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A New Species of *Thismia* (Thismiaceae) from West Kalimantan, Borneo

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Abstract—A new species of Thismiaceae, ***Thismia betung-kerihunensis*** Tsukaya et H. Okada, found during a botanical survey of Betung-Kerihun National Park, West Kalimantan, Borneo, Indonesia, is described and illustrated. This species closely resembles *Thismia clavigera* (Becc.) F. Muell, which is distributed in Borneo, Sumatra, Langkawi, and Thailand; however, it differs in flower shape, size, and color, having conspicuous hood-like appendages at the tip of the brilliant blue-green colored mitre formed by the three inner tepals. Moreover, it differs in the shape of the anther connectives that lack acutely elongated apices and has rectangular glands. The smaller stature of the species also distinguishes it from *T. clavigera*.

Keywords—Borneo, Burmanniaceae, Kalimantan, key to Malaysian species of *Thismia,* mycoheterotrophic plant, new species, *Thismia betung-kerihunensis*, Thismiaceae.

Thismia Griff. (Thismiaceae; Merckx 2008) consists of more than 30 mycoheterotrophic species and is sometimes placed in the Burmanniaceae (Ridley 1924; Jonker 1948; Stone 1980; van Steenis 1982; Jarvie 1996; Saunders 1996; Maas-van de Kamer 1998; Yang et al. 2002; Tsukaya and Okada 2005; Larsen and Averyanov 2007; Chantanaorrapint 2008). In the past decade, several new species of this genus have been reported, including *Thismia mullarensis* from Borneo (Tsukaya and Okada 2005), *T. annamensis* from Vietnam (Larsen and Averyanov 2007), *T. tentaculata* from China (Ho et al. 2009), and *T. angustimitra* from Thailand (Chantanaorrapint 2008). However, the majority of these species appear to have been collected only once or a few times because the supraterrestrial parts of *Thismia* can be recognized only at the flowering stage and they are rare. In particular, members of section *Sarcosiphon* (Blume) Jonk., which is characterized by connected inner perianth lobes at the apex forming an erect mitre with three holes and coralloid roots, are quite rare. *Thismia clavigera* (Becc.) F. Muell. and *T. episcopalis* (Becc.) J. J. Sm. are representative species of section *Sarcosiphon*. The former species was originally named after a specimen collected from Gunung (Mt.) Gadin in Sarawak in 1865 (Beccari 1877) and rediscovered at Pulau (Island) Langkawi, Malaya Peninsula, Gunung Leuser Reserve, Sumatra, in 1979 (Stone 1980; Stone and Ratnasabapathy 1980), and in Thailand in 2008 (Chantanaorrapint and Chantanaorrapint 2009).

Since the Kalimantan area of Borneo, Indonesia, has a rich biodiversity, particularly in the tropical rain forests, some undescribed members of *Thismia* are expected to be present there. To conserve this biodiversity against the destruction of natural forests, the "Heart of Borneo" initiative of the governments of Indonesia, Malaysia, and Brunei was initiated in 2007 to protect forests in the trans-border area of Borneo. Furthermore, botanical expeditions in this trans-border area have been planned by the Research Center for Biology – Indonesian Institute of Sciences (LIPI) for 2009–2014 to obtain detailed floristic information. As part of this project, we participated in two botanical expeditions in Betung Kerihun National Park, West Kalimantan, Borneo, from December 2009 to January 2011. Betung Kerihun National Park, which covers ca. 800,000 ha of forest, lies to the north of Putussibau, extending to the border with Sarawak. Several new species and a new genus were discovered in this area in the first botanical survey, which was conducted from December 2009 to January 2010 (Okada and Tsukaya 2010; Tsukaya et al. 2011; Vermeulen and Tsukaya 2011). While performing the second floristic survey in this area between December 2010 and January 2011, we found a species of *Thismia* (Fig. 1) that resembles *T. clavigera*. Here we describe this previously unrecognized mycoheterotrophic species, and provide a key to the Malaysian species of *Thismia*.

Materials and Methods

Flower Structure—Specimens were kept in 50% (v/v) ethanol, and the structure of the entire plant was observed under a stereomicroscope (MZ16a; Leica Microsystems).

Results

The *Thismia* plants (Figs. 1, 2) collected from Betung Kerihun National Park, West Kalimantan, Borneo, Indonesia, had brilliant blue-green flowers 1.8 cm in length, excluding the 1.5 cm long claviform tentacles/appendages. The root system was coralliform. The connected inner perianth lobes at the apex forming an erect mitre with three holes and coralloid roots clearly showed that this species belongs to section *Sarcosiphon* (Bl.) Jonk. Moreover, the presence of three slender tentacles on the mitre suggested a close relationship between this species and *T. clavigera.* To date, no other species bearing this type of tentacle on the mitre has been discovered. The collected species clearly differs from *T. clavigera* in terms of the color and shape of the mitre. While *T. clavigera* is "luteo-crocei" (Sarawak specimen; Beccari 1877) or "all yellow-orange" (Langkawi specimen; Stone 1980), the mitre of our

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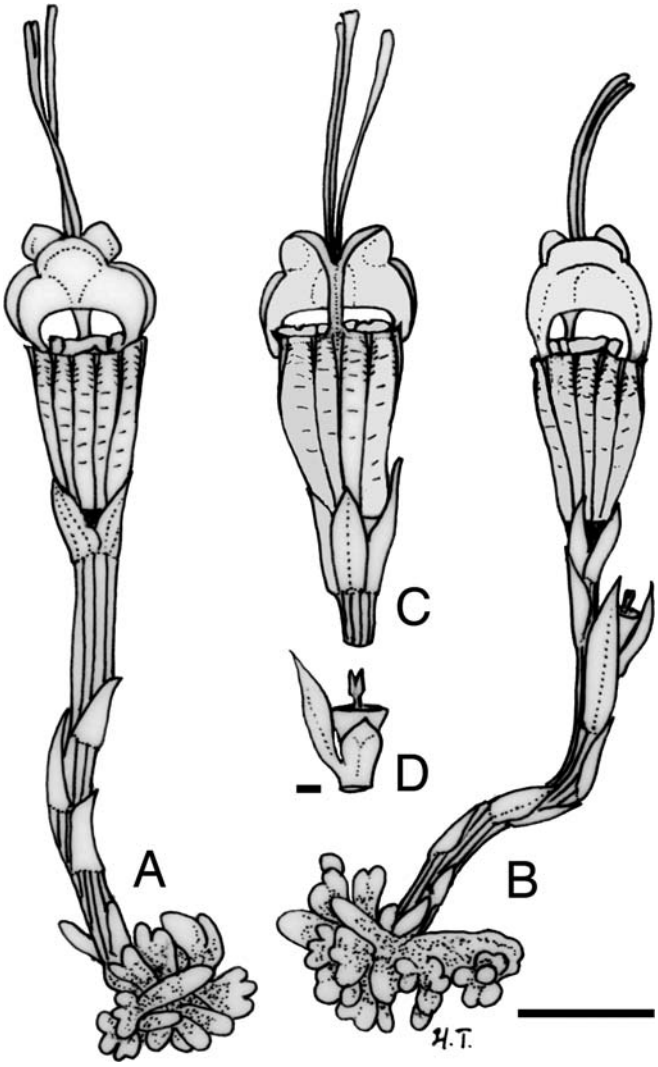


Fig. 1. *Thismia betung-kerihunensis* Tsukaya & H. Okada. A-B. Gross morphology of the plant. Two individuals (right, in younger stage) are shown. C. Flower. D. Ovary with a stigma just after the fall of the corolla. Scale for A-C, 1 cm. Scale for D, 1 mm. All pictures were drawn from the type specimen by Hirokazu Tsukaya.

new specimen is blue-green. As seen in the color photographs in the report of Chantanaorrapint and Chantanaorrapint (2009), individuals of *T. clavigera* collected from Thailand show indigo blue only in the anther connectives; the mitre is "yellow-orange," while the perianth tube is "bright pink-red." Since all known specimens of *T. clavigera* from various localities have a yellow-orange mitre, the blue-green color of the new sample is unique. In addition, the shape of the mitre in the new specimen is unique. *Thismia clavigera* and the new specimen share "a dome-shaped mitre with three wide archway-like openings" (Stone 1980). Importantly, only the figure of *T. clavigera* in Beccari (1877) shows small but significant appendices that look like eaves; all other reports on *T. clavigera* describe the absence of such appendices (Stone 1980; Chantanaorrapint and Chantanaorrapint 2009). The new specimen had a mitre bearing three hood-shaped appendices (arrows in Fig. 2A) that are not observed, or seen only poorly, in *T. clavigera*. Since Beccari (1877) described poorly developed, eave-like appendices in the figure of *T. clavigera*, it is possible that this quantitative difference is intraspecific variation; however, the conspicuous development of the mitre appendices in the new specimen is a unique character considering that the specimen is smaller in stature than *T. clavigera*, as described below.

Moreover, we found morphological and qualitative differences in the anther connectives. First, the morphology of the wing of the anther connectives differs. The wing of the anther connectives in *T. clavigera* is hairy, has an unequal margin (with an elongated, triangular lamina), and is acute at the apex (Stone 1980; Chantanaorrapint and Chantanaorrapint 2009). The new specimen also has hairy anther connectives (Fig. 2E), but the margin of the connectives is equal in shape and lacks an acute, elongated apex (Fig. 2C-D). Second, whereas a round, nectariferous gland is described for *T. clavigera* (Stone 1980; Chantanaorrapint and Chantanaorrapint 2009), the new specimen has rectangular, long glands ("g" in Fig. 2D-F). These characters are completely different from those seen in *T. clavigera.*

Quantitative differences were also recognized. The flowers in the new specimen, including the appendages, are 3.0–3.7 cm in length, which is smaller than in *T. clavigera* from Thailand (up to 6 cm; Chantanaorrapint and Chantanaorrapint 2009) but similar to that in *T. clavigera* from Langkawi (ca. 3 cm; Stone 1980) (Fig. 2B). Irrespective of the similarity in overall flower size, the anther thecae is ca. 3.5 mm (Stone 1980) or 2 mm long (Chantanaorrapint and Chantanaorrapint 2009) in *T. clavigera* compared to ca. 1 mm long in the new specimen (Fig. 2D). While tepal size varies in many taxa, anther size is a more stable character; consequently, this difference distinguishes the new specimen. In addition, the new specimen has smaller ovaries (1.3–2.8 mm long; Fig. 2B-C) than *T. clavigera* (5 mm long; Stone 1980; Chantanaorrapint and Chantanaorrapint 2009). A smaller stature is also evident in other parts of the plant. While the stem of *T. clavigera* is reported to be ca. 12 cm long and bears 1–5 flowers, that in the new species is only 2–3 cm long and bears 1–2 flowers. The floral bract is also smaller in the collected species (8 vs. 12 mm long for *T. clavigera*). Taken together, the new species appears to be distinct from *T. clavigera*.

Discussion

In the past decade, several new species of *Thismia* have been discovered, but no new species has been reported for section *Sarcosiphon*. The new species described in this study is morphologically similar to *T. clavigera*, but has different morphological characters and a different flower color. Although *T. clavigera* has been collected from three distinct areas (Sarawak, Langkawi, and Sumatra), the observed differences were not seen in the other individuals collected.

Taxonomic Treatment

We herein describe a new species, *T. betung-kerihuensis,* which can be inserted into the 'Key to species' of *Thismia* in Flora Malesiana I, 4 (Jonker 1948) 22, modified by Tsukaya and Okada (2005) and Chantanaorrapint and Chantanaorrapint (2009) as follows.

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Fig. 2. *Thismia betung-kerihunensis* Tsukaya & H. Okada. A. Habitus. B. Three collected plants are shown. The thin root system observed under the middle individual does not belong to *Thismia*. The scale is in centimeters. C. Close-up of the flower preserved in 50% ethanol. The perianth tube was opened by a longitudinal slit. Note the absence of an acute apex in the anther connectives. Scale, 1 mm. D-E. Outer (abaxial) view of the anther connective. a, anther thecae; g, gland. Note the absence of acute apices and rectangular shape of the glands. Scale, 1 mm. Panel E shows the three-dimensional shape of the connectives and hairs from a specimen in 50% ethanol. F. Magnified image of the gland shown in panels D and E. Note the aggregates of round, nipple-like cells. Scale, 100 mm.

Key to the Malaysian Species of *Thismia*

1. Inner perianth lobes free, spreading or erect. Underground part vermiform, creeping 2
   2. Perianth lobes equal in length and size 3
      3. Flowers zygomorphic, geniculate ..... *T. chrysops* Ridl.
      3. Flowers actinomorphic 4
         4. Stems several, flowers 4–6 in a raceme ..... *T. racemosa* Ridl.
         4. Stem simple; flowers usually 1–3, terminal 5
            5. Leaves and bracts beset with distinct, prominent, blunt processes ..... *T. grandiflora* Ridl.
            5. Leaves and bracts without processes 6

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6. Perianth lobes lanceolate, acute to acuminate, flat ..... *T. fumida* Ridl.
6. Perianth lobes triangular at the base, tapering into long, filiform tentacles 7
7. Stigmas bifid 8
8. Transverse bars found throughout the perianth tube inside. Anther appendages 2 9
9. Perianth white with 12 brownish purple streaks; lobes with tentacles ca. 17 mm ..... *T. mullerensis* Tsukaya & H. Okada
9. Perianth white with 12 white streaks; lobes with tentacles ca. 70 mm ..... *T. lauriana* Jarvie
8. Transverse bars found only in the basal part of the perianth tube. Anther appendages 3 ..... *T. bifida* M. Hotta
7. Stigmas not bifid 10
10. Perianth tube with horizontal bars inside. Stigmas lanceolate 11
11. Anthers provided with 3 thick-filiform appendages at the free apical margin. Perianth yellowish in the basal part, bright orange-yellow in the upper part and limb. Tentacles bright orange-red at the base. Perianth lobes with tentacles up to 10 mm ..... *T. aseroe* Becc.
11. Anthers with 1 thick-filiform, median appendage and 2 lateral, short teeth at the free apical margin. Perianth white with 6 ochre-brown streaks; lobes with tentacles ca. 20 mm ..... *T. alba* Holttum ex Jonker
10. Perianth tube without bars. Apical margin of the anthers with 2 teeth, each bearing a globose body at the top. Stigmas funnel-shaped with prominent margin ..... *T. ophiuris* Becc.
2. Inner perianth lobes larger 12
12. Perianth zygomorphic, bilabiate. Upper lip fleshy, bent over the opening of the tube ..... *T. labiata* J. J. Sm.
12. Flowers actinomorphic 13
13. Inner perianth lobes simple. Tube with prominent horizontal bars inside 14
14. Anthers with 3 distinct teeth at the free apical margin, each tooth bearing a stiff hair. Outer perianth lobes broadly ovate, obtuse, erect ..... *T. javanica* J. J. Sm.
14. Anthers slightly dentate apically. Outer perianth lobes short, ear-shaped ..... *T. arachnites* Ridl.
13. Inner perianth lobes consisting of 3 parts. Basal part erect, short, bearing the transverse part, hamate at the base and broadened at the apex. Third part awl-shaped, inserted on the broad apex of the second part. Perianth tube without bars ..... *T. neptunis* Becc.
1. Inner perianth lobes connected at the apex to an erect mitre with 3 holes 15
15. Under ground part vermilliform 16
16. Mitre broader than perianth tube, annulus erect ..... *T. mirabilis* K. Larsen
16. Mitre narrower than perianth tube, annulus curved ..... *T. angustimitra* Chantanaorr.
15. Underground part coralliform 17
17. Inner perianth lobes connate at the tips, forming an erect mitre with large holes 18
18. The mitre lacks clavate segments 19
19. Inner perianth lobes linear. Anthers ciliate in the basal part, toothed at the apex 20
20. Apical margin of the anthers provided with 2 teeth, each bearing a stiff hair. Anthers slightly constricted in the middle, below the thecae ..... *T. clandestina* (Blume) Miq.
20. Apical margin of the anthers provided with 3 teeth, each bearing a stiff hair. Anthers constricted at the base, just above the thecae ..... *T. episcopalis* (Becc.) F. Muell.
19. Inner perianth lobes spathulate, connate to a mitre with rather small holes. Anthers not ciliate, truncate at the apex ..... *T. crocea* (Becc.) J. J. Sm.
18. Inner perianth lobes continued above the mitre as 3 free, almost erect, filiform, clavate segments 21
21. Flowers yellow-orange to pink-red, three hood-shaped appendices on the mitre are not or only poorly developed, wing of the anther connectives has an unequal margin and is acute at the apex, bearing round, nectariferous glands ..... *T. clavigera* (Becc.) F. Muell.
21. Flowers blue-green, three hood-shaped appendices on the mitre are conspicuous, the margin of the anther connectives is equal in shape and lacks an acute, elongated apex, bearing rectangular, long glands ..... *T. betung-kerihunensis* Tsukaya & H. Okada

Thismia betung-kerihunensis Tsukaya & H. Okada sp. nov.—TYPE: INDONESIA. West Kalimantan: Betung Kerihun National Park, near Sungai (River) Tobong Kopang, ca. 228 m altitude, 00° 54′51.1″N, 113° 40′20.7″E, on a slope under tropical rain forest (lower hill forest), mainly composed of Dipterocarpaceae, December 27, 2010, *H. Okada, H. Nagamasu, & H. Tsukaya HT1012* (holotype: BO; isotype: TI, preserved in 50% ethanol).

Herbae terrestris, erectae. *Thismia clavigera* (Becc.) F. v. M. affinis, sed corolla caerulea, lobi affixi appendicis cuculatae conspicuae, connectivum staminis absque oxysegmentum trigonus, glans rectangularis (non semiglobosa) differt.

Terrestrial, achlorophyllous herb, mycotrophic. Stems erect, simple, bearing 1–2 flowers, bluish white at young stage, turning pale purple, then pale brown, 3–4 cm long. Roots coralliform, brown, tips whitish. Leaves spirally arranged, lanceolate, to 5 mm long, pale whitish blue to pale brown. Floral bracts to 8 mm long, 2 mm wide, lanceolate, acuminate. Flowers 2 cm long, excluding the tentacles; basal perianth tube white with indigo and brown with 12 nerves at young stage, which turns pale brown with purple-dark blue nerves later, 1.1–1.2 cm long, glabrous; throat margin thickened; outer perianth lobes deltoid, minute; inner perianth mitriform with clawed lobes, incurved, centrally adnate to form a dome-shaped mitre with three wide windows, midveins riblike, bearing three hood-like accessory lobes at the tip and three slender claviform appendages. The mitre is blue-green, 4.4–6.9 mm long, except for the ca. 15-mm-long claviform appendages, which are pale blue at the base and tinged with orange at the tip at the young stage. Stamens 6, borne on the thickened margin of the perianth-tube, curved downwards, filaments short, ribbon-shaped, free; connective broad with a quadrangular wing, hairy, connate to form a tube; anther thecae oblong, adnate, seen on the adaxial side of the connectives, 0.9–1.1 mm long; gland present near the apex on the line of fusion between the connectives, rectangular, 0.6–0.8 mm long, 0.2 mm wide. Stigmas free, ca. 1.4 mm long. Ovary 1.3–2.8 mm long and cup-shaped. Fruit not seen.

***Note*—**We collected three individuals in a less than 10 m × 10 m square in the locality. No other individual

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was discovered in neighboring places during the botanical survey, suggesting that this species is rare even in the Betung-Keruhin National Park, although the type locality is under protection. Areas around the type locality were rich in myco-heterotroph species, such as four Burmanniaceae (one species of *Gymnosiphon* and three *Burmannia*), two Polygalaceae (two *Epirixanthes*), two Triuridaceae (two *Schiaphila*), and seven Orchidaceae (three *Lecanorchis* and so on) species, but none co-habited with this species.

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