalah untuk mengkaji faktor-faktor ekologi jenis tersebut di tiga lokasi di Malaysia Timur, yaitu Gunung Gading, Matang dan Bengoh, serta menganalisis kemampuan bertahan hidup *M. cuspidata* yang ditanam di dalam pot terbuka yang terpapar sinar matahari dengan intensitas cahaya yang berbeda-beda di Universiti Malaysia Sarawak, Malaysia Timur. Kerapatan jenis tertinggi tercatat di Matang dengan jumlah 1,98 individu/ha, diikuti Bengoh (1,42) dan Gunung Gading (0,96). pH tanah di lokasi tersebut berkisar dari 4,9 di Bengoh hingga 5,7 di Matang, dengan kandungan tanah organik berkisar antara 3,47% di Bengoh dan 8,68% di Gunung Gading. Intensitas cahaya tertinggi tercatat di Matang dengan 0,94 kLux, dan menghasilkan tumbuhan dengan kandungan klorofil tertinggi (nilai SPAD 64,8). Penelitian ini menunjukkan bahwa *M. cuspidata* yang ditanam dalam pot setelah melalui durasi pertumbuhan selama empat bulan mempunyai kemampuan bertahan hidup sebesar 90%, menghasilkan 8 daun baru, dan membutuhkan waktu rata-rata 15,8 hari untuk menghasilkan daun baru serta mempunyai kandungan klorofil dengan nilai SPAD 30,3 terlepas dari intensitas cahaya di mana tanaman terpapar. Penelitian ini menunjukkan bahwa *M. cuspidata* dapat tumbuh dengan baik dalam semua kondisi cahaya, oleh sebab itu memungkinkan untuk penanaman dan menanam kembali jenis *Mapania* lainnya di lokasi baru. Diharapkan inisiatif untuk merelokasi jenis *Mapania* lain yang menjadi perhatian konservasi akan efektif jika dilakukan metode penanganan pasca panen yang memadai.

Kata kunci: Ekofisiologi, intensitas cahaya, *Mapania,* perbanyakan vegetatif.

INTRODUCTION

Cyperaceae (sedges) is a monocotyledonous angiosperm plant family with over 5387 species (Govaerts *et al*., 2007). They are of economic, ethnobotanical, conservation and environmental importance. Their economic importance has often been underestimated due to their local and regional use (Simpson & Inglis, 2001). Since early Egyptian civilization, sedges have been recognized, particularly through the role of papyrus (*Cyperus papyrus*), in providing writing and construction materials. Their importance has since wide-ranging, from the trouble they cause as weeds (*e.g. Cyperus rotundus* L.), to the substantial number of uses such as providing materials for basketry, matting, construction, perfumery, medicine and fuel, as well as food and animal fodder (Negbi, 1992; Govaerts *et al*., 2007, Simpson & Inglis, 2001). They also serve as dominant components of many wetland ecosystems and are reliable indicators of habitat degradation in such systems (Simpson *et al*., 2003), consequently acting as environmental indicators for conservation. They also play a vital role in preventing erosion and flooding in many ecosystems (Naczi & Ford, 2008). This family currently includes two subfamilies, Mapanioideae and Cyperoideae (Govaerts *et al*., 2007; Muasya *et al*., 2009), with genus *Mapania* being under subfamily Mapanioideae. The diversity of *Mapania* species from Sarawak is tremendous, with 31 out of 71 world's total number are recorded (Miraadila *et al*., 2016). Studies on *Mapania* of Sarawak since 2008 by Shabdin *et al*. (2013a, 2013b, 2016) has observed the high tendency of endemicity of the species to Borneo (*M. longiflora*, *M. angustifolia*, *M. lorea*, *M. debilis*, *M. maschalina*, *M. obscuriflora*, *M. richardsii*, *M. borneensis*, *M. latifolia* and *M. hispida*), and hyper-endemicity (*M. foxworthyi, M. graminea*, *M. sapuaniana* and *M. multiflora*). Only a few species are widespread; for instance, *M. cuspidata.* This species is well-distributed in South-East Asia, including Thailand, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo, Brunei Darussalam, Philippines, Maluku, Papua, Sulawesi, Papua New Guinea, Solomon Islands and New Hebrides. In Sarawak, this species may occur in mixed dipterocarp, kerangas, swamp, limestone and degraded forests. *Mapania* is locally known as rumput serapat or pandan tikus by the Malay people. In Sarawak, *Mapania* is also called as daun meing by the Iban, tenduh in Bidayuh language, daon sisiet by Melanau, ieee in Saban and Kelabit language, and da'aah in Kenyah and Penan dialectal (Miraadila, 2018). Although many Cyperaceae members are heliophytes adapted to open environment, this does not apply to members of *Mapania* which prefers growing on the ground layer of tropical rainforests in low light conditions (Simpson, 1992). According to Engelbrecht *et al.* (2007), drought has a limiting effect on the tropical plant distributions and observed that global warming in tropical rainforests could result in loss of diversity and species extinction. Drier conditions could, therefore, accelerate the decline, and extinction of many *Mapania* species throughout the tropics (Simpson *et al*., 2011). Other factors such as dispersal ability of the species and niche suitability certainly play parts in the survival of *Mapania* spp. However, how well *Mapania* could migrate with changing climate or adapt to new conditions is unknown.

Most *Mapania* species occur in an uncommon habitat of Cyperaceae, which prefer open areas with direct sunlight (Miraadila, 2018). Members of this genus occur where little light penetrates through the canopy, and usually in areas where the soil is damp, muddy, or peaty, or in swampy depressions or by the side of pools or streams (Simpson, 1992). Some species occur in a very restricted habitat, resulting in a high number of endemic species. *M. sapuaniana* for example, has so far only been recorded in a small area at Sungai Joh (approx. 3 km radius) of Lanjak Entimau Wildlife Sanctuary (LEWS) (Shabdin *et al.*, 2016), while *M. ballehensis, M. kipas* and *M. mirae* are recorded only from Baleh National Park. In many field expeditions conducted since 2008, the effort of collecting living specimens to be planted in our arboretum has failed, although the collection includes preserving some soil of the species original habitat. We have been attempting to plant several species of conservation concern, such as *M. kadimiana* which was found only in Sarikei to this date, but unable to survive in its transplanted habitat. Another notable attempt at transplanting involved the vulnerable species *M. multiflora*, which was discovered in 2008 in Limbang. This species has not been found in Sarawak since the site of its discovery was cleared for development in 2010. Should we understand the physiology or translocation management of the species, we might have been able to transplant this species to a new habitat for its conservation. As ex situ transplanted for *Mapania* species are difficult to be done due to sensitivity of the plants to a new environment and incapable to uphold the water in evaporation from the root system, this paper aims to understand how environmental factors affect the distribution of

Fig. 1. The locations of Matang, Gunung Gading and Bengoh where *Mapania cuspidata* inhabits. (Source: Google Map).

Mapania cuspidata in different natural habitats and then quantify key ecophysiology metrics of this species concerning survival, growth and development following attempt in transplanting at a new location.

MATERIALS AND METHODS

Observational field study

Three locations in Sarawak, Malaysia were selected for this study, namely Matang (1°37'52.4"N, 110°08'11.3"E), Gunung Gading (1°41'29.15"N, 109°50'46.33"E) and Bengoh (1°18'24.4"N, 110° 13'09.3"E) (Fig. 1). These three locations were selected due to accessibility and the presence of *M. cuspidata.* In each location, the sampling was conducted in five random plots with each plot measuring 250 m^2. Within each plot, 10 quadrates of 25 m^2 were randomly placed to quantify plant populations, chlorophyll content, soil pH and organic matter content. Non-destructive approach was used to count plant populations and a chlorophyll meter (SPAD-502Plus, Konica, Minolta) was used to measure the plant chlorophyll content. Soil samples were collected at 0–200 mm depth using a soil auger. The soil samples were then sent to the laboratory for chemical analysis. Soil pH was measured using a pH meter whereas soil organic matter was measured using Loss on Ignition (LoI) method (Ball, 1964). For light intensity, five readings were taken from each plot using a handheld light meter (Extech EA30, Massachusetts, U.S.).

Transplantation experiment

A total of 36 healthy and disease-free individuals were collected from the Matang habitat for a transplantation experiment on survival and growth in Universiti Malaysia Sarawak. Plants from Matang were selected because of it was the nearest location to Universiti Malaysia Sarawak (approximately a two hour drive) and thereby reduced the lag time of plant recovery due to injury and stress. At the sampling location, the soil around the plants was explored to determine the extent of feeding roots prior to lifting. Using a hand shovel, the plants were dug with a mass of soil around the roots while keeping as much of the root ball intact as possible. The sampling was done early in the morning and the plants were selected with no particular age consideration. All leaves were removed during the transportation process, to reduce the water stress due to evaporation. Upon arrival at the destination, the plants were placed in plastic buckets filled with 1.5 L tap water to keep the roots moistened and stored in an unlit, air-conditioned laboratory at 25°C for five days to restore the plant vigor. This was also intended to simulate the natural living conditions of *M. cuspidata* as this species were found living in damp and wet areas near to the rivers and streams with moist and wet soil conditions (Miraadila *et al*., 2015). Then, the plants in the buckets were placed in a corridor outside the laboratory (sheltered condition) for another five days to acclimatize before transplanting into polybags measuring 254 × 305 mm. These polybags were filled with potting mix containing a mixture of coco peat, burnt soil, river sand, burnt husk, rich humus and charcoal powder (Kean Beng Lee Industries (M) Sdn. Bhd.).

The transplantation experiment comprised of four light intensities, *i.e.* 7, 18, 54 and 100% with nine replicates each. To do this, three mini-green houses were built with different shading netting percentage (1 layer created 54%, 2 layers created 18% and 3 layers created 7% light intensity). For 100% light intensity, the plants in polybags were exposed under full sunlight. The relative light intensity was obtained by comparison of light readings taken inside and outside of the mini-green house. No fertilizer and pesticide were applied during the experiment. Any fungus or weed growth were removed manually and polybags were watered daily to ensure the soil remained moist. The plants were left to grow for a period of 130 days with observations taken at weekly intervals, starting at 30 days from the date of transplanting. Four ecophysiology parameters were measured, *i.e.* final number of leaves, leaf production rate, chlorophyll content and survival rate of each treatment. The leaf production rate was calculated from the regression of the leaf number against accumulated days. The chlorophyll content was measured using a chlorophyll meter (SPAD-502Plus, Konica, Minolta). Plant survival rate was calculated by dividing the number of survived plants in the end of the experiment against total number of transplanted plants at the beginning of the experiment.

Data analysis

Statistical analysis used VassarStat (http://vassarstats.net/) (Richard Lowry, 1998-2021). All variables were analyzed using analysis of variance (ANOVA) and treatment means were compared by Tukey's Honest Significant Test (HSD) using an alpha value of $P<0.05$ for establishing statistical significance. Pooled standard errors of the mean were reported for each measured variable.

RESULTS

The density of *M. cuspidata* was highest at Matang with total density of 1.98 individuals/ha compared to Bengoh (1.42) while Gunung Gading showed the lowest density of 0.96. However, statistical analysis showed no significant difference in the populations of *M. cuspidata* per 250 m^2 among these three locations (Table 1). Matang recorded the highest light intensity of 0.94 kLux on the forest floor, whereas both Gunung Gading and Bengoh had an average of ~0.34 kLux. Plants in Matang also had the greatest chlorophyll content (67.4 SPAD unit) compared with those in Gunung Gading and Bengoh (~56.2 SPAD unit). In terms of soil parameters, the pH and organic matter content varied among the locations (Table 1). The soil in all locations was found to be acidic with the lowest pH recorded in Bengoh (pH 4.9) followed by Gunung Gading (pH 5.5) and Matang (pH 5.7). The soil organic matter ranged from 3.47% in Bengoh to 8.68% in Gunung Gading.

Observation after 130 days from transplanting found that there was no significant difference in the ecophysiology of *M. cuspidata* with an average survival rate of 88.9% across all light treatment (Table 2). In addition, the plants successfully produced an average of ~7.7 new leaves throughout the growing period with ~15.8 days interval to produce each succesive leaf. These new, developing leaves had an average chlorophyll content of ~30.3 SPAD unit across all light conditions. In contrast, plants in the natural habitats despite living under low illumination had a higher chlorophyll content (52.6–67.4 SPAD unit) (Table 1) because the leaves had fully developed and matured. Lower chlorophyll content in the new, young leaves was expected because the leaves have not attained their maximum size and therefore were unable to maximize photosynthetic activity.

DISCUSSION

Observation of *M. cuspidata* in its natural habitat found that the population densities of the species were similar across all locations in Gunung Gading, Matang and Bengoh with an average density of 14.4 individuals per 250 m^2 area. The results from statistical analysis showed that presence of *M. cuspidata* was not affected by the differences in light intensity (0.32–0.94 kLux) and soil chemical properties (pH 4.9–5.7, organic matter 3.47–8.68%) (Table 1). This observation is consistent with the generalized expectation that most *Mapania* species are found in shaded areas with water-logging soil conditions or near bodies of water (Simpson, 1992). Despite variation in light intensity among the locations, the highest illuminance of 0.94 kLux on the forest floor is

Table 1. Plant populations, chorophyll content, light intensity and soil parameters in Gunung Gading, Matang and Bengoh where *Mapania cuspidata* (Miq.) Uittien were observed.

Location	*M. cuspidata* populations/250 m^2	Light intensity (kLux)	Chlorophyll content (SPAD unit)	Soil parameters	
				pH	Organic matter (%)
Gunung Gading	9.2	0.32^b	59.8^b	5.5^a	8.68^a
Matang	19.8	0.94^a	67.4^a	5.7^b	5.77^b
Bengoh	14.2	0.35^b	52.6^b	4.9^c	3.47^c
S.E.M	1.90	0.078	2.03	0.15	0.953
P-value	0.062 (ns)	<0.001	<0.001	<0.001	<0.001

S.E.M., Standard Error of Means; ns, P>0.05. Means with the same letters are not significantly different (P>0.05) based on Tukey's HSD test.

Table 2. Survival, leaf production rate, number of leaves and chlorophyll content of *Mapania cuspidata* (Miq.) Uittien grown under different levels of light intensity in Universiti Malaysia Sarawak, East Malaysia.

Relative light intensity (%)	Ecophysiology parameters			
	Survival[1] (%)	Leaf production rate (days/leaf)	Number of leaves[1]	Chlorophyll content[1] (SPAD unit)
7	77.8	14.4	8.2	31.9
18	88.9	16.0	8.2	32.8
54	100.0	16.2	7.2	26.6
100	88.9	16.5	7.3	29.7
S.E.M.	5.31	0.80	0.41	1.95
P-value	0.553 (ns)	0.818 (ns)	0.754 (ns)	0.707 (ns)

[1]Survival, final number of leaves and chlorophyll content were measured after 130 days from transplanting. S.E.M., Standard Error of Means; ns, P>0.05.

equivalent to an overcast weather in an open area and therefore is considered as conditions of low brightness. This study suggests that *M. cuspidata* can thrive in conditions of acidic soil with significant amount of organic matter. Associated with this is the need to identify other *Mapania* species that may inhabit the same ecological niche with *M. cuspidata* in future work.

The results of transplantation experiment have shown successful establishment of *M. cuspidata* under shaded and open area conditions with an average survival rate of 89% (Table 2). During the course of 130 days post-transplanting, *M. cuspidata* developed an average of 7.7 new leaves with leaf production rate of 15.8 days/leaf. The findings of this study are substantial yet confounding given extensive reviews on *Mapania* species being shade loving plants that grow well in conditions of damp and wet soils (Simpson, 1992; Shabdin *et al*., 2013a, 2013b; Miraadila *et al*., 2016a) and failing attempts to plant the species in new locations (Z. Shabdin, pers. comm.). Following successful pot transplantation experiment, the individuals of *M. cuspidata* were relocated to the arboretum of Universiti Malaysia Sarawak and observation two years later found these plants remain thriving the new environment (Fig. 2). These new findings on high survival of *M. cuspidata* in the transplantation study implies that there is a good chance to plant other *Mapania* species that are of a greater conservation concern in new locations.

Fig. 2. Mature (left) and juvenile (right) *Mapania cuspidata* successfully established in the arboretum of Universiti Malaysia Sarawak two years after the pot transplanting experiment.

Nevertheless, the success in transplantation and growing *M. cuspidata* in different environments was likely aided by careful considerations of the impact of lifting, transporting and pre-transplanting during the process of plant relocation. Careful lifting of plants from the ground is critical because the roots need to be protected during handling. This is because the survival and performance of any transplanted plant is largely dependent on the ability of roots to develop and recover from injury and stress (Jackson *et al*., 2012). Equally, the conditions of transport and storage determine the survival rate and quality of plants after transplanting. Water stress during transport or storage of plants can delay root regeneration and subsequent growth following transplanting, while worst case scenario could result in high mortality rate (Apostol *et al*., 2009). Therefore, transit time, temperature, moisture and duration of storage are important parameters that need to be optimized (Goyette *et al*., 2014). Additionally, plants should be acclimatized to prepare them for survival under higher temperatures and levels of irradiance. Transplanting should be carried out under ideal conditions, *i.e.* late afternoon or overcast weather to allow the plants to recover from transplanting injury while avoiding midday heat and being subjected to less evaporation of water. Finally, the plants should be transplanted to the same depth in its new location. This can be done by examining the soil mark on the stem. Specifically for endemic plant species, factors concerning the plant life form, physical size, distribution range, population size and whether the relocation site is within the species historical range must be taken into account first before making decision to transplant for the purpose of ex situ conservation (Liu *et al*., 2015). This is because endemic species have specific habitat conditions which require stable and constant environment, making them more vulnerable than other plant species to natural changes. Due to its potential ecological risks, conservation transplantation of endemic species to new location should be within the historical range area and would require careful management and longer post planting monitoring. In short, the survival and success in establishment of transplanted plant are greatly dependent on the decisions and post harvest handling practices. With adequate knowledge and understanding on plant ecophysiology and post harvest management, it is possible to relocate and establish plant species in new locations for ex situ conservation and to increase its widespread distribution.

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