

Notes on *Gymnopetalum* (Cucurbitaceae) from the Lesser Sunda Islands, Indonesia

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Abstract. Pratami MP, Santika Y, Rugayah. 2026. Notes on *Gymnopetalum* (Cucurbitaceae) from the Lesser Sunda Islands, Indonesia. *Nusantara Bioscience* 18 (1): n180101. <https://doi.org/10.13057/nusbiosci/n180101>. Four species of *Gymnopetalum* (*G. chinensis*, *G. orientale*, *G. scabrum*, and *G. pectinatum*) have been reported for the Malesian Region, all of which can be found in the Lesser Sunda Islands, Indonesia. The genus is closely related to *Trichosanthes*, and one species, *G. orientale*, morphologically resembles *T. quinquangulata*. Moreover, molecular data place *Gymnopetalum* as a section of *Trichosanthes* (= *Trichosanthes* sect. *Tripodanthera*). In this study, morphology and leaf anatomy observation have been conducted on BO collections of *Gymnopetalum* from the Lesser Sunda Islands. Anatomical observation of leaf paradermal sections follows the method of Sass and Cutler. An unidentified specimen collected from Lombok (Kahono, Nakano, and Abbas 2005-36) resembles *G. orientale* in floral characters but differs in leaf shape. Anatomical data support morphological data that the specimen is similar to *G. orientale* in epidermis characters. They have the same epidermis cell shape i.e. irregularly shaped with shallowly sinuous anticlinal walls, but differ in size only, *G. orientale* has epidermal cell sizes of 19-24.80 × 12.40-14.88 μm (upper) and 19.84-21.32 × 12.40-14.88 μm (lower), whereas the Kahono Nakano, Abbas 2005-36 specimen has epidermal cell sizes of 27.28-29.76 × 14.88-17.36 μm (upper) and 24.80-27.28 × 17.36-19.84 μm (lower). These differences fall within morphological variation and support the identification of the Lombok material as *G. orientale*. The anatomical evidence corroborates previous morphological and molecular studies, indicating intermediate characters between *G. orientale* and *T. quinquangulata*, reinforcing the close evolutionary relationship between the two genera. This study contributes additional morphological and anatomical data supporting the phylogenetic placement of *Gymnopetalum* within *Trichosanthes*.

Keywords: Anatomy, *Gymnopetalum*, Lesser Sunda Islands, morphology, *Trichosanthes*

INTRODUCTION

Gymnopetalum is a genus of climbing plants that belongs to the family Cucurbitaceae. This genus has unique characteristics, like a simple tendril or two branches, leaves are simple with a rough texture due to the presence of white cystoliths, and unisex flowers with white crowns, male flowers are solitary or in the form of a raceme, and female flowers are solitary. *Gymnopetalum* has red fruit when ripe, with a smooth surface or shallow grooves, and the seeds are numerous, flat, and without ornamentation (de Wilde and Duyfjes 2010).

Gymnopetalum is native to Tropical and Subtropical Asia to the Western Pacific and is widely distributed in South India, Sri Lanka, North India, South China, and East Malesia (de Wilde and Duyfjes 2010). In the Malesian Region, *Gymnopetalum* consisted of three species and two varieties, i.e., *G. chinensis*, *G. orientale*, *G. scabrum*, and *G. scabrum* var. *scabrum* and var. *pectinatum*, until de Wilde et al. (2015) elevated the status of var. *pectinatum* from Sumbawa to the species *G. pectinatum*. Hence, *Gymnopetalum* in Malesia consists of 4 species, all found in the Lesser Sunda Islands, Indonesia. Two species, *G. chinensis* (not known from Maluku and Papua), *G.*

orientale, are found across East Malesia (Lesser Sunda Islands: Bali, Lombok, Flores, Maluku: Seram, Babar Is. and Sulawesi), *G. scabrum* (not known from Sumatra), and *G. pectinatum* is restricted to East Java and West Sumbawa (de Wilde and Duyfjes 2010; de Wilde et al. 2015).

Trichosanthes is more diverse, consisting of 100 species, distributed throughout subtropical and tropical eastern Asia (de Wilde and Duyfjes 2010). In Malesia, 43 species have been reported (Rugayah and de Wilde 1999; de Wilde and Duyfjes 2010). Morphologically, both genera have similar flowers with white, free petals, an elongated receptacle tube of their corolla, and compressed seeds. They differ in *Gymnopetalum* having no or short fimbriate petals, few narrowly lateral lobes of the sepal, smaller fruit and seed, whereas *Trichosanthes* has short, mostly with long fimbriate petals, bigger and various shapes of fruit, and seeds.

de Wilde and Duyfjes (2006) reported that *G. orientale* resembles some species of *Trichosanthes*, and therefore could be regarded as intermediate between the two genera. Morphologically, *T. quinquangulata* is the most closely related to *G. orientale*, in which both species have orbicular with entire or angular - shallowly leaf lobed, rhomboid bracts, sepal with few slender lateral sidelobed

and entire seed margined. The first species has short-long fimbriate petals, a globose fruit, and a cuneate seed base. In contrast, the latter species has no fimbriate petals, ellipsoid-fusiform fruit, and an acute end of the seed (de Wilde and Duyfjes 2010). Unsurprisingly, molecular data have recently changed the position of *Gymnopetalum* to be a section of *Trichosanthes*, and as a consequence, all species of *Gymnopetalum* move to *Trichosanthes* (de Boer and Thulin 2012). However, in this paper, we still used the genus name under *Gymnopetalum*.

Morphological observation of BO materials of *Cucurbitaceae* from the Lesser Sunda Islands indicated that one specimen collected by Kahono, Nakano, and Abbas (2005-36) from Lombok was identified as *Trichosanthes* sp., which required further study. The material has laterally lobed sepals and an elongated corolla tube that resembles the flower of *G. orientale*, but differs in its leaf shape, being entire and ovate (*G. orientale*: leaf orbicular with 3-5 angular or shallowly lobed). Hence, the study aims to provide information on *Gymnopetalum* species in LSI and re-identify this material and clarify the possible existence of intermediate forms between *Gymnopetalum* and *Trichosanthes*, as expected in *G. orientale* and *T. quinquangulata*. A leaf anatomical study has been conducted to address these taxonomic problems.

This study addresses whether morphological and leaf epidermal anatomical characters support the identification of the Lombok specimen (Kahono, Nakano and Abbas 2005-36) as *G. orientale*, and whether these characters provide phenotypic evidence consistent with the molecular placement of *Gymnopetalum* within *Trichosanthes*. Specifically, we ask: (i) Do the morphological characters of the Lombok material fall within the variation range of *G. orientale*? and (ii) Do epidermal cell shape and size patterns reinforce its taxonomic placement and the proposed close evolutionary relationship between *Gymnopetalum* and *Trichosanthes*?

MATERIALS AND METHODS

Morphological observation

Morphological observations were conducted at the Herbarium Bogoriense, Cibinong, Indonesia, by examining four herbarium specimens of *Gymnopetalum* stored at BO that originated from the Lesser Sunda Islands (LSI) and two specimens of *G. orientale* from Maluku. Re-identification of specimens was conducted using literature such as Backer and van den Brink (1963) and Flora Malesiana (de Wilde and Duyfjes 2010). Taxonomic nomenclature and species delimitation follow Plants of the World Online (POWO 2025).

Anatomical observations

A paradermal section was conducted for observing the epidermal tissue and stomata of *Gymnopetalum* and *Trichosanthes* species, based on Sass (1951) and Cutler (1978). We cut the mature leaf to $\pm 1 \times 0.5$ cm² and took three samples from each specimen. Each sample observed 3 fields of view and measured 10 epidermal cells. Heat the

HNO₃ 25% solution to boiling and turn off the heat, soak for 1 minute to soften. Rinsed with aquadest to remove acid. The adaxial and abaxial epidermal layers were scraped. After cleaning, the layers were stained with 1% safranin. Aquadest is used to clean residual safranin. The epidermal section was placed on a glass slide, and 30% glycerin was added before the addition of a coverslip for further observation. Observation was performed using a Nikon Eclipse 80i microscope, captured with an Indomicro HDMI camera, and using BetaView software.

RESULTS AND DISCUSSION

Based on morphological observations of *Gymnopetalum* specimens at the Herbarium Bogoriense, the four species present in the Lesser Sunda Islands (LSI) of *Gymnopetalum*, i.e., *G. chinensis*, *G. orientale*, *G. pectinatum*, and *G. scabrum*, are described below.

1. *Gymnopetalum chinensis* (Lour.) Merr.

Gymnopetalum chinense (Lour.) Merr., Philipp. J. Sci. (1919) 256; W.J.de Wilde and Duyfjes, Blumea 51 (2006) 283; Reinwardtia 12 (2008) 268, Fl. Thailand 9, 4 (2008) 443. - *Evonymus chinensis* Lour., Fl. Cochinch. (1790) 156. W.J.de Wilde and Duyfjes, Fl. Males, Ser. 1, 19 (2010) 72-Type: Untraced. Neotype: Levine 1705 (holo A, designated by de Wilde and Duyfjes, Reinwardtia (2008)), South China.

Bryonia cochinchinensis Lour., Fl. Cochinch. (1790) 595. - *Gymnopetalum cochinchinense* (Lour.) Kurz, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 40 (1871) 57; C.B.Clarke in Hook.f., Fl. Brit. Ind. 2 (1879) 611; Cogn. in A.D.C. and C.D.C., Monogr. Phan. 3 (1881) 391; Ridl., Fl. Malay. 1 (1922) 846; Craib, Fl. Siam. 1 (1931) 755; Backer in Backer and Bakh.f., Fl. Java 1 (1964) 302. - Type: Loureiro s.n. (BM), Vietnam.

Momordica surculata Noronha, Verh. Batav. Genootsch. Kunsten 4 (1790) 21, nom. inval.

Gymnopetalum quinquelobum Miq., Fl. Ned. Ind. 1, 1 (1856) 681. - Type: Horsfield s.n. (holo U, barcode U0001464), Java, Soerakarta.

Trichosanthes laciniata Ridl., J. Straits Branch Roy. Asian. Soc. 59 (1911) 107. - Type: Curtis in Ridley 8350 (holo K, not seen), Peninsular Malaysia, Langkawi.

Diagnostic: Probract (minute, caducous or) absent. Tendrils unbranched. Leaves ovate or triangular in outline (deeply) lobed, cystoliths usually faint. Male flowers are solitary or in a raceme. Female flowers are solitary. Fruit oblong-elliptic, sharply 10-ribbed; fruiting pedicel 1-4 cm long. Seeds narrowly elliptic, faces not ornamented, with a marginal groove (Figure 1).

Distribution: Widely distributed in Indonesia, except Maluku and Papua.

Ecology: Forest edges, clearings, scrub, in hedges and in open fields, on sandy soil, to 500 m altitude; flowering and fruiting throughout the year (de Wilde and Duyfjes 2010).

Specimens examined: Bali (Sarip 18) and Bali (de Wilde and Duyfjes 21722, 9 January 1995).

2. *Gymnopetalum orientale* W.J.de Wilde and Duyfjes

Gymnopetalum orientale W.J.de Wilde and Duyfjes, *Blumea* 51 (2006) 290, f. 5.; W.J.de Wilde and Duyfjes, *Fl. Males, Ser. 1*, 19 (2010) 73. ---Type: de Wilde and Duyfjes 21937 (holo L), Lombok.

Diagnostic: Probract absent or various in size, (ob)ovate, up to 1 cm long, irregularly sharp-dentate, glandular. Tendrils (simple or) unequally 2-branched in the lower half. Leaves lobed (3-) 5, blade scabrous by cystoliths above, male flower solitary or in the raceme. Female flowers are solitary, with sepals varying in longitudinal bands (Maluku) and elongated triangles (Lombok). Fruit obovate-ellipsoid, shortly beaked, harshly fine-hairy, glabrescent, sometimes with scattered wartlets; Seeds numerous, long pear-shaped, rather acute at one end, faces shallowly verrucose-rugose, not margined (de Wilde and Duyfjes 2006) (Figure 2).

Distribution: Sulawesi, LSI (Bali, Lombok, Flores), Maluku

Habitat and Ecology: Climber in scrub and forest edges; damp sites; 25-1500 m altitude; flowering mainly June to January; fruiting in February (de Wilde and Duyfjes 2010).

Note: Specimens of *G. orientale* from Maluku and a revision of *G. orientale* in *Flora Malesiana* as a comparison and reference for re-identifying the Kahono, Nakano, and Abbas (2005-36) specimens; that are thought to have similar morphological characters to *G. orientale*.

Specimens examined: P. Babar (J.van Borssum W. 3111, 5 Maret 1956); Seram and Maluku (P.J.Eyma 2496, 6 Januari 1938); Lombok (Kahono Nakano, Abbas 2005-36, 15 Agustus 2005); photo line drawing (*Fl. Malesiana*, 2010).



Figure 1. *Gymnopetalum chinensis*: A. Living plant (Photo: Rugayah), B. Herbarium specimen (BO) Sarip 18, C. de Wilde and Duyfjes 21722 (Photo: Mentari Putri Pratami)

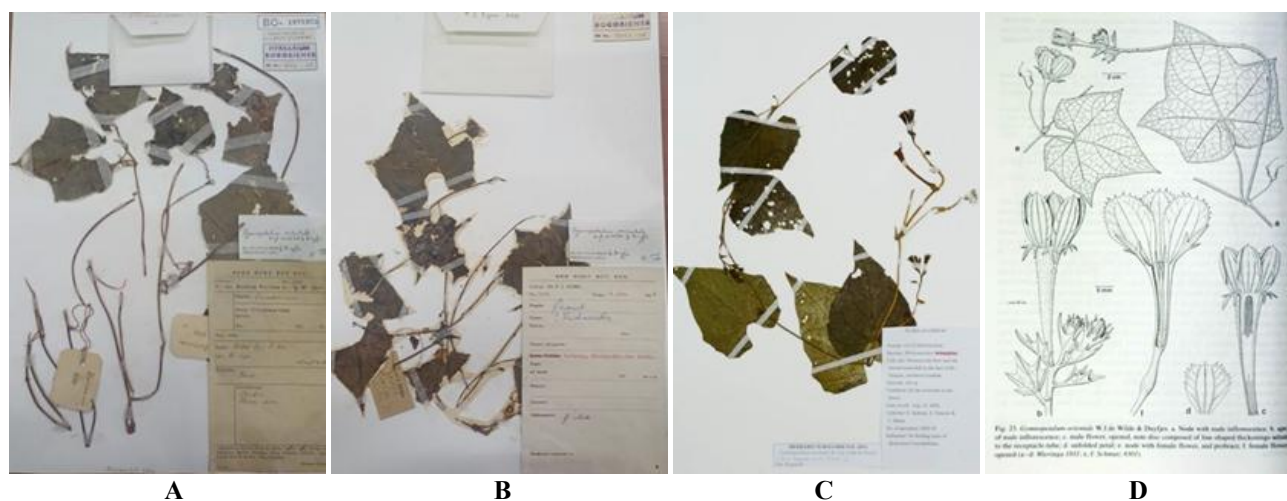


Figure 2. *Gymnopetalum orientale*: Herbarium specimens (BO). A. J.van Borssum W. 3111 (P. Babar), B. P.J.Eyma 2496 (Seram), C. Kahono Nakano, Abbas (2005-36), and D. Line drawing (*Fl. Malesiana* 19, 2010: 72). (Photo: Mentari Putri Pratami)

3. *Gymnopetalum pectinatum* (W. J. de Wilde and Duyfjes) Rugayah

Gymnopetalum pectinatum (W. J. de Wilde and Duyfjes) Rugayah, Reinwardtia 14, 2 (2015) 323-324. - Type: de Wilde and Duyfjes 21692 (L), male fl., E Java.

Gymnopetalum integrifolium (Roxb.) Kurz var. *pectinatum* W. J. de Wilde and Duyfjes, Blumea 51, 2 (2006) 287, fig. 4. - *Gymnopetalum scabrum* (Lour.) W. J. de Wilde and Duyfjes var. *pectinatum* (W.J.de Wilde and Duyfjes) W. J. de Wilde and Duyfjes, Reinwardtia 12 (2008a) 268; Fl. Males, Ser. 1, 19 (2010) 78, f. 24: a,b.; 26: b, b';; pll.. 10:: c.

Diagnostic: Probract absent or possibly inconspicuous and caducous. Tendrils are sparsely hairy, simple or 2-branched near the base. Leaf blade subcircular or angular in outline, margin (sub)entire. Bracts of male raceme with upper margin regularly, finely, densely lacinate. Sepals subtentire or shallowly few-lobed. Fruits orange, sparsely hairy, ellipsoid with obtuse apex, c. 4 cm long, finely hairy, not ridged. Seeds ellipsoid-oblong, faces slightly raised, somewhat rugose, margin broad, rounded (Figure 3).

Distribution: LSI (Sumbawa), East Java

Ecology: Coastal flatland on clayey soil; low altitudes (de Wilde and Duyfjes 2010)

Specimens examined: Sumbawa, Alas, 5-10m alt., S. Nakano and Kahono 99111, 26 Juni 1999

4. *Gymnopetalum scabrum* W.J.de Wilde and Duyfjes

Gymnopetalum scabrum (Lour.) W.J.de Wilde and Duyfjes, Reinwardtia 12 (2008) 268; Fl. Thailand 9, 4 (2008) 445. - *Trichosanthes scabra* Lour., Fl. Cochinch. (1790) 589. - Type: Untraced. Neotype: Poilane 11322 (holo P, designated by De Wilde and Duyfjes, Reinwardtia (2008); iso L), Vietnam, Annam. W.J.de Wilde and Duyfjes, Fl. Males, Ser. 1, 19 (2010) 74.

Trichosanthes lucioniana Naves ex F.Villar, Fl. Filip., ed. 3 [F.M. Blanco] (1880) Nov. App.: 95, pl. 460 (see note); Merr., Sp. Blancoan. (1918) 13.

Gymnopetalum integrifolium (Roxb.) Kurz, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 40 (1871) 58; C.B.Clarke in Hook.f., Fl. Brit. Ind. 2 (1879) 612; King, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 67 (1898) 31; Ridl., Fl. Malay Penin. 1 (1922) 846; Cogn. and Harms in Engl., Pflanzenr. 88, 4.275.2 (1924) 179; W.J.de Wilde and Duyfjes, Blumea 51 (2006) 286. - *Cucumis integrifolius* ('*integrifolia*') Roxb., Fl. Ind. (1832) 724. - Type: Wallich Cat. 6730 (KW, IDC microfiche), Myanmar, Ponlong.

Gymnopetalum leucostictum Miq., Fl. Ned. Ind. 1, 1 (1856) 680; Backer in Backer and Bakh.f., Fl. Java 1 (1964) 302. - Type: Junghuhn s.n. (lecto L, barcode L0589693, designated by de Wilde and Duyfjes (2006); iso U, barcode U0001465), Java, Weltevreden.

Diagnostic: Probract green-yellow, lanceolate, unlobed or (deeply) 2- or 3-lobed, acute, sometimes caducous. Tendrils are unbranched or unequally 2-branched near the

base. Leaf blade subcircular in outline or 3-5-angular, margin entire or shallowly dentate. Bracts of the male raceme are variously rather few-lobed. Sepals narrow-triangular, lanceolate, entire or shallowly few-lobed. Fruit (sub)globose, glabrescent. Seeds' faces are small, almost smooth, demarcated by a groove from a broad, rounded margin (Figure 4).

Distribution: Java, Sulawesi, LSI (Bali), Kalimantan.

Ecology: Roadsides and disturbed places, to 500 m; flowering and fruiting throughout the year.

Distribution: There are no specimens of LSI stored in BO (recorded in the book Fl. Malesiana vol. 10).

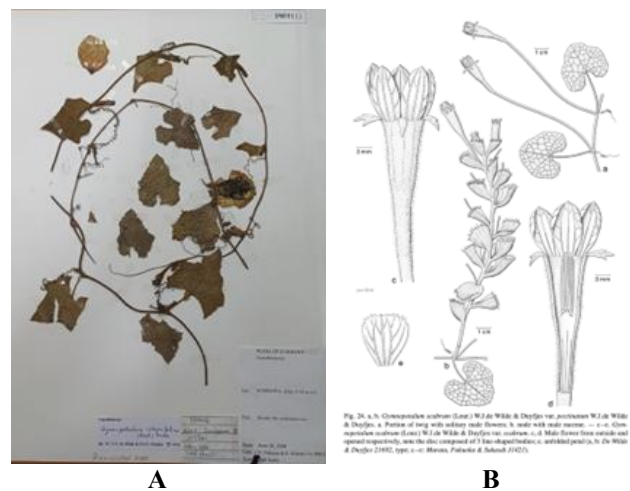


Figure 3. *Gymnopetalum pectinatum*: A. Herbarium specimen (BO): S. Nakano and Kahono 99111 (Photo: Mentari Putri Pratami), B. Line drawing (Fl. Malesiana 19, 2010: 75) (Photo: Mentari Putri Pratami)

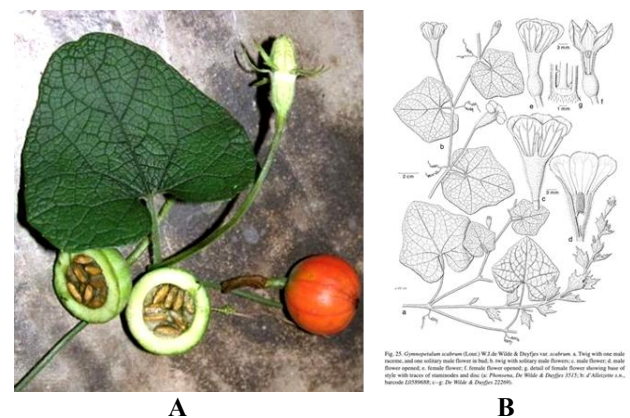


Figure 4. *Gymnopetalum scabrum*: A. Living plant (Photo: Rugayah), B. Line drawing (Fl. Malesiana, 19, 2010:76) (Photo: Mentari Putri Pratami)

Confirmation of the species *G. orientale* Specimen J. Van Borssum W. 3111, P.J.Eyma 2496, and specimen Kahono, Nakano, Abbas 2005-36

The observed morphological characteristics of *G. orientale* and Kahono specimens show similarities in flower characteristics with overlapping sizes, but differ in leaf shape and leaf margin. Meanwhile, the observed leaf characteristics of *G. orientale* have shallow lobes, while the Kahono specimen has entire or unlobed leaves. Based on de Wilde and Duyfjes (2010), *G. orientale* has membranous leaf blades that are ovate or subcircular in outline, 6-14 cm in diameter, and usually have 3-5 sharp-angular or deeply lobed margins. Male flowers of *G. orientale* have bracts rhomboid 2×1.4 cm; glands present; margin lobed; calyx linear 0.5 cm long, margin crenulate-lobate, while the Kahono specimen has Bracts broadly rhomboid 1×0.5 cm; gland present; margin dentate; calyx 0.3 cm long, triangular with an irregular lobed margin. According to de Wilde and Duyfjes (2010), the petals of *G. orientale* are narrowly obovate, 20-30 mm long, with some fringes up to 5.0 mm long at the base, and crenulate-lobate margins (Table 1). Thus, the leaf variation exhibited by the Kahono specimen still falls within the range of morphological variation of the *G. orientale* species.

The epidermal cells of the two specimens have the same shape but different sizes (Figure 5). The Kahono specimen from Lombok has a bigger cell size than Eyma's. Cell size differences are usually affected by the environment, such as water stress, light intensity, and nutrition availability (Sakamoto et al. 2022). The confirmation from specimen *Trichosantes* sp. (Kahono 2005-36). Its anatomical

characters support the morphological data for clarification that it is confirmed as *G. orientale*, as an additional specimen for the Lesser Sunda Islands. These anatomical data are used to support the intermediate morphological form and paraphyletic results between *T. quinquangulata* and *G. orientale*. This is not primary data, but rather supplementary data that can strengthen the position of the two genera.

The close relationship between *Trichosantes* and *Gymnopetalum* is based on morphological characteristics

Based on morphological characteristics, *Trichosantes* and *Gymnopetalum* share several similarities in leaf dimorphism and flower shape, being star-shaped or tubular with white petals and fimbriate tips (*Trichosantes*), while *Gymnopetalum* lacks the fimbriate tips (Figure 6); this is in line with the de Wilde and Duyfjes (2006). *Gymnopetalum* is very similar to some species of *Trichosantes*; however, *Gymnopetalum* lacks the thread-like fimbriae on its petals, and the overall shape of the folded petals on the mature bud is elongated (short and rounded in *Trichosantes*). Between the two genera, there are two species, namely *G. orientale* and *T. quinquangulata*, that have transitional characteristics. Both have narrow sidelobes of sepals, a characteristic specific to the genus *Gymnopetalum*, and also fimbriate petals, similar to those of the genus *Trichosantes*, although in *G. orientale* the petals have very short threads.

Table 1. Comparison of characteristics of *G. orientale* specimens J. Van Borssum W. 3111, P.J.Eyma 2496, and Kahono Nakano, Abbas 2005-36

Morphological and anatomical characteristics of leaves	Specimen J. Van Borssum W. 3111 and P.J.Eyma 2496 from Maluku	Specimen Kahono Nakano, Abbas 2005-36 from Lombok
Leaf margin	Shallowly lobed (3-) 5; 5.5-8.5 × 8-10 cm	Entire, 7.0-10.5 × 8.0 cm
Inflorescence	Pedicele 5.1 cm	Pedicele 5.0-5.3 cm
Male flowers	Bracts rhomboid 2.0 × 1.4 cm; glands present; margin lobed; calyx linear 0.5 cm long, margin crenulate.	Bracts broadly rhomboid 1.0 × 0.5 cm; gland present; margin dentate; calyx 0.3 cm long, triangular with irregular lobed margin
Female flowers	4.5-5.0 cm	5.0 cm
Fruit (immature)	Oblong-orbicular 2 × 1.5 cm, hairy	Not seen
Upper leaf epidermis	19.00 - 24.80 × 12.40 - 14.88 μm	27.28 - 29.76 × 14.88 - 17.36 μm
Lower leaf epidermis	19.84 - 21.32 × 12.40 - 14.88 μm	24.80 - 27.28 × 17.36 - 19.84 μm

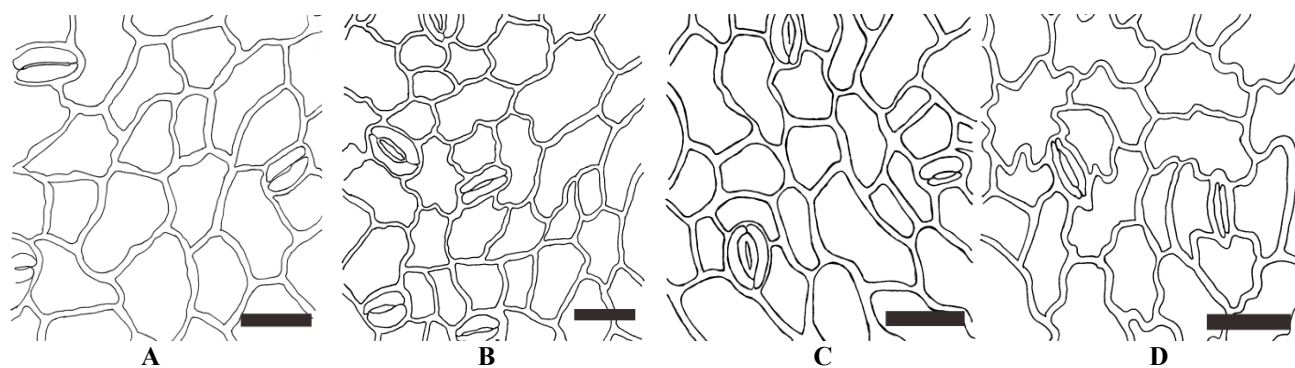


Figure 5. Paradermal section of *G. orientale* (Eyma's collection): A. Adaxial epidermis, B. Abaxial epidermis. *G. orientale* (Kahono's collection): C. Adaxial epidermis, D. Abaxial epidermis. Scale bars 20μm

In addition, *Trichosanthes* and *Gymnopetalum* have a variety of fruit shape characteristics, such as globose, ellipsoid, and oblong (Figure 7), and the shape and color of the seeds. de Wilde and Duyfjes (2010) report that the fruit shape of *Trichosanthes* is ellipsoid, globose, or fusiform, whereas *Gymnopetalum* has globose or ovoid-ellipsoid fruit. The seeds of *Trichosanthes* are light to dark brown, gray (or black), flat or swollen (with inflated margins), varying in shape, with a surface that is smooth or slightly sculptured, edges usually present, edges usually smooth, or serrated or wavy; whereas the seeds of *Gymnopetalum* are black or brown in color, and are ovoid or pear-shaped in form.

Phylogenetic analysis of molecular data reveals that *Gymnopetalum* and *Trichosanthes* form a monophyletic group, supporting their classification as a single clade (de Boer and Thulin 2012; Liu et al. 2021). Molecular phylogeny reveals that the long-fimbriate petals evolved independently in *Hodgsonia* and *Trichosanthes-Gymnopetalum*, followed by two losses of petal fimbriae in the latter clade, suggesting that this is likely related to pollinator shifts (de Boer et al. 2012). Based on molecular data, *Gymnopetalum* is nested within *Trichosanthes* (Kocyan et al. 2007), with the Malesian species being widely separated from the single species *G. tubiflorum*.

A study conducted by Liu et al. (2021) using 4,759 nucleotides of nuclear and plastid DNA markers strongly supports a phylogenetic relationship between *Gymnopetalum* and *Trichosanthes*. Several *Gymnopetalum* species, such as *G. integrifolium*, show a very high genetic closeness to members of the genus *Trichosanthes*. *G. integrifolium* has synonyms *T. integrifolia* and *T. scabra*; at the same time, *G. chinense* has a synonym, *T. costata*.

Phylogenetic analysis based on the matK sequence reveals that *Trichosanthes* species are grouped within *Gymnopetalum*, and the trnL-trnF IGS sequence cannot distinguish between species of the genera *Luffa*, *Trichosanthes*, and *Gymnopetalum*. Furthermore, combined analyses of ITS+matk, ITS+trnL-trnF IGS, and

ITS+matk+trnL-trnF IGS produce a tree topology that groups *Gymnopetalum* species (*G. integrifolium* and *G. chinense*) and *Trichosanthes* species into a single clade (Nurbaiti et al. 2025).

The close relationship between *Trichosanthes* and *Gymnopetalum* is based on anatomical characteristics.

In general, the upper epidermal cells of *Gymnopetalum* are polygonal in shape with straight to undulate anticlinal walls shallowly. There is variation in the lower epidermal cells, with anomocytic stomata. The lower epidermal cells in *G. chinensis*, *G. pectinatum*, and *G. scabrum* are irregularly shaped with shallowly undulate anticlinal walls. *G. orientale* has lower epidermal cells that are irregularly shaped with shallowly sinuous anticlinal walls. In *T. quinquangulata*, the adaxial epidermis is polygonal with straight anticlinal walls, whereas the abaxial epidermis is irregularly shaped with deeply sinuous anticlinal walls. In general, *Trichosanthes* species have upper epidermal cells that are irregularly shaped with shallowly undulate anticlinal walls. At the same time, the lower epidermis tends to have a sinuous anticlinal wall with its deep variation (Rugayah 2002). *T. quinquangulata*, which has polygonal epidermal cells with straight anticlinal walls, tends to resemble those found in *Gymnopetalum* species; in contrast, the abaxial epidermis of *T. quinquangulata* is similar to that typically found in *Trichosanthes*. The opposite condition is observed in *G. orientale*, which has a lower epidermis resembling that of *Trichosanthes*, with irregularly shaped cells and shallowly sinuous anticlinal walls, while its upper epidermis is typical of *Gymnopetalum* (Figures 8 and 9). Based on anatomical data, *G. orientale* and *T. quinquangulata* exhibit intermediate epidermal forms between the two genera within Cucurbitaceae. Morphologically, the intermediate form of the two species was discussed by de Wilde and Duyfjes (2010), and this is in line with the anatomical results of this study.



Figure 6. Morphological characteristics: *Gymnopetalum*: A. Leaves from juvenile plant, B. Flower and leaves of older plant (Photo: Rugayah) and *Trichosanthes*: C. Leaves of older plant, D. Flower (Photo: de Wilde)

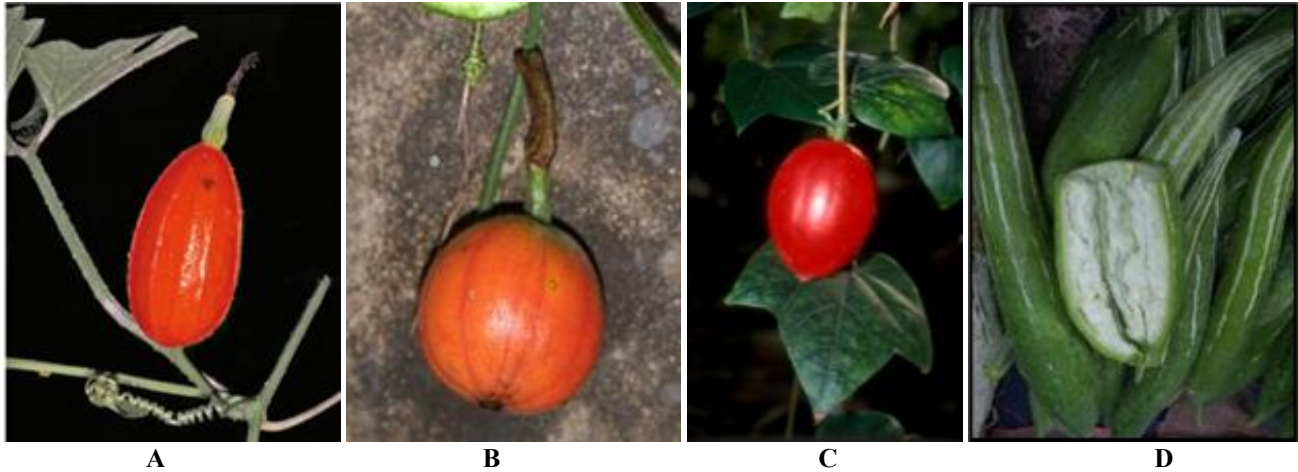


Figure 7. Variations in fruit shape *Trichosanthes* and *Gymnopetalum*: A. *G. chinensis* (Photo: de Wilde), B. *G. scabrum*, C. *T. tricuspidata*, and D. *T. cucumerina* var. *anguina* (Photo: Rugayah)

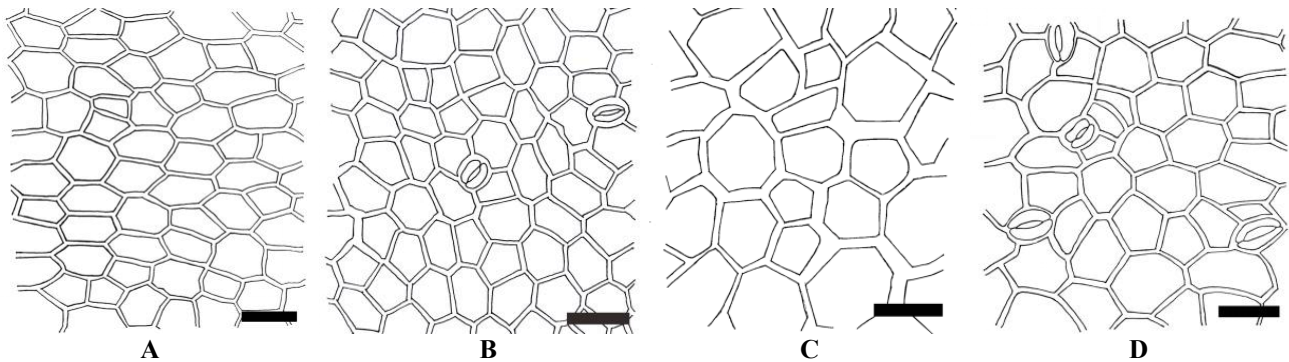


Figure 8. Paradermal section of adaxial epidermal tissue, *T. quinquangulata* has similarly shaped cells with *Gymnopetalum* species, i.e., polygonal shape. A. *T. quinquangulata*, B. *G. chinensis*, C. *G. pectinatum*, D. *G. scabrum*

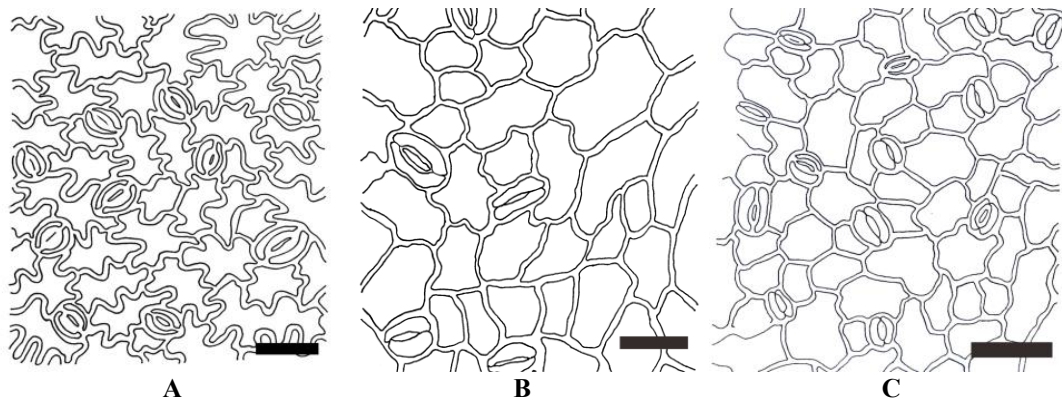


Figure 9. Paradermal section of abaxial epidermal tissue, *T. quinquangulata* has irregularly shaped cells with deeply sinuous anticlinal walls as typical of *Trichosanthes* species, compared with shallowly sinuous to undulate anticlinal walls in *Gymnopetalum* species. A. *T. quinquangulata*, B. *G. orientale*, C. *G. chinensis*

Trichosanthes is monophyletic if it includes *Gymnopetalum*, which itself is polyphyletic (de Boer et al. 2012). The genus *Gymnopetalum* changed its position to the section of *Trichosanthes* (de Boer and Thulin 2012). Our anatomical results support the phylogenetic

relationship between those two genera. The intermediate character of epidermal cells of *T. quinquangulata* and *G. orientale* is a phenotypic correlate of the close evolutionary relationship between *Trichosanthes* and *Gymnopetalum*.

At a regional level, the LSIs have the highest *Gymnopetalum* diversity in Indonesia, with 4 species. Java and Sulawesi have 3 species. Moluccas 2 species. Sumatra, Borneo, and Papua have only 1 species. In 2019, the *G. scabrum* species was reported in Kalimantan, adding to its distribution data (Pratami et al. 2019). In general, *Gymnopetalum* diversity is found in Java, except for the *G. orientale* species. Limited exploration may also be the reason for the limited number of *Gymnopetalum* species in some areas. Papua and Sulawesi are known for their unique and high biodiversity, much of which has not yet been discovered (Kementerian Perencanaan Pembangunan Nasional / Badan Perencanaan Pembangunan Nasional (Bappenas) 2024).

Morphologically, *Gymnopetalum* in LSI and other regions exhibits similar characteristics. Variations are observed only in size, which is influenced by environmental factors, as each region has distinct ecological conditions. However, these variations are not significant and fall within the range of characteristics of *Gymnopetalum*.

In conclusion, the diversity of *Gymnopetalum* species in the Lesser Sunda Islands (LSI) consists of 4 species: *G. chinensis*, *G. orientale*, *G. pectinatum*, and *G. scabrum*. Morphological comparisons showed that the Lombok specimen Kahono, Nakano, Abbas 2005-36 is consistent with *G. orientale*, despite having entire leaves rather than the typical 3-5 shallow lobes. The confirmation is supported by epidermal size data, indicating size differences (*G. orientale*: 19-24.80 × 12.40-14.88 μm (upper) and 19.84-21.32 × 12.40-14.88 μm (lower), whereas the Kahono Nakano, Abbas 2005-36 specimen has epidermal cell sizes of 27.28-29.76 × 14.88-17.36 μm (upper) and 24.80-27.28 × 17.36-19.84 μm (lower), but identical cell shapes and anticlinal wall patterns. The anatomical evidence supports previous morphological interpretations that *G. orientale* and *T. quinquangulata* exhibit intermediate characters, consistent with molecular studies placing *Gymnopetalum* within *Trichosanthes*. This study is limited by the small number of examined specimens and the absence of statistical analysis of anatomical variation. Future research should incorporate broader population sampling, quantitative morphometric analyses, and molecular data to evaluate species boundaries further and test the phylogenetic placement of *Gymnopetalum* within *Trichosanthes* in a comprehensive integrative taxonomic framework.

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