



Thismia brunneomitra, another new species of *Thismia* (Thismiaceae) from Ulu Temburong, Brunei Darussalam

MICHAL HRONEŠ¹, LUCIE KOBRLOVÁ¹, VOJTĚCH TARAŠKA¹, ONDŘEJ POPELKA¹, RADIM HÉDL^{1,2}, RAHAYU SUKMARIA SUKRI³, FAIZAH METALI³ & MARTIN DANČÁK⁴

¹ Department of Botany, Faculty of Science, Palacký University, Šlechtitelů 27, CZ-78371 Olomouc, Czech Republic;
email: michal.hrones@gmail.com

² Institute of Botany, Czech Academy of Sciences, Lidická 25/27, CZ-60200 Brno, Czech Republic

³ Universiti Brunei Darussalam, Environmental and Life Sciences Programme, Faculty of Science, Jalan Tungku Link, BE1410, Brunei Darussalam

⁴ Department of Ecology and Environmental Sciences, Faculty of Science, Palacký University, Šlechtitelů 27, CZ-78371 Olomouc, Czech Republic

Abstract

A new species of *Thismia* (Thismiaceae) from northwest Borneo is described and illustrated. *Thismia brunneomitra* was discovered in 2015 in lowland mixed dipterocarp forest in the Ulu Temburong National Park, Temburong district of Brunei Darussalam. The new species is characterized by brown to blackish flowers with twelve darker vertical stripes on the perianth tube, inner tepal lobes that are connate to form a mitre with three very short processes at the apex, three-toothed apical margin of the connective and large wing-like appendage of the connective. An updated determination key of *Thismia* species found in Borneo is included.

Key words: mycoheterotrophy, Malesia, mixed dipterocarp forest, *Sarcosiphon*

Introduction

Primary tropical rainforests of Borneo are one of the most species-rich ecosystems in one of the world's biodiversity hotspots (Myers *et al.* 2000). The island harbours some 15,000 vascular plant species in an area of 743,330 km², of which ca. 37% are endemic (Raes *et al.* 2009). The lowland mixed dipterocarp forest represents the dominant natural forest habitat in Borneo (Primack & Corlett 2005). Unfortunately, these forests are threatened by large-scale timber extraction, as they contain several economically important tree species (Bryan *et al.* 2013). Thus, a combination of unique biodiversity and rapid deforestation has highlighted Borneo as a priority for nature conservation.

One of the most intriguing inhabitants of the primary tropical forests of Borneo are small mycoheterotrophic herbs from the genus *Thismia* Griffith (1844: 221; Thismiaceae, or alternatively Burmanniaceae; for discussion see Merckx *et al.* 2006). Species of this genus are achlorophyllous plants with very specific and complex morphology.

Currently, almost 60 species are recognized in the genus (Hroneš 2014, Hunt *et al.* 2014, Mar & Saunders 2015, Chantanaorrapint & Sridith 2015). Species of *Thismia* have scattered distribution through the (sub-)tropical areas of the Asia, Australia, New Zealand and South America (Jonker 1938, Maas *et al.* 1986, Hunt *et al.* 2014). Along with Thailand, Borneo represents one of the species diversity centres of the genus (Dančák *et al.* 2013, Chantanaorrapint *et al.* 2015).

According to Jonker (1938), Bornean species with free perianth lobes and creeping rhizomes are treated as section *Thismia*, while species with connate perianth lobes forming mitre-like flowers and dense coralliform rhizomes are treated as section *Sarcosiphon* (Blume 1850: 65) Jonker (1938: 251). In Borneo, two species from this section are known: *T. episcopalis* (Beccari 1877: 250) F. Mueller (1891: 235) and *T. goodii* Kiew (1999: 179).

During our recent expedition to Ulu Temburong in January and February 2015, we found a species of *Thismia* with fused tepals, which turned out to be another taxonomic novelty. This finding is only the second record of the family Thismiaceae for Brunei Darussalam (see Dančák *et al.* 2013).

Material & Methods

This study is based on material collected during February 2015 in the vicinity of the Kuala Belalong Field Studies Centre (KBFS), Brunei Darussalam. Morphological characters were studied using stereo microscope and high-resolution macro photography. Collected specimens were thoroughly compared with original drawings and descriptions given in protologues of *Thismia* sect. *Sarcosiphon* and also with high-resolution image of *Thismia episcopalis* type specimen (Beccari 1504 deposited in FI).

Description

Thismia brunneomitra Hroneš, Koblřová & Dančák, *sp. nov.*, Fig. 1

Similar to *Thismia episcopalis*, but differing in having 1–2 flowers per individual, presence of three short processes at the apex of the mitre, free apical margin of the stamen connective with two broad obtusely triangular lateral lobes and narrowly triangular middle lobe, large entire wing-like lateral appendage of the connective and brown to blackish colour of the perianth tube (Table 1).

Type:—BRUNEI DARUSSALAM. Temburong distr.: Kuala Belalong, right bank of the stream Sungai Mata Ikan, ca. 150 m NW from the Kuala Belalong Field Studies Centre. Coordinates WGS 84: N 04°32'51.2"; E 115°09'24.5"; elevation ca. 105 m a.s.l., 3 February 2015. *Hroneš & Koblřová 402015* (holotype BRUN! [herbarium specimen, accession number B031129], isotype OL! [herbarium specimen, accession number 31594]).

Description:—Perennial achlorophyllous mycoheterotrophic herb, 6.2–8 cm tall. Roots coralliform, slightly branched towards the apex, whitish. Stem 4.5–6.5 cm tall, ascending to erect, simple, one or two flowered, sparsely shortly hairy, mostly pale brown (Figs 1A, 2A, B), blackish when young (Fig. 2C); pedicel dark brown to blackish and elongating after anthesis (Fig. 2D). Leaves 6–7, spirally arranged, well-spaced, scale-like, triangular, acute, entire, 3.5–5 mm long, 2–3 mm wide at base, pale brown, glabrous. Floral bracts three, similar in shape to leaves but slightly larger, 5.5–7 mm long, 3–3.5 mm wide at base, keeled, enveloping base of flower, pale brown. Flowers bisexual, actinomorphic, 1.6–1.7 cm long, 0.9–1 cm wide at top of perianth tube; perianth tube urceolate, of 6 fused tepals; outer surface with six longitudinal ribs, dark brown to blackish when young, later pale brown to brown with 12 vertical dark brown stripes; outer tepal lobes absent; inner tepal lobes well-developed, connate at top and forming mitre with three holes, 5–7 mm tall; holes reniform-elliptic to almost rounded, 4–6 mm wide, 2–4 mm high; mitre dark brown to blackish when young, at maturity dark brown with paler brown to reddish-brown apex and margins of holes, topped by three short obtuse processes (Figs 1B, 2E). Annulus absent. Stamens 6, hanging from top of perianth tube, bluish to purplish (Figs 2G–I); connectives flattened, ribbon shaped, connate to form tube; individual connective with two tufts of glandular hairs on adaxial side and three lobes on free apical margin; lateral lobes wide, obtusely triangular; middle lobe narrowly triangular (Figs 1D, 2I); each lobe terminated by tuft of glandular hairs; lateral appendage of connective flattened, large, wing-like, protruding outwards to the perianth tube, with marginal glandular hairs; thecae whitish (Figs 1C, 2G). Style trifid, papillose, terminated by very shallowly notched stigmas (Fig. 2F); ovary obconical, with six vertical ribs on surface and blackish horizontal line at apex. Capsule cup-shaped, brown to dark brown, sparsely hairy, topped by basal ring of perianth tube and withered style (Fig. 2D). Seeds not seen.

Variability:—The basic colour of the perianth tube and the mitre varies from almost black to brown-reddish. The number of flowers in one individual varies from one to rarely two.

Habitat and ecology:—Shaded understory of lowland mixed dipterocarp forest. The only known site is in a ravine of a small stream. The terrain is steep, rocky and somewhat disturbed, with patches of bare mineral soil. Plants were found primarily in these bare patches with several individuals growing on a rock crevice just next to the stream in association with *Diplazium cordifolium* Blume (1828: 190), *Epipremnum falcifolium* Engler (1898: 11), *Mapania monostachya* Uittien (1935: 194), *Schismatoglottis asperata* Engler (1879: 297) and *Selaginella involvens* agg. Several other mycoheterotrophic species were recorded around, within a distance of 5 m: *Epirixanthes elongata* Blume (1823: 82), *E. papuana* J.J.Smith (1912: 486), *Sciaphila densiflora* Schlechter (1912: 87), *S. secundiflora* Thwaites ex Benth (1855: 10) and *Gymnosiphon aphyllus* agg.

Distribution:—*Thismia brunneomitra* was found near the Kuala Belalong Field Studies Centre in the Temburong district of Brunei Darussalam. The only known population occurs on the right bank of the small stream Sungai Mata Ikan, approximately 100 m from its confluence with the Belalong River and near the “Ashton trail” forest circuit.

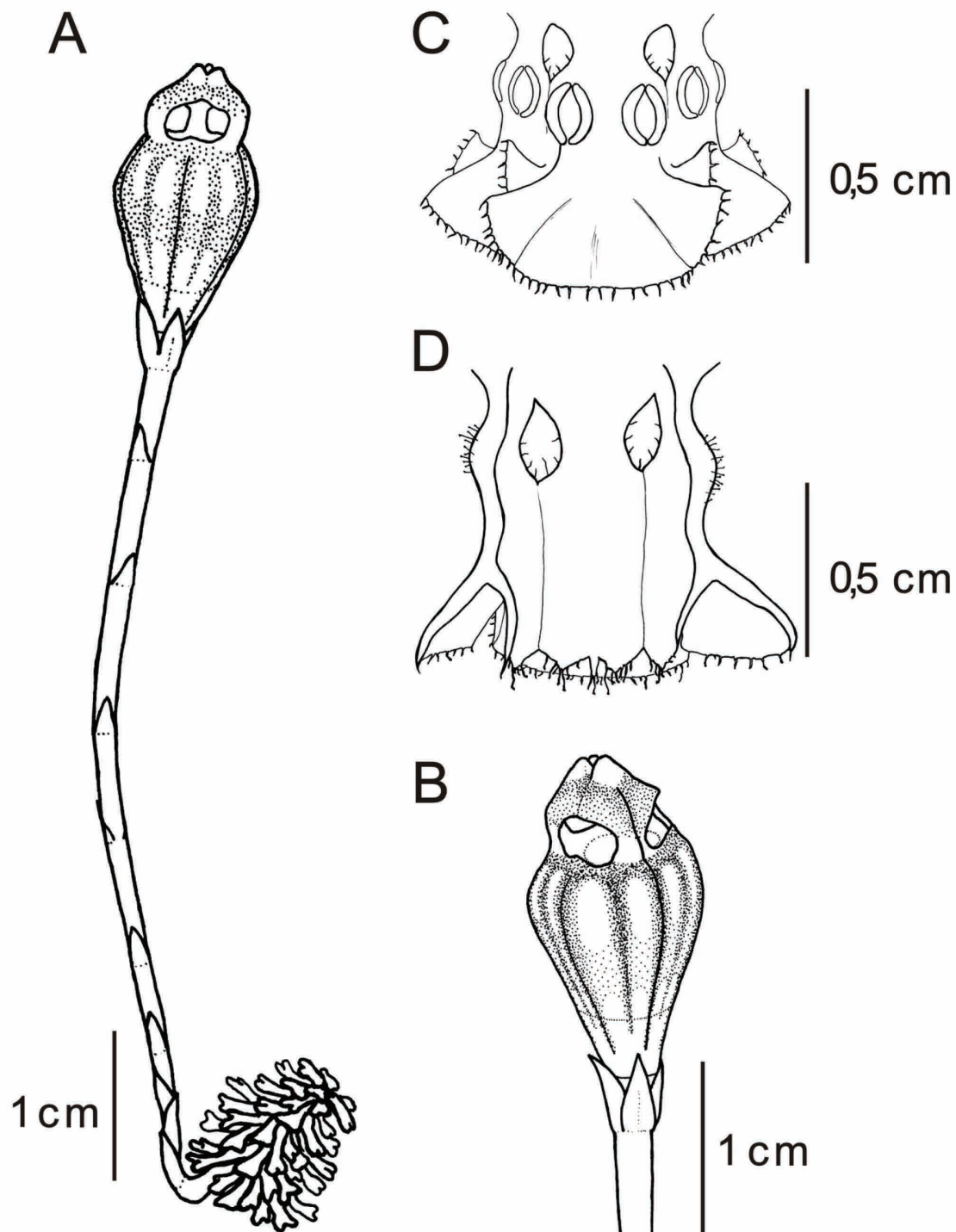


FIGURE 1. *Thismia brunneomitra*. A. Habit of the plant. B. Flower. C. Stamen with lateral appendage and thecae, outer view. D. Stamen with apical lobes, inner view. Drawn by K. Janošíková.

Conservation status:—Population of *T. brunneomitra* occurs within the designated research zone of Ulu Temburong National Park, to which public access is restricted. The type locality and its surroundings are thus protected from logging or other destructive anthropogenic activities. However, given that after a thorough search, no more than 15 individuals were noticed, and that the population is situated near relatively frequented forest trail, we suggest evaluating the species as critically endangered (CR) according to the IUCN Red List Categories and Criteria (IUCN 2012).

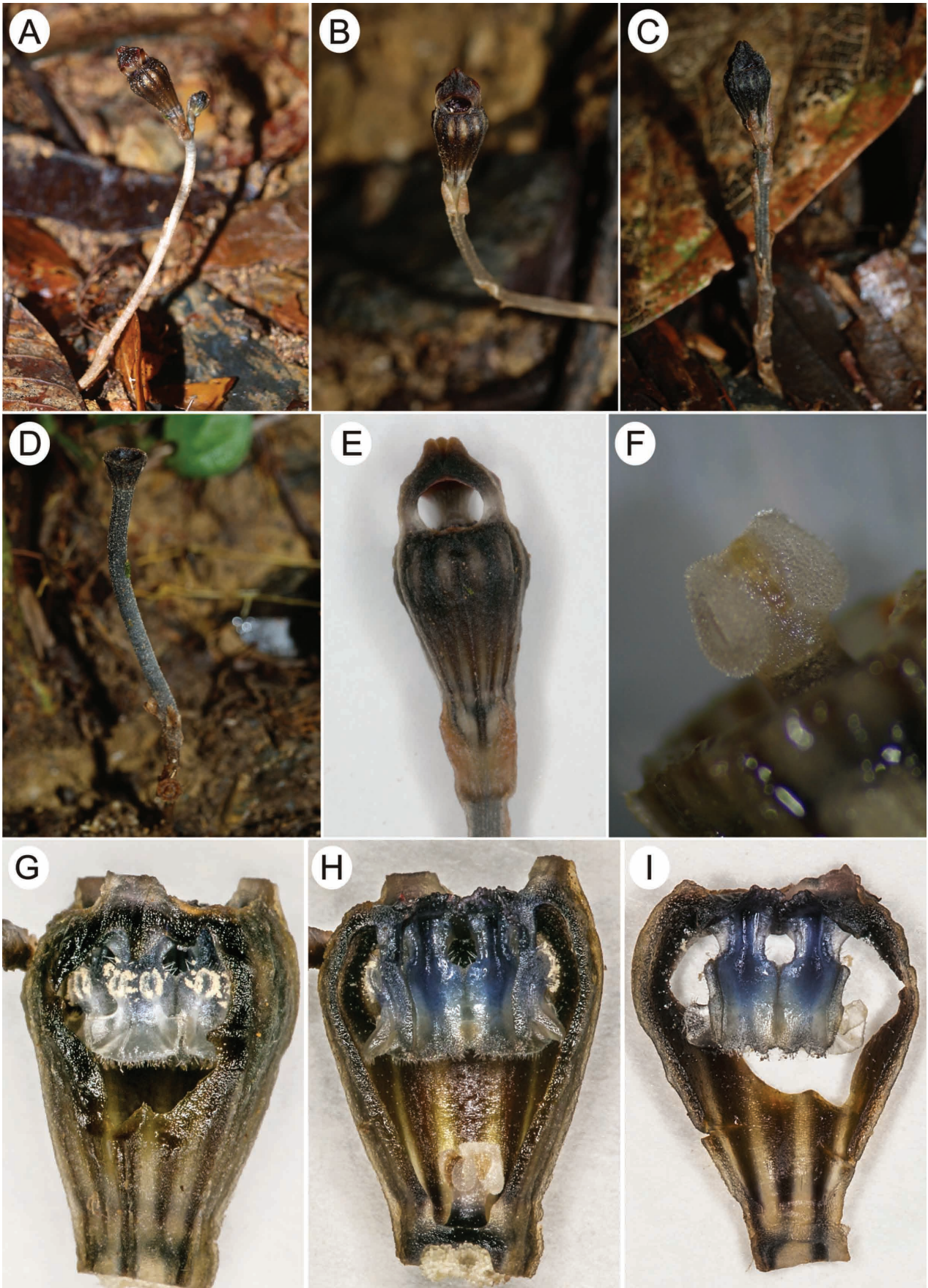


FIGURE 2. *Thismia brunneomitra*. A–B. Habit of the plant. C. Habit of the immature plant. D. Elongated stem with a capsule after the anthesis. E. Flower. F. Style. G. Perianth with removed mitre and proximal part showing stamens with anthers and lateral appendage. H. Longitudinal section of perianth tube with anthers and style. I. Section of the perianth and anther tube showing apical anther appendages.

Etymology:—Name of the species is composed from Latin words *brunneus* (brown) and Greek *mitra*, referring to the typical colour and shape of the flowers.

Taxonomic affinities

Thismia brunneomitra belongs to the section *Sarcosiphon*. Members of this section share several characteristics, such as coralliform rhizomes, three floral bracts enveloping the base of the flower and inner tepal lobes fused at the top and forming a mitre. Up to now, this section included five species, *Thismia clandestina* (Blume 1850: 65) Miquel (1855: 616) from western Java, *T. crocea* (Beccari 1877: 249) J. J. Smith (1909: 193) from West Papua, *T. episcopalis* and *T. goodii* Kiew (1999: 179) from Sarawak and *T. yorkensis* Cribb (1995: 51) from northern Australia. Moreover, two other species, *T. clavigera* (Beccari 1877: 251) F. Mueller (1891: 235) and *T. betung-kerihunensis* Tsukaya & Okada (2012: 56), both known from western Borneo, are sometimes included to this section (Tsukaya & Okada 2012). *Thismia brunneomitra* is readily distinguished from the two last species by the absence of the long clavate segments on the apex of the mitre. Flowers of *T. yorkensis* are white with well developed outer perianth lobes and inner perianth lobes wide, forming hemispherical mitre (Cribb 1995). *Thismia crocea* flowers have much longer perianth tube with a distinct constriction in the middle, stamen tube inserted near the constriction inside and the mitre with small triangular holes formed by wide inner perianth lobes (Beccari 1877). The remaining species from Java and Borneo are therefore morphologically most similar. *Thismia goodii* differs by the blue colour of the flowers and glabrous stamens, and *T. clandestina* differs by its conspicuous annulus, shorter mitre and two (or sometimes three) asymmetrical lobes on the free apical margin of the connective (Smith 1911, Jonker 1938, Kiew 1999). This leaves *T. episcopalis* the most similar to *T. brunneomitra* (see Table 1).

TABLE 1. Main morphological differences among members of *Thismia* sect. *Sarcosiphon* (*T. betung-kerihunensis* and *T. clavigera* excluded) from Borneo and Java.

	<i>T. brunneomitra</i>	<i>T. clandestina</i>	<i>T. episcopalis</i>	<i>T. goodii</i>
number of flowers	1(–2)	1–3	1–7	1(–2)
perianth coloration	brown to blackish with 12 longitudinal dark brown stripes	pale brown to dark greenish gray with 12 longitudinal dark brown stripes	orange-yellow	white with faint dark green tinge and narrow dark blackish green longitudinal stripes
outer perianth lobes	absent	absent	absent	distinct
height of mitre (mm)	5–7	ca 2(–4)	ca 5	(5–)7(–9)
mitre apex	not fully connate with three short erect obtuse projections	obtusely acuminate without any projections	obtuse without any projections	acuminate without any projections
teeth on free apical part of connective	3; middle lobe narrowly triangular, lateral lobes larger, obtusely triangular	2–3; asymmetrical, with additional several bristle- like laciniae	3; all teeth obtusely triangular, all similar in shape and size	3; middle lobe wide, triangular, lateral lobes smaller
hairs on apical part of connective	present	present	present	absent
lateral appendage of the connective	large, entire, exceeding whole apical part of the connective	dentate, not exceeding apical part of the connective	entire, slightly undulated, not exceeding apical part of the connective	? (not stated in the protologue)

The colour of the perianth tube of *T. episcopalis* is described as “*luteo-crocei*” by O. Beccari, i.e. yellow-orange, whereas in our species perianth tube is brown to blackish. Number of flowers is generally higher in *T. episcopalis*, in which varies from 1 to 7, than in *T. brunneomitra*, in which only one or rarely two flowers per individual plant were recorded. The mitre of *T. episcopalis* has round holes and entire, blunt apex in comparison with *T. brunneomitra*, in which mitre holes are rather reniform-elliptic and there are three short erect obtuse projections on the apex, which represent tips of the perianth lobes. Differences between these two species also exist in the size and shape of the stamens. Free apical margin of connective in both species bear three teeth. However, the teeth architecture differs—all three teeth are ± similar in shape and size in *T. episcopalis*, but in *T. brunneomitra* the two lateral teeth are noticeably larger and obtusely triangular while the central tooth is narrowly triangular. Lateral appendage of the connective is much larger, exceeding whole apical part of the connective when viewed from the outside of the flower in *T. brunneomitra*, while the appendage of *T. episcopalis* is noticeably shorter than the apex of the connective (Table 1).

Revised key of genus *Thismia* in Borneo modified after Tsukaya & Okada 2012

1. Perianth lobes free; roots creeping, vermiform 2
- Perianth lobes connate above the mouth of the perianth tube; roots clustered, coralliform 7
2. All perianth lobes simple, of the same length and size 3
- Inner perianth lobes simple, outer perianth lobes consisting of three parts *Thismia neptunis*
3. Perianth tube with distinct transverse bars at least at the base; stigmas bifid 4
- Perianth tube without transverse bars; stigmas not bifid *Thismia ophiuris*
4. Transverse bars found only in the basal part of the perianth tube; anther appendages 3 *Thismia bifida*
- Transverse bars found throughout the perianth tube; anther appendages 2 or 4 5
5. Annulus bright yellow, sharply hexagonal; anthers with 4 finger-shaped appendages: 2 upper and 2 lower at the free apical margin of the connective *Thismia hexagona*
- Annulus pale purple, round or weakly hexagonal; anthers with 2 appendages 6
6. Perianth tube white with brownish-purple streaks; lobes with appendages ca. 17 mm *Thismia mullerensis*
- Perianth tube white; perianth lobes with appendages ca. 70 mm *Thismia lauriana*
7. Inner perianth lobes form three free, long, almost erect, clavate appendages above the mitre; free apical margin of the connective entire or slightly emarginate 8
- Inner perianth lobes lack any elongated appendages; free apical margin of the connective clearly trilobed 9
8. Flowers yellow-orange to pink-red; free apical margin of the connective triangular, acute *Thismia clavigera*
- Flowers blue-green; free apical margin of the connective rounded to slightly emarginate *Thismia betung-kerihunensis*
9. Flowers blue; outer perianth lobes distinct; free apical margin of the connective glabrous, without any hairs or ciliae *Thismia goodii*
- Flowers yellow, orange, brown or blackish; outer perianth lobes not distinct; free apical margin of the connective hairy 10
10. Perianth tube yellow-orange; apex of the mitre obtuse without any projections; free apical margin of the connective with lobes of the ± same length and size *Thismia episcopalis*
- Perianth tube brown to blackish; apex of the mitre acuminate with three very short projections; free apical margin of the connective with lateral lobes larger, obtusely triangular and the middle lobe narrowly triangular *Thismia brunneomitra*

Acknowledgements

We would like to thank Michal Sochor, who first noticed the plant and took photograph of the fruiting individual in 2013. Kateřina Janošíková has pictures on Figure 1. Chiara Nepi (Herbarium FI) graciously provided photographs of *T. episcopalis* holotype. Zdeněk Mačát provided excellent photographs of perianth tube. We would like to thank also KBFSC staff for their excellent service and support during our stay at the research station, and UBD for permission to conduct research at KBFSC. We also thank the Brunei Forestry Department and the Biodiversity Research and Innovation Centre, Ministry of Industry and Primary Resources for permission to work at the Ulu Temburong National Park and permit to export specimens respectively. Researchers from Palacký University were supported by internal grant from Palacký University (IGA_PrF_2015_001) and project no. CZ.1.07/2.2.00/28.0149. RH was further supported by the long-term research development Project No. RVO 67985939.

References

- Beccari, O. (1877) Burmanniaceae. *Malesia* 1: 240–253.
- Bentham, G. (1855) On the South American Triurideae and leafless Burmanniaceae from the collections of Mr. Spruce. *Hooker's journal of botany and Kew Garden miscellany* 5: 8–17.
- Blume, C.L. (1823) *Catalogus van eenige der merkwaardigste zoo in- als uit-heimse Gewassen te vinden in 's Lands Plantentuin te Buitenzorg*. Ter Lands Drukkery, Batavia, 112 pp.
- Blume, C.L. (1828) *Enumeratio plantarum Javae et insularum adjacentium* 2. J.W. van Leeuwen, Batavia, 174 pp.
- Blume, C.L. (1850) Burmanniaceae. *Museum Botanicum Lugduno-Batavum* 1 (5): 65.
- Bryan, J.E., Shearman, P.L., Asner, G.P., Knapp, D.E., Aoro, G. & Lokes, B. (2013) Extreme differences in forest degradation in Borneo: Comparing practices in Sarawak, Sabah, and Brunei. *PLOS ONE* 8 (7): e69679.
<http://dx.doi.org/10.1371/journal.pone.0069679>
- Chantanaorrapint, S. & Sridith, K. (2015) *Thismia nigricans* Chantanaorr. & Sridith, a new species of Thismiaceae from Southern Thailand. *Phytotaxa* 217 (3): 293–297.
<http://dx.doi.org/10.11646/phytotaxa.217.3.7>
- Chantanaorrapint, S., Tetsana, N. & Sridith, K. (2015) Notes on *Thismia clandestina* (Thismiaceae), a little known mycoheterotrophic

- species. *Polish Botanical Journal* 60: 71–74.
<http://dx.doi.org/10.1515/pbj-2015-0013>
- Cribb, A.B. (1995) The saprophytic flowering plant, *Thismia yorkensis* sp. nov., from Australia. *The Queensland Naturalist* 33: 51–54.
- Dančák, M., Hroneš, M., Sochor, M., Koblrová, L., Hédl, R., Hrázský, Z., Vildomcová, A., Sukri, R.S. & Metali, F. (2013) A new species of *Thismia* (Thismiaceae) from Brunei Darussalam, Borneo. *Phytotaxa* 125 (1): 33–39.
<http://dx.doi.org/10.11646/phytotaxa.125.1.5>
- Engler, A. (1879) Araceae specialmente Borneensi e Papuane raccolte da O. Beccari. *Bullettino della Reale Società Toscana d'Orticoltura* 4: 295–302.
- Engler, A. (1898) Beiträge zur Kenntnis der Araceae VII. *Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie* 25: 1–28.
- Griffith, W. (1844) On the root parasites referred by authors to Rhizanthae and their allies. *Proceedings of the Linnean Society of London* 1: 216–221.
- Hroneš, M. (2014) *Thismia gigantea*, a new combination in *Thismia* (Thismiaceae). *Phytotaxa* 172 (1): 55–56.
<http://dx.doi.org/10.11646/phytotaxa.172.1.8>
- Hunt, C.A., Steenbeeke, G. & Merckx, V.S.F.T. (2014) *Thismia megalongensis* (Thismiaceae), a new species of *Thismia* from New South Wales. *Telopea* 16: 165–174.
<http://dx.doi.org/10.7751/telepea20147809>
- IUCN (2012) *IUCN Red List Categories and Criteria: Version 3.1*. Second edition. Gland, Switzerland and Cambridge, UK, 32 pp.
- Jonker, F.P. (1938) A monograph of the Burmanniaceae. *Mededeelingen van het Botanisch Museum en Herbarium van de Rijks Universiteit te Utrecht* 51: 1–279.
- Kiew, R. (1999) *Thismia goodii* (Burmanniaceae), the Blue-capped *Thismia*, a New Species from Borneo. *Gardens' Bulletin Singapore* 51: 179–182.
- Maas, P.J.M., Maas-van de Kamer, H., van Benthem, J., Snelders, H.C.M. & Rübsamen, T. (1986) Burmanniaceae. *Flora Neotropica Monograph* 42: 1–189.
- Mar, S.S. & Saunders, R.M.K. (2015) *Thismia hongkongensis* (Thismiaceae): a new mycoheterotrophic species from Hong Kong, China, with observations on floral visitors and seed dispersal. *PhytoKeys* 46: 21–33.
<http://dx.doi.org/10.3897/phytokeys.46.8963>
- Merckx, V., Schols, P., Maas-van de Kamer, H.M., Maas, P., Huysmans, S. & Smets, E. (2006) Phylogeny and evolution of Burmanniaceae (Dioscoreales) based on nuclear and mitochondrial data. *American Journal of Botany* 93 (11): 1684–1698.
<http://dx.doi.org/10.3732/ajb.93.11.1684>
- Miquel, F.A.W. (1855) *Flora van Nederlandsch Indie* 3. Van der Post, Amsterdam, Netherlands, 773 pp.
<http://dx.doi.org/10.5962/bhl.title.93>
- Mueller, F.J.H. (1891) Notes on a new Tasmanian plant of the order Burmanniaceae. *Papers and proceedings of the Royal Society of Tasmania* 1890: 232–235.
- Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B. & Kent, J. (2000) Biodiversity hotspots for conservation priorities. *Nature* 403: 853–858.
<http://dx.doi.org/10.1038/35002501>
- Primack, R.B. & Corlett, R.T. (2005) *Tropical Rainforests: An Ecological and Biogeographical Comparison*. Blackwell, Oxford, UK, 336 pp.
- Raes, N., Roos, M.C., Slik, J.W., Van Loon, E.E. & Steege, H.T. (2009) Botanical richness and endemism patterns of Borneo derived from species distribution models. *Ecography*, 32 (1): 180–192.
<http://dx.doi.org/10.1111/j.1600-0587.2009.05800.x>
- Schlechter, R. (1912) Neue Triuridaceae Papuasien. *Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie* 49: 70–89.
- Smith, J.J. (1909) Burmanniaceae. *Nova Guinea* 8 (3): 193–195.
- Smith, J.J. (1911) Beiträge zur Kenntnis der Saprophyten Javas. IV. Zur Systematik von *Thismia clandestina* Miq. und *Thismia versteegi* J. J. Sm. *Annales du Jardin botanique de Buitenzorg* 24: 55–59.
- Smith, J.J. (1912) Neue papuanische Pflanzen I. *Repertorium specierum novarum regni vegetabilis* 10: 486–488.
<http://dx.doi.org/10.1002/fedr.19120103010>
- Tsukaya, H. & Okada, H. (2012) A New Species of *Thismia* (Thismiaceae) from West Kalimantan, Borneo. *Systematic Botany* 37: 53–57.
<http://dx.doi.org/10.1600/036364412X616639>
- Uittien, H. (1935) The Cyperaceae of the Oxford University Expedition to Sarawak in 1932. *Recueil des travaux botaniques néerlandais* 32: 193–202.