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Systematics of the Burmannia coelestis complex (Burmanniaceae)

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Patterns of morphological variation in the *Burmannia coelestis* species complex are investigated, and three distinct species recognized. *Burmannia coelestis* sensu stricto (widespread in Asia, extending from eastern Nepal and Assam to New Guinea and northern Australia) possesses outer perianth lobes with conspicuous double margins running the entire lengths of the lobes. The name *B. chinensis* is revived for specimens from north-eastern India, southern China, northern Indochina and northern Thailand which possess outer perianth lobes with single margins or short double margins. A new species, *B. filamentosa*, is described from Guangdong province, China; it is distinctive in possessing narrow triangular outer and inner perianth lobes, and stamens with prominent filaments.

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Introduction

The genus *Burmannia* L. (Burmanniaceae) consists of c. 57 species of small mycoheterotrophic to (semi-) autotrophic herbs (Jonker 1938) with an essentially pantropical distribution, although some species extend into warm temperate regions.

Although *Burmannia* species are generally small herbs with highly reduced vegetative organs, they possess structurally complex flowers that are either solitary or borne in terminal cymes. The perianth consists of a narrow tube that is derived from the fusion of two whorls of tepals. The perianth lobes are apically free, and often possess a double margin along their lateral margins (Fig. 1); the occurrence and size of these double margins are variable and diagnostically valuable, although their utility in species delimitation has often been overlooked. The perianth tube is trigonous, often with three distinct lateral "wings" that are taxonomically variable in size and shape. The androecium consists of three essentially sessile anthers located in the perianth tube; although the stamens are reduced to just a pair of thecae separated by a connective, the structure of this connective is highly variable and taxonomically valuable: the connective typically bears one or two apical glandular crests and/or a central, pendent basal spur.

The semi-mycoheterotrophic species *B. coelestis* D. Don was first described from Nepal (Don 1825), although it has subsequently been reported throughout tropical Asia (Jonker 1938: 120-126). Although there is considerable variation in the size of vegetative and reproductive characters throughout the geographical range of the species, it is characterized by inner and outer perianth lobes with conspicuous double margins. This feature is only shared with one other species in the genus, *B. disticha* L. (Jonker 1938: 115-117); *B. disticha* is not closely related, however, and is a robust autotroph, flowering at a height of c. 75 cm.

Jonker (1938, 1948) recognized the morphological

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variability of *B. coelestis* and followed earlier authors (e.g., Smith 1912) by defining the species in a broad sense by reducing numerous other names into synonymy with it (see list of synonyms given in the taxonomic treatment, below). This approach was generally followed by later taxonomists, including Backer & Bakhuizen van den Brink (1968), Wu & Chen (1981) and Cramer (1983).

The present paper reassesses the patterns of morphological variation in *B. coelestis* sensu lato; variation that warrants taxonomic recognition is observed, and is formally published here.

Materials and methods

Over 200 herbarium collections of the *Burmannia coelestis* complex were examined from the following herbaria: A, B, BM, BO, BR, C, E, GH, HK, HKU, IBSC, IBK, K, KUN, L, LY, MO, NAS, NY, P, PE, SYS, UC, UPS, US (herbarium acronyms according to Holmgren et al. 1990).

Micromorphology was studied using a Cambridge S-440 scanning electron microscope. Fresh specimens were fixed in FAA overnight and then transferred to 70% alcohol, whereas dried material was rehydrated at 70° C for 2-4 hrs, before being transferred to 70% alcohol. The specimens were then dehydrated in an ethanol series prior to critical point drying, and mounted on metal stubs using conducting carbon cement.

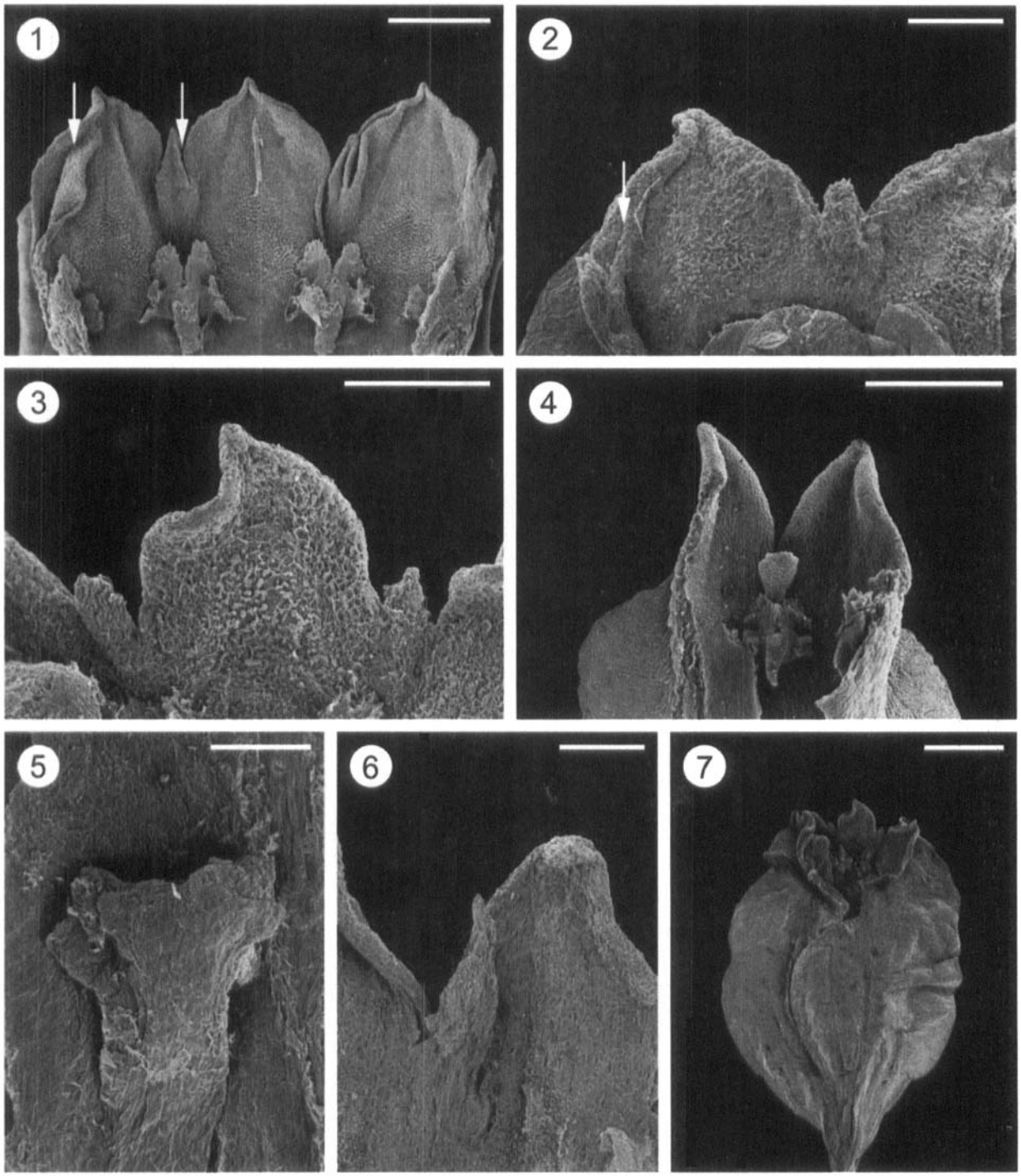
Results and discussion

Three distinct taxa are apparent within the *Burmannia coelestis* species complex, differing in both qualitative and quantitative morphological characters, some of which are discrete and non-overlapping (Table 1). The three taxa have consequently been accorded specific status, following application of the phylogenetic species concept advocated by Luckow (1995). A narrower concept of *B. coelestis* is proposed in the present revision, following the reinstatement of *B. chinensis* Gandog. (Gandoger 1919) as a distinct species; the name *B. chinensis* was previously reduced to synonymy with *B. coelestis* by Jonker (1938: 120-121). In addition, a closely related species, *B. filamentosa*, is newly described here.

Variation in the type of perianth lobe margin is taxonomically very important in the *B. coelestis* complex. *Burmannia coelestis* sensu stricto is characterized by outer and inner perianth lobes with conspicuous double margins extending the entire length of the lobes (Table 1; Fig. 1), whereas *B. chinensis* and *B. filamentosa* either lack double margins entirely, or, if present, the double margins are shallow and restricted to the lower half or less of the outer perianth lobes (Figs 2-3, 6). The shape of the inner perianth lobes is also variable, with *B. chinensis* possessing semi-elliptic or spathulate lobes with rounded apices (Table 1; Figs 3-4), whereas they are triangular with acute apices in both *B. coelestis* sensu stricto (Fig. 1) and *B. filamentosa* (Fig. 6).

Table 1. Comparison of morphological characteristics within the *B. coelestis* complex.

	B. coelestis sens. str.	*B. chinensis*	*B. filamentosa*
Height of plant at anthesis	(10-) 15-25 (-40) cm	(4.5-) 8-15 (-29) cm	(8-) 10-18 (-24) cm
Stem leaves (length)	(5-) 10-18 (-31) mm	4-12 mm	(5-) 7-11 (-15) mm
Outer perianth lobe margin	Prominent double margins, extending the entire length of the lobes	Double margins absent, or, if present, shallow and restricted to lower half or less of the lobes	Shallow double margins, restricted to lower half or less of the lobes
Inner perianth lobe margin	Prominent double margins, extending the entire length of the lobes	Double margins absent	Double margins absent
Inner perianth lobe shape	Triangular; apex acute	Semi-elliptic or spathulate; apex rounded	Triangular; apex acute
Stamen attachment	Sessile	Sessile	Attached by short filament
Pendent basal spur on connective	Present	Present	Absent



Figs 1-7. Scanning electron micrographs of floral characters in *Burmannia coelestis* and *B. chinensis*: – 1. *B. coelestis* (Choong s.n., Singapore); 2. *B. chinensis* (Yu 18146, Yunnan, China); 3. *B. chinensis* (Hamilton 847, Bengal, India); 4. *B. chinensis* (Ng s.n., Hong Kong, China); 5-6. *B. filamentosa* (Deng 8241, Guangdong, China); 7. *B. chinensis* (Hamilton 847, Bengal, India). – Scale bars: 1, 3: 1 mm; 2, 4, 6: 500 μm; 5: 250 μm; 7: 2 mm. Arrows indicate double margins of perianth lobes.

Burmannia filamentosa is characterized by the possession of subsessile stamens with short filaments (Table 1; Fig. 5). This is an unusual feature in *Burmannia*, but has also been observed in *B. championii* Thwaites, *B. congesta* (Wright) Jonker, *B. densiflora* Schltr. and *B. longifolia* Becc. (Jonker 1938: 60, 95-96; Zhang 1999: 71); the occurrence of a short filament is not a genetically constant character in these species, although it is a consistent feature of all populations of *B. filamentosa* examined. Another androecial difference between the three species is the pendent basal spur on the connective; although its size is variable within species, it is consistently present in *B. coelestis* (Fig. 1) and *B. chinensis* (Fig. 4), but absent in *B. filamentosa* (Fig. 5).

The three species recognized also differ in various size characteristics, viz. height of the plant at anthesis, length of stem leaves, etc. (Table 1). *Burmannia coelestis* sensu stricto is typically a larger and more robust species than *B. chinensis*, although *B. filamentosa* is intermediate.

The three species occupy largely exclusive geographical ranges (Fig. 9): *B. coelestis* sensu stricto is widely distributed, extending from eastern Nepal and Assam through Malesia to New Guinea and northern Australia; *B. chinensis* is restricted to southern China, northern Indochina and north-eastern India (Orissa and Bengal); and *B. filamentosa* is endemic to the eastern part of Guangdong province, China. These geographical differences are broadly correlated with differences in ecological preferences: *B. chinensis* typically grows on wet rock surfaces with decaying leaf litter and running water, whereas *B. coelestis* and *B. filamentosa* more commonly occur in open, grassy places with poor soil, often by streams.

The morphological differences between *B. coelestis* sensu stricto and *B. chinensis* apparently reflect differences in chromosome number. Larsen (1963) reported chromosome counts of $2n$ = c. 32 for "*B. coelestis*" from Thailand; a voucher specimen of this collection (Sørensen, Larsen & Hansen 4698 [C!]) was examined during the present revision and determined as *B. chinensis*. Sarkar et al. (1973) subsequently reported chromosome counts of $2n$ = c. 16 for specimens of *B. coelestis* from India; although it was not possible to examine the voucher specimens for this cytological report, the geographical origin of the plants suggest that they represent *B. coelestis* sensu stricto.

Jonker (1938: 131-132) described a new variety of *B. pusilla* (Wall. ex Miers) Thwaites, var. *hongkongensis* Jonker, based on two collections from Hong Kong, although Wu & Chen (1981: 173) subsequently assigned collections from Guangdong, Guangxi, and Hunan provinces to this variety. The diagnostic features cited by Jonker (1938) that distinguish var. *hongkongensis* from var. *pusilla* were the longer stems and narrower perianth wings. Other differences between the two taxa exist, however, including: the shape of the outer perianth lobes (ovate with obtuse apices in *B. pusilla* var. *pusilla*, but broadly ovate with apiculate apices in var. *hongkongensis*); and the shape of the inner perianth lobes (linear to lanceolate with subacute apices in var. *pusilla*, but spathulate with rounded apices in var. *hongkongensis*). The two varieties of *B. pusilla* recognized by Jonker (1938) are dissimilar, and *B. pusilla* var. *hongkongensis* appears to be conspecific with *B. chinensis*, with no distinguishing morphological features; *B. pusilla* var. *hongkongensis* is accordingly reduced to a synonym of *B. chinensis* in this treatment.

Taxonomic treatment

1. Burmannia coelestis D. Don

Prod. Fl. Nep.: 44 (1825). – Type: Nepal, 1821, Wallich 9005 (K! holotype).

Burmannia javanica Blume, Enum. Fl. Javae 1: 28 (1827). – Type: Java, without date, Blume s.n. (L! holotype; A!, BR!, L!, LY!, NY!, P!, UC! isotypes).

Burmannia uniflora Rottler ex Sprengel, Syst. Veg. 4(2): 23 (1827), syn. nov. – Type: India, without date, Wight 32 (?B holotype destroyed; E! lectotype, designated here).

Burmannia triflora Roxb., Fl. Ind. 2: 117 (1832). – Type: India, Prince of Wales Island, without date, Roxburgh s.n. (?K holotype; BM! isotype).

Cryptonema malaccensis Turcz., Bull. Soc. Imp. Naturalistes Moscou 21(1): 591 (1848), nom. illeg. - *Nephrocoelium malaccense* Turcz., Bull. Soc. Imp. Naturalistes Moscou 26(1): 287 (1853). – Type: Malacca, Cuming 2325 (?KW holotype; BM!, L!, UPS! isotypes).

Burmannia azurea Griff., Not. 3: 326 (1851). – Type: "Tenasserim & Andamans", 1862-63, W. Griffith 5596 (K! holotype; C!, L!, NY! isotypes).

Burmannia selebica Becc., Malesia 1: 243 (1878 ["1877"]).– Type: Sulawesi, without date, Beccari s.n. (FI [photograph!] holotype).

Burmannia candida Griff. var. *coerulea* O. Kuntze, Rev. Gen. Pt. 2: 645 (1891), nom. nud., syn. nov. – Type: Sikkim, 14 Nov 1875, Kuntze 6494 (NY! holotype).

Burmannia borneensis Gandog., Bull. Soc. Bot. Fr. 66: 290 (1919). – Type: British North Borneo [Sabah], Labuan, 1877, Burbidge s.n. (LY holotype; BM!, GH!, K!, NY!, US! isotypes).

Burmannia malaccensis Gandog., Bull. Soc. Bot. Fr. 66: 290 (1919). – Type: Malay Peninsula, Singapore, 1898, Ridley s.n. (LY! holotype; BM!, UC! isotypes).

Chlorophyllous, semi-mycotrophic, annual herbs. Stem simple or sometimes branched, flowering at (10-) 15-25 (-40) cm. Roots fibrous, rather short. Rhizome absent. Leaves present as basal rosette and cauline forms; basal leaves linear or lanceolate, acute or acuminate, 3 veins, (4.5-) 10-12 (-18) × c. 3 mm; cauline leaves appressed, triangular lanceolate, (5-) 10-18 (-31) × c. 2.5 mm. Bracts lanceolate, 3-6 × c. 2 mm. Inflorescence an apical double cincinnus of (1-) 2-6 (-8) flowers. Flowers shortly pedicellate or subsessile, 10.5-16 mm long; perianth (4.5-) 5-8 (-13) mm long, prominently 3-winged, blue or blue-purple with yellow lobes; perianth wings semi-elliptical or semi-obovate, 6-13 × 1.5-3 mm, running from the middle of outer perianth lobes to below the base of ovary; perianth-tube cylindrical-trigonous, 4-8 mm long; outer perianth lobes erect, ovate or ovate-triangular, apex acute, 1-2 mm long, with prominent double margins; inner perianth lobes triangular, apex acute, c. 0.5-1 mm long, with double margins; stamens sessile in perianth throat; connective with two short lateral arms bearing thecae, two apical, curved, divergent crests, and an obtuse basal pendent spur; style thick-filiform, bearing 3 subsessile stigmas; stigma funnel-shaped; style and stigma as long as the perianth tube; ovary ellipsoid or obovoid, 3-7 mm long. Capsule obovoid, truncate, dehiscing by transverse splits. Seeds ellipsoid, yellow. – Fig. 8.

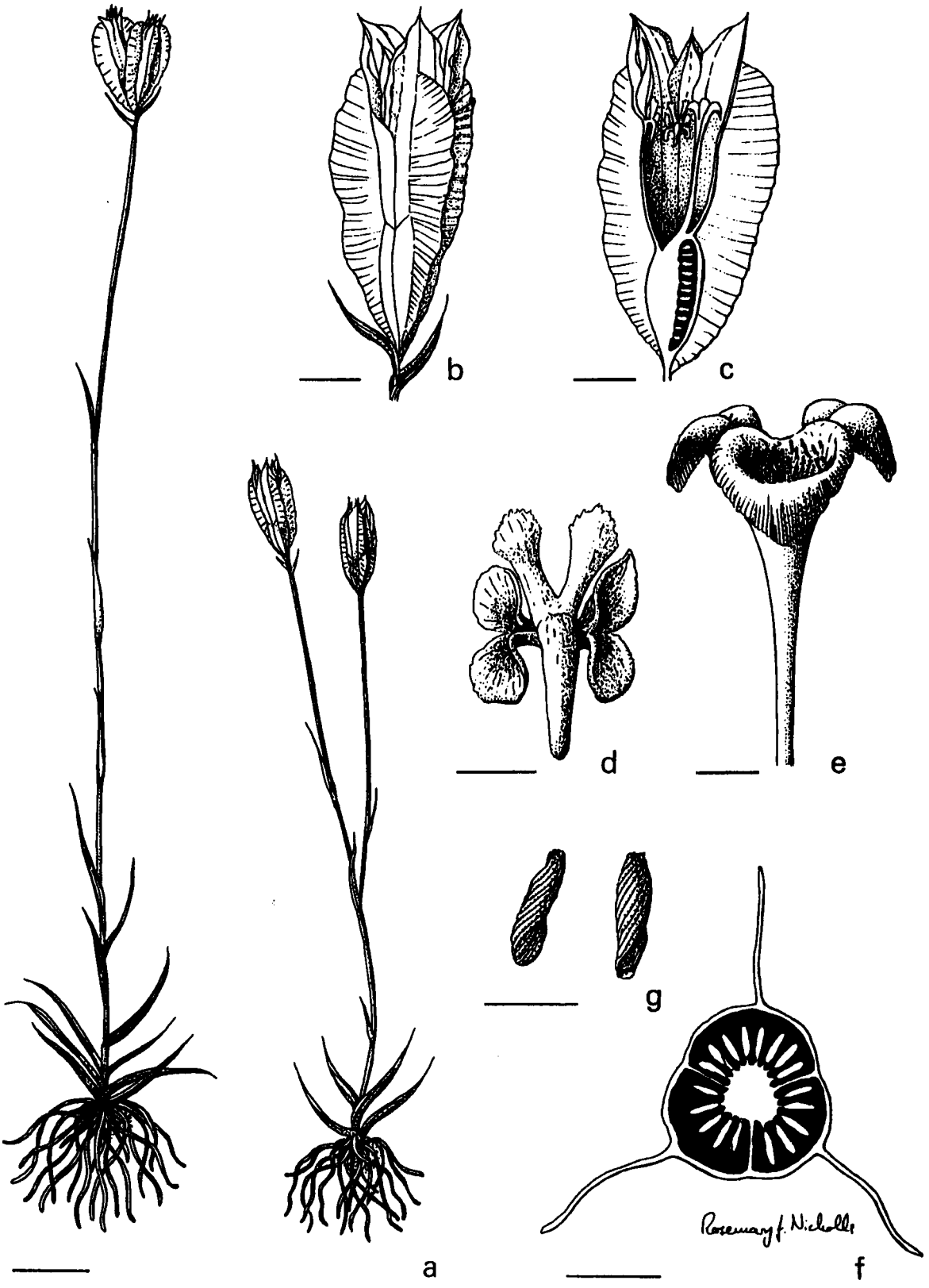
Phenology: Flowering between June and October, and fruiting between October and February; flowering throughout the year in Borneo.

Distribution: Widespread in Asia, extending from eastern Nepal and Assam through Malesia to New Guinea and northern Australia (Fig. 9). Although "*B. coelestis*" was recorded from the Philippines in Jonker (1938: 124), two of the three specimens cited (Cuming 2324 [L!] and Cuming 2325 [BM!, L!, UPS!]) are actually from the Malay Peninsula (Steenis-Kruseman 1950: 121); the third specimen (Ramos 4913) was apparently collected in Luzon, but was not located during the present study.

Habitat: In open, wet grassy areas on either humus-rich or poor soils, occasionally in paddy fields, swampy areas or in dry savannahs; 0-300 (-800) m altitude.

Notes: Morphological variation in *B. coelestis* is geographically correlated: specimens from Borneo are considerably more robust than specimens from other localities, and generally grow to 15-40 cm in height. Conversely, specimens from Java are shorter, and typically do not grow to more than 15 cm in height. The Australian specimens are furthermore characterized by possessing very short connective spurs. These minor morphological differences do not warrant nomenclatural recognition.

Representative specimens examined: Australia. Northern Territory: Ningalaye Brook, Craven 6174 (L, MO). Queensland: Beagle North Camp, Cook District, Clarkson 4483 (MO). – Bangladesh. Silhet/Sylhet, Wallich 9005B (B, BM, BR, K, NY, P, UC). – Borneo. Brunei: Seria, Fuchs & Diederix 21188 (K). Kalimantan Barat: Pontianako, Shah 405 (L). Kalimantan Selatan: Bangarmassing, Motley 55 (K). Sabah: Beaufort District, Weston, Beaman 8060 (K, NY). Sarawak: Baram District, Chew 997 (UC, K). – Burma [Myanmar]. Narayonpur: precise locality unknown, Wallich 9005A (K). Tenasserim: precise locality unknown, 1844, Packman s.n. (BM). – Cambodia. Kompongchuang: Smith 307 (US). – China. Guangdong: Guangzhou & vicinity, Wang 165207 (IBSC). Guangxi: Shangsi (Shiwandashan), Tsang 24676 (IBSC, MO, NY, SYS). Hainan: Wanning, Zhong 60168 (IBSC). Hong Kong: Sheungshui, Herb. HK 8152 (HK). – India. Assam: Lushai Hills, Parry 333 (K). Madhya Pradesh: Surguja, Ramanujganj, Koelz 19537 (L). Meghalaya: Khasia, without date, Hooker & Thomson s.n. (BM, BR, C, L, NY, UPS). Sikkim: precise locality unknown, Treutler 1124 (K). – Java. Jawa Barat: Jakarta, Buitenzorg, Bakhuizen van den Brink 29 (L). Laos. Sarannakhet: Sala Malpuech, Poilane 27941 (HKU, P). Vientiane: precise locality unknown, Stolliday B23 (BM). – Malay Peninsula. Johore: precise locality unknown, Vesterdal 227 (C). Kedah: Langkawi, without date, Fox s.n. (BM). Malacca: Cuming 2324 (L). Negeri Sembilan: Port Dickson, De Froideville & Monod 677 (L). Selangor: Telok Merbau, Frank 1012 (BR, C, L). Singapore: MacRitchie Reservoir, Chua & Tan 281 (HKU, SING). Terengganu: precise locality unknown, Sinclair 8536 (US). – Nepal. Precise locality unknown: Pilluk, Wallich 9005D (BM, K, L). – New Guinea. Papua New Guinea: Lake Daviumbu, Brass 7831 (BM, L). – Sulawesi. Majene: Mapili, by Sinaygha, Eyma 3305 (L). Menado: Kolone Dak, Eyma 3305bis (L). – Sumatra. Bangka: Bünnemeyer 1472 (K, L). Riau: P. Bintan, Bünnemeyer 6338 (L). Sumatera Barat: Prain Econtang, Robinson & Kloss 54 (BM). Sumatera Selatan: Soengei Bingis, Verboom 16 (L). Sumatera Utara: Asahan, Rahmat si Boeea, 7404 (GH). – Sunda Strait. Precise locality unknown: without date, Staunton s.n. (BM). – Thailand. Banha, Coll. Ind. 12a (BM). Bor Rai: precise locality unknown, Larsen et al. 32308 (AAU, IBSC). Chantaburi: Foot of Khao Soi Dao, van Beusekom & Smitinand 2146 (A, AAU, C, E, L, UC). Kaw Chang: Klang non Si, Kerr 9201 (BM, C, L). Krabin: Ban Keng, Marcan 2533 (BM, C, K, L). Maehongson: Khun Yuan, Larsen & Larsen 34140


b
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(AAU, BM, C, IBSC). Narathiwat: Tak Bai, Nyyomdham & Ueachirakan 1922 (AAU, C, E, L, NY). Ranong: Ngao Park, Phengkhlai & Smitinand 6095 (C, K). Sisaket: Dongrak Range, Maxwell 76-504 (AAU, L). Songkhlai: Thepha Bay, Larsen et al. 43938 (AAU). Sriracha: Taphan Hin, Geesink & Phengkhlai 6323 (C, L). Surat: Bandon, Seidenfaden 2061 (C). Surin: Ngao Park, Phengklai & Smitinand 6095 (C, K). Suippora: precise locality unknown, 1 Feb 1916, Annaudak s.n. (K). Tarutao: Talo Oo Dang, Congdon 184 (A, AAU). Trang: Thung Khai, Larsen et al. 43987 (AAU). Trat: Taphan Hin, Geesink & Phengkhlai 6323 (AAU, C, L). – Vietnam. Due Phon: precise locality unknown, Balansa 3120 (K). West Tonkin: precise locality unknown, Bon 3073 (P). South Vietnam: precise locality unknown, without date, Pierre s.n. (L, NY). Cuu Long: Cui Cung, Thorel 1160 (P). Quang Ninh: Tien-Yen, Tsang 30756 (IBSC).

2. Burmannia chinensis Gandog.

Bull. Soc. Bot. Fr. 66: 290 (1919). – Type: China, Guizhou, Tchai Keou Gai, 16 Jul 1901, Bodinier & Cavalerie s.n. (LY! holotype).

Burmannia rigida Gandog., Bull. Soc. Bot. Fr. 66: 290 (1919), syn. nov. – Type: Laos, 1902, Spire 294 (LY! holotype).

Burmannia pusilla (Wall. ex Miers) Thwaites var. *hongkongensis* Jonker, Meded. Bot. Mus. Herb. Rijks Univ. Utrecht 51: 131-132 (1938). – Type: China, Hong Kong, Pokfulam Reservoir, 9 Oct 1894, Bodinier 924 (P! holotype; LY isotype).

Burmannia coelestis auctt. non D. Don; Hooker f., Fl. Brit. Ind. V: 665 (1888), pro parte; Wright, J. Linn. Soc. 36: 4 (1905); Jonker, Meded. Bot. Mus. Herb. Rijks Univ. Utrecht 51: 121 (1938), pro parte; T. L. Wu & S. Chen, Fl. Reipubl. Popul. Sin. 16(2): 171 (1981), pro parte.

Chlorophyllous, semi-mycotrophic, annual herbs. Stem simple or sometimes branched, flowering at (4.5-) 8-15 (-29) cm. Roots fibrous, rather short. Rhizome absent. Leaves present as basal rosette and cauline forms; basal leaves linear or lanceolate, acute or acuminate, 3 veins, (2.5-) 10-12 (-14) × 1.3-3 mm; cauline leaves appressed, triangular lanceolate, 4-12 × 2 mm. Bracts lanceolate, 4-5.5 × c. 1.2 mm. Inflorescence an apical double cincinnus of 1-4 (-6) flowers. Flowers shortly pedicellate or subsessile, 6-13 mm long; perianth 4-6.5 mm long, prominently 3-winged, blue or blue-purple with yellow lobes; perianth wings semi-elliptical or semi-obovate, 5-11 × 1.1-3 mm, running from the middle of outer perianth lobes to below the base of ovary; perianth-tube cylindrical-trigonous, 3-9 mm long; outer perianth lobes erect and reflexed apically upon anthesis, broad ovate, apiculate, 1-3 mm long, without double margins or with very shallow double margins restricted to the base or rarely up to the apex; inner perianth lobes spathulate, apex rounded, c. 0.4-1.2 mm long, without double margins; stamens sessile in perianth throat; connective with two short lateral arms bearing thecae, two apical, curved, divergent crests, and sometimes with an obtuse basal pendent spur; style thick-filiform, bearing 3 subsessile stigmas; stigma funnel-shaped; style and stigma as long as the perianth tube; ovary ellipsoid or obovoid, 2.5-7 mm long. Capsule obovoid, truncate, dehiscing by transverse splits. Seeds ellipsoid, yellow.

Phenology: Flowering between June and October, and fruiting between July and February.

Distribution: Southern China (Fujian, Jiangxi, Guangdong, Guangxi, Guizhou, Hainan, Yunnan and Zhejiang), Laos, northern Thailand, northern Vietnam to eastern India (Fig. 9).

Habitat: In open places, usually on rock surfaces with a thin layer of humus with running or stagnant water; occasionally in disturbed habitats or on grassy slopes. Generally growing on granite substrates or clay soils, occasionally on sandy soils, and often associated with *Eriocaulon*, *Utricularia*, etc.; (0-) 300-1500 m.

Representative specimens examined: China. Fujian: Jianning, Li 5970 (PE). Guangdong: Buoluo, Zhang 427 (HKU, IBSC). Guangxi: Hepu, Zhong 809433 (IBK). Guizhou: Tcha Keou Gai, 16 Jul 1901, Bodinier & Cavalerie s.n. (LY). Hainan: Changjiang, Liang 66388 (IBSC, NY). Hong Kong: Nazareth, Bodinier 924 (E, HK). Hunan: Yizhang, Liu 921(IBSC, PE). Jiangxi: Lushan, Cheo 475 (IBSC, K, NAS). Yunnan: Jingdong, Li 1698 (IBSC, KUN, PE). Zhejiang: Leqing, Coll. ind. 1025 (KUN). – India. Narayonpur: Hamilton 847 (E). Orissa: Puri District, Lace 2529(E). Bengal: Chota Nagpur, Prain's Collector 58 (GH, K). West Bengal: Siligori, Clarke 26562 (BM, E). – Laos. Precise locality

Fig. 8. *Burmannia coelestis* (A-F, Chua & Tan 281, Singapore; G, Teruya 2210, Singapore): A. habit; B. entire flower; C. half flower; D. stamen, with lateral thecae and connective consisting of two apical crests and a pendent basal spur; E. three stigmas with united style; F. ovary (transverse section). – Scale bars: A: 1 cm; B-C: 2 mm; D-E, G: 0.25 mm; F, 0.5 mm. Del. R. J. Nicholls; reproduced from Saunders (1998), © National Parks Board, Singapore.

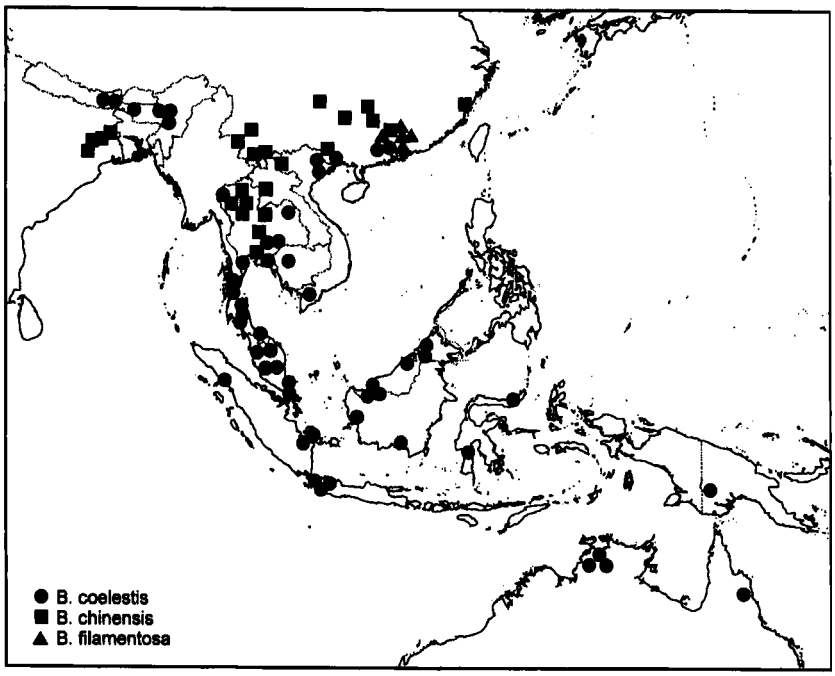

Fig. 9. Geographical distribution of *Burmannia coelestis* sensu stricto, *B. chinensis* and *B. filamentosa*.

unknown: 1902, Spire s.n. (LY). – Thailand. Chaiyaphum: Tunhamamg, Beusekom et al. 9257 (C, MO, P). Chiangmai: Doi Inthanond, Beusekom & Phengklai 2487a (AAU, BM, C, K, L). Chiangrai: Bo Luang, Hansen et al. 10980 (C). Chonburi: Kow Kieo, Maxwell 75-1108 (AAU, L). Phetchaburi: Wang Tho Thung Salaeng Lung National Park, Koyama et al. 31942 (A). Phu Kradung: South of Loi, Charoenphol, Larsen & Warncke 4624 (MO). Sakhonnakhon: Phu Phan National Park, Mitsuta et al. 50451 (A). – Vietnam. North Vietnam, Bois 218 (L).

3. Burmannia filamentosa D. X. Zhang & R. M. K. Saunders, sp. nov.

Type: China, Guangdong, Xingfeng County, 29 Oct 1958, Deng 8241 (IBSC! holotype; PE!, KUN! isotypes).

Differt a species *B. chinensi* filamentis elongatis et lobo perianthio exteriore angusto-triangularis.

Chlorophyllous, semi-mycoheterotrophic, annual herbs. Stem simple or rarely branched, flowering at (8-) 10-18 (-24) cm. Roots fibrous, short. Rhizome absent. Leaves present as basal rosette and cauline forms; basal leaves lanceolate or triangular-lanceolate, acute or acuminate, 3 veins, (4.5-) 8.1-14 × 2-3 mm; cauline leaves appressed, linear, (5-) 7-11 (-15) × 1.5-2.8 mm. Bracts lanceolate, c. 5 × 2 mm. Inflorescence an apical double cincinnus of (1-) 3-5 (-8) flowers. Flowers shortly pedicellate, 9-13.5 mm long; perianth 6-7.5 mm long, prominently 3-winged, purple or bluish purple; perianth wings half-obovoid, (8-) 10-16 × (1.7-) 2-3 mm, running from the middle of outer perianth lobes to below the base of ovary; perianth tube cylindrical, 5-9 mm long; outer perianth lobes narrow triangular, apex acute, 1.5-3 mm long, with double margin at base; inner perianth lobes lanceolate, with apiculate apices, 1-2 mm long, without double margins; stamens with short filaments basally adnate to perianth throat; connective with two short lateral arms bearing thecae, and two small, apical divergent crests but without a basal spur; style thick-filiform, bearing 3 subsessile stigmas; stigmas funnel-shaped; style and stigma as long as the perianth tube; ovary ellipsoid, c. 3-7 mm long. Capsule obovoid, truncate, dehiscing by transverse splits. Seeds ellipsoid, yellow. – Fig. 10.

Phenology: Flowering and fruiting between October and November.

Distribution: Only known from eastern Guangdong Province (from Buoluo and Conghua in the west to Huidong in the east, and to Renhua and Wongyuan in the north) (Fig. 9).

Habitat: Open, wet mountain slopes and in valleys by streams; 300-800 m altitude.

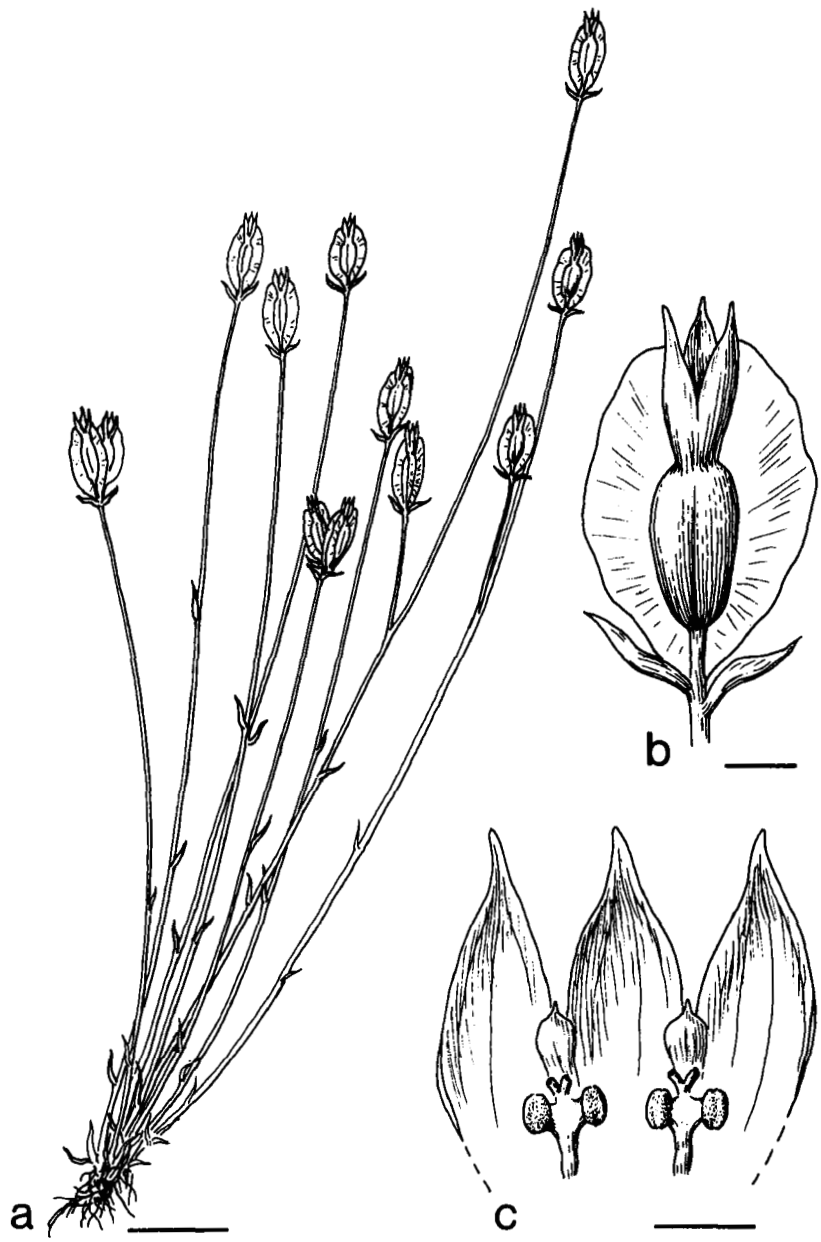

Fig. 10. *Burmannia filamentosa* (Deng 8241, Guangdong, China): A. habit; B. entire flower; C. dissected flower, showing stamen structure with elongated filament and a pair of apical crests, relative to position of larger outer and smaller inner perianth lobes. – Scale bars: A: 2 cm; B: 2 mm; C: 1 mm. Del. Yu Feng.

Etymology: In reference to the well developed filaments.

Specimens examined (Paratypes): China. Guangdong: Buoluo (Luofushan), Huang & Zhang 82 (IBSC, PE), 83 (IBSC, PE); idem, Yue-78 6438 (BR, IBSC); idem, Metcalfe et al. 17943 (SYS); Conghua, Wang & Zhang 8269 (IBSC); Huidong, Chen et al. 186 (IBSC); Renhua (Danxia Mt.), Huang & Zhang 64 (IBSC, PE); Wongyuan, Lau 24695 (IBSC).

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