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Journal of Plant Taxonomy and Geography (*Webbia*) is a peer-reviewed journal on Plant Taxonomy, Nomenclature, Phylogeny, Phytogeography and Palaeobotany. Most of the contributions deal with the Vascular Plants, but sometime contributions on Briophytes, Lichenes, Fungi and Algae are encouraged.
The journal aims to allow research in botanical topics such as taxonomy, systematics, nomenclature, molecular phylogeny, conservation, biogeography, and history of botany, and botanical collections.
It was founded in **1905** in Florence by **Ugolino Martelli** (1860-1934), a botanist well known for his studies of and contributions to the systematics of the tropical genus *Pandanus* and on the Flora of Sardinia.
In the 19th century Florence represented one of the most important European centres in Plant Taxonomy and Phytogeography with several notable Italian botanists worth mentioning such as Filippo Parlatore, Teodoro Caruel, Eugenio Baroni, Stefano Sommier, Odoardo Beccari and Ugolino Martelli himself. In 1842 **Filippo Parlatore** (1817-1877) founded in Florence the *Herbarium Centrale Italicum (FI)*, which soon became one of the most important herbaria in the world. Most of the specimens described and/or cited in *Webbia* are still kept in it.
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Webbia had been created in honor of **Philip Barker Webb** (1793-1845), a close friend of Filippo Parlatore, who before passing away entrusted his personal herbarium and a library rich of old botanical books and publications to the then Botanical Museum in Florence.

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Comments

A complementary note to Baldini's article "The impact of Covid-19 crisis on Plant Taxonomy: will we be able to approach to plant taxonomy as in the past?"

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On March 12, 2020, the World Health Organization (WHO 2020) declared the Coronavirus disease 2019 (COVID-19) outbreak to be a pandemic (Viner et al. 2020; WHO 2020). Over the last six months, the COVID-19 pandemic has generated major challenges for society and the global higher education (Crawford et al. 2020) and medical (Chatterjee et al. 2020) communities, among others. Within this scope and having read the recent comments published in Webbia 75: 3-4 by the Editor-in-Chief, Riccardo M. Baldini, I couldn't resist offering my modest opinion based on my own experiences as a result of the disruption of activities due to the new coronavirus.

In this note, I particularly follow up on Baldini's observations on how this epidemic has disrupted our society and changed our careers and professional endeavors in plant systematics and accessing natural history collections. In order to keep this note concise and in correspondence with Baldini's communication, I'll focus on some of the adverse effects and benefits that the COVID-19 epidemic has brought to our personal and professional lives in the herbarium and the field.

DIFFICULTIES CREATED BY COVID-19

Among the numerous adverse effects, I will highlight only a few. Foremost, the epidemic has brought not only disruption to regular work habits but also the risk of death from infection and severe emotional pressure. Economic impact on households, particularly in developing countries, has added burden and stress to parents and family providers as a result of the loss of income, childcare services, and adequate nutrition. Immediate access to health care has been also challenging particularly in hard hit COVID-19 countries (Wang et al. 2020).

As researchers, educators and public servers, we are facing unprecedent times of social distancing. In relation to education, Cao et al. (2020) suggest-

ed that college students' mental health should be monitored during epidemics. Research training has also been halted by the COVID-19 pandemic. The conventional student hands-on interactive training involving field and/or lab courses has undergone several adjustments. These modules are now limited to very small groups and only under strict physical distancing rules while working and traveling, even during plant and data collection and analysis. Other daily adjustments include disinfecting protocols, self-monitoring for symptoms, remote work whenever possible, etc. Furthermore, when it comes to fieldwork across international borders, the situation is more complicated as some countries have closed borders and prohibited travel, especially to citizens from areas severely affected by COVID-19. In fact, during the initial outbreak several colleagues, including myself, had to abandon field sites because of the imminent outbreak with ensuing imposed national lockdowns and mandatory quarantine periods. Evidently, other issues impacting our society exist beyond the scope of this note.

BENEFITS AS A CONSEQUENCE OF COVID-19

Aside from education and research, an analysis (Greenstone and Nigam 2020) suggests that the proposed social distancing policies in response to the COVID-19 epidemic have significant economic benefits. That is, they have likely saved millions of lives and avoided overwhelming hospital intensive care units.

The ancient, yet commonly used, medicinal use of plants seems to have come back strongly. The ongoing epidemic outbreak has triggered research on neutraceutical and botanical agents against COVID-19 (Editorial 2020). Several extracts from *Morus* spp. exhibited antiviral activity on human coronavirus and are important as they have the potential in promising applications for antiviral strategies (Evans et al. 2020; Thabti et al. 2020). Quite likely more plant extracts useful to control the virucidal activity will be screened and characterized in the near future in search of a vaccine and cure for COVID-19.

The drastic and sudden lockdown with ensuing transition to online communication platforms has led to more effective online teaching and learning skills and quick redevelopment of online course offering. Considering the effects of the COVID pandemic on students, recent studies show the importance of online training for pediatric postgraduate students. In addition, the rapid curriculum redevelopment for fully online offerings in most universities indicates that students' satisfaction levels with online learning were comparable to the previous studies with the traditional classroom lectures (Agarwal and Kaushik, 2020) and that it is important to plan a balanced integration of video learning with other course materials (Scagnoli et al. 2019).

With the advent of digital technology, we are able to offer virtual visits to our herbaria and collections despite the negative fact that numerous institutions have reduced and/or laid off staff by 20-40%, such as the American Museum of Natural History in New York and the California Academy of Sciences, respectively (Pennisi 2020). Now more than ever, we value digital collections and virtual herbaria. Although working with real herbarium specimens and museum artifacts is a unique experience, owing to digital technology we can remotely access records and high-quality specimen images from the most important herbaria as well as the taxonomic and geographic databases associated with their collections. This brings to mind the precious, detailed, almost life-like, wax plant collection including plant anatomy models at the herbarium of the University of Florence (FI). These models were produced in the 1800s by talented artists working under the guidance of expert botanists, such as Giovanni Battista Amici (Abbott 2008). This, along with other valuable historical collections, like that of Andrea Cesalpino are among the nearly 5 million specimens hosted at FI.

In response to prevent the spread of COVID-19 at our herbarium (SASK), we have adopted strict safety guidelines established by our institutional leaders and the multidisciplinary Pandemic Response Team (PRT) in conjunction with health and government authorities. As our university gradually reopens for research activities, the herbarium, department and individual research labs are getting ready to work safely. Canadian and American institutions and individual units (facilities management, environmental health, security, custodial, transportation) are prepared to support the increasing on-site campus activities. In response to social distancing strategies on our herbarium facility and on campus, we're making plans to respect the required 2 m social distance among personnel, visiting researchers, students, and general public; disinfect common surfaces before and after use; wear personal protection equipment, whenever social distance is not possible, and keep a tracking logbook for the activity of personnel and visitors, in addition to the traditional approaches (Cota-Sánchez and Harms 2009).

Finally, I couldn't agree more with Baldini's comment regarding the much-needed face-to-face interaction at the personal and professional levels. We are social beings, and with the implementation of social isolation and remote conferences the importance of human interactions and relationships has become more evident. Unfortunately, I think that the likelihood that regular visits to herbaria

and other research facilities will be reinstated in the near future is low, especially with the new distancing norms. As an individual researcher and instructor delivering lectures, I am preparing for my online botany courses this coming fall. I already miss enormously the possibility of interacting with my botany students as well as visiting and learning from my colleagues and their important botanical collections in institutional herbaria across the world. I also wish we could go back to the face-to-face interactions during professional meetings, conferences and seminars. Zoom, FaceTime, WebEx, Microsoft Teams, among others, are excellent platforms for Webinars and group communication, but they lack the intimacy and comradery of face-to-fact interactions.

Moving forward, I am hopeful that we will find solutions to continue to engage in multidisciplinary collaborations effectively, either on a personal basis or remotely and that we will be better prepared to face the adverse consequences of another potential social or health disaster. At this point our commitment to support scientific development and the use of natural history collection needs to focus on reinforcing efforts towards new graduate students in taxonomy and botanical sciences as well as young professionals, who are the future generation of plant systematics, guardians of botanical collections and biodiversity.

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Taxonomic revision of the genus *Flemingia* (Leguminosae: Papilionoideae) in India

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Abstract. Indian *Flemingia* species are grouped under five subgenera, namely *Chalaria*, *Flemingiastrum*, *Lepidocoma*, *Ostryodium* and *Rhynchosioides*. Here, we revise the taxonomy of the genus (excluding subg. *Rhynchosioides*) based on the study of live material and preserved specimens. We report 21 species and one variety (22 taxa) in India, of which one variety is endemic, i.e. *F. praecox* var. *robusta*. All the taxa have been described, illustrated and their ecology discussed. In the process, twelve binomials (*F. angustifolia*, *F. blancoana*, *F. chappar*, *F. congesta*, *F. grahamiana*, *F. latifolia*, *F. macrophylla*, *F. nudiflora*, *F. paniculata*, *F. stricta*, *F. wallichii* and *F. wightiana*) and one trinomial (*F. praecox* var. *robusta*) are lectotypified. *F. sericans* and *F. stricta* subsp. *pteropus* are proposed as new synonyms for *F. macrophylla* and *F. stricta*, respectively. *F. parviflora*, an Australian species, is recorded for India. *F. strobilifera* var. *nudiflora* is raised to the species level and a new combination proposed, i.e. *F. nudiflora*. *F. tiliacea* is relegated to the synonymy of *F. nudiflora*. A taxonomic key for the subgenera and species therein is provided for easy identification. Additionally, distributional maps for the genus and species are given.

Keywords: *Cajanus*, *Flemingia*, *Moghania*, Fabaceae, distribution, India, taxonomy.

INTRODUCTION

Flemingia Roxb. ex W.T.Aiton is a genus in the subtribe *Cajaninae* Benth. (Leguminosae Juss.: Papilionoideae DC.). It has been named after Dr. John Fleming (1747-1829), a friend and colleague of Roxburgh (Roxburgh 1820; Turner 2014) and President of the Bengal Medical Service from 1800. *Flemingia* is one of the wild relatives of the pigeonpea *Cajanus cajan* (L.) Huth. It is said that the genus *Cajanus* Adans. could only be handled after its relations to *Atylosia* Wight & Arn. and other wild relatives such as *Adenodolichos* Harms, *Baukea* Vatke, *Bolusafra* Kuntze, *Carissoa* Baker f., *Chrysoscias* E. Mey., *Dunbaria* Wight & Arn., *Eriosema* (DC.) Desv. and *Rhynchosia* Lour. had been studied (modified after van der Maesen 1986). These wild relatives are important from the point of view of conferring important traits

such as disease resistance and salt tolerance to *Cajanus cajan*.

Some species of the genus are economically important. *Flemingia vestita* (Grah.) Benth. ex Baker is a tuber crop in northern India. Inhabitants from Nepal, Himachal Pradesh and Khasi hills (Meghalaya) cultivate this species. Tubers are sold in the local market and eaten raw as a source of starch. *Flemingia grahamiana* Wight & Arn. is used in skin diseases (Sornay 1916). The liquid from boiled leaves and old stems of *Flemingia sootepensis* Craib. is drunk to increase women's breast milk production; and used in sauna baths. Raw or roasted tubers of *F. tuberosa* Dalzell are eaten by local people; it was useful to cure dysentery and leucorrhoea (Dymock et al. 1890). *Flemingia stricta* Roxb. and *F. semialata* Roxb. are used as host plants for the culture of the lac insect. The leaves of *F. strobilifera* (L.) W.T.Aiton are used as vermifuge in Java (Anonymous 1956). *Flemingia strobilifera* is occasionally grown in gardens as ornamental shrubs (Firminger 1930), as "wild hops". The roots of *F. bracteata* (Roxb.) Wight have been used to cure epilepsy and the wood of *F. chappar* Buch.-Ham. ex Benth. serves as tooth brush (Haines 1922). The glands from pods serve as a principal source of 'waras', an orange-red coloured dye, used for colouring silk (Anonymous 1956). Flemingin ($C_{12}H_{12}O_3$) is the principal pigment found in waras. It melts at 171–172°C to form orange-red needles that dissolve in cold alkali to give a deep orange-red solution (Anonymous 1956).

Flemingin + Alkali → Salicylic acid + o-Hydroxycinnamic acid.

Flemingia is distributed in the old world tropics (Mabberley 2017) and consists today of 44 species and two varieties (46 taxa) (modified after ILDIS 2005; The Plant List 2013). It is thought to have originated in the Indo-Burmese region (Mukerjee 1953). Bentham (1865) subdivided the genus in three sections: *Ostryodium* DC., *Chalaria* Wight & Arn. and *Flemingiastrum* DC. Baker (1876) reported five subgenera, namely *Chalaria* (Wight & Arn.) Baker, *Flemingiastrum* (DC.) Baker, *Lepidocoma* (Jungh.) Baker, *Ostryodium* (Desv.) Baker and *Rhynchosioides* Baker. Prain (1897) used only subg. 1. *Ostryodium* Desv. but then refers to "this section" in the following sentence of his publication, and refrains from further generic subdivisions, but maintains the species numbers as used by Baker (1876). Mukerjee (1953) treated these subgenera as sections and reported 26 species and seven varieties from India and Burma. As of now 28 species and one variety have been reported from India (modified after Gavade et al. 2019).

Flemingia shrubs or herbs can be easily recognized by a combination of characters such as unifoliolate or trifoliolate leaves, gland-dotted beneath blades, winged or grooved petiole, stipels and rachis absent, flowers in racemes or capitula, 5-toothed calyx, small and turgid pod with 1 or 2 rounded or ellipsoid seeds. As the genus is an important genetic resource, taxonomic revision is needed (Lewis et al. 2005). The present piece of work is an outcome of the taxonomic study conducted for more than nine years by the authors (Lekhak et al. 2011; Van der Maesen 2012; Gavade and Lekhak 2015; Gavade et al. 2016a, 2016b, 2017).

A revision of the subgenus *Rhynchosioides* has already been published (Gavade et al. 2019) and hence is not a part of the present publication. We follow Baker (1876) and consequently treat infrageneric taxa as subgenera. Various authors considered these as sections (Bentham 1865; Mukerjee 1953). Van der Maesen (1986) used sections in *Cajanus*. The present revision comprises taxonomic accounts of all the taxa in the genus *Flemingia* as presently reported in India except those in subgenus *Rhynchosioides* Baker. Descriptions, line illustrations and photoplates are provided here. The nomenclature for the all taxa has been resolved and results in lectotypification of twelve binomials (*F. angustifolia*, *F. blancoana*, *F. chappar*, *F. congesta*, *F. grahamiana*, *F. latifolia*, *F. macrophylla*, *F. nudiflora*, *F. paniculata*, *F. stricta*, *F. wallichii* and *F. wightiana*) and one trinomial (*F. praecox* var. *robusta*) as per the rules of ICN (Turland et al. 2018). A taxonomic key for easy identification of all taxa is also provided.

MATERIALS AND METHODS

This taxonomic account is based on the examination of plant materials collected from different parts of the country during 1975-1984* and 2012-2018, and the specimens housed at various herbaria (A*, ARUN, ASSAM, B*, BAMU, BARO, BK*, BKF*, BLAT, BM*, BNRH*, BR*, BRI*, BSA, BSD, BSHC, BSI, BSID, C*, CAL, CALI, DD, E*, G*, GH*, HBG*, ICRISAT*, JCB, K*, KFRI, L*, LE*, LD*, LINN*, LIV, LWG*, LY*, M*, MEL*, MH, N*, OXF*, P*, PBL*, PE*, RHT, S*, SBT*, SUK, TBGT, TCD*, US*, WII and the herbaria of Goa University, Goa; the University of North Bengal, New Jalpaiguri, West Bengal and the North-Eastern Hill University, Shillong, Meghalaya). The specimens of the herbaria marked with an asterisk * were loaned and studied by the second author. Live material is being maintained in the Botanic Garden, Shivaji University, Kolhapur. The recent voucher specimens of the collected species have been deposited in the Shivaji University Herbarium (SUK), Kolhapur, India. The detailed descriptions were made following the terminology of Hickey and King (2000). Blank maps were

made by using DIVA-GIS software (Hijmans et al. 2001). Details of location legends, symbols were added in the map using Adobe Photoshop 7.0.

HISTORY OF THE GENUS

The generic name *Flemingia* (Leguminosae) was validly published in Hortus Kewensis (Aiton 1812) with six species (*F. congesta* Roxb., *F. lineata* (L.) W.T.Aiton, *F. nana* Roxb., *F. semialata* Roxb., *F. stricta* Roxb. and *F. strobilifera* (L.) W.T.Aiton). Kuntze (1891) proposed a new name *Moghania* J.St.-Hil. for Roxburgh's plants named *Flemingia*. However, many workers did not follow that proposed name. Li (1944) published an article which proved that the name *Moghania* is the valid name for Roxburgh's genus *Flemingia*, a leguminous plant. He stated that "the name *Flemingia* was used by Roxburgh thrice, the name first appearing, in each case, in the works of another author. He used the name first in 1803, *Flemingia* Roxb. ex Rottler, neue Schrift. Ges. Naturf. Fr. 4: 202. 1803, accompanied by an ample description; this is placed as a synonym of *Thunbergia* Retz. of the Acanthaceae. He used the name a second time in 1812: *Flemingia* Roxb. ex W.T.Aiton, Hort. Kew. Ed. 11, 4: 349 (1812), and this has since been recognized and used by most authors for the leguminous genus under discussion. The name was again used, *Flemingia* Roxb. ex Wall. List No. 4361 (1831), in the synonymy of the gentianaceous *Canscora diffusa* (L.) R.Br., appearing as *Flemingia virgata* Herb. Roxb.; there was no description. A fourth homonym of this same generic name is *Flemingia* Hunter, proposed in 1802 or 1803, but not published until 1909, when unfortunately, Ridley in publishing Hunter's old manuscript did not eliminate the Hunterian new names. This *Flemingia* of Hunter from Penang represents a rubiaceous group and according to Ridley is apparently a synonym of *Webera* Schreb. (1791) = *Tarenna* Gaertn. (1788). Rottler's publication of *Flemingia* Roxb. in 1803 clearly invalidates Aiton's publication of the second and different *Flemingia* Roxb. (1812). Finally, Rudd (1970) proposed to conserve the commonly used and validly published name *Flemingia* Roxb. ex W.T.Aiton in the 12th International Botanical Congress (IBC) held in Leningrad, Russia (then Soviet Union) in 1975. Her proposal got accepted and conserved in 1973 (Voss 1973).

SYSTEMATIC TREATMENT

Flemingia Roxb. ex W.T.Aiton, Hort. Kew., ed. 2, 4: 3. 1812
Type: *Flemingia strobilifera* (L.) W.T.Aiton

Bas.: *Hedysarum strobiliferum* L.

Roxb., Pl. Coromandel 3(3): 44. t. 248. 1820; Roxb., Fl. Ind. 3: 337. 1832; Wight & Arn. Prodr. Fl. Ind. Orient. 1: 241. 1834; Wight, Icon. Pl. Ind. Orient. 1(1): 14, t. 267. 1840; Benth. in Pl. Jungh. 2: 244. 1852; Dalzell & A. Gibson, Bombay Fl. 75. 1861; Benth. Fl. Austral. 2: 269. 1864; Baker, in Hook. f., Fl. Brit. India 2: 227. 1876; Kurz, Forest Fl. Burma 2: 370. 1877; Prain in J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 69(2): 436. 1897; Prain, Bengal Pl. 1:375. 1903; T. Cooke, Fl. Bombay 2: 389. 1902; Talbot, For. Fl. Bombay 1:417. 1909; Haines, Bot. Bihar Orissa 3: 267. 1922; Gamble, Fl. Madras 1: 376. 1928; Sanjappa, Legumes of India 175. 1992; Saxena & Brahman, Fl. Orissa 1: 524. 1994. Kothari in N.P. Singh et al., Fl. Maharashtra, Dicot. 2, 683. 2001.

(=) *Flemingia* Roxb. ex Rottler, Neue Schriften Ges. Naturf. Freunde Berlin iv. 202. 1803, *nom. rej.*
Type: *Flemingia grandiflora* Roxb. ex Rottler, *nom. illeg.*

(=) *Flemingia* W.Hunter ex Ridl., J. Straits Branch Roy. Asiat. Soc. 53: 83. 1909, *nom. illeg.*
Type: *Flemingia fragrans* W. Hunter ex Ridl.

(=) *Luorea* Neck. ex J.St.-Hil. in Nouv. Bull. Sci. Soc. Philom. Paris iii. No. 63: 193. 1812, *nom. rej.*
Type: not typified.

(=) *Maughania* J.St.-Hil., Nouv. Bull. Sci. Soc. Philom. Paris 3(64): 216. 1813.
Type: not typified.

(≡) *Ostryodium* Desv., J. Bot. Agric. 3: 119, t. 4. 1814.

Description

Erect herbs or shrubs, undershrubs or decumbent herbs up to 0.4–3.2 m tall, with branched stem; stems 2–40 mm in diameter, triangular when young, terete when mature, gland-dotted, hairy; hairs antrorse. Leaves unifoliolate or trifoliolate, 2–52 cm long, stipulate, petiolate; stipules 2, fused or separate 0.5–10 × 0.2–2.5 cm, straight or slightly falcate, acuminate with equal tips, persistent or caducous, basifixed, many nerved, gland-dotted, hairy; petioles 0.3–55 cm long, grooved or winged, gland-dotted, hairy; leaflets 1–3, 1.5–30 × 1–11 cm, ovate–lanceolate or linear–lanceolate or oblong–lanceolate or obovate–rounded, middle leaflets rounded or cordate or cuneate at base, lateral leaflets asymmetrical or oblique at base, apex acute or acuminate or obtuse, glabrous or hairy, dorsally gland-dotted; glands minute, orange-red, or black; petiolules 1–8 mm long, hairy,

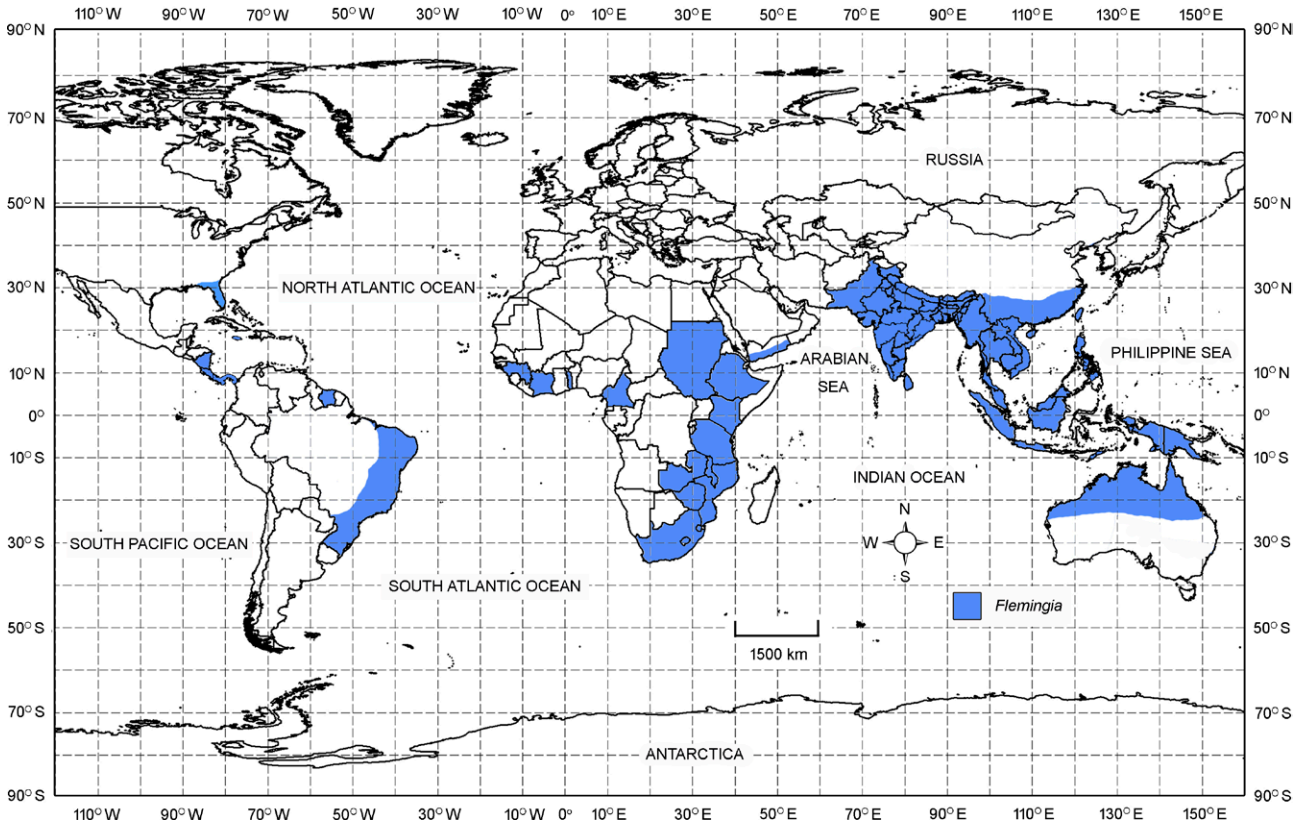
gland-dotted. Inflorescences solitary or geminate or axillary and terminal racemes or lax racemes or raceme comprising small cymes of 2–3 flowers enclosed by membranous bracts, in two series or capitulum or geminate. Flowers 6–17 mm long, pedicellate, bracteate; pedicels 1–3 mm long, hairy; bracts 1.6–2.8 × 2.2–4.2 cm, reniform, acute at apex, many nerved, papery, hairy, gland-dotted or ovate to lanceolate or rounded 0.4–16 × 2.5–3 mm; exterior bracts absent or present, small 2–2.2 × 1–1.2 mm, lanceolate, persistent. Calyx 4.5–11.5 mm long, hairy, gland-dotted; calyx tube 1–6.5 mm long, campanulate, hairy, gland-dotted; calyx teeth 5, 3–6 × 1–3 mm, linear to lanceolate, acute at apex, equal or subequal, lower one the longest, connate for 1/2–1/5 of its length, many nerved, hairy, gland-dotted. Corolla white, pink to purple, with pink or reddish striations; standard 5–15 × 4–15.5 mm, rounded, cordate, obovate, apex retuse, rounded, glabrous or hairy; clawed with 2 auricles; claw 1–2.5 mm long; auricle l–2 mm long or less than 1 mm; wing petals 5–13 × 1–5 mm, oblong, slightly falcate, hairy or glabrous, gland-dotted or without glands; claw 1.5–4.5 mm long; keel petals, 7–14 × 2–4 mm, boat-shaped, slightly falcate, fused at apex at lower side; claw 1.5–5.5 mm long. Stamens 10, diadelphous (9+1); staminal tube 3–6 × 1 mm; anthers uniform, less than 1 mm long, basifixed, filaments of united stamens 1–4.5 mm long, that of free stamens 4–11 mm long. Ovary 1.5–2 × 1 mm, hairy, gland-dotted; ovules 1 or 2; style 4–8.5 mm long, glabrous, swollen at middle; stigma globose, hairy. Fruits a pod, 6–17 × 4–7.5 mm, beaked, turgid, slightly septate between seeds or not, hairy, sparsely or densely gland-dotted; beak 1 mm long; glands orange-red or black or white (mealy), withering or disappearing post maturity. Seeds 1–2, 2.8–4 × 2–4 × 2–3 mm, rounded or ellipsoid, mottled or brown or black shiny; hilum granular, 1 mm long, position ± central.

Etymology

The generic name 'Flemingia' is after Dr. John Fleming (1747–1829), Roxburgh's friend and colleague, who compiled the Catalogue of Indian medicinal plants and drugs (Hindustani Press, Calcutta 1810).

Distribution

Flemingia is an old world genus. A few species occur in Africa: Burkina Faso, Cameroon, Ethiopia, Gam-



Map 1. Distribution of the genus *Flemingia*.

bia, Ghana, Guinea, Guinea Bissau, Ivory Coast, Kenya, Malawi, Mali, Mozambique, Senegal, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zaire, Zambia and Zimbabwe. Most species originate in Asia: Bangladesh, Bhutan, Brunei, Cambodia, China (provinces Fujian, Guangdong, Guangxi, Guizhou, Hainan, Hubei, Hunan, Jiangxi, Sichuan and Yunnan), East Timor, India (Andaman and Nicobar Islands, Andhra Pradesh, Assam, Bihar, Chhattisgarh, Goa, Gujarat, Himachal Pradesh, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Nagaland, Rajasthan, Sikkim, Tamil Nadu, Telangana, Tripura, Uttar Pradesh, Uttarakhand and West Bengal), Indonesia (Irian Jaya, Java, Kalimantan, Lesser Sunda Islands, Moluccas, Sumatra), Laos, Malaysia (Peninsular Malaysia and Borneo), Myanmar, Nepal, Pakistan, Philippines, Japan (Ryukyu Islands), Sabah, Singapore, Sri Lanka, Taiwan, Thailand, Vietnam, Papua New Guinea. Australia: Northern Territory, Queensland and Western Australia. A few species were introduced on purpose or inadvertedly to the Americas: the Caribbean (Barbados, Cayman Islands, Dominican Republic, Haiti, Jamaica, St. Vincent, Trinidad and Tobago). Central America: Nicaragua and Panama. Also some species reached the Pacific Ocean area: Bismarck Archipelago, Northern Marianas, Society Islands and South America (Brazil and Surinam) (Map 1).

Flowering and fruiting

Most months of the year.

Habitat and ecology

Most of the herbaceous species (*Flemingia gracilis*, *F. mukerjeeana*, *F. nilgheriensis* and *F. rollae*) grows on high altitude lateritic plateaus, i.e. above 1000 m asl. *F. tuberosa* grows on low altitude plateaus, i.e. up to 300 m asl, whereas *F. vestita* occurs on hill slopes, i.e. up to 1500-3200 m asl. All the other species are mostly shrubby in nature and grow either in deep moist forests, Sal (*Shorea robusta*) forests, along water streams, or on hill slopes and along roadsides. Some species grow amid herbs and shrubs on grasslands while others occupy forest borders and shola (deep valley) forests.

Affinities

Flemingia is closely related to *Cajanus*, *Cylista*, *Dunbaria* and *Rhynchosia*. It differs from *Cajanus* and *Dunbaria* in having only 1–2 ovules in the ovary and from *Cylista* in non-accrescent calyx teeth and from *Rhynchosia* by the presence of a small rigid ellipsoid pod and winged or grooved petiole. A bracketed dichotomous taxonomic key is provided below for easy identification of the Indian taxa:

Key to the subgenera of **Flemingia** in India

1. Herbs, prostrate or erect with herbaceous or tuberous roots, leaves 3-foliolate, flowers in long-peduncled heads or corymbs ..... subgenus *Rhynchosioides* (see Gavade et al. 2019)

1. Shrubs, undershrubs, erect or prostrate with woody roots, leaves 1- or 3-foliolate, flowers in axillary racemes or short-peduncled heads 2

2. Leaves 1-3-foliolate, bracts entire, ovate, small, not enclosing the flowers 3

2. Leaves 1-foliolate, bracts folded, reniform, large, enclosing the small racemes with flowers..... subg. *Ostryodium*

3. Leaves 1-foliolate (except *F. lineata*) ..... subg. *Chalaria*

3. Leaves 3-foliolate 4

4. Inflorescences in axillary racemes..... subg. *Flemingiastrum*

4. Inflorescences in dense globose heads .....subg. *Lepidocoma*

Flemingia subg. **Chalaria** (Wight & Arn.) Baker

Flemingia subg. *Chalaria* (Wight & Arn.) Baker in Hook f. Fl. Brit. India 2: 227. 1876.
Type: *Flemingia lineata* (L.) W.T. Aiton. (Map 2).

Erect shrubs, undershrubs, leaves simple or trifoliolate, bracts minute, caducous, flowers in lax panicled racemes, flowering axes visible.

Key to the species of subg. **Chalaria**

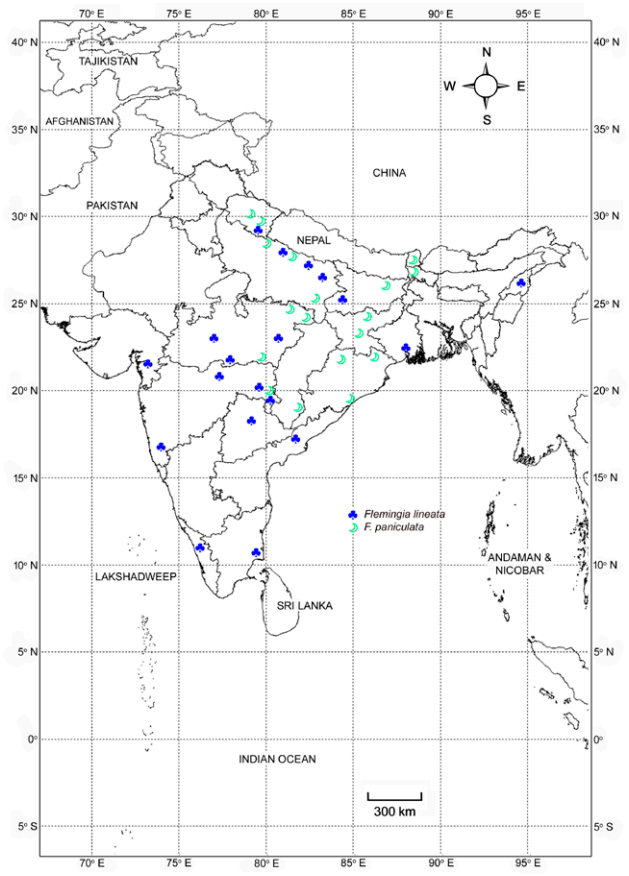
1. Leaves 1-foliolate ..... *F. paniculata*

2. Leaves 3-foliolate ..... *F. lineata*

Flemingia lineata (L.) W.T.Aiton, Hortus Kew., ed. 2. 4: 350. 1812

Bas.: *Hedysarum lineatum* L., Syst. Nat., ed. 10. 2: 1170. 1759.
Type: (Herb. Linn. 3 11.17 (S-G-10429 image!). Lectotype designated by Schrire (1997: 471).

Roxb., Fl. Ind. 3: 341. 1832; Wight & Arn., Prodr. Fl. Ind. Orient. 1: 242. 1834; Wight, Icon. Pl. Ind. Orient. 2(1): 1, t. 227. 1843; Benth. in Miquel, Pl. Jungh. 2: 245. 1852; Baker in Hook. f., Fl. Brit. India 2: 228. 1876; Kurz, Forest Fl. Burma 2: 372. 1877; Prain in J. Asiat. Soc. Ben-



Map 2. Distribution of subgenus *Chalaria* (Wight & Arn.) Baker in India.

gal, Pt. 2, Nat. Hist. 69(2): 438. 1897. Prain, Bengal Pl. 1: 377. 1903; T. Cooke, Fl. Bombay 2: 391. 1902; Gamble, Fl. Madras 1: 378. 1928; Sanjappa, Legumes of India 176. 1992; Saxena & Brahman, Fl. Orissa 1: 527. 1994. Kothari in N.P. Singh et al., Fl. Maharashtra, Dicot. 2: 686. 2001. (Figures 1, 23a, 24a, 25a and 26a).

(=) *Onobrychis lineata* Desv. J. Bot. Agric. 3: 80. 1814.
Type: not seen.

(=) *Flemingia blancoana* Llanos, Fragm. Pl. Filip. 80. 1851.
Type: Merrill, Sp. Blancoana (1918) 191, as topotype: Luzon, Bulacan Prov., Calumpit, s.d., *Blancoana 699* (lectotype designated here, L; isolectotype, W).

(≡) *Lespedeza lineata* (L.) Pers., Syn. Pl. 2(2): 318. 1807.

(≡) *Maughania lineata* (L.) Kuntze Revis. Gen. Pl. 1:199. 1891; Mukerjee, Bull. Bot. Soc. Bengal 6(1): 14. 1953. (as *Moghania lineata*).

Description

Erect small shrubs, up to 0.3–0.4 m tall, with profuse branching; stems 2–3 mm in diameter, young triangular, mature terete, hairy; hairs silky, antrorse. Leaves digitately trifoliolate, 2.5–6.5 cm long, stipulate, petiolate; stipules 2, 8–9 × 2–2.5 mm, lanceolate, acuminate with equal tips, fused when young, splitting at maturity, persistent, basifixed, many nerved, hairy; petioles 0.6–1.7 cm long, grooved, not winged, gland-dotted, hairy; leaflets 3, 2–4.6 × 1–2.8 cm, obovate to lanceolate, obtuse at apex, the central cuneate at base, lateral oblique at base, margin ciliate, apex mucronate, sparsely hairy on both surfaces, densely hairy on nerves; dorsally gland-dotted, glands orange-red; petiolules 1–2 mm long, hairy, gland-dotted. Inflorescences an axillary panicle; panicles lax 2–4 cm long, longer than the petiole. Flowers 6–6.5 mm long, pedicellate, bracteate; pedicels 1–2 mm long, hairy; bracts 1.5–2 × 1–1.5 mm, ovate to lanceolate, acuminate at apex, many nerved, hairy, gland-dotted. Calyx 4.5–5 mm long, hairy, gland-dotted; calyx tube 1.8–2 mm long, campanulate, hairy; calyx teeth 5, 3–3.5 × 0.8–1 mm, lanceolate, subequal, lower one the longest, connate for 1/3 of its length, hairy, many nerved, gland-dotted. Corolla pinkish; standards 5–5.5 × 4–4.5 mm, rounded, apex pointed, glabrous, clawed with 2 auricles; claw 1–1.5 mm long; auricles 1 mm or less than 1 mm; wing petals 8–8.5 × 1.8–2 mm, falcate; claw 1.5–2 mm long; keel petals 5–5.5 × 2–2.5 mm, slightly falcate, fused at apex at lower side; claw 1–1.5 mm long. Stamens 10, diadelphous (9+1); staminal tube 3–3.5 × 1 mm, anthers uniform, less than 1 mm long, basifixed, filaments of united stamens 1–2 mm long, that of free stamens 4–4.5 mm long. Ovary 1.8–2 × 0.8–1 mm, gland-dotted, hairy; ovules 2; style 4–4.5 mm long, glabrous, swollen at middle; stigma globose, hairy. Fruits a pod, 12–14 × 6–7 mm, beaked, turgid, slightly septate between seeds or not, densely hairy, densely gland-dotted; beak 1 mm long; glands mealy, withering post maturity. Seeds 2, 4 × 3 × 2.5 mm, brown, mottled, shiny, rounded to elliptic; hilum granular, 1 mm long, position ± central.

Etymology

The specific epithet 'lineata' refers to the straight line-like veins of leaflets.

Distribution

Asia: Bangladesh, Cambodia, India (Andhra Pradesh, Bihar, Kerala, Madhya Pradesh, Maharashtra, Nagaland, Tamil Nadu, Telangana, Uttar Pradesh, Uttarakhand and West Bengal), Indonesia, Laos, Malay-

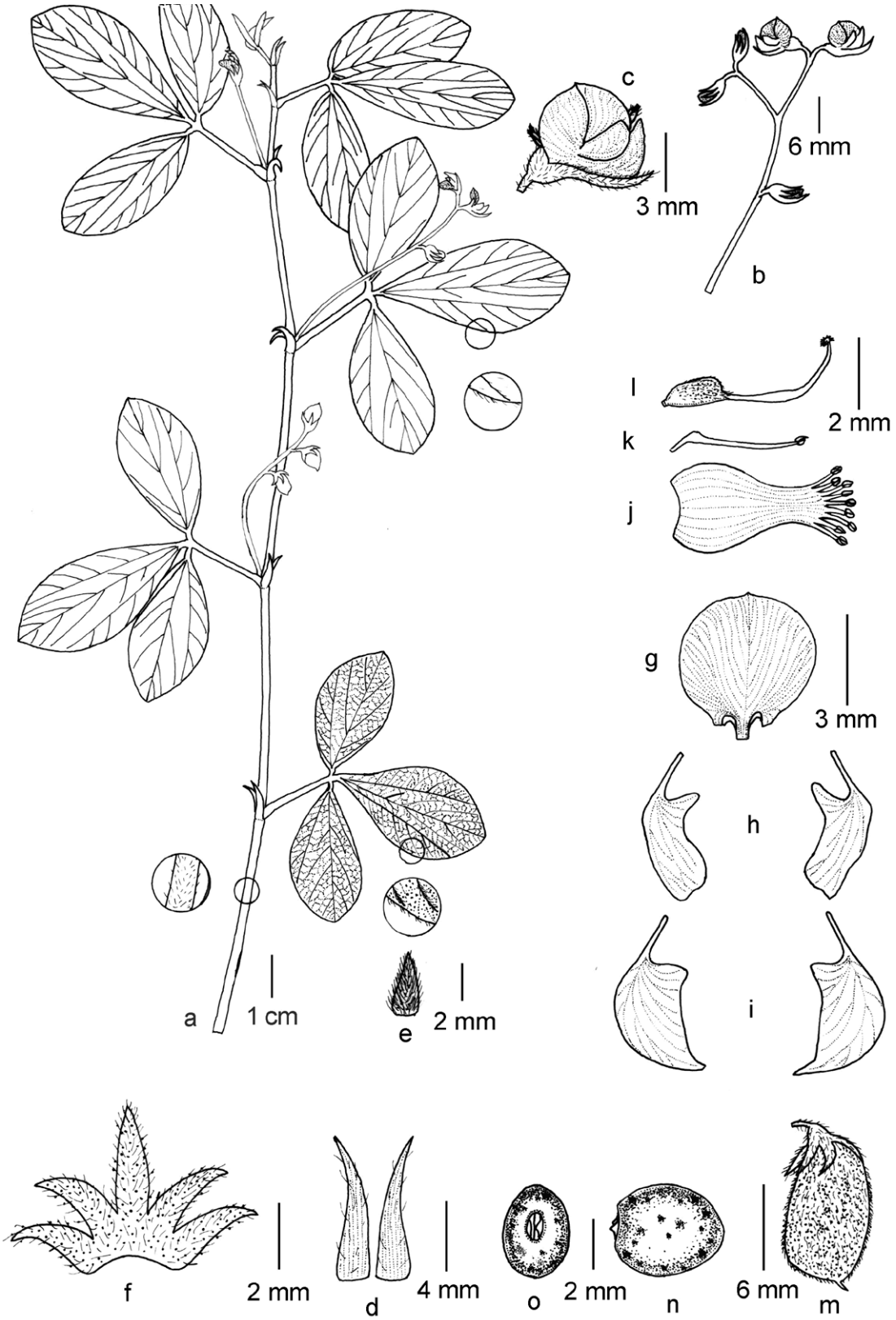


Figure 1. *Flemingia lineata* (L.) W.T.Aiton. (a) Habit. (b) Inflorescence. (c) Flower. (d) Stipules. (e) Bract. (f) Calyx, dorsal view. (g) Standard. (h) Wing petals. (i) Keel petals. (j) Fused androecium. (k) Free stamen. (l) Gynoecium. (m) Fruit. (n) Seed, lateral view. (o) Seed, dorsal view.

sia, Myanmar, Sri Lanka, Thailand, Vietnam. Australia: Northern Territory, Queensland, West Australia.

Flowering and fruiting

November to March.

Habitat and ecology

Flemingia lineata is found on open grasslands at low altitudes of ca. 500–750 m asl. It grows in association with *Alternanthera tenella* Colla, *Argemone mexicana* L., *Chrozophora rottleri* (Geiseler) Spreng., *Crotalaria prostrata* Rottler, *Gliricidia sepium* (Jacq.) Kunth, *Iphigenia pallida* Baker, *Ledebouria revoluta* (L.f.) Jessop and *Polygala arvensis* Willd.

Selection of specimens examined

BANGLADESH: Sylhet, s.d., *F. De Silva s.n., Wallich Catalogue Number 5752g* (BR, K001122011); s.d., *J.G. Koenig s.n.* (LD1739365); *J.G. Koenig s.n.* (LD1740773). **INDIA**: s.d., *N.A. Dalzell s.n.* (CAL, DD); *C.L. Willdenow s.n.* (B-W 13780-020); s.d., W. Roxburgh, Wallich Catalogue Number 5752a (K001122005); s.d., *R. Wight s.n., Wallich Catalogue Number 5752i* (K001122008); 5 February 1809, *s.coll. s.n., Wallich Catalogue Number 5752c* (K001122007); Andhra Pradesh, East Godavari district, February 1885, *J.S. Gamble 16057* (CAL, MH); Bihar, Bhojpur district, Jaugarh, 16 December 1948, *H.F. Mooney 3166* (DD); 27 January 1949, *H.F. Mooney 3161a* (DD); Gujarat, Surat district, Varachha, 2 October 1977, *J.V. Joshi 423* (BARO); Kerala, Malabar, Concan region, 1860, *J.E. Stocks & J.S. Law s.n* (CAL,W); Madhya Pradesh, Betul district, Mohta, 6 February 1891, *J.F. Duthie 10374* (DD); Jabalpur district, Jabalpur, March 1902, *R.S. Hole 126* (CAL, DD); Sehore district, Budhni, 18 February 1905, *E. Moyes 261* (CAL); Maharashtra, Amravati district, Melghat, *Roger s.n.* (CAL); Chandrapur district, Ashriti, 6 January 1890, *J.F. Duthie 9407* (DD); 15 January 1890, *J.F. Duthie 9407* (DD); Ballarpur, 29 December 1889, *J.F. Duthie 9407* (DD); Gadchiroli district, Venkatapur, 15 January 1890, *J.F. Duthie 9407* (DD); 19 January 1890, *J.F. Duthie 9407* (DD); Jalgaon district, Bhusawal, 2 January 1917, *E. Blatter 10542* (BLAT, BSI); Kolhapur district, Shivaji University campus, Lead Botanic Garden, 29 March 2015, *S.K. Gavade 37* (SUK); 22 February 2016, *S.K. Gavade 130* (SUK); 6 February 2017, *S.K. Gavade & M.M. Lekhak 189* (SUK); Mumbai Suburban district, Bhandup, 19 November 1916, *s.coll. 11290* (BLAT); Nagaland, Naga Hills, s.d., *F. Kingdon-Ward 11262* (BM, CAL); Northern Madras Presidency, s.d., *P. Russell s.n.* (K001122009); Tamil Nadu, Nagapattinam district, Tharangambadi, s.d., *Anon. 181* (LINNHS1210-53-2); Telangana, Karimnagar district, Eklaspur, 31 December 1964, *G.V. Subbarao 22523* (MH); Uttar Pradesh, Bahraich district, Katarniaghat Wildlife Sanctuary, 9 December 1986, *K.K. Khanna & R. Saran 37679* (BSA, CAL); Uraital, 14 February 1965, *O.P. Misra 7992* (BSA); *G. Panigrahi 7992* (CAL); Balrampur district, Balrampur, February 1898, *Inayat Khan 20965* (DD); Lakhimpur Kheri district, Palia Kalan, 14 May 2006, *B.K. Shukla 66135* (BSA); Sant Kabir Nagar district, Maghar, 16 March 1814, *F. Buchanan-Hamilton s.n., Wallich Catalogue Number 5752h* (K001122012, K); Uttarakhand, Udham Singh Nagar district, Pantnagar, 11 April 2009, *D.S. Rawat 605* (BSA); West Bengal, Howrah district, Acharya Jagadish Chandra Bose Indian Botanic Garden, 15 December 1965, *R.L. Mitra 433* (CAL); 7 January 1815, *F. Buchanan-Hamilton, Wallich Catalogue Number 5752b* (K001122006); s.d., *s.coll. s.n., Wallich Catalogue Number 5752f* (K001122010).

Affinities

Flemingia lineata shows close resemblance to *F. procumbens* but differs from it in having upright stature, lax panicle, sparsely hairy leaflets and pods with mealy glands.

Taxonomic notes

Flemingia lineata was described by Linnaeus (1759) as *Hedysarum lineatum* L. in his 'Systema Naturae'. Persoon (1807) transferred this taxon from *Hedysarum* to *Lespedeza* Michx. and made a new combination *L. lineata* (L.) Pers. Aiton (1812) transferred *Lespedeza lineata* to *Flemingia*.

Nomenclatural notes

Linnaeus (1759), while describing *H. lineatum*, mentioned that he used Burmann's specimen. We could find the lectotype of *F. lineata* in S (Schrire 1997). In India all *F. lineata* concerns the var. *lineata*, elsewhere the other variety may occur: var. *glutinosa* Prain, from Myanmar to Australia.

Flemingia paniculata Wall. ex Benth. in Miquel, Pl. Jungh. 2: 245. 1852

Type: Myanmar, Ataran river, 29 January 1827, *N. Wallich, Wallich Catalogue Number 5759* (lectotype designated here, K001122038 image!); Myanmar, Ataran river, 11 March 1827, *N. Wallich, Wallich Catalogue Number 5759* (G, K001122037 image K!, syntypes); s.d., *N. Wallich, Wallich Catalogue Number 5759* (BM000958663 image!, syntype); India, Uttar Pradesh, Gorakhpur, 28

March 1814, F. Buchanan-Hamilton s.n., *Wallich Catalogue Number 5758* (K, K001122036 image!, syntypes).

Baker, in Hook. f., Fl. Brit. India 2: 22. 1876; Kurz, Forest Fl. Burma 2: 372. 1877; Prain, Bengal Pl. 1: 377. 1903; Haines, Bot. Bihar Orissa 3: 268. 1922; Babu, Herbac. Fl. Dehra Dun 149. 1977; Sanjappa, Legumes of India 177. 1992; Saxena & Brahman, Fl. Orissa 1: 530. 1994. (Figures 2, 23b, 24b, 25b and 26b).

(≡) *Maughania paniculata* (Wall. ex Benth.) H.L. Li, Amer. J. Bot. 31. 227. 1944; Mukerjee, Bull. Bot. Soc. Bengal 6(1): 14. 1953. (as *Moghania paniculata*).

Flemingia phursia Buch.-Ham. ex Wall., Numer. List n. 5758. 1831, *nom. nud.*

Maughania phursia Kuntze, Revis. Gen. Pl. 1: 199. 1891, *nom. nud.*, (as *Moghania phursia*).

Description

Erect shrubs, up to 0.8–1.5(-2) m tall, with branched stem; stems 5–10 mm in diameter, terete, hairy; hairs silky, antrorse. Leaves unifoliolate, 6–30 cm long, stipulate, petiolate; stipules 2, 8–9 × 2.5–3 mm, lanceolate, acuminate with equal tips, fused when young, splitting at maturity, caducous, basifixed, many nerved, hairy; petioles 3–6 cm long, grooved, hairy, gland-dotted; leaflet 1, 5–25 × 3.5–11 cm, broadly ovate, rounded or cordate at base, apex acuminate, glabrous on ventral surface, dorsally hairy, gland-dotted; glands orange-red; petiolules 3–6 mm long, hairy, gland-dotted. Inflorescences an axillary and terminal lax panicles, 4–8 cm long. Flowers 1.2–1.3 cm long, pedicellate, bracteate; pedicels 3–3.5 mm long, hairy; bracts 2.5–3 × 3.5–4 mm, ovate, acute at apex, many nerved, hairy, gland-dotted. Calyx 9–9.5 mm long, hairy, gland-dotted; calyx tube 1.5–2 mm long, campanulate, hairy; calyx teeth 5, 7.5–8 × 2–2.5 mm, lanceolate, subequal, lower one the longest, connate for 1/4 of its length, many nerved, hairy, gland-dotted. Corolla pale green with pink striations; standard 9–10 × 9–10 mm, rounded, apex retuse, glabrous, clawed with 2 auricles; claw 1.5–2 mm long; auricles 1 mm or less than 1 mm; wing petals 8–8.5 × 2–2.5 mm, oblong; claw 1.5–2 mm long; keel petals 7.5–8 × 3.5–4 mm, boat shaped, fused at apex at lower side; claw 1.5–2 mm long. Stamens 10, diadelphous (9+1); staminal tube 4.5–5 × 1 mm, anthers uniform, less than 1 mm long, basifixed, filaments of united stamens 2.5–3 mm long, that of free stamens 6.5–7 mm long. Ovary 2–2.2 × 1 mm, gland-dotted, hairy; ovules 2; style 5–6 mm long, glabrous, swollen at middle; stigma globose, hairy. Fruits a pod, 18–22 × 6–7.5 mm, beaked, turgid, slightly septate between seeds or not, hairy, sparsely gland-dotted; beak 1 mm long; glands orange-red, withering post maturity. Seeds 2, 3.5 × 3.5 × 2.5 mm, rounded, mottled, shiny; hilum granular, 1 mm long, position ± central.

Etymology

The specific epithet 'paniculata' refers to the paniculate type of inflorescence.

Distribution

Asia: Bangladesh, China (Yunnan), India (Chhattisgarh, Jharkhand, Madhya Pradesh, Maharashtra, Orissa, Sikkim, Uttar Pradesh, Uttarakhand and West Bengal), Myanmar, Thailand, Vietnam.

Flowering and fruiting

February to March.

Habitat and ecology

Flemingia paniculata grows on hill slopes in damp forests at altitudes of ca. 700–800 m asl, outside India up to 1600 m. It grows in association with *Arthraxon lancifolius* (Trin.) Hochst., *Bauhinia macrophylla* Poir., *Bidens pilosa* L., *Colebrookea oppositifolia* Sm., *Dillenia pentagyna* Roxb., *Dioscorea pentaphylla* L., *D. pubera* Blume, *Globba racemosa* Sm., *Leea asiatica* (L.) Ridsdale, *Leucas decemdentata* (Willd.) Sm., *Oplismenus compositus* (L.) P.Beauv and *Smilax zeylanica* L.

Selection of specimens examined

INDIA, Bihar, Supaul district, Gaunha, 12 March 1955, *J.G. Srivastava 20098* (LWG); Chhattisgarh, Bastar district, Kotumsar, s.d., *A.N. Singh s.n.* (BSA); 19 February 1963, *G. Panigrahi & C.M. Arora 1183* (BSA); *G. Panigrahi 1183* (CAL); on the way to Darba, 11 February 1961, *N.P. Balakrishnan & A.N. Henry 12063* (MH); Surguja district, Sabag, 21 February 1976, *G. Sen Gupta 24098* (BSA); Jharkhand, Chota Nagpur region, 1886, *A. Campbell s.n.* (DD); Giridih district, Parasnath hills, April 1886, *A. Campbell 8278* (CAL); 20 September 2002, *V. Rajan & K.L. Maity 31723* (CAL); 19 March 2005, *V. Rajan & K.L. Maity 37844* (CAL); Hazaribagh district, Hazaribagh, 10 April 1884, *C.B. Clarke 3460d* (CAL); Madhya Pradesh, Seoni district, December 1914, *D.O. Watt 40* (DD); Karmajhiri, 19 March 1978, *L.K. Banerjee 28224* (BSA); Rewa district, Kanhaiya, 28 January 1971, *G. Sen Gupta 14419* (BSA); Sidhi district, Jir, 28 February 1917, *G. Sen Gupta 14694* (BSA); Maharashtra, Gadchiroli district, Goth, 4 April 2015, *S.K. Gavade & V. Kahalkar 40* (SUK); 1 February 2017, *S.K. Gavade 182*

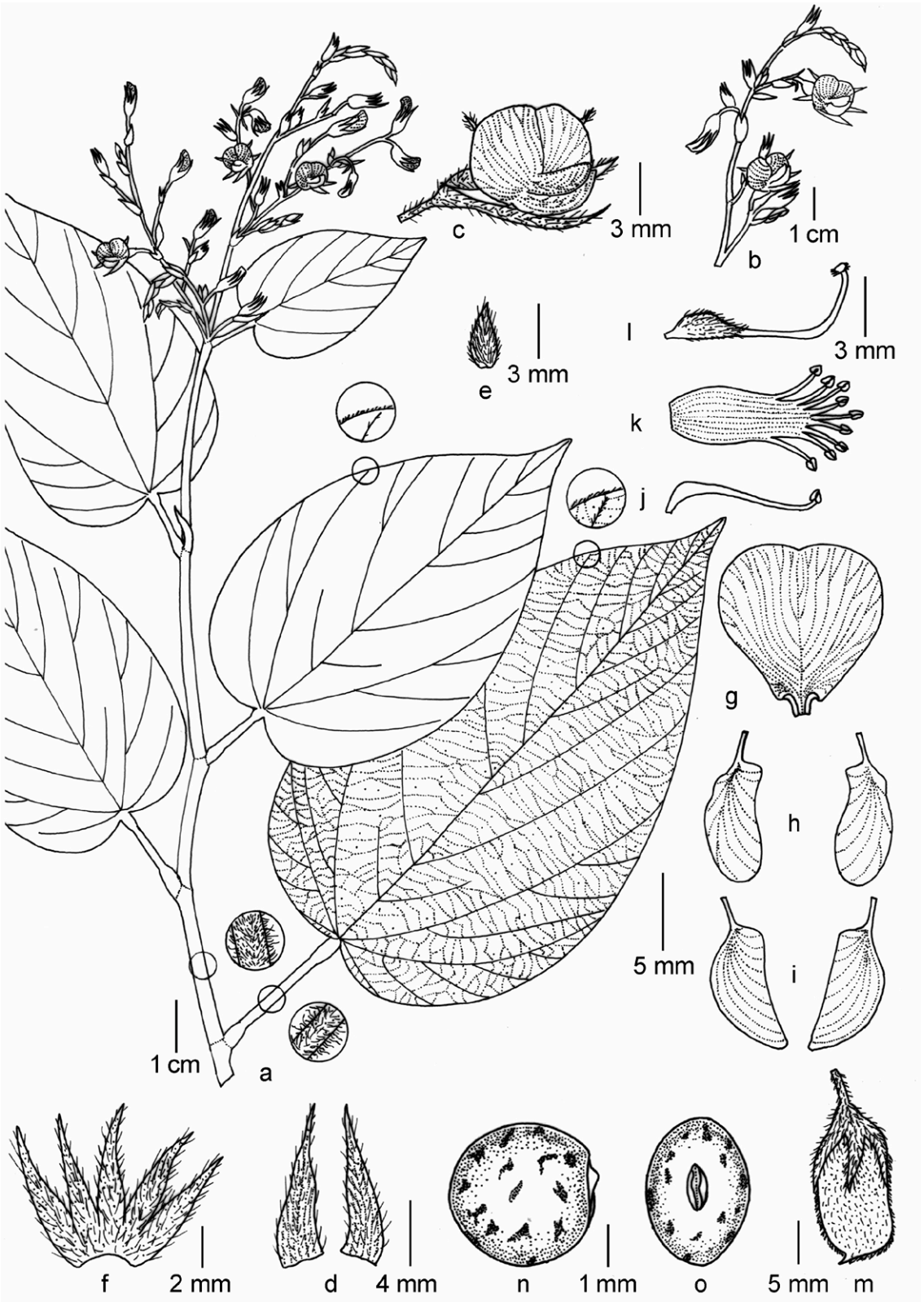


Figure 2. *Flemingia paniculata* Wall. ex Benth. (a) Habit. (b) Inflorescence. (c) Flower. (d) Stipules. (e) Bract. (f) Calyx, dorsal view. (g) Standard. (h) Wing petals. (i) Keel petals. (j) Free stamen. (k) Fused androecium. (l) Gynoecium. (m) Fruit. (n) Seed, lateral view. (o) Seed, dorsal view.

(SUK). Odisha, Ganjam district, Bhanjanagar, 2 March 1964, *S.L. Kapoor & party 63194* (LIV, LWG); Mayurbhanj district, Bhanjabasa, 13 February 1958, *G. Panigrahi 12298* (CAL); on the way to Bakua to Simlipal, 17 February 1985, *G. Panigrahi 12516* (CAL); Sambalpur district, Badrama, 24 March 1964, S.L. Kapoor & party 71378 (LWG); Sikkim, Gok, 10 March 1919, *G.H. Cave s.n.* (E, G); Rangeet river, 14 March 1876, *C.B. Clarke 27335C* (CAL); *127335g* (BM); East Sikkim, Rangpo, 24 February 1909, *Kari 508* (CAL); Uttar Pradesh, Bahraich district, Rampurwa, 15 March 1964, *G. Panigrahi 2904* (BSA); Bulandshahr District, Dharampur, 15 March 1964, *G. Panigrahi & O.P. Misra 2904* (CAL); Lakhimpur Kheri district, 25 March 1921, *S. Ram s.n.* (DD); 4 April 1898, *Inayat Khan 21505* (DD, K); Salukapur, 19 March 1980, *J.K. Maheshwari & party 400* (LWG); Lalitpur district, Madanpur, 23 September 1920, *S. Ram s.n.* (DD); Varanasi district, Ramnagar, Sitabani, 20 February 1922, *A.R. Osmaston 1180* (DD); Uttarakhand, Almora district, Someswar hills, 13 April 1963, *K. Thothathri 10046* (CAL); Dehradun District, Lacchiwalla, April 1901, *U. Kanjilal 912* (DD); 26 April 1901, *U. Kanjilal s.n.* (CAL); Rispana, 31 January 1965, *C.R. Babu 33862* (BSD); Hardwar district, Mohand, 10 April 1994, *K.K. Singh & A. Kumar 215770* (LWG); West Bengal, Darjeeling district, Darjeeling, 29 May 1962, *R.V. Sitholay 71321* (LWG); Kolkata district, Kolkata, s.d., *J.W. Helfer 69* (A, BM, BR, C, G, US, WAG); *J.W. Helfer 138* (CAL); Maldah district, Karja Danga, 27 April 1966, *R.M. Datta 225* (CAL).

Affinities

Flemingia paniculata looks like *F. chappar*, but differs from it in the absence of papery folded bracts, its paniculate inflorescence and ovate leaf blades.

Taxonomic note

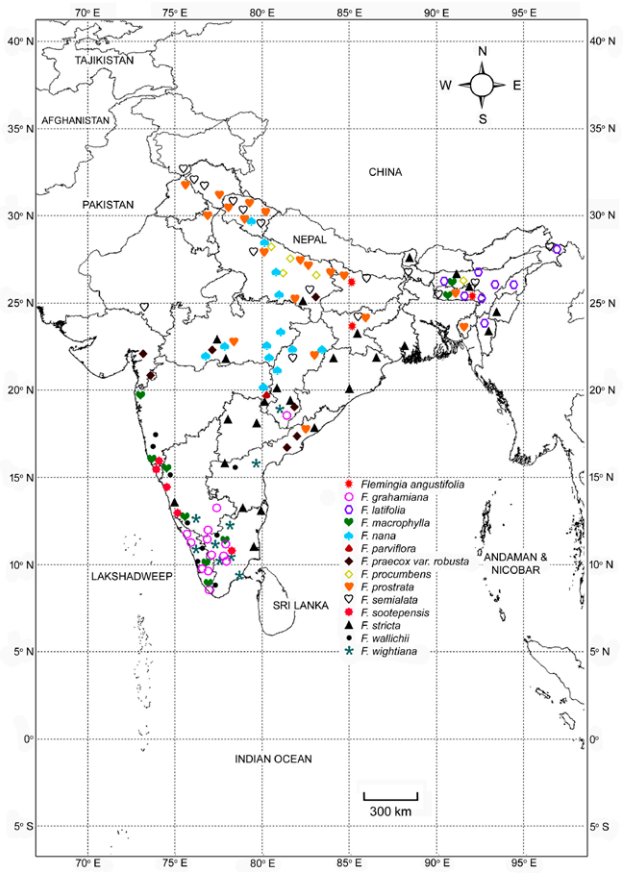
It is a very distinct species with unifoliolate leaves.

Nomenclatural notes

The binomial *F. paniculata* was proposed by Wallich (1831) and validly published by Bentham (1852) in Miquel's 'Plantae Junghuhnianae'. In the protologue Bentham cited Wallich Catalogue Number 5759 and *F. phursia* as synonym along with Wallich Catalogue Number 5758. In the search of type specimen, we could trace two sheets bearing Wallich Catalogue Number 5759 at K and one at BM (BM000958663). One of the sheets at K has two separate twigs with different barcodes (K001122037 and K001122038). The other sheet bears Wallich Catalogue Number 5758 (K001122036). The sheet at BM bears Wallich Catalogue Number 5759. The specimens with barcodes K001122037 and K001122038 were collected by Wallich from Ataran river, Myanmar, on different dates (Wallich 1831). The BM specimen was collected by Wallich from Ataran river, Myanmar but it bears no collection date (Wallich 1831). All these specimens serve as syntypes. As per articles 9.11 and 9.12 of Shenzhen Code (Turland et al. 2018), we selected and designated here the specimen K001122038 which matches well with the description given in the protologue as lectotype.

Flemingia subg. **Flemingiastrum** (DC.) Baker
Flemingia subg. *Flemingiastrum* (DC.) Baker, in Hook. f. Fl. Brit. India 2: 228. 1876. (Map 3).

Type: *Flemingia stricta* Roxb.
Erect (under-) shrubs, leaves trifoliolate, stipules caducous or persistent, flowers in axillary racemes, bracts small or large, axes not or hardly visible.



Map 3. Distribution of subgenus *Flemingiastrum* (DC.) Baker in India.

Key to the species of subg. **Flemingiastrum**

1. Leaflets linear, oblong or lanceolate, longer than 1.8 cm .. 2
1. Leaflets obovate, small, shorter than 1.8 cm 13
2. Leaflets twice as long as broad 3
2. Leaflets thrice as long as broad 10
3. Abaxial side of leaflets hairy 8
3. Abaxial side of leaflets glabrous 4
4. Stipules small, up to 2.6(-4) x 0.4(-0.5) cm; bracts shorter than flowers 5
4. Stipules large, up to 10 x 2.5 cm; bracts longer than flowers ..... *F. stricta*
5. Racemes longer than the petiole; petiole winged 6
5. Racemes shorter than the petiole; petiole grooved ..... *F. macrophylla*
6. Pod sparsely gland-dotted 7
6. Pod densely gland-dotted ..... *F. sootepensis*
7. Stipules, bracts and calyx grey tomentose, leaflets narrow-ovate-elliptic ..... *F. semialata*
7. Stipules, bracts and calyx conspicuously rusty tomentose, leaflets broad-ovate ..... *F. latifolia*
8. Pods not included within the calyx 9
8. Pods included within the calyx ..... *F. wallichii*
9. Stipules persistent ..... *F. grahamiana*
9. Stipules caducous ..... *F. wightiana*
10. Leaflets hairy, with acute or obtuse apex 11
10. Leaflets glabrous, with acuminate apex ..... *F. praecox* var. *robusta*
11. Leaflets linear-lanceolate 12
11. Leaflets oblong ..... *F. prostrata*
12. Inflorescence with 22-25 flowers, equal or longer than petiole ..... *F. angustifolia*
12. Inflorescence with 5-10 flowers, shorter than petiole ..... *F. parviflora*
13. Petioles shorter than leaflets ..... *F. procumbens*
13. Petioles longer than leaflets ..... *F. nana*

Flemingia angustifolia Roxb., Fl. Ind. 3: 341. 1832

Type: India, Uttar Pradesh, Ramnagar district, Sitabandi, s.d., *W. Roxburgh s.n.* (lectotype designated here, MEL; isolectotype DD). Syntype: without precise locality, s.d., *W. Roxburgh s.n.* (BR).

Benth. in Miquel, Pl. Jungh. 2: 245. 1852; Haines, Bot. Bihar Orissa 3: 269. 1922. (Figures 3, 23c, 24c, 25c and 26c).

Flemingia angustifolia Roxb., Hort. Bengal. 98. 1814, *nom. nud.*

Description

Erect small shrubs, up to 0.5–0.6 m tall, with branched stem; stems 3–4 mm in diameter, young triangular, mature terete, hairy. Leaves digitately trifoliolate, 6–12 cm long, stipulate, petiolate; stipules 2, 10–11 × 1.5–2 mm, lanceolate, falcate, acuminate with equal tips, fused when young, splitting at maturity, persistent, basifixed, many nerved, hairy; petioles 2.5–3.5 cm long, winged, hairy, gland-dotted; leaflets 3, 5–8 × 1.5–2.2 cm, linear lanceolate, acute or obtuse at apex, the central cuneate at base, lateral oblique at base, margin ciliate, hairy on both surfaces, densely hairy on veins, dorsally gland-dotted; glands black; petiolules 1–2 mm long, hairy, gland-dotted. Inflorescences an axillary and terminal raceme; racemes 1–3 in cluster, 2–4.5 cm long, equal or longer than the petiole. Flowers 7–8 mm long, pedicellate, bracteate; pedicels 1.2–1.5 mm long, hairy; bracts 3–3.5 × 1.5–2 mm, ovate to lanceolate, acuminate at apex, many nerved, hairy, gland-dotted. Calyx 8–8.5 mm long, hairy, gland-dotted, hairs antrorse; calyx tube 1–1.2 mm long, campanulate, hairy; calyx teeth 5, 5–7 × 0.8–1 mm, lanceolate, subequal, lower one the longest, connate for 1/5 of its length, many nerved, hairy, gland-dotted. Corolla pink with striations; standard 5–5.5 × 3–3.5 mm, elliptic, apex retuse with a point, glabrous, clawed with 2 auricles; claw 1–1.2 mm long; wing petals 5–5.2 × 1.2–1.5 mm, oblong, falcate; claw 1.8–2 mm long; keel petals 6–6.2 × 1.8–2 mm, boat shaped, fused at apex at lower side; claw 1.8–2 mm long. Stamens 10, diadelphous (9+1); staminal tube 3–4 × 0.8 mm; anthers uniform, less than 1 mm long, basifixed, filaments of united stamens 1.2–2.2 mm long, that of free stamens 5–5.2 mm long. Ovary 1.5–1.8 × 0.5–0.8 mm, gland-dotted, hairy; ovules 2; style 4–4.5 mm long, glabrous, swollen at middle; stigma globose, hairy. Fruits a pod, 11–12 × 4–4.5 mm, beaked, turgid, slightly septate between seeds or not, hairy, sparsely gland-dotted; beak 0.8–1 mm long; glands black, withering post matu-

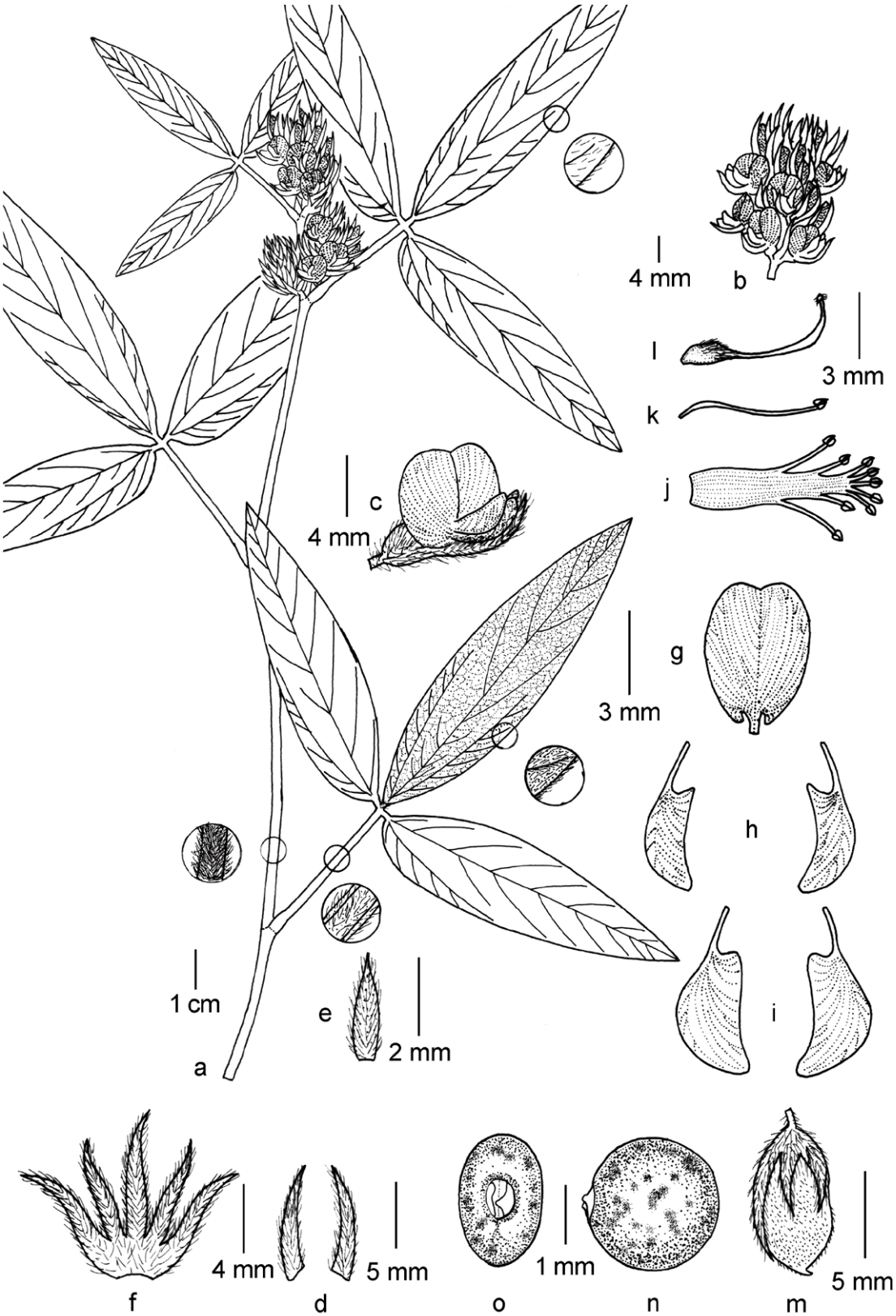


Figure 3. *Flemingia angustifolia* Roxb. (a) Habit. (b) Inflorescence. (c) Flower. (d) Stipules. (e) Bract. (f) Calyx, dorsal view. (g) Standard. (h) Wing petals. (i) Keel petals. (j) Fused androecium. (k) Free stamen. (l) Gynoecium. (m) Fruit. (n) Seed, lateral view. (o) Seed, dorsal view.

rity. Seeds 2, 2.5 × 2.5 × 2 mm, brown, mottled, shiny, rounded; hilum granular, 1 mm long, position ± central.

Etymology

The specific epithet 'angustifolia' refers to its narrow leaflets.

Distribution

Asia: India (Meghalaya and Jharkhand).

Flowering and fruiting

October to December.

Habitat and ecology

Flemingia angustifolia is found in open grassy hill slopes as well as in *Pinus* forests at high altitude of ca. 1400–1600 m asl. It grows in association with *Ageratum conyzoides* L., *Crotalaria pallida* Aiton, *Pinus kesiya* Royle ex Gordon, *Themeda* species, *Thysanolaena* species.

Additional specimens examined

INDIA, Meghalaya, Khasi Hills, July 1878, *J.L. Lister 1102* (CAL); Thoyung, 14 March 1885, *C.B. Clarke 37550* (CAL); East Khasi Hills district, on the way to Shillong to Jowai, 20 December 2005, *K.V.C. Gosavi 115* (SUK); Shillong, 21 October 1872, *C.B. Clarke 18667A* (CAL); *C.B. Clarke 18667B* (CAL); 18 August 1885, *C.B. Clarke 38916B* (CAL); 3 September 1885, *C.B. Clarke 40327B* (CAL); West Jaintia Hills district, Jowai to Shongpung, 8 November 1938, *G.K. Deka 17509* (ASSAM); Jharkhand, Ranchi district, Ranchi, 8 September 1896, *W. Kerr s.n.* (CAL).

Affinities

Flemingia angustifolia shows close resemblance to *F. prostrata* but differs from it in its upright stature, linear leaflets, and inflorescence equal or longer than the petiole.

Taxonomic note

Flemingia angustifolia was synonymized under *F. prostrata* by Mukerjee (1953). Both *F. angustifolia* and *F. prostrata* were described by Roxburgh (1832) in his seminal work 'Flora Indica'. Haines (1922) had pointed out that *F. prostrata* and *F. angustifolia* are different species. A critical study of the circumscription of *F. angustifolia* lends support to Haines's view and hence we have treated *F. angustifolia* as a distinct species.

Nomenclatural notes

The binomial *Flemingia angustifolia* appeared in Roxburgh's 'Flora Indica' in 1832. While describing the species, he mentioned that "this species grows in vicinity of Hurdwar (Haridwar, Uttarakhand) and discovered by Hardwicke". It seems that this plant or its seeds were sent to Roxburgh by Hardwicke from Hurdwar.

A search of type specimens in the herbaria revealed five sheets. Of these, three at BR collected by Roxburgh do not bear locality details, and one sheet each at MEL and DD collected by Roxburgh from Sitabani, Uttar Pradesh India is without precise locality. All these specimens serve as syntype. As per articles 9.11 and 9.12 of Shenzhen Code (Turland et al. 2018) we have selected and designated here the specimen from MEL as lectotype.

Flemingia grahamiana Wight & Arn., Prodr. Fl. Ind. Orient. 1: 242. 1834

Type: India, East Peninsular region, s.d., *R. Wight 816* (lectotype designated here, MH000020489 image!; isolectotypes CAL0000012298, E00157783 image!).

Benth. in Miquel, Pl. Jungh. 2: 245. 1852; Baker, in Hook. f., Fl. Brit. India 2: 228. 1876; Gamble, Fl. Madras 1: 378. 1928; Verdcourt, Fl. Trop. East Africa, Leguminosae 4, Papil. part 2: 806-807. 1971; Verdcourt, Kew Bulletin 31: 175. 1976; Sanjappa, Legumes of India 175. 1992. (Figures 4, 23d, 24d, 25d and 26d).

(=) *Flemingia pycnantha* Benth., Linnaea 24: 643. 1852.
Type: India, Nilgiri hills, s.d., *R.F. Hohenacker 1211* (BM, G00365319 image!, G00385323 image!, K, MEL, WAG).

(≡) *Maughania grahamiana* (Wight & Arn.) Kuntze, Revis. Gen. Pl. 1: 199. 1891; Mukerjee, Bull. Bot. Soc. Bengal 6(1): 16. 1953. (as *Moghania grahamiana*)

Description

Erect shrubs, up to 0.6–1.2 m tall, with profuse branching; stems 3–10 mm in diameter, triangular when young, terete when mature, hairy; hairs silky, antrorse. Leaves digitately trifoliolate, 10–20 cm long, stipulate, petiolate; stipules 2, 16–20 × 2.5–3 mm, lanceolate, acuminate with equal tips, fused when young, splitting when in maturity, persistent, basifixed, many nerved, hairy; petioles 2.5–6 mm long, winged, gland-dotted, hairy; leaflets 3, 4.5–13 × 3–7 cm, obovate, acute or obtuse at apex, the central cuneate at base, laterals oblique at base, margin ciliate, apex mucronate, sparsely hairy on both surfaces, densely hairy on nerves; dorsally gland-dotted, glands orange-red or black; petiolules 1–4 mm long, hairy, gland-dotted. Inflorescences

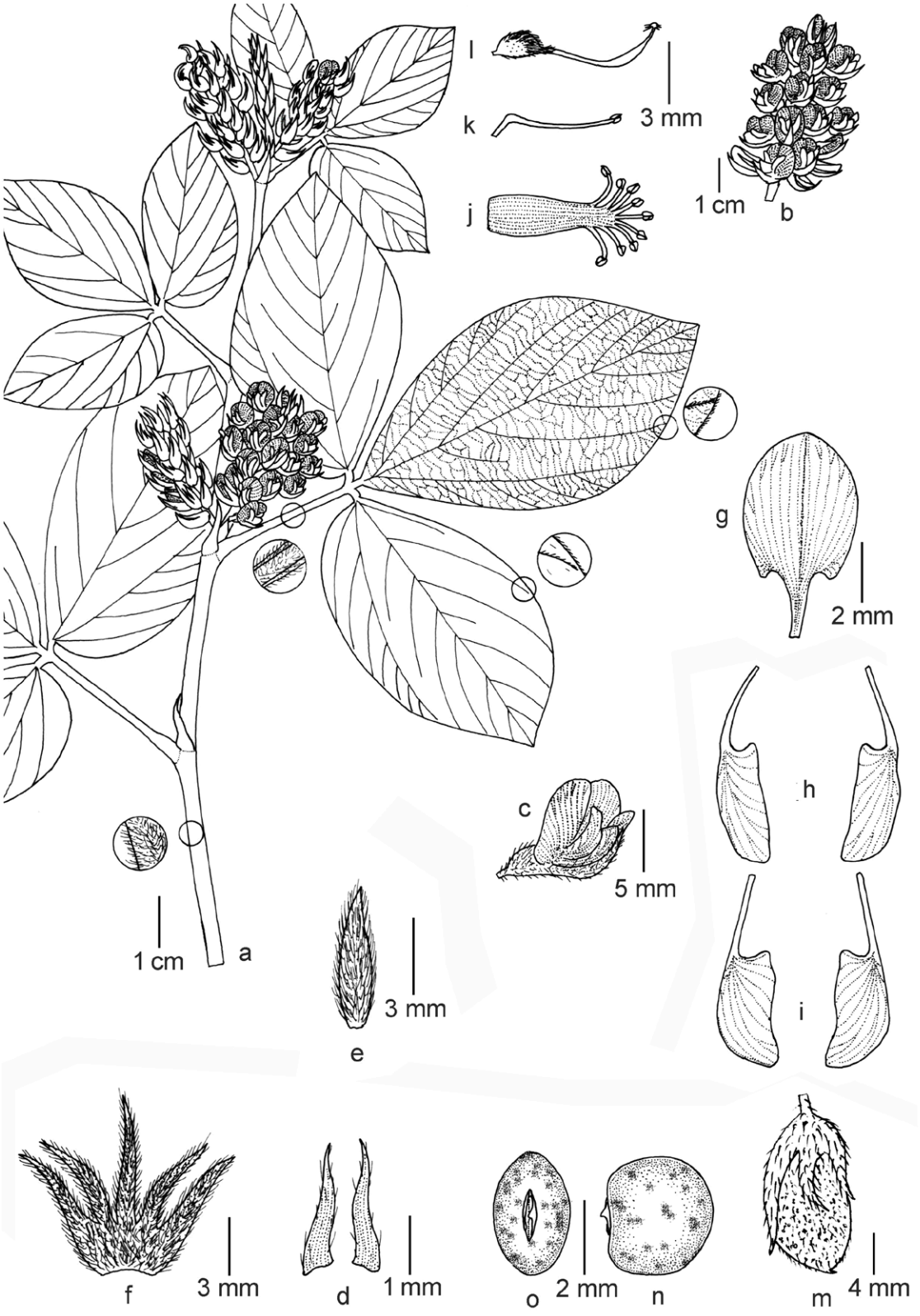


Figure 4. *Flemingia grahamiana* Wight & Arn. (a) Habit. (b) Inflorescence. (c) Flower. (d) Stipules. (e) Bract. (f) Calyx, dorsal view. (g) Standard. (h) Wing petals. (i) Keel petals. (j) Fused androecium. (k) Free stamen. (l) Gynoecium. (m) Fruit. (n) Seed, lateral view. (o) Seed, dorsal view.

an axillary and terminal raceme; racemes 2–5 in cluster, ovate dense, capitate, 2–4 mm long, equal or longer than the petiole. Flowers 10–11 mm long, pedicellate, bracteate; pedicels 2–2.5 mm long, hairy; bracts 5–5.2 × 1.2–1.5 mm, linear to lanceolate, acuminate at apex, many nerved, hairy, gland-dotted. Calyx 10–10.5 mm long, hairy, gland-dotted; calyx tube 2.5–3 mm long, campanulate, hairy; calyx teeth 5, 7–7.5 × 0.8–1 mm, subequal, lanceolate, lower one the longest, connate for 1/3 of its length, many nerved, hairy, gland-dotted. Corolla white with green striations; standard 7–7.5 × 4–4.2 mm, rounded to elliptic, apex obtuse, glabrous, clawed with 2 auricles; claw 2.8–3 mm long; auricles 1 mm or less than 1 mm; wing petals 8–8.5 × 1.8–2 mm, oblong, slightly falcate; claw 3–3.2 mm long; keel petals 7.8–8 × 2–2.5 mm, slightly falcate, fused at apex at lower side; claw 3.5–3.8 mm long. Stamens 10, diadelphous (9+1); staminal tube 4.5–5.5 × 1 mm, anthers uniform, less than 1 mm long, basifixed, filaments of united stamens 1–2 mm long, that of free stamens 6–6.5 mm long. Ovary 1.8–2 × 0.8–1 mm, gland-dotted, hairy; ovules 2; style 5–5.5 mm long, glabrous, swollen at middle; stigma globose, hairy. Fruits a pod, 16–17 × 6–6.5 mm, beaked, turgid, slightly septate between seeds or not, densely hairy, sparsely gland-dotted; beak 1 mm long; glands orange-red, withering post maturity. Seeds 2, 4 × 3 × 2.5 mm, brown, mottled, shiny, rounded; hilum granular, 1 mm long, position ± central.

Etymology

Specific epithet '*grahamiana*' honours Robert Graham (1786–1845), a Scottish physician and botanist.

Distribution

Africa: Kenya, Uganda to Zimbabwe and South Africa. Asia: India (Chhattisgarh, Karnataka, Kerala and Tamil Nadu).

Flowering and fruiting

December to April.

Habitat and ecology

Flemingia grahamiana is found on hill slopes at an altitude of ca.1300–2300 m asl. It grows in association with *Breynia retusa* (Dennst.) Alston, *Elaeagnus conferta* Roxb., *Flueggea leucopyrus* Willd., *Lantana camara* L., *Mimosa pudica* L., *Phyllanthus* species, *Polygala arvensis* Willd., *Smilax zeylanica* L., *Stachytarpheta jamaicensis* (L.) Vahl, *Strobilanthes kunthiana* T.Anderson ex Benth., etc.

Selection of specimens examined

INDIA, Chhattisgarh, Dantewada district, Bailadila hills, Malingar valley, 20 March 1977, *L.J.G. van der Maesen 2741* (CAL, ICRISAT, WAG); Jashpur district, 2 May 1964, *C.P. Arora 3819* (BSA); Karnataka, Chamarajanagara district, Bandipur National Park, 28 January 1965, *B.D. Naithani 23208* (CAL, MH); Biligiriranga-na Hills, Honnametti, 1 February 1971, *R.R. Rao 1258* (JCB); Tumkur district, Pavagada, 7 February 1964, *J.L. Ellis 18580* (CAL); Kerala, Ernakulam district, Kodanad, reserve forest, 12 November 1970, *E. Vajravelu 36851* (MH); Idukki district, Devikulam, December 1910, *A.K. Meebold 6691* (CAL); *A.K. Meebold 3361* (CAL); Lockhart Gap, 10 October 1963, *K.M. Sebastine 17483* (MH); Vattavada, 29 March 1978, *V.P.K. Nambiar 450* (KFRI); Kannur district, on the way to Theethunda-malai to Chandanathode, *J.L. Ellis 29465* (MH); on the way to Varayadu to Eravikulam, 20 October 1989, *P. Bhargavan 91853* (BSID); Kollam district, Chandanathope, Jheethunda Malai top, 4 December 1967, *J.L. Ellis 29465* (CAL); Kottayam district, Vagamon, 20 February 2008, *K.V. Krishnaraj 61802* (TBGRI); Kozhikode district, Pavangad, *J.L. Ellis 18580* (MH); Palakkad district, Siruvani, 18 December 1956, *K. Subramanyam 1790* (CAL); Trivandrum district, Hut road to Poovar, 22 July 1998, *S.D Biju 38293* (TBGRI); Wayanad district, 3 October 1983, *C.N. Mohanan 79931* (MH); East Peninsular region, s.d., *R. Wight 803* (GH, HBG, K); Tamil Nadu, Anaimalai Hills, 15 January 1912, *C.E.C. Fischer 3286* (CAL); Konalar, 16 November 1980, *M. Chandrabose 57778* (CAL, MH); Poonachi, 14 October 1901, *C.A. Barber 3783* (MH); Nilgiri hills, January 1848, *R. Wight s.n.* (BR, C, CAL, K, MEL, P); December 1885, *J.S. Gamble 16919* (BSI); 19 May 1907, *G.A. Gammie 453* (BSI); Neddiwuttum, s.d., *G. King 1321* (CAL); Coimbatore district, Ayinigiri betta, Geddesal, 15 March 1931, *K.C. Jacob 364* (MH); Gudalur, 10 January 1903, *C.A. Barber 5554* (MH); Siruvani, 18 December 1956, *K. Subramanyam 1790* (MH); Dindigul district, Silver Cascade, 5 March 1978, *D.K. Hore 612* (CAL); Kodaikanal, 21 March 1847, *s.coll. s.n.* (MH); May 1941, *s.coll. s.n.* (RHT); 19 March 1950, *D. Daniel, S. Roy & J.S. Rao 93870* (MH); 15 March 1956, J. Pallithanam 1443 (RHT); 15 September 1956, J. Pallithanam 2158 (RHT); Palni Hills, Berijam road, 6 December 1986, *K.M. Matthew & M. Charles 47738* (RHT); Kookal, 19 October 1987, *K.M. Matthew 50806* (RHT); Mahilkundram, 6 July 1987, *K.M. Matthew 49891* (RHT); 19 December 1989, *K.M. Matthew 54077* (RHT); Perumalmalai hills, 24 October 1977, *M. Chandrabose 51655* (CAL, MH); 30 October 1985, *K.M. Matthew & N. Rajendran 42420* (RHT); on the way Shembaganur to Periyakulam, 5 December

1986, *M. Charles 47678* (RHT); Coolie path, 10 January 1985, *S.J. Britto 40861* (RHT); on the way to Shembaganur to Kodaikanal, Levinge path, December 1956, *K.M. Matthew 207* (RHT); *K.M. Matthew & M. Charles 47725* (RHT); 14 November 1984, *K.M. Matthew 40841* (RHT); Shembaganur, Charlier's path, 29 October 1985, *K.M. Matthew & N. Rajendran 42377* (RHT); Vadakavanchi, 29 November 1985, *K.M. Matthew & N. Rajendran 43478* (RHT); on the way to Vandaravu, 25 October 1988, *K.M. Matthew 53612* (RHT); Vembadi Peak, 19 November 1985, *K.M. Matthew et al. 42764* (RHT); 7 December 1986, *K.M. Matthew & M. Charles 47793* (RHT); 27 August 1987, *K.M. Matthew & N. Rajendran 50415* (RHT); 4 November 1987, *K.M. Matthew & K.T. Matthew 51063* (RHT); Madurai district, Madurai, 14 April 1985, *K.M. Matthew & S.J. Britto 41231* (RHT); Picnic shola, 19 September 1968, *D.B. Deb 31006* (MH); Nilgiris district, Coonoor, 8 March 1878, *C.B. Clarke 10511* (CAL); November 1883, *J.S. Gamble 13267* (CAL, DD); October 1889, *J.S. Gamble 21426* (MH, DD); s.d., *G. King 1355* (CAL); Mudumalai National Park and Wildlife Sanctuary, 18 November 1958, *K.M. Sebastine 7370* (MH); Benne forest, 19 January 1961, *B.V. Shetty 11930* (MH); Upper Tiger Shola, 19 January 1957, *K.M. Sebastine 2058* (CAL, MH); s.d., *G. King 1044* (CAL); Theni district, Meghamalai, Eravangalar, 11 January 1986, *K. Ravikumar 2932* (MH); Salem district, Shevaroy hills, Yercaud, 11 July 2016, *S.K. Gavade 134* (SUK); 19 January 2017, *S.K. Gavade 170* (SUK); 2 February 2017, *S.K. Gavade & M.M. Lekhak 187* (SUK).

Affinities

Flemingia grahamiana shows close resemblance to *F. wightiana* but differs from it in having sparsely hairy, obovate, acute or obtuse leaflets, persistent stipules and linear to lanceolate bracts. The tell-tale character to distinguish *F. grahamiana*, the orange to red glandular dots on calyx tube and calyx teeth and pods quite more conspicuous than the glands on other species, tend to wear away in time, upon drying, handling etc.

Taxonomic note

Flemingia grahamiana was described by Wight and Arnott (1834) from East Peninsular India. Bentham (1852) described a new species, *F. pycnantha* based on Hohenacker's collection from Nilgiri hills. After studying the protologue and type specimens, we realized again that *F. pycnantha* is conspecific to *F. grahamiana*. Mukerjee (1953), Sanjappa (1992) and some online databases (ILDIS 2005; The Plant List 2013) earlier synonymised *F. pycnantha* under *F. grahamiana*.

Nomenclatural notes

Wight and Arnott (1834) while describing *F. grahamiana* mentioned Wight catalogue Number 816 in the protologue. In search of type specimens we could trace three specimens, one each at CAL (CAL0000012298), E (E00157783) and MH (MH000020489). These specimens were collected by Wight from the East Peninsular region, India. As per articles 9.11 and 9.12 of Shenzhen Code (Turland et al. 2018), we selected and designated here the specimen MH000020489 as the lectotype. This specimen is the most complete and matches well with the description provided in the protologue.

Flemingia latifolia Benth. in Miquel, Pl. Jungh. 2: 246. 1852

Type: Indonesia, Central Java, Ungaran, s.d., *Junghuhn s.n.* (lectotype designated here, K000980309 image!).

Kurz, Forest Fl. Burma 2: 375. 1877; Prain in J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 69(2): 441. 1897. (Figures 5 and 23e).

(=) *Flemingia congesta* var. *latifolia* Baker, in Hook. f., Fl. Brit. India 2: 228. 1876.
Type: India, Khasia, 2-3000 ft, s.d., *J.D. Hooker & T. Thomson s.n.* (CAL0000012304!).

(≡) *Maughania macrophylla* var. *latifolia* Kuntze, Revis. Gen. Pl. 1: 199. 1891.

(≡) *Maughania latifolia* (Benth.) Mukerjee, Bull. Bot. Soc. Bengal 6(1): 17. 1953 (as *Moghania latifolia*).

Description

Erect shrubs, up to 3–3.2 m tall, with profuse branching; stems 5–15 mm in diameter, young triangular, mature terete, hairy; hairs golden yellow to rusty brown, antrorse. Leaves digitately trifoliolate, 11–21 cm long, stipulate, petiolate; stipules 2, 21–26 × 3–4 mm, ferrugineous, lanceolate, acuminate with equal tips, fused when young, splitting at maturity, caducous, broad, basifixed, many-nerved, hairy; petioles 4–7 cm long, winged, gland-dotted, hairy; leaflets 3, 7–14 × 3–5.2 cm, ovate to lanceolate, acuminate at apex, the central cuneate at base, lateral oblique at base, margin ciliate, apex mucronate, hairy on both surfaces, densely hairy on veins, dorsally gland-dotted; glands orange-red; petiolules 4–6 mm long, hairy, gland-dotted. Inflorescences an axillary and terminal raceme; racemes 3–4 in cluster, 3–8 cm long, equal or longer than the

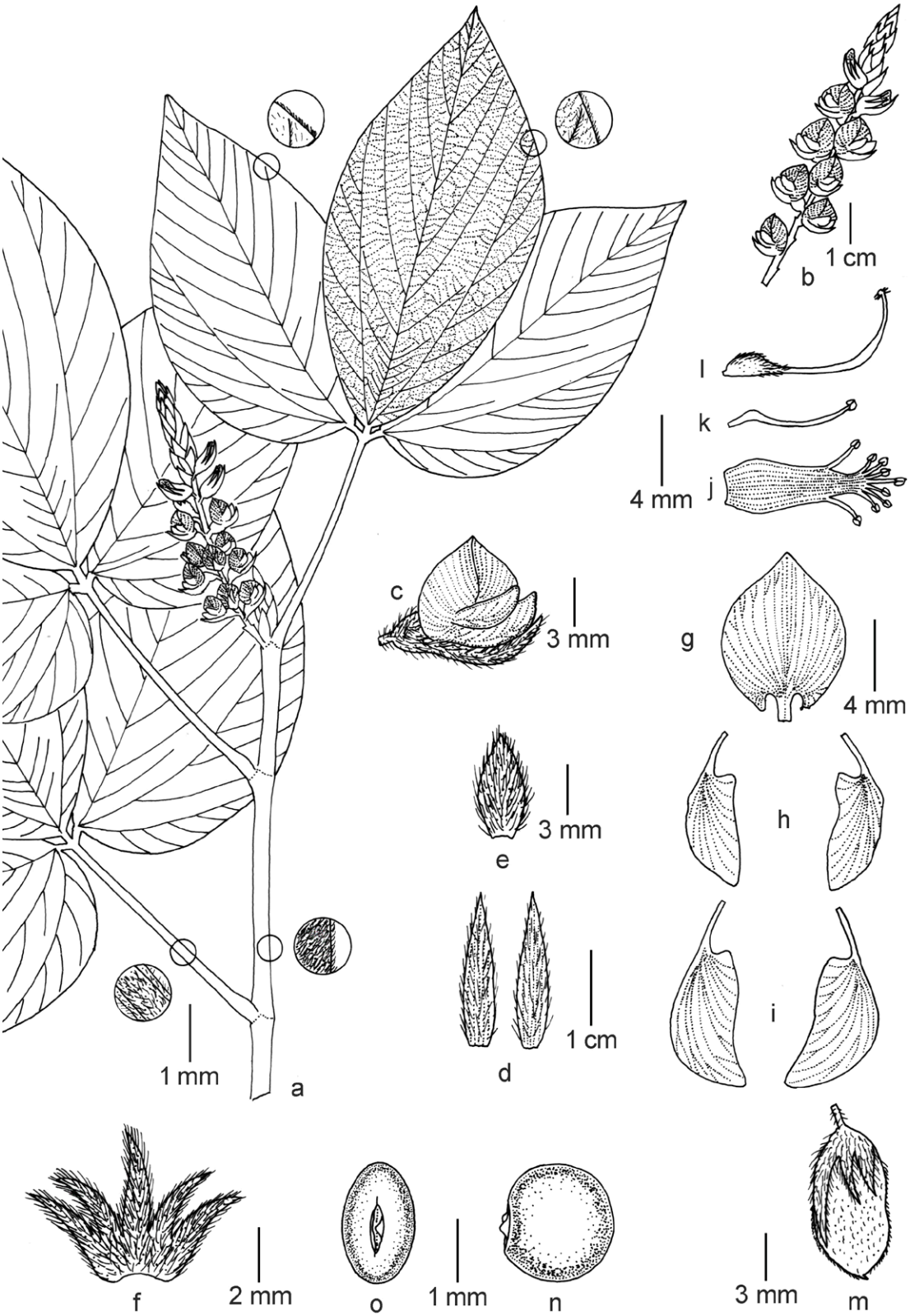


Figure 5. *Flemingia latifolia* Benth. (a) Habit. (b) Inflorescence. (c) Flower. (d) Stipules. (e) Bract. (f) Calyx, dorsal view. (g) Standard. (h) Wing petals. (i) Keel petals. (j) Fused androecium. (k) Free stamen. (l) Gynoecium. (m) Fruit. (n) Seed, lateral view. (o) Seed, dorsal view.

petiole. Flowers 1.3–1.5 cm long, pedicellate, bracteate; pedicels 2–2.5 mm long, hairy; bracts 6–8 × 4–4.5 mm, ovate acute at apex, many nerved, hairy, gland-dotted. Calyx 1–1.1 cm long, hairy, gland-dotted; calyx tube 2–2.5 mm long, campanulate, hairy; calyx teeth 5, 5.2–8 × 1.8–2 mm, lanceolate, subequal, lower one the longest, connate for 1/5 of its length, many nerved, hairy, gland-dotted. Corolla purple; standard 7.5–8 × 6–6.5 mm, rounded to elliptic, apex pointed, glabrous, clawed with 2 auricles; claw 1.8–2 mm long, auricles 1 mm or less than 1mm; wing petals 8.5–9 × 2–2.5 mm, oblong, slightly falcate; claw 2.8–3 mm long; keel petals 8–8.5 × 3–3.5 mm, falcate, fused at apex at lower side; claw 3–3.2 mm long. Stamens 10, diadelphous (9+1); staminal tube 4.8–5 × 1 mm, anthers uniform, less than 1 mm long, basifixed, filaments of united stamens 0.8–1.8 mm long, that of free stamens 7–8 mm long. Ovary 2–2.2 × 1 mm, gland-dotted, hairy; ovules 2; style 8–9 mm long, glabrous, swollen at middle; stigma globose, hairy. Fruits a pod, 12–13 × 5–5.5 mm, beaked, turgid, slightly septate between seeds or not, hairy, gland-dotted; beak 1 mm long; withering post maturity. Seeds 2, 2.5 × 2.5 × 2.5 mm dark brown, globose; hilum granular, 1 mm long, position ± central.

Etymology

The specific epithet 'latifolia' refers to its broad-sized leaflets.

Flowering and fruiting

July to December.

Habitat and ecology

Flemingia latifolia is found on hill slopes at high altitude of ca. 1000–1200 m asl. In Yunnan, China, it occurs at 3000 m in Java, Indonesia at low altitude of 20 m.

Distribution

China (Kwangtung and Yunnan), India (Arunachal Pradesh, Assam, Meghalaya and Mizoram), Indonesia (Java), Laos, Myanmar and Vietnam.

Selection of specimens examined

INDIA, Arunachal Pradesh, Anjaw district, on the way to Hayuliang to Donliang, 22 November 1957, *R.S. Rao 10740* (ASSAM); Assam, East Karbi Anglong district, Garampani Wildlife Sanctuary, 30 October 1956, *G. Panigrahi 4218* (ASSAM); 17 October 1979, *K. Haridasan 4143* (ASSAM); Goalpara district, Amguri experimental area, 22 November 1983, *D. Nath 13247* (ASSAM); Golaghat district, on the way to Kohora to Animora, 24 November 1964, *S.K. Kataki 41694* (ASSAM); Sonitpur district, Bura Chapori Wildlife Sanctuary, 31 May 2005, *M. Bhoumik 110117* (ASSAM); Meghalaya, Pungtong, Pangtum forests, 5 November 1938, *S.R. Sharma 18222* (ASSAM); Umleswar forest, 26 November 1949, *B.B. Syam 22889* (ASSAM); East Khasi Hills district, Khasia, 2 November 1850, *J.D. Hooker & T. Thomson s.n.* (CAL, GH, K); 25 October 1972, *N. Gour 53601* (ASSAM); Beadon falls, 16 August 1913, *U. Kanjilal 2428* (ASSAM); Jaintia Hills district, 21 km from Raling (or Ralang) to Garampani, 21 November 1979, *G. Remanandan 4698* (ICRISAT, WAG); on the way to Jowai to Raliang, 24 January 1957, *G.K. Deka 5112* (ASSAM); Ri Bhoi district, Nongpoh, *H. Deka 17186* (ASSAM); Mizoram, Lushai hills, Lamphai to Myanmar border, 19 January 1963, *D.B. Deb 31039* (ASSAM); Nagaland, Naga hills, s.d., *Masters 1013* (CAL).

Affinities

Flemingia latifolia shows affinities towards *F. macrophylla* but differs from it in having racemes equal or longer than the petiole, large sized stipule, distinctly winged petiole, broad ovate to lanceolate leaflets and rusty tomentose bracts.

Taxonomic note

Baker (1876) treated *Flemingia latifolia* as a variety under *F. congesta*, i.e. *F. congesta* var. *latifolia* in the Flora of British India. While replacing the generic name *Flemingia* by *Moghania*, Kuntze (1891) considered *F. latifolia* as a variety under *F. macrophylla*, i.e., *M. macrophylla* var. *latifolia*. But other workers such as Kurz (1877), Prain (1897), Mukerjee (1953) treated *F. latifolia* at the rank of species. After studying the type specimen and protologue, we have also concluded that *F. latifolia* is a distinct species.

Nomenclatural notes

Flemingia latifolia was described by Bentham in Miquel's Plantae Junghuhnianae (Bentham 1852). He mentioned "Hab. in Javae mont. Ungaran, altit. 3-4000 ped., ad Djati kalangan...(Jungh.)", which indicates that he used Junghuhn's specimen while describing the species. Our search for original material in relevant herbaria led to the tracing of a single sheet at K (K000980309) which matches well with the protologue. Hence, as per articles 9.11 and 9.12 of Shenzhen Code (Turland et al. 2018) we have designated Junghuhn's specimen (K000980309) as the lectotype.

Flemingia macrophylla (Willd.) Kuntze ex Merr., Philipp. J. Sci., C 5: 130. 1910

Bas.: *Crotalaria macrophylla* Willd. Sp. Pl., ed. 4 [Willdenow] 3(2): 982. 1802.
Type: India, without precise locality, 1797, *J.G. Klein 13260* (lectotype designated here, B-W 13260-010 image!).

Gandhi in Saldanha & Nicolson, Fl. Hassan Distr. 254: 1976; Sanjappa, Legumes of India 176. 1992; Saxena & Brahman, Fl. Orissa 1: 528. 1994; M.R. Almeida Fl. Maharashtra 2: 78. 1998; Kothari in N.P. Singh et al., Fl. Maharashtra, Dicot. 2: 686. 2001. (Figures 6, 23f, 24e, 25e and 26e).

(=) *Flemingia congesta* Roxb., in W.T. Aiton, Hortus Kew., ed. 2. 4: 349. 1812.

Type: India, without precise locality, s.d., *W. Roxburgh s.n.* (lectotype designated here, K001121990 image!; isolectotype BR0000005173655 image!, BR0000005196890 image!, BR0000005173327 image!).

Fl. Ind. 3: 340. 1832 (as *Flemingia conjesta*); Wight & Arnott, Prodr. Fl. Ind. Orient. 1: 241. 1834 [10 Oct 1834]; Wight, Icon. Pl. Ind. Orient. 2(1): 7, t. 390. 1843; Benth. in Pl. Jungh. 2: 246. 1852; Baker, in Hook. f., Fl. Brit. India 2: 228. 1876; Kurz, Forest Fl. Burma 2: 374. 1877; Prain in J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 69(2): 439. 1897; T. Cooke, Fl. Bombay 2: 392. 1902; Prain, Bengal Pl. 1: 378. 1903; Talbot, Forest Fl. Bombay 1: 419. 1909; Haines, Bot. Bihar Orissa 3: 270. 1922; Gamble, Fl. Madras 1: 378. 1928.

(=) *Flemingia sericans* Kurz, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 43(3): 186. 1874; Kurz, Forest Fl. Burma 2: 373. 1877; Prain in J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 69(2): 442. 1897, **syn. nov.**
Type: Myanmar, Prome, 1826, *N. Wallich, Wallich, Catalogue Number 5748b* (K-W001121999 image!).

(≡) *Maughania macrophylla* (Willd.) Kuntze, Revis. Gen. Pl. 1: 199. 1891; Mukerjee, Bull. Bot. Soc. Bengal 6(1): 16. 1953 (as *Moghania macrophylla*).

Description

Erect shrubs, up to 1.8–2.4 m tall, with branched stem; stems 10–15 mm in diameter, young triangular, mature terete, hairy; hairs silky, antrorse. Leaves digitately trifoliolate, 30–52 cm long, stipulate, petiolate; stipules 2, 20–25 × 3–4 mm, lanceolate, acuminate with equal tips, fused when young, splitting at maturity, persistent, basifixed, many nerved, hairy; petioles 10–16 cm long, grooved, gland-dotted, hairy; leaflets 3, 20–36 × 8–10 cm, ovate to lanceolate, acuminate at apex, the central cuneate at base, lateral oblique at base, margin ciliate, apex mucronate, glabrous on both surfaces, except on veins, dorsally gland-dotted; glands orange-red; petiolules 6–8 mm long, hairy, gland-dotted. Inflorescences axillary and terminal racemes; racemes 2–5 in cluster, 3–6 cm long, shorter than the petiole. Flowers 1–1.2 cm long, pedicellate, bracteate; pedicels 1.5–2 mm long, hairy; bracts 3.5–4 × 1.5–2 mm, ovate acuminate at apex, many nerved, hairy, gland-dotted. Calyx 11–12 mm long, hairy, gland-dotted; calyx tube 2–2.5 mm long, campanulate, hairy; calyx teeth 5, 6–8 × 1.5–2 mm, lanceolate, subequal, lower one the longest, connate for 1/5 of its length, many nerved, hairy, gland-dotted. Corolla pale pink with striations; standard 8–9 × 6–7 mm, rounded to obovate, apex pointed, glabrous, clawed with 2 auricles; claw 1.5–2 mm long; auricles 1 mm or less than 1 mm; wing petals 7–7.5 × 1.5–2 mm, oblong; claw 2.5–3 mm long; keel petals 9.5–10 × 2.5–3 mm, falcate, fused at apex, at lower side; claw 2.5–3 mm long. Stamens 10, diadelphous (9+1); staminal tube 5–5.5 × 1–1.5 mm, anthers uniform, less than 1 mm long, basifixed, filaments of united stamens 2–4 mm long, that of free stamens 8–8.5 mm long. Ovary 1.8–2 × 1 mm, gland-dotted, hairy; ovules 2; style 7.5–8 mm long, glabrous, swollen at middle; stigma globose, hairy. Fruits a pod, 15–16 × 6–7 mm, beaked, turgid, slightly septate between seeds or not, hairy, sparsely gland-dotted; beak 1 mm long; glands orange-red, withering post maturity. Seeds 2, 4 × 3 × 2.5 mm, brown, mottled, shiny, orbicular; hilum granular, 1 mm long, position ± central.

Etymology

The specific epithet 'macrophylla' refers to its large-sized leaves.

Distribution

Africa: introduced in Mauritius, Uganda. America: introduced in Florida, Guadeloupe. Asia: Bangladesh, Bhutan, China (Hainan, Kwangsi, Kwangtung, Szechwan, Yunnan), India (Assam, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Meghalaya, Punjab, Tamil Nadu and West Bengal), Indonesia (Java, Kalimantan, Seram, Sumatra), Malaysia, Myanmar, Nepal, Philippines, Taiwan, Thailand, Vietnam. Australia (Queensland).

Flowering and fruiting

December to April.

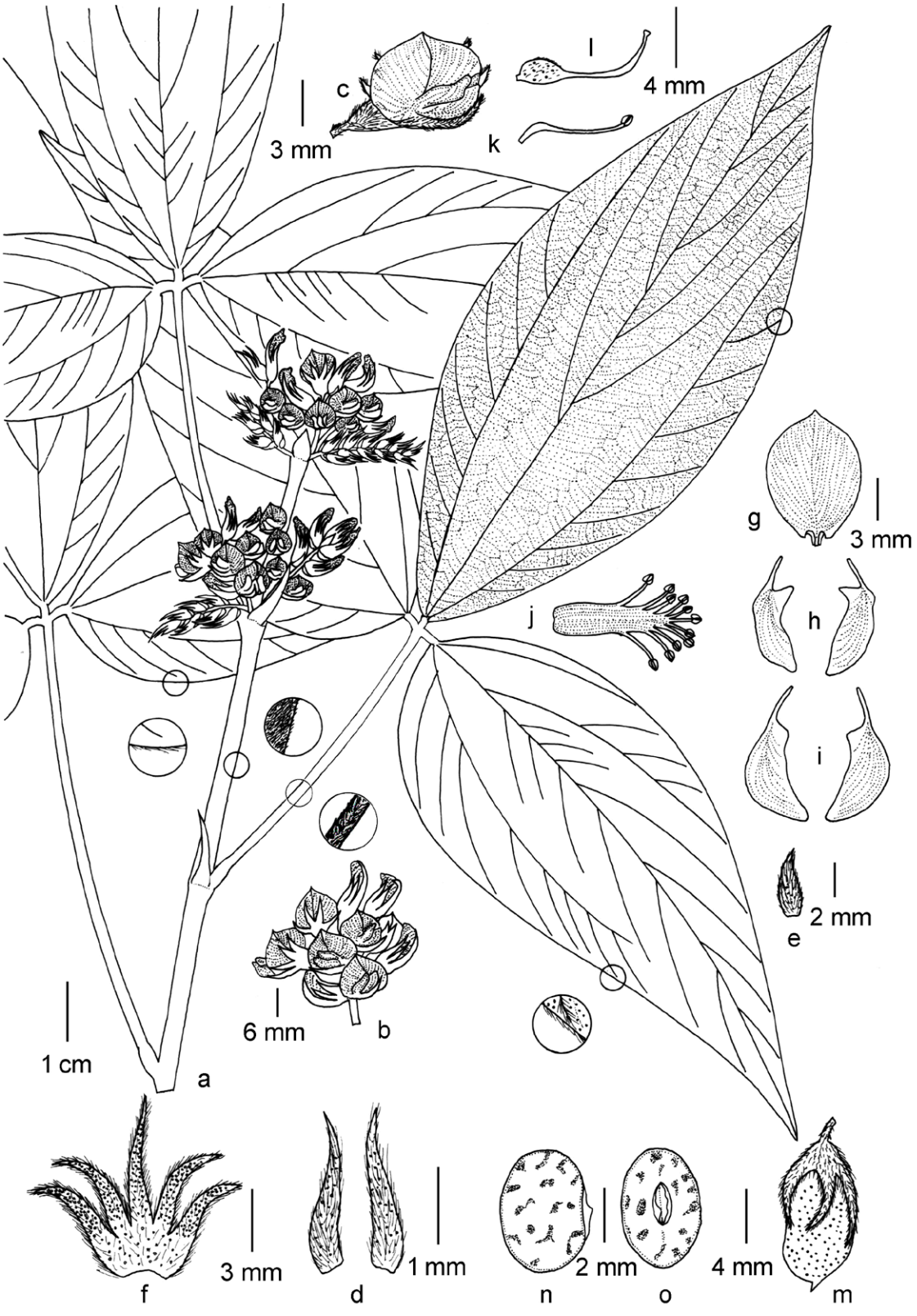


Figure 6. *Flemingia macrophylla* (Willd.) Kuntze ex Merr. (a) Habit. (b) Inflorescence. (c) Flower. (d) Stipules. (e) Bract. (f) Calyx, dorsal view. (g) Standard. (h) Wing petals. (i) Keel petals. (j) Fused androecium. (k) Free stamen. (l) Gynoecium. (m) Fruit. (n) Seed, lateral view. (o) Seed, dorsal view.

Habitat and ecology

Widely dispersed, *Flemingia macrophylla* is commonly found in evergreen forests at an altitude of ca.150–650 m asl. It grows in association with *Clausena indica* Oliv., *Connarus monocarpos* L., *Flemingia bracteata* (Roxb.) W.T.Aiton, *F. strobilifera* (L.) R.Br., *F. wallichii* Wight & Arn., *Holigarna grahamii* Kurz, *Leea indica* (Burm.f.) Merr., *Macaranga peltata* Boiv. ex Baill., *Memecylon umbellatum* Burm.f., *Syzygium cumini* (L.) Skeels and *Urena lobata* L.

Selection of specimens examined

BANGLADESH, Chittagong, *H. Bruce 5746d* (K001121992); Sylhet, *F. De Silva & H. Bruce 5747e* (K001121993); 57 km S of Teknaf, 16 March 1979, *L.J.G. van der Maesen 3775* (ICRISAT, WAG). **INDIA**, Assam, Goalpara, 10 November 1806, *Buchanan & Hamilton 5747a* (K001121989); *Buchanan & Hamilton 5747b* (K001121990); *Buchanan & Hamilton 5747c* (K001121991); Karnataka, Belgaum district, Hemmadaga village, *N.V. Malpure 3906* (SUK); 13 March 2016, *S.K. Gavade & N.V. Malpure 132* (SUK); 23 January 2017, *S.K. Gavade 180* (SUK); Dakshina Kannada, Shiradi Ghat, 30 January 1969, *C. Saldanha 12628* (JCB); Kerala, Idukki district, between Meenkuthi and Anakulam, 10 December 2003, *K.K.N. Nair 4450* (KFRI); Gavi, 21 January 2009, *M.V. Krushnaraj 61888* (TBGRI); Kollam district, Arippa, Kulathupuzha Range, Quilon, 5 August 1981, *N. Sasidharan 1401* (KFRI); Thiruvananthapuram district, Bonaccord, 22 December 1988, *M. Mohanan 7940* (TBGRI); Palode, 21 January 1992, *A. Nazarudeen 13676* (TBGRI); Maharashtra, Bombay, *N.A. Dalzell s.n.* (CAL, K); Malabar & Konkan region, *J. Stocks & J. Law s.n.* (BM, CAL, K); *A. Gibson 7* (CAL); Thane district, Shahapur research garden, 23 June 1967, *K.V. Billore 111073* (BSI); Sindhudurg district, hill near Kunkawale 8-miles from Malvan, 16 February 1966, *M.Y. Ansari 108309* (BSI); Pulas forest, Chafeli, 12 February 1970, *B.G. Kulkarni 120057* (BSI); Tamil Nadu, Salem District, Yercaud, Vallaikadai and Cauvery Peak ±1250 m, 18 March 1976, *K.M. Matthew & V. Alphonse 1798* (RHT016752); West Bengal, Sonepur Chowpathi, 29 August 1982, *L.J.G. van der Maesen 4894* (ICRISAT, WAG); **MALAYSIA**, Penang, 1822, *N. Wallich 5747f,* (K001121994); Meghalaya, s.d., *s.coll. s.n.* (NEHU); **MYANMAR**, Taunggyi, 16 March 1980, *L.J.G. van der Maesen 4210* (ICRISAT, WAG); without precise locality/Amherst, Moulmeyn, Martabania, 26 January 1827, *N. Wallich 5747g* (K001121995, K001121996, K001121997, LE).

Affinities

Flemingia macrophylla shows affinities towards *F. semialata*, *F. sootepensis* and *F. latifolia* but differs from them in having racemes shorter than the petiole, grooved petiole and large ovate-lanceolate leaflets.

Taxonomic notes

Flemingia macrophylla (Willd.) Kuntze ex Merr. was described by Willdenow in 1802 as *Crotalaria macrophylla* Willd. Roxburgh (1814) described *Flemingia congesta* (= *Flemingia macrophylla*), which was validated by Aiton (1812). While describing *F. congesta*, Roxburgh was not aware of Willdenow's plant. Kuntze (1891) suggested that the generic name *Flemingia* be replaced by *Moghania*. Consequently, he made a new combination for *C. macrophylla*, i.e., *Moghania macrophylla*. He also mentioned that *F. congesta* by Roxburgh is a heterotypic synonym of *C. macrophylla* (≡ *F. macrophylla*) Willdenow's plant. Prain (1897) noticed this and he stated that Kuntze failed to make clear what *F. macrophylla* signified. However, he gave credit to Kuntze for a new combination, i.e. *F. macrophylla* Kuntze. Subsequently, Merrill (1910) made it clear that *F. macrophylla* and *F. congesta* are the same plant. Merrill (1910) mentioned that as per his request, Harms studied the type of *C. macrophylla* (≡ *F. macrophylla*) of Willdenow along with some specimens of *F. congesta* from the Philippines and found them identical. Prior to Merrill (1910), many botanists have used Roxburgh's name *F. congesta* in their respective work (Wight and Arnott 1834; Wight 1843; Bentham 1852; Kurz 1877; Prain 1897, 1903; Cooke 1902) instead of *F. macrophylla*. Haines (1922) and Gamble (1928) also used the name *F. congesta*.

The species *Flemingia latifolia* Benth., *F. nana* Roxb. ex W.T.Aiton, *F. prostrata* Roxb. junior ex Roxb., *F. semialata* Roxb. ex W.T.Aiton and *F. sootepensis* Craib. have been synonymised or relegated as subspecies or varieties under *F. macrophylla* by many botanists and taxonomic databases (Babu 1977; Sanjappa 1992; The Plant List 2013) but as per Prain (1897) and Mukerjee (1953) these species are distinct. We follow Prain (1897) and Mukerjee (1953) in our treatment.

Nomenclatural notes

In search of type specimens we could trace a single specimen at B. This sheet was studied by Harms and bears the collection number 13260 (Merrill 1910). This sheet matches well with the protologue of *F. macrophylla* and depicts all the diagnostic characters and hence as per articles 9.11 and 9.12 of Shenzhen Code (Turland et al. 2018) has been designated as lectotype here.

In the case of the binomial *Flemingia congesta* we could trace four specimens of which one is at K and the other three are at BR. The specimens from BR are of Roxburgh and were purchased by Martius, the founder of Flora Brasiliensis from Linnean Society of London in 1863 (Forman 1997). As per articles 9.11 and 9.12 of Shenzhen Code (Turland et al. 2018), the specimen at K (K001121990) having Roxburgh handwriting as '*Hedysarum trinervium*' is selected and designated here as a lectotype (per articles 9.11 and 9.12 of Shenzhen Code (Turland et al. 2018). The specimens from BR (BR0000005173655, BR0000005196890, BR0000005173327) become isolectotypes.

Flemingia nana Roxb., in W.T.Aiton, Hortus Kew., ed. 2. 4: 349. 1812

Type: flowering specimen in Roxburgh drawing number 1622 (K image!, lectotype designated by Gavade et al., 2016b: 74):). Wallich Catalogue Number 5748a, *Roxburgh s.n.* (K-W001121998 image!, syntype)

Fl. Ind. 3: 339. 1832; Wight & Arn., Prodr. Fl. Ind. Orient. 1: 242. 1834; Wight, Icon. Pl. Ind. Orient. 2(1): 7, t. 389. 1843; Prain in J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 69(2): 441. 1897; Prain, Bengal Pl. 1: 378. 1903; T. Cooke, Fl. Bombay 2: 334. 1902; Talbot, Forest Fl. Bombay 1: 419, 1909. (Figures 7, 23g, 24f, 25f and 26f).

(≡) *Flemingia congesta* var. *nana* (Roxb.) Baker, in Hook. f., Fl. Brit. India 2: 230. 1876.

(≡) *Maughania nana* (Roxb.) Mukerjee, Bull. Bot. Soc. Bengal 6(1): 20. 1953 (as *Moghania nana*).

(≡) *Flemingia macrophylla* var. *nana* M.R. Almeida, Fl. Maharashtra 2: 77. 1998.

Flemingia nana Roxb., Hort. Bengal. 56. 1814, *nom. nud.*

Description

Dwarf suffruticose shrubs, 10–15 (-30) cm in height on a woody rootstock; stems unbranched, 5–7 mm in diameter, young triangular, mature terete, hairy; hairs silky, antrorse. Leaves digitately trifoliolate, 20–44 cm long, stipulate, petiolate; stipules 2, 13–14 × 2–2.5 mm, lanceolate, acuminate with equal tips, fused when young, splitting at maturity, persistent, basifixed, many nerved, hairy; petioles 20–28(-55) cm long, distinctly winged, gland-dotted beneath, hairy; leaflets 3, 9–18 × 5–13 cm, broadly obovate, acute at apex, the central cuneate at base, lateral oblique at base, margin ciliate, apex mucronate, glabrous on both surfaces, except on veins, dorsally gland-dotted; glands orange-red; petiolules 2–7 mm long, hairy, glandular. Inflorescences axillary racemes; racemes 2–5 in cluster, shorter than petiole. Flowers 9–10 mm long, pedicellate, bracteate; pedicels 2–3 mm long, hairy; bracts 3–3.5 × 1–1.5 mm, ovate to lanceolate, acuminate at apex, many nerved, hairy, gland-dotted. Calyx 5–5.5 mm long, hairy, gland-dotted; calyx tube 1.5–2 mm long, campanulate, hairy; calyx teeth 5, 4–5 × 1–1.5 mm, lanceolate, subequal, lower one the longest, connate for 1/4 of its length, many nerved, hairy, gland-dotted. Corolla pink with red striations; standard 5–5.5 × 5–5.2 mm, rounded, apex slightly pointed, glabrous, clawed with 2 auricles; claw 1–1.7 mm long; auricles 1 mm or less than 1 mm; wing petals 5–5.5 × 1.5–1.6 mm, oblong; claw 1–1.7 mm long; keel petals 6–6.5 × 2–2.5 mm, falcate, fused at apex at lower side; claw 1.5–2 mm long. Stamens 10, diadelphous (9+1); staminal tube 4–4.5 × 1 mm, anthers uniform, less than 1 mm long, basifixed, filaments of united stamens 1.5–1.8 mm long, that of free stamens 6.5–7 mm long. Ovary 2–2.5 × 1 mm, gland-dotted, hairy; ovules 2; styles 4.5–5 mm long, glabrous, swollen at middle; stigma globose, hairy. Fruits a pod, (10-)12–13 × 5–5.5 mm, beaked, turgid, slightly septate between seeds or not, hairy on margin, densely gland-dotted; beak 1–2 mm long; glands orange-red, withering post maturity. Seeds 2, 3 × 2.5 × 2.5 mm brown, mottled, ellipsoid; hilum granular, 1 mm long, position ± central.

Etymology

The specific epithet 'nana' refers to its dwarf and stunted habit.

Distribution

Asia: India (Chhattisgarh, Madhya Pradesh, Maharashtra, Uttar Pradesh and Uttarakhand).

Flowering and fruiting

October to March-April.

Habitat and ecology

Flemingia nana occurs in deciduous and mixed forests. It is also found in Sal forests. It grows in open areas, roadsides and along dried water streams at an altitude of ca. 100–500 m asl. It grows in association with *Asparagus racemosus* Willd., *Casearia tomentosa* Roxb., *Celastrus paniculatus* Willd., *Curculigo orchioides* Gaertn., *Desmodium gangeticum* (L.) DC., *Diospyros melanoxylon* Roxb., *Hemidesmus indicus* (L.) R.Br.,

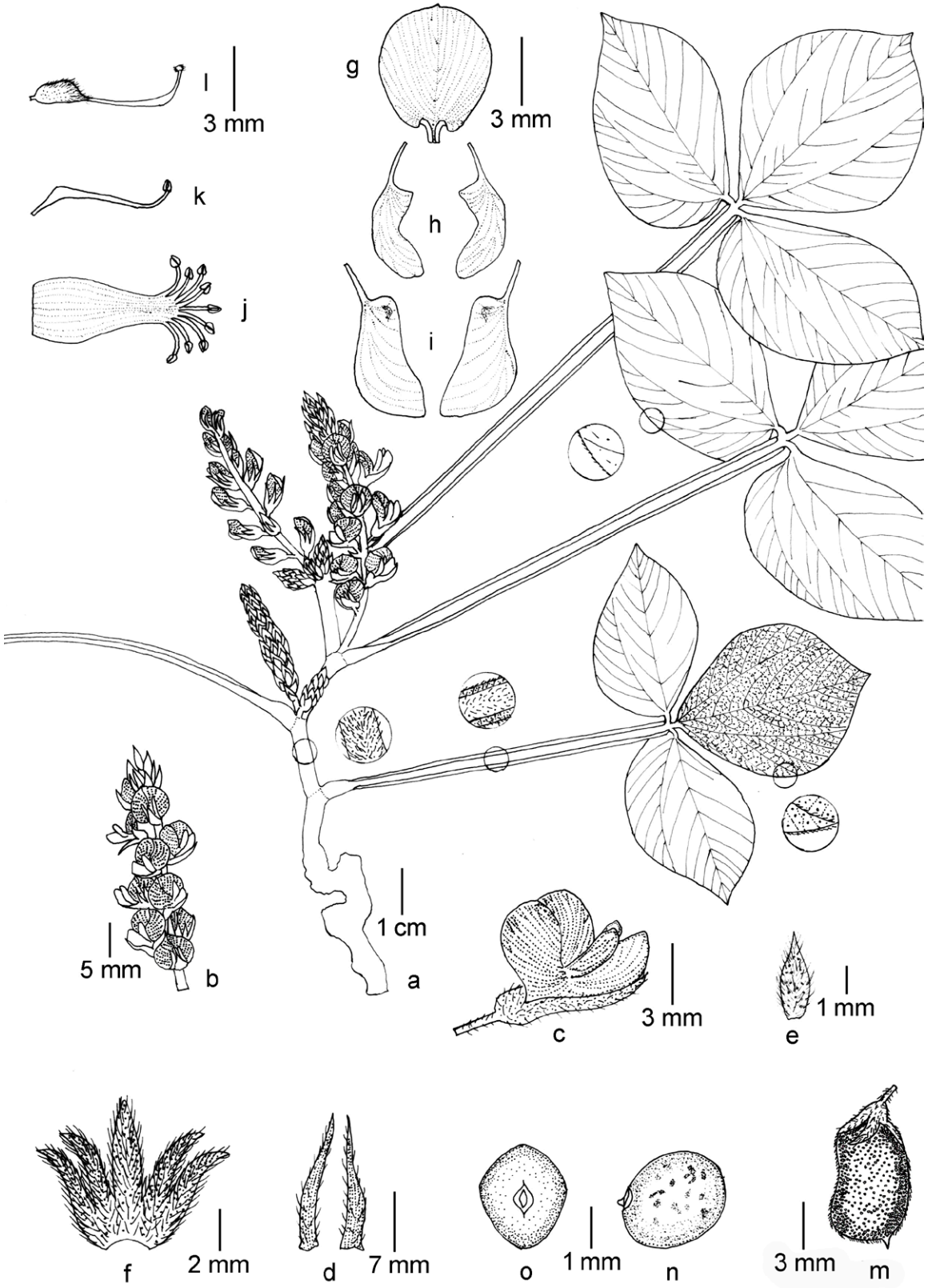


Figure 7. *Flemingia nana* Roxb. (a) Habit. (b) Inflorescence. (c) Flower. (d) Stipules. (e) Bract. (f) Calyx, dorsal view. (g) Standard. (h) Wing petals. (i) Keel petals. (j) Fused androecium. (k) Free stamen. (l) Gynoecium. (m) Fruit. (n) Seed, lateral view. (o) Seed, dorsal view.

Hemigraphis hirta T.Anderson, *Lagerstroemia parviflora* Roxb., *Leucas montana* Spreng., *Sida cordifolia* L. and *Tectona grandis* L.f.

Selection of specimens examined

INDIA, Chhattisgarh, Mungeli District, Achanakmar Wildlife Sanctuary, 11 September 2015, *S.K. Gavade & A.P. Tiwari 92* (SUK); Raigarh District, Khondra village, 9 September 2015, *S.K. Gavade & A.P. Tiwari 90* (SUK); 24 October 2016, *S.K. Gavade 148* (SUK); Rajnandgaon district, Lumerkhari, 14 April 1974, *P.C. Pant 2039* (BSA); Karnataka, North Kanara district, 2 April 1884, *W.A. Talbot 960* (K); Madhya Pradesh, Balaghat district, Paraswada, 21 January 1991, *B. Lal 8938* (NBRI); Hoshangabad District, Bori-Satpura Tiger Reserve, January 2004, *Sarnam Singh 103796* (BSD); Khandawa district, Sundardev forest, 2 January 2016, *S.K. Gavade & M. Shaikh 122* (SUK); Mandla district, Kanha Tiger Reserve, November 2003, *Sarnam Singh 103600*; Umaria district, Bandhavgarh National Park, March 2004, *Surendra Singh 105655* (BSA); Maharashtra, Chandrapur district, Torgaon, 26 December 2014, *S.K. Gavade & V. Kahalkar s.n.* (SUK); 26 January 2015, *S.K. Gavade 10* (SUK); 14 February 2016, *S.K. Gavade 126* (SUK); Uttar Pradesh, Chitrakoot district, 14 November 1957, *M.A. Rao 3747* (BSD); Lakhimpur Kheri district, 20 April 1998, *Inayat Khan 21507* (CAL); Uttarakhand, Lucknow district, Kishanpur Wildlife Sanctuary, 14 May 2017, *S.K. Gavade & H. Singh 193* (SUK); Nainital district, Ramnagar, 21 April 1958, *M.A. Rao 5294*; *M.A. Rao 2304* (BSD); on the way Seljam to Lalkua, 28 April 1958, *M. A. Rao 5425* (BSD).

Affinities

Flemingia nana is very distinct from all other *Flemingia* species in having a dwarf suffruticose habit, broadly obovate leaves, petiole longer than leaflets. Leaves of the species fall down post fruiting.

Taxonomic note

Flemingia nana is a very distinct species. It was validly published by Aiton (1812) in Hortus Kewensis. Baker (1876) treated *Flemingia nana* as a variety under *F. congesta* (≡ *F. macrophylla*), i.e. *F. congesta* var. *nana* Baker. Almeida (1998) also treated *Flemingia nana* a variety under *F. macrophylla*, i.e., *F. macrophylla* var. *nana*. However, many botanists (Prain 1897; Cooke 1902; Talbot 1909; Mukerjee 1953) agreed with Roxburgh and recognized *Flemingia nana* as a distinct species. We also treat *F. nana* at specific rank.

Nomenclatural notes

In search of type specimens we found only one sheet, having Wallich Catalogue Number 5748a at K (K-W001121998), collected by Roxburgh (Wallich 1831) having Roxburgh's handwriting as '*Hedysarum brevis*'. However, the sheet bears only a stem with many fruits. It lacks the long petiole and obovate middle leaflet, characteristic of *F. nana*. Hence, the specimen is not showing good characters. Roxburgh's drawing number 1622 from Flora Indica was, therefore, designated lectotype (Gavade et al. 2016b) as it depicts the diagnostic characters of the species mentioned in the protologue.

Flemingia parviflora Benth., Fl. Austral. 2: 269. 1864 (Figures 8, 23h, 24g, 25g and 26g).

Type: Australia, Queensland, Brisbane River, August 1855, *F. Mueller, s.n.* (lectotype designated here, K); Australia, Queensland, Brisbane River, July 1855, *F. Mueller, s.n.* (syntype, MEL54414); On the road to Mount Elliot, *J. Dallachy, s.n.* (syntypes, K, MEL54415); Shoal water Bay, 26 August 1802, *R. Brown 4140* (syntypes, BM000810777, BRI-AQ0425022, NT and K), Burdekin river, s.d., *E.M. Bowman s.n.* (syntype, MEL54417); Lynedoch valley (Lynd River), May 1845, *F.W.L. Leichhardt s.n.* (syntype, MEL54416).

(≡) *Maughania parviflora* Kuntze, Revis. Gen. Pl. 1: 199. 1891.

Description

Erect shrubs, up to 30-45 cm tall, with branched stem; stems 3–4 mm in diameter, young triangular, mature terete, hairy, hairs silky, antrorse. Leaves digitately trifoliolate, 10–20 cm long, stipulate, petiolate; stipules 2, 7–10 × 1.5–2 mm, persistent, separate, lanceolate, acuminate with equal tips, falcate, basifixed, many nerved, hairy; petioles 3–5 cm long, grooved, gland-dotted, hairy; leaflets 3, 6–14 × 2–2.8 cm, linear to lanceolate, acuminate at apex, the central cuneate at base, lateral oblique at base, margin ciliate, apex mucronate, hairy on both surfaces, densely hairy on veins, dorsally gland-dotted; glands black; petiolules 1–2 mm long, hairy, gland-dotted. Inflorescences an axillary or terminal raceme; racemes solitary, 1.8–2 cm long, shorter than the petiole. Flowers 1–1.2 cm long, pedicellate, bracteate; pedicels 2–2.5 mm long, hairy; bracts 2–2.5 × 1–1.2 mm, ovate to lanceolate, acuminate at apex, many nerved, hairy, gland-dotted. Calyx 9–10 mm long, hairy, gland-dotted; calyx tube 1.5–2 mm long, campanulate, hairy; calyx teeth 5, 4.5–8 × 0.8–1 mm, lanceolate, subequal,

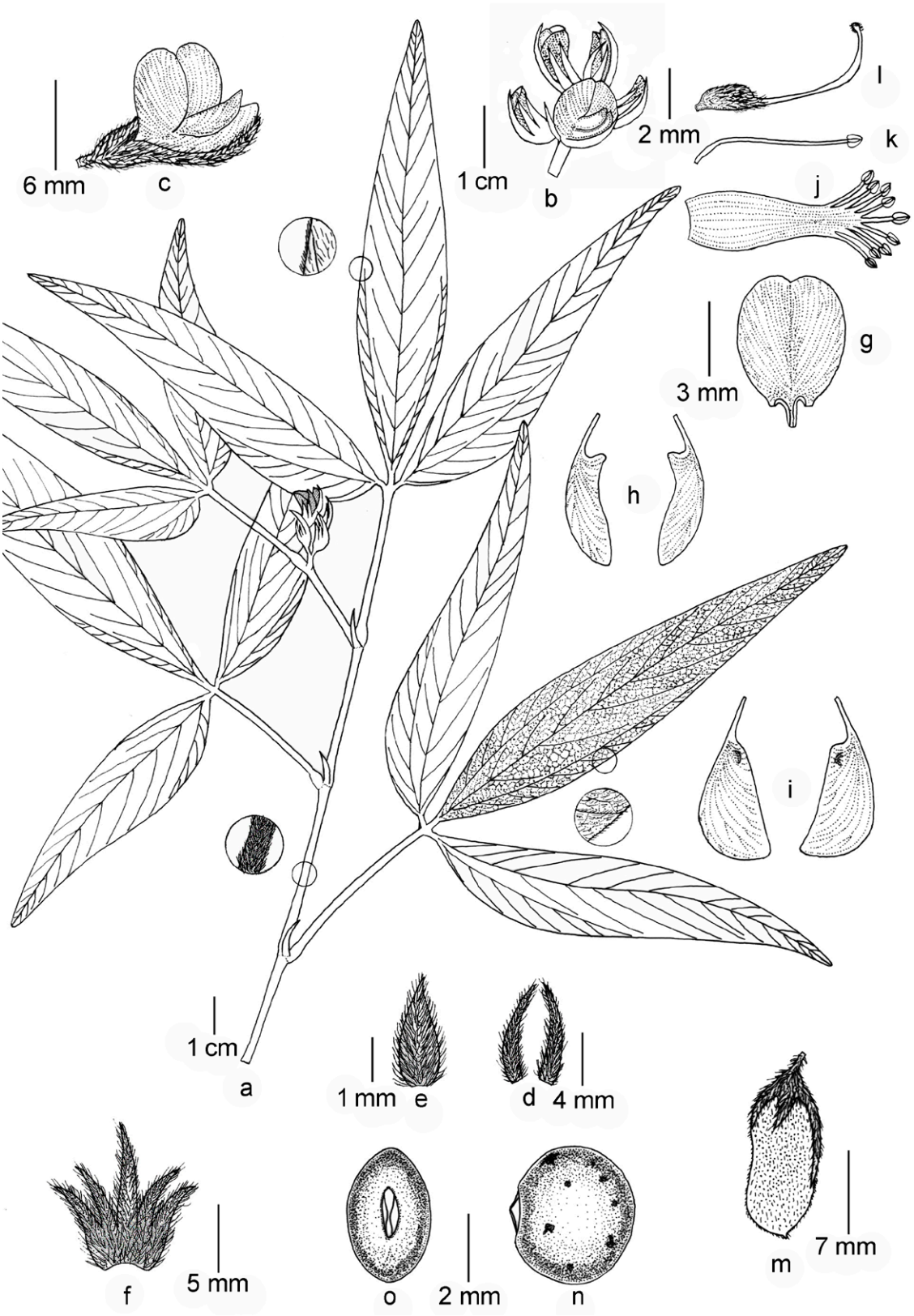


Figure 8. *Flemingia parviflora* Benth. (a) Habit. (b) Inflorescence. (c) Flower. (d) Stipules. (e) Bract. (f) Calyx, dorsal view. (g) Standard. (h) Wing petals. (i) Keel petals. (j) Fused androecium. (k) Free stamen. (l) Gynoecium. (m) Fruit. (n) Seed, lateral view. (o) Seed, dorsal view.

lower one the longest, connate for 1/5 of its length, hairy, many nerved, gland-dotted. Corolla pink with purple striations; standard 6–6.5 × 5–5.5 mm, rounded, apex retuse, glabrous, clawed with 2 auricles; claw 1.2–1.5 mm long, auricled; auricles 1 mm or less than 1 mm; wing petals 6–6.2 × 1.5–1.8 mm, oblong, slightly falcate; claw 1.8–2 mm long; keel petals 6.8–7 × 2.5–3 mm, boat-shaped, fused at apex at lower side; claw 1.8–2 mm long. Stamens 10, diadelphous (9+1); staminal tube 4.8–5 × 1 mm, anthers uniform, less than 1 mm long, basifixed, filaments of united stamens 1–2 mm long, that of free stamens 6–6.2 mm long. Ovary 1.8–2 × 0.8–0.1 mm, gland-dotted, hairy; ovules 2; style 5.2–5.5 mm long, glabrous, swollen at middle; stigma globose, hairy. Fruits a pod, 12–14 × 4–5 mm, beaked, turgid, slightly septate between seeds or not, hairy, sparsely gland-dotted; beak 0.5 mm long; glands black, withering post maturity. Seeds 2, 3.8 × 3.5 × 2.5 mm, brown, mottled, shiny, rounded; hilum granular, 1 mm long, position ± central.

Etymology

The specific epithet 'parviflora' refers to small-sized flowers of the species.

Distribution

Flemingia parviflora was known from Northern Australia only (ILDIS 2005). It has not been reported earlier from India. We collected *F. parviflora* from Gadchiroli district, Maharashtra state.

Flowering and fruiting

August to January.

Additional specimens examined

INDIA, Maharashtra, Gadchiroli district, September 2017, *V. Kahalkar s.n.* (SUK).

Affinities

Flemingia parviflora is allied to *F. angustifolia* and *F. prostrata* but differs from them in its habit, long leaflets, large-sized flowers and pods.

Nomenclatural note

While describing *Flemingia parviflora*, Bentham (1864) cited five specimens that were collected by Bowman, Brown, Dallachy, Leichhardt and Mueller from Queensland, Australia. In search of the type specimens we found ten specimens. Four specimens are of Brown (BM000810777, BRI-AQ0425022, NT and K), two of Dallachy (MEL54415 and K), two of Mueller (K and MEL54414) and one each of Bowman (MEL54417), Leichhardt (MEL54416). All these specimens constitute syntypes. As per articles 9.11 and 9.12 of Shenzhen Code (Turland et al. 2018), to narrow down the type to one specimen, MEL54417 is selected and designated here as lectotype.

Flemingia praecox C.B.Clarke ex Prain var. **robusta** (Mukerjee) An. Kumar, Nation. Acad. Sci. Lett. 5(8): 249. 1982

Type: India, Maharashtra, Gadchiroli district, Yenkatapur, 19 January 1890, *J.F. Duthie 9408* (lectotype designated here, DD!; isolectotype DD!). Syntypes: India, Maharashtra, Thana district, Thana forest, s.d., *L.J. Sedgwick & T.R.D. Bell 3634* (BLAT) (not found).

Bennet, J. Econ. Taxon. Bot. 4(2): 592. 1983; Sanjappa, Legumes of India 178. 1992; Pullaiah & Chennaiah, Fl. Andhra Pradesh 1: 282. 1997. (Figures 9, 23i, 24h, 25h and 26h).

(≡) *Maughania praecox* var. *robusta* Mukerjee, Bull. Bot. Soc. Bengal 6(1): 15. 1953. (*Moghania praecox* var. *robusta*).

Description

Erect shrubs, up to 1–3 m tall, with branched stem; stems 8–10 mm in diameter, young triangular, mature terete, hairy. Leaves digitately trifoliolate, 30–35 cm long, stipulate, petiolate; stipules 2, 18–20 × 2.5–3 mm, lanceolate, acuminate with equal tips, fused when young, splitting at maturity, caducous, basifixed, many nerved, hairy; petioles 4–11 cm long, distinctly winged, gland-dotted, hairy; leaflets 3, 8–24 × 2–4 cm, linear lanceolate, acuminate at apex, the central cuneate at base, lateral oblique at base, margin ciliate, apex mucronate, glabrous on both surfaces, except on veins, dorsally gland-dotted; glands orange-red; petiolules 3–4 mm long, hairy, gland-dotted. Inflorescences an axillary and terminal raceme; racemes solitary, 4–6 cm long, equal or shorter than the petiole. Flowers 9–9.5 mm long, pedicellate, bracteate; pedicels 1.8–2 mm long, hairy; bracts 5–6 × 2–2.5 mm, ovate to lanceolate, acuminate at apex, many nerved, hairy, gland-dotted. Calyx 7–7.5 mm long, hairy, gland-dotted; calyx tube 1.5–2 mm long, campanulate, hairy; calyx teeth 5, 3–5 × 0.8–1 mm, lanceolate, subequal, lower one the longest, connate for 1/3 of its length, many nerved, hairy, gland-dotted. Corolla pale yellow with bluish striations; standard 7–7.5 × 5.2–5.5 mm, rounded, apex blunt, glabrous, clawed with 2 auricles; claw 1–1.5 mm long; auricles 1 mm or less than 1

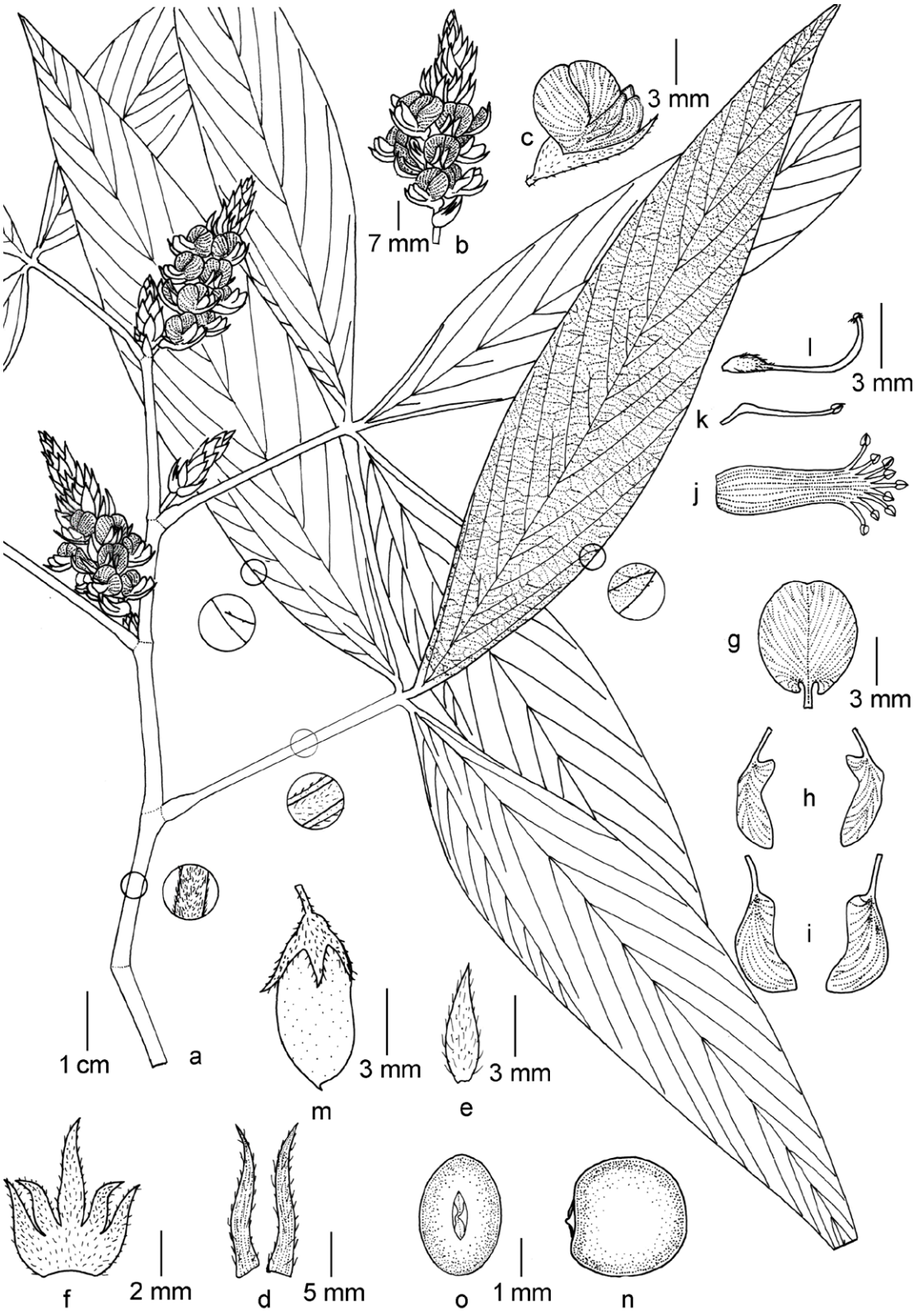


Figure 9. *Flemingia praecox* var. *robusta* (Mukerjee) An. Kumar. (a) Habit. (b) Inflorescence. (c) Flower. (d) Stipules. (e) Bract. (f) Calyx, dorsal view. (g) Standard. (h) Wing petals. (i) Keel petals. (j) Fused androecium. (k) Free stamen. (l) Gynoecium. (m) Fruit. (n) Seed, lateral view. (o) Seed, dorsal view.

mm; wing petals 6–6.5 × 1.5–2 mm, oblong, falcate; claw 2–2.2 mm long; keel petals 7–7.2 × 2–2.5 mm, falcate, fused at apex; claw 2–2.2 mm long. Stamens 10, diadelphous (9+1); staminal tube 5–5.5 × 1 mm, anthers uniform, less than 1 mm long, basifixed, filaments of united stamens 1–1.5 mm long, that of free stamens 6–6.5 mm long. Ovary 1.5–1.8 × 0.5–0.8 mm, gland-dotted, hairy; ovules 2; style 5.5–6 mm long, glabrous, swollen at middle; stigma globose, hairy. Fruits a pod, 12–13 × 6–7 mm, beaked, turgid, slightly septate between seeds or not, hairy, sparsely gland-dotted; beak 1 mm long; glands black, withering post maturity. Seeds 2, 3 × 3 × 2.5 mm, brown, mottled, shiny, rounded; hilum granular, 1 mm long, position ± central.

Etymology

The specific epithet 'praecox' refers to the flowering that occurs before the appearance of leaves and the varietal epithet 'robusta' refers to its stout habit.

Distribution

Asia: India (Andhra Pradesh, Chhattisgarh, Gujarat, Madhya Pradesh and Uttar Pradesh).

Flowering and fruiting

February to March.

Habitat and ecology

Flemingia praecox var. *robusta* is found along the streams in semi evergreen forests at low altitude of ca. 100–250 m asl. It grows in association with *Barleria cristata* L., *Buchanania cochinchinensis* (Lour.) M.R.Almeida, *Dalbergia paniculata* Roxb., *Cassia fistula* L., *Dendrocalamus strictus* Nees, *Dioscorea bulbifera* L., *Mallotus philippensis* (Lam.) Mull.Arg., *Saccopetalum tomentosum* Hook.f. & Thomson, *Triumfetta rotundifolia* Lam. and *Ventilago madraspatana* Gaertn.

Selection of specimens examined

INDIA, Andhra Pradesh, East Godavari district, Marudranalli, 21 February 1956, *S.K. Wagh 1638* (BLAT); *S.K. Wagh 1639* (BLAT); *S.K. Wagh 1640* (BLAT); *S.K. Wagh 1664* (BLAT); West Godavari district, Roy Gudem, 19 February 1987, *D. Narasimhan 85505* (BSID); Gujarat, Dang district, Pimpari, 30 December 1957, *R. Asrana 5394* (BLAT); Waghai, 11 February 1956, *D.P. Panthaki 2513a* (BLAT); Vadodara district, Baroda, Botanical garden and arboretum, The Maharaja Sayajirao University, 30 January 2017, *R.J. Desai s.n.* (SUK); 25 February 2017, *K.S. Rajput s.n.* (SUK); Chhattisgarh, Bastar district, Darba, 11 February 1961, *N.P. Balakrishnan & A.N. Henry 12066* (MH); Kotumsar, 19 February 1963, *G. Panigrahi & C.M. Arora 1113* (BSA); Madhya Pradesh, Khandwa district, Dhama, 2 January 2016, *S.K. Gavade & M. Shaikh 212* (SUK); Uttar Pradesh, Chandauli district, Chakiya forest, 11 February 1959, *M.A. Rau 8230* (BSD).

Affinities

Flemingia praecox var. *robusta* is allied to *F. praecox* var. *praecox* but differs from it in its large leaflets and robust habit.

Taxonomic note

Flemingia praecox var. *robusta* is a distinct variety described by Mukerjee (1953) based on the collection made by Duthie, Sedgwick and Bell from Maharashtra.

Mukherjee (1993) reported *Flemingia praecox* var. *praecox* from Bastar in the Flora of Madhya Pradesh. However, he did not provide any specimen details. Thorough examination of specimens at BSA and other Indian herbaria did not lead to the tracing of any specimen of *F. praecox* var. *praecox*. Hence, we are of the opinion that *F. praecox* var. *praecox* may not be occurring in India. The type of var. *praecox* is reported from Chittagong, Bangladesh.

Nomenclatural notes

Flemingia praecox var. *robusta* was described by Mukerjee (1953) from Peninsular India. He cited Chanda, Yenkatapur, *J.F. Duthie 9408 A* 'Type in Herb. CAL'. We could not locate the type specimen at CAL. However, we could locate two specimens labeled as *Duthie 9408* at DD. These specimens serve as isotypes. Of these specimens, one is selected designated as lectotype as per articles 9.11 and 9.12 of Shenzhen Code (Turland et al. 2018). Mukerjee also mentioned that the specimen 3634 was collected by Sedgwick & Bell from Thana forest. However, this specimen could not be located at CAL or any Indian herbaria.

Flemingia procumbens Roxb., Fl. Ind. 3: 338. 1832; Wight, Icon. Pl. Ind. Orient. 2(1): 9, t. 408. 1843

Type: flowering specimen in Roxburgh drawing number 1893 (K image!, lectotype designated by Gavade et al. 2016b: 74).

Benth. in Miquel, Pl. Jungh. 2: 245. 1852; Prain in J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 69(2): 442. 1897. Sanjappa, Legumes of India 178. 1992. (Figures 10, 23j, 24i, 25i and 26i).

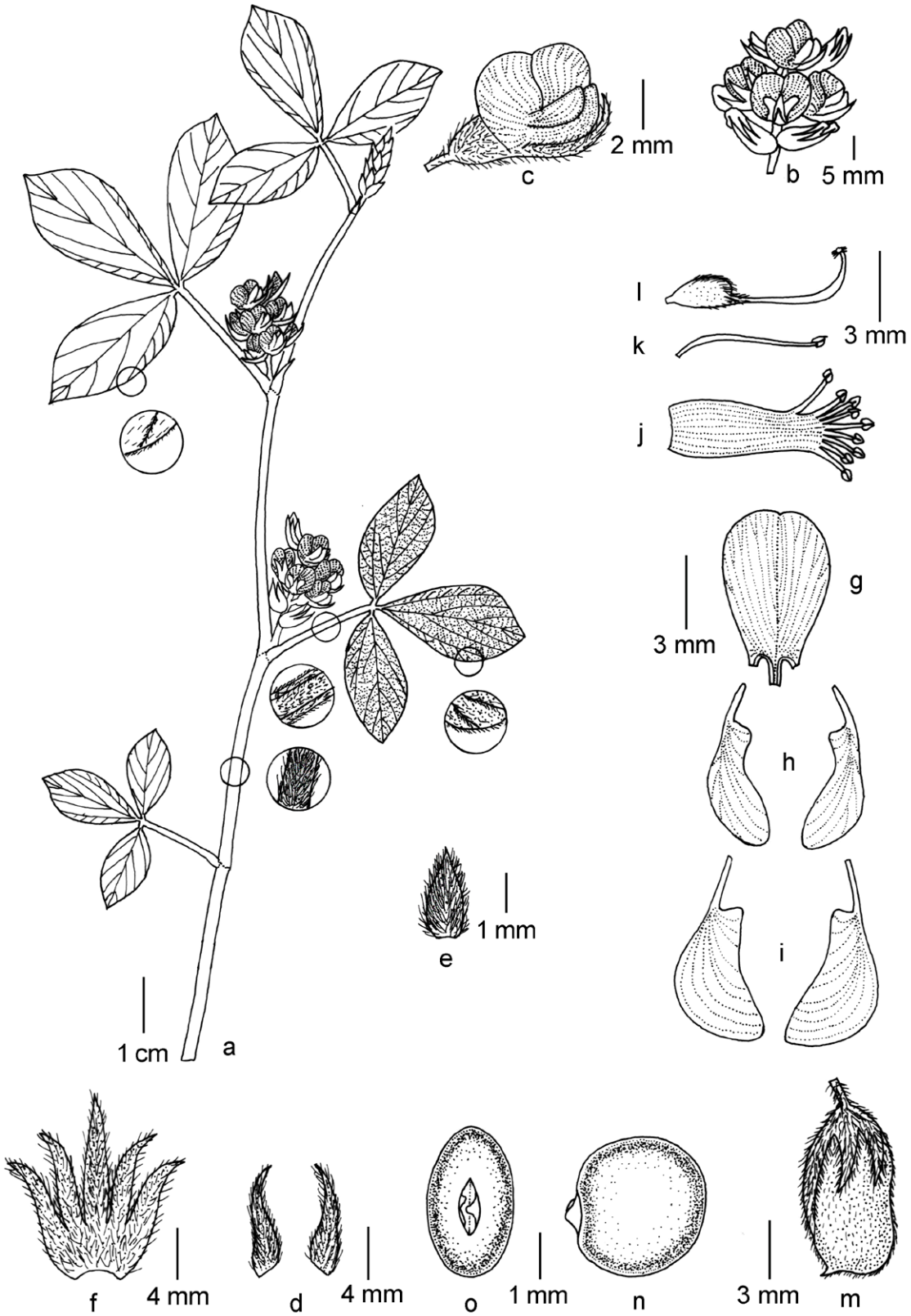


Figure 10. *Flemingia procumbens* Roxb. (a) Habit. (b) Inflorescence. (c) Flower. (d) Stipules. (e) Bract. (f) Calyx, dorsal view. (g) Standard. (h) Wing petals. (i) Keel petals. (j) Fused androecium. (k) Free stamen. (l) Gynoecium. (m) Fruit. (n) Seed, lateral view. (o) Seed, dorsal view.

(≡) *Maughania procumbens* (Roxb.) Mukerjee, Bull. Bot. Soc. Bengal 6(1): 20. 1953 (as *Moghania procumbens*).

Description

Procumbent shrubs, up to 30–45 cm long, branched; stems 2–3 mm in diameter, young triangular, mature terete, hairy; hairs silky, antrorse. Leaves digitately trifoliolate, 7.4–8.6 cm long, stipulate, petiolate; stipules 2, 7–8 × 1–1.5 mm, lanceolate, acuminate with equal tips, fused when young, splitting at maturity, persistent, basifixed, many nerved, hairy; petioles 2–3 cm long, winged, gland-dotted, hairy; leaflets 3, 4.9–5.4 × 2.1–2.4 cm, obovate, acute or acuminate at apex, the central cuneate at base, lateral oblique at base, margin ciliate, hairy on both ventral surfaces; dorsally glabrous, densely hairy on nerves, gland-dotted; glands orange-red; petiolules 2–3 mm long, hairy, gland-dotted. Inflorescences an axillary, solitary raceme; racemes 3–5.5 mm long, longer than the petiole. Flowers 8–9 mm long, pedicellate, bracteate; pedicels 2–2.2 mm long, hairy; bracts 2.2–2 × 1.2–2 mm, ovate to lanceolate, acuminate at apex, many nerved, hairy, gland-dotted. Calyx 7–7.5 mm long, hairy, gland-dotted; calyx tube 1.2–1.5 mm long, campanulate, hairy; calyx teeth 5, 6.2–6.5 × 0.8–1 mm, lanceolate, subequal, lower one the longest, connate for 1/6 of its length, many nerved, hairy, gland-dotted. Corolla whitish pink with pink striations; standards 6–7 × 3.5–4 mm, narrowly cordate, apex retuse, glabrous, clawed with 2 auricles; claw 0.8–1 mm long, auricled; auricles 1 mm or less than 2 mm; wing petals 5–6 × 1.2–1.5 mm, falcate; claw 1.8–2 mm long; keel petals 6–6.5 × 2–2.2 mm, slightly falcate, fused at apex at lower side; claw 2–2.5 mm long. Stamens 10, diadelphous (9+1); staminal tube 4.5–5 × 1 mm, anthers uniform, less than 1 mm long, basifixed, filaments of united stamens 1–1.5 mm long, that of free stamens 6–6.5 mm long. Ovary 2–2.2 × 1.2–1.5 mm, gland-dotted, hairy; ovules 2; style 4.8–5 mm long, glabrous, swollen at middle; stigma globose, hairy. Fruits a pod, 10–12 × 4.5–5 mm, beaked, turgid, slightly septate between seeds or not, densely hairy, densely gland-dotted; beak 1 mm long; glands orange-red, withering post maturity. Seeds 2, 3.5 × 3.5 × 2.5 mm brown, mottled, shiny, rounded; hilum granular, 1 mm long, position ± central.

Etymology

The specific epithet 'procumbens' refers to its procumbent habit.

Distribution

Asia: India (Assam and Uttar Pradesh).

Flowering & fruiting

April to May.

Habitat and ecology

Flemingia procumbens is found growing in Sal forests in shady places. It occasionally occurs in grasslands at low altitudes of ca. 150–200 m asl. It grows in association with *Bridelia retusa* (L.) A.Juss., *Crotalaria* species, *Desmodium triflorum* (L.) DC., *Hemidesmus indicus* (L.) R.Br. ex Schult., *Grewia asiatica* L., *Sida cordata* (Burm.f.) Borss.Waalk., *Shorea robusta* C.F.Gaertn. and *Trichodesma zeylanicum* (Burm.f.) R.Br.

Selection of specimens examined

INDIA, Assam, Brahmaputra plains, *S. Kurz s.n.* (CAL); Uttar Pradesh, Nepal frontier district, Morkatwa, 26 April 1900, Inayat Khan 23620 (LY); Bahraich district, Nand nala, 15 April 1900, *Inayat Khan 23620a* (DD); Gorakhpur district, Chanmokha, 3 April 1898, *Harsukh 21515a* (CAL); 10 & 17 April 1898, *Inayat Khan 21515* (DD, K leg. *Duthie*); 17 April 1898, *Harsukh 21515b* (CAL, DD); Lucknow district, Chandan Chowki, 23 April 1964, *C.L. Malhotra 31545* (BSD); Kishanpur Wildlife Sanctuary, 14 May 2017, *S.K. Gavade & H. Singh 192* (SUK); Lakhimpur Kheri district, Ambara, 10 April 1898, *Inayat Khan 21515* (DD); Dudhwa National Park, April 1985, *L.A. Rodgaro 3875* (WII).

Affinities

Flemingia procumbens shows close resemblance to *F. lineata* but differs from it in its prostrate habit, rather herbaceous branches sprouting from a woody rootstock, having a solitary raceme, hairy leaflets on ventral side, with acute or acuminate apex and orange-red coloured glands on pod.

Taxonomic note

Flemingia procumbens is a distinct species, rarely found.

Nomenclatural notes

The binomial *Flemingia procumbens* was first proposed by Roxburgh in Flora Indica (1832). Wight (1846) used the same name for his plant that was collected from Nilgiri hills. This plant was totally different from Roxburgh's plant. Wight (1846) realized his mistake and corrected the error and spelled the name as *Flemingia neilgherrensis* on a slip that is attached with the type sheets of *F. nilgheriensis* (Cooke 1902).

While describing *Flemingia procumbens*, Roxburgh stated that this plant is native of the mountains of north

of Oude and Rohilcund (now a part of Uttar Pradesh state, India). The protologue does not indicate the type. We could not trace any original specimens of Roxburgh in the relevant herbaria; however, the flowering specimen in Roxburgh's drawing number 1893 from Flora Indica tallies well with characters mentioned in the protologue such as "procumbent, middle leaflet obovate, raceme axillary usually single and about the length of leaf, legumes oval, besprinkled with garnet-coloured glands". In order to fix the application of the name, this illustration was selected as the lectotype.

Flemingia prostrata Roxb. Junior ex Roxb., Fl. Ind. 3: 338. 1832

Type: flowering specimen in Roxburgh drawing number. 1894 (K image!, lectotype designated by Do et al. 2018). Syntype: India, s.d., *s.coll. s.n., Wallich Catalogue Number 5749b* (K-W001122001).

Benth. in Miquel, Pl. Jungh. 2: 245. 1852; Kurz, Forest Fl. Burma 2: 374. 1877; Prain in J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 69(2): 440. 1897. Prain, Bengal Pl. 1:378. 1903; Haines, Bihar Orissa 3: 269. 1922; Sa Ren & Gilbert, Fl. China 10: 232-237. 2010. (Figures 11, 23k, 24j, 25j and 26j).

(=) *Flemingia lamontii* Hance, J. Bot. 16: 10. 1878
Type: China, West River, prov. Cantonensis, May 1875, *J. Lamont 19479* (BM000958665 image!).

(=) *Flemingia philippinensis* Merr. & Rolfe, Philipp. J. Sci., C 3: 103. 1908
Type: Philippines, District of Lepanto, Luzon, November 1905, *E.D. Merrill 4460* (P00709073 image!).

(≡) *Maughania prostrata* (Roxb. Junior ex Roxb.) Mukerjee, Bull. Bot. Soc. Bengal 6(1): 19. 1953 (as *Moghania prostrata*)

Flemingia prostrata Roxb., Hort. Bengal. 56. 1814, *nom. nud.*

Description

Prostrate shrubs, branched stems up to 0.5–1 m long, 3–4 mm in diameter, young triangular, mature terete, hairy; hairs silky, antrorse. Leaves digitately trifoliolate, 7–12 cm long, stipulate, petiolate; stipules 2, 7–9 × 1.5–2 mm, lanceolate, acuminate with equal tips, falcate, fused when young, splitting at maturity, persistent, basifixed, many nerved, hairy; petioles 2.8–5.2 cm long, grooved, gland-dotted, hairy; leaflets 3, 4–8 × 2–3 cm, oblong lanceolate, acute or obtuse at apex, the central cuneate at base, lateral oblique at base, margin ciliate, apex mucronate, hairy on both surfaces, densely hairy on veins, dorsally gland-dotted; glands orange-red; petiolules 1–2 mm long, hairy, gland-dotted. Inflorescences an axillary and terminal raceme; racemes 1–2 in cluster, 2–5 cm long, equal or shorter than the petiole. Flowers 9–10 mm long, pedicellate, bracteate; pedicels 2–2.5 mm long, hairy; bracts 4–5.5 × 1.5–2.5 mm, ovate to lanceolate, acuminate at apex, many nerved, hairy, gland-dotted. Calyx 9–10 mm long, hairy, gland-dotted; calyx tube 1.5–2 mm long, campanulate, hairy; calyx teeth 5, 7–7.5 × 0.8–1 mm, subequal, lower one the longest, lanceolate, connate for 1/5 of its length, hairy, many nerved, gland-dotted. Corolla whitish pink with pink striations; standard 5–6.5 × 5–5.5 mm, rounded, apex blunt, glabrous, clawed with 2 auricles; claw 1–1.5 mm long; auricles 1 mm or less than 1 mm; wing petals 5.5–6 × 1.5–2 mm, oblong, falcate; claw 1.5–2 mm long, auricled; keel petals 6–6.5 × 2.5–3 mm, boat shaped, fused at apex; claw 1.5–2 mm long. Stamens 10, diadelphous (9+1); staminal tube 4–5 × 1 mm, anthers uniform, less than 1 mm long, basifixed, filaments of united stamens 1–2 mm long, that of free stamens 5.5–6 mm long. Ovary 1.8–2 × 0.8–1 mm, gland-dotted, hairy; ovules 2; style 5–5.5 mm long, glabrous, swollen at middle; stigma globose, hairy. Fruits a pod, 11–12 × 4–4.5 mm, beaked, turgid, slightly septate between seeds or not, hairy, sparsely gland-dotted; beak 0.5–0.8 mm long; glands orange or black, withering post maturity. Seeds 2, 2.8 × 2.8 × 2 mm, brown, mottled, shiny, rounded; hilum granular, 1 mm long, position ± central.

Etymology

The specific epithet 'prostrata' refers to the prostrate habit of this species.

Distribution

India (Andhra Pradesh, Assam, Bihar, Chhattisgarh, Haryana, Himachal Pradesh, Jharkhand, Madhya Pradesh, Meghalaya, Odisha, Punjab, Tripura, Uttar Pradesh and Uttarakhand), Bangladesh, China (Hupeh, Kiangsi, Kwangtung, Kweichow, Sechuan, Yunnan), Myanmar, Ryukyu Islands, Taiwan, Thailand, Vietnam.

Flowering and fruiting

January to July.

Habitat and ecology

Flemingia prostrata is found on open grassy hill slopes as well as in *Pinus* forests at high altitude of

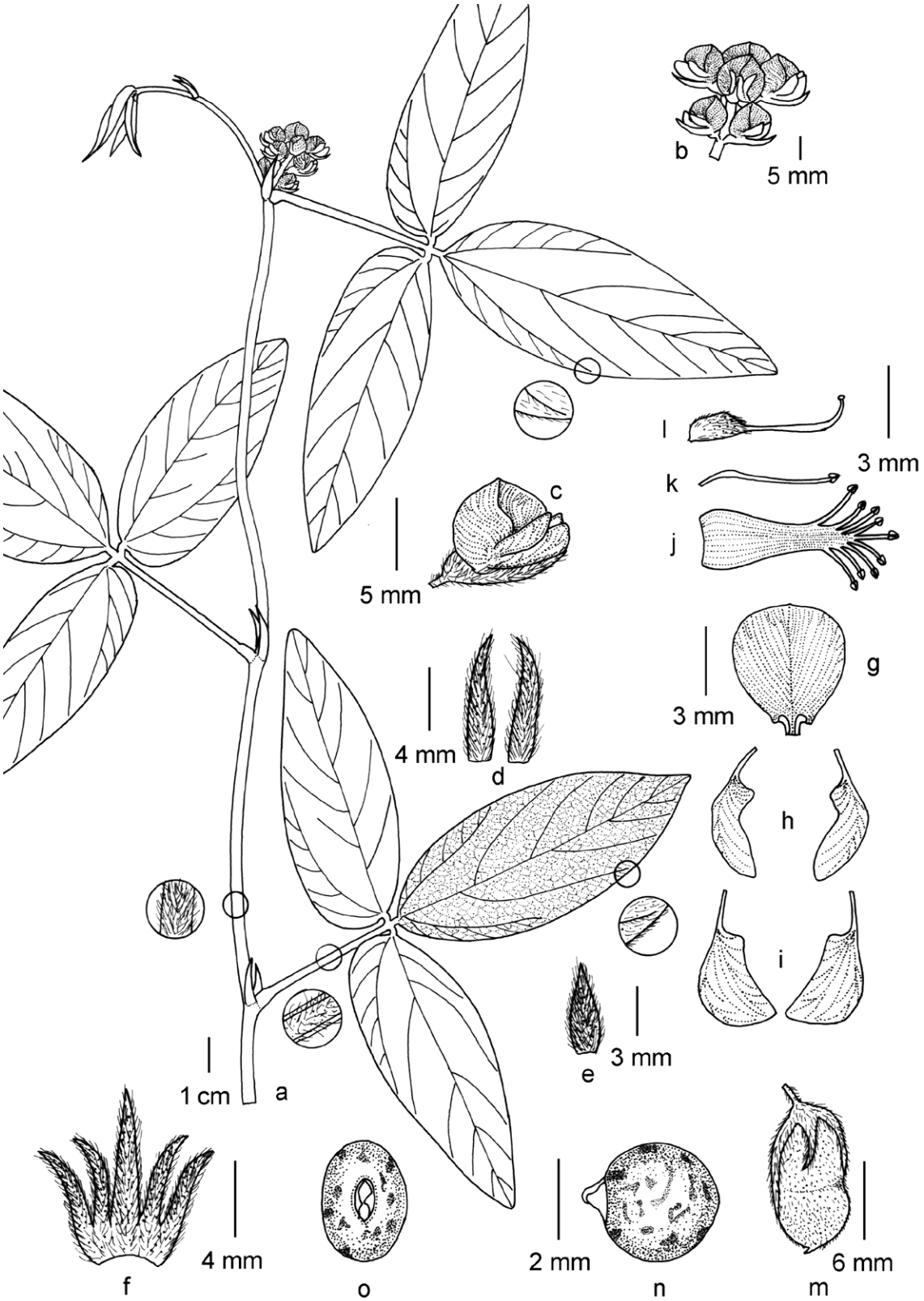


Figure 11. *Flemingia prostrata* Roxb. Junior ex Roxb. (a) Habit. (b) Inflorescence. (c) Flower. (d) Stipules. (e) Bract. (f) Calyx, dorsal view. (g) Standard. (h) Wing petals. (i) Keel petals. (j) Fused androecium. (k) Free stamen. (l) Gynoecium. (m) Fruit. (n) Seed, lateral view. (o) Seed, dorsal view.

ca.1400–1600 m asl, elsewhere from 100-1930 m. It grows in association with *Ageratum conyzoides* L., *Crotalaria pallida* Aiton, *Pinus kesiya* Royle ex Gordon, *Themeda* species and *Thysanolaena* species.

Selection of specimens examined

INDIA, Sukhanaghar, *F. Buchanan-Hamilton s.n., Wallich Catalogue Number 5749a* (K001122000); Andhra Pradesh, Visakhapatnam district, Araku Valley, 15 September 1961, *N.P. Balakrishnan 825* (CAL); *N.P. Balakrishnan 572* (CAL); Assam, 23 October 1955, *R.S. Rao 1476* (ASSAM); Kamrup district, Lukikhas forest, 26 June 1964, *A.S. Rao 39120* (ASSAM); Bihar, Champaran district, Manguraha forest, 12 April 1963, *K. Thothathri 10041* (CAL); Naurangia, 12 September 1965, *S.P. Banerjee 452* (CAL); Chhattisgarh, Raigarh district, Dharamjaigarh, 24 December 1964, *C.M. Arora 7210* (BSA, CAL); Haryana, Yamuna Nagar district, Kalesar forest reserve, 28 December 1919, *R.N. Parker s.n.* (BSD); 29 December 1919, *R.N. Parker s.n.* (DD); Himachal Pradesh, Shimla district, near Shimla, 11 October 1984, *P.K. Hajara 76811* (BSD); Jharkhand, Giridih district, Nimiaghat, 18 October 1982, *G.N. Tribedi 726* (BSA); Madhya Pradesh, Hoshangabad district, on the way Madai to Pachmarhi, 3 May 2001, *B.K. Sinha 54459* (BSA); Jabalpur, Kisti, 14 April 1983, *J. Lal & A. Kumar 34699* (BSA); Meghalaya, East Khasi Hills district, s.d., *G. Mann s.n.* (ASSAM); West Jaintia Hills, on the way to Jowai, 22 November 1969, *N.P. Balakrishnan 50128* (ASSAM); on the way to Jowai to Shangpung, 8 November 1938, *G.R. Deka 17509* (ASSAM); Odisha, Maharajganj district, Domakhand, 24 January 1968, *J.K. Maheshwari 81544* (LWG). Punjab, Hoshiarpur district, 19 July 1971, *O.P. Misra 44605* (BSD); Jawar, 6 September 1970, *O.P. Misra 41734* (BSD); Tripura, West Tripura, Agartala, 26 August 1957, *D.B. Deb 1022* (CAL); Uttar Pradesh, Allahabad district, Lehari, 1 November 1963, *C.M. Arora 1432* (BSA); Bahraich district, Abdullah Ganj, 5 July 1954, *V. Chandra & party 11943* (LWG); 28 November 1954, *P. Singh 16590* (LWG); 17 November 1964, *G. Panigrahi & C.M. Arora s.n.* (CAL); Chakiya forest block, 11 February 1959, *M.A. Rau 8230* (BSA); Murthia gate, 12 March 1964, *G. Panigrahi & C.M. Arora 2888* (CAL); Nishan Gara, 20 November 1964, *G. Panigrahi & C.M. Arora 6458* (BSA); on the way to Sujauli to Dharampur, 20 November 1964, *G. Panigrahi & C.M. Arora 6458* (CAL); Balrampur district, Sohelura, 16 October 2005, *K.K. Khanna 48086* (BSA); 17 October 2005, *K.K. Khanna 54956* (BSA); Gonda district, Balrampur, February 1898, *Inayat Khan 20964* (DD); Kushinagar district, Mathauli, 15 April 1992, *S.L. Kapoor 57* (LWG); Suhelwa Wildlife Sanctuary, 29 November 1954, *G.S. Srivastava 16684* (LWG); *G. Saran & Party 16684* (LWG); Lakhimpur Kheri district, 5 June 1900, I*nayat Khan 23619* (DD); 4 April 1898, *Inayat Khan 21510a* (DD); Daibhor, 23 April 1898, *Harsukh 21509* (DD); Dudhwa National Park, near Salukapur rest house, 20 October 1994, *B.P. Uniyal 88935* (BSD); Gola, 4 April 1898, *Inayat Khan 21510* (DD); Gola camp number 2, 7 May 2006, *B.K. Shukla 65978* (BSA); Mailam, 18 April 1964, *C.L. Malhotra 31452* (BSD); Pilibhit district, Bargad, 24 May 1898, *Inayat Khan 21511* (DD); Mala forest, 6 December 1946, *D.D. Avasthi 318* (LWG); Uttarakhand, Rajaji National Park, November 1986, *SSRB 1198* (WII); Almora district, Almora, s.d., *D.D. Avasthi 1258* (LWG); Gairar, 17 October 1975, *J.N. Vohra 57980* (BSD); on the way Almora to Kalmatia, 2 October 1967, *T.A. Rao 4707* (BSD); Dehradun district, Dehradun, December 1956, *T.A. Rao 1239* (BSD); Lachhiwala, 5 October 1922, *K. Ram s.n.* (DD); Mussoorie, November 1995, *W.A. Rodgers 4627* (WII); Rispana, 1 November 1964, *C.R. Babu 34615* (BSD); Thano, December 1935, *N.L. Debverma s.n.* (DD); Timli, 15 October 1949, *S.K. Jain s.n.* (LWG); 24 October 1949, *R. Singh s.n.* (LWG); Chamoli district, Nandaprayag, 26 August 1978, *G. Panigrahi 65413* (BSD); Haridwar district, Dholkhand forest, 7 May 1994, *A. Prakash 214578* (LWG); Nainital district, Ramnagar, 21 April 1958, *M.A. Rau 5282* (BSD); Garhwal division, Pharkot reserve forest, 5 December 1919, *B.B. Osmaston 1133* (DD); Trisul, 20 October 1970, *B.D. Naithani 42275* (BSD); Kumaon division, Baram Gori valley, 24 April 1962, *U.C. Bhattacharya 21221* (BSD); Jim Corbett National Park, 9 November 1970, *P.C. Pant 43085* (BSD); on the way Sarpduli to Dhikala road, 27 November 1972, *K.P. Janardhanan 51232* (BSD); Sitabani, 11 February 1922, *B.B. Osmaston 1188* (DD); Pithoragarh district, Lekghati, 13 October 2013, *M. M. Lekhak s.n.* (SUK); 1 August 2015, *S.K. Gavade & M.M. Lekhak 84* (SUK); 17 June 2016, *S.K. Gavade & M.M. Lekhak s.n.* (SUK); 2 August 2016, *S.K. Gavade & M.M. Lekhak s.n* (SUK); 19 September 2016, *S.K. Gavade & M.M. Lekhak 143* (SUK); 8 July 2017, *S.K. Gavade & M.M. Lekhak 195* (SUK); 6 July 2018, *S.K. Gavade & M.M. Lekhak 214* (SUK); Milankuli, 12 September 1983, *B. Baon 75030* (BSD); Askot, 29 May 1984, *J.F. Duthie 2835* (DD); 3 September 1971, *C.M. Arora 45509* (BSD); Tehri Garhwal district, Tehri, 22 January 1942, *M.B. Raizada 15630* (DD); Udham Singh Nagar district, Khatima, 22 October 1986, *K.K. Singh 5929* (LWG).

Affinities

Flemingia prostrata shows affinities towards *F. angustifolia* but differs from it in its oblong lanceolate leaflets, inflorescence shorter than the petiole and

prostrate habit. The seedlings of *Flemingia praecox* var. *robusta* look similar to those of *F. prostrata*.

Taxonomic note

Flemingia lamontii was described by Hance (1878) from China, while *Flemingia philippinensis* was described by Merrill and Rolfe (1908) from the Philippines. After studying the protologue and types of *F. lamontii* and *F. philippinensis*, it was found that these species are conspecific to *F. prostrata* (see also Sa Ren & Gilbert 2010).

Nomenclatural notes

Do et al. (2018) designated a lectotype for the binomial *Flemingia prostrata*. They selected the flowering specimen in Roxburgh drawing number 1894 as lectotype. The binomial *Flemingia prostrata* was given by Roxburgh Junior, son of Roxburgh and the taxon was described by Roxburgh in 'Flora Indica'. While searching the original material of *F. prostrata* we found a sheet at K (K-W001122001) and a coloured plate. The sheet bears Roxburgh's handwriting as '*Hedysarum* a new, undetermined species' which is filed under *F. capitata* at K. This could have been chosen by Do et al. (2018) as the type.

Flemingia semialata Roxb., in W.T. Aiton, Hortus Kew., ed. 2. 4: 349. 1812

Type: India, without precise locality, s.d., *W. Roxburgh s.n.* (K001121982 image!, lectotype designated by Gavade et al. 2016b: 76; isolectotype BR0000005172993 image!).

Roxb., Pl. Coromandel 3(3): 45. t. 249. 1820; Roxb., Fl. Ind. 3: 340. 1832; Wight & Arnott, Prodr. Fl. Ind. Orient. 1: 241. 1834; Wight, Icon. Pl. Ind. Orient. 2(1): 1, t. 226. 1843; Benth. in Miquel Pl. Jungh. 2: 245. 1852; Kurz, Forest Fl. Burma 2: 374. 1877; Prain in J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 69(2): 441. 1897; Prain, Bengal Pl. 1: 378. 1903; Haines, Bihar Orissa 3: 269. 1922; Gamble, Fl. Madras 1: 378. 1928; Sanjappa, Legumes of India 178. 1992; Kothari in N.P. Singh et al., Fl. Maharashtra, Dicot. 2: 688. 2001. (Figures 12, 23l, 24k, 25k and 26k).

(≡) *Flemingia congesta* var. *semialata* Baker, in Hook. f., Fl. Brit. India 2: 229. 1876.

(≡) *Maughania semialata* (Roxb.) Mukerjee, Bull. Bot. Soc. Bengal 6(1): 16. 1953. (as *Moghania semialata*).

Flemingia semialata Roxb., Hort. Bengal. 56. 1814, *nom. nud.*

Hedysarum semialatum Roxb., Numer. List n. 5746g. 1831, *nom. nud.*

Description

Erect shrubs, up to 1.2–1.5 m tall, with profusely branched stem; stems 8–10 mm in diameter, young triangular, mature terete, hairy; hairs silky, antrorse. Leaves digitately trifoliolate, 5–22 cm long, stipulate, petiolate; stipules 2, 13–14 × 2–2.5 mm, lanceolate, acuminate with equal tips, fused when young, splitting at maturity, persistent, basifixed, many nerved, hairy; petioles 2–7 cm long, distinctly winged, gland-dotted, hairy; leaflets 3, 3–13 × 2–5.5 cm, broadly lanceolate, the central cuneate at base, lateral oblique at base, margin ciliate, apex mucronate, glabrous on both surfaces, except on veins, dorsally gland-dotted; glands orange-red; petiolules 2–5 mm long, hairy, gland-dotted. Inflorescences axillary and terminally branched racemes; racemes 1–5 per axil. Flowers 10–13 mm long, pedicellate, bracteate; pedicels 1–2 mm long, hairy; bracts 3–3.5 × 1–1.5 mm, ovate to lanceolate, acuminate at apex, many nerved, hairy, gland-dotted. Calyx 9–10 mm long, hairy, gland-dotted; calyx tube 1.5–2 mm long, campanulate, hairy; calyx teeth 5, 3.5–6 × 1–1.5 mm, lanceolate, subequal, lower one the longest, connate for 1/4 of its length, many nerved, hairy, gland-dotted. Corolla pale green with pink striations; standard 9–10 × 7–8 mm, rounded to elliptic, apex retuse, glabrous, clawed with 2 auricles; claw 1.8–2 mm long; auricles 1 mm or less than 1 mm; wing petals 7–8 × 2–2.5 mm, oblong; claw 1.8–2 mm long; keel petals 9–10 × 3–4 mm, falcate, fused at apex at lower side; claw 2.5–3 mm long. Stamens 10, diadelphous (9+1); staminal tube 6.5–7 × 1 mm, anthers uniform, less than 1 mm long, basifixed, filaments of united stamens 2–2.5 mm long, that of free stamens 8–9 mm long. Ovary 2–2.5 × 1 mm, gland-dotted, hairy; ovules 2; styles 6–7 mm long, glabrous, swollen at middle; stigma globose, hairy. Fruits a pod, 13–14 × 6–7 mm, beaked, turgid, slightly septate between seeds or not, hairy, sparsely gland-dotted; beak 1 mm long; glands orange-red, withering post maturity. Seeds 2, 3 × 3 × 3 mm black, shiny, rounded; hilum granular, 1 mm long, position ± central.

Etymology

The specific epithet 'semialata' refers to its half or partially winged petiole.

Distribution

Asia: Bangladesh, China (Guangdong, Hongkong, Szechwan, Yunnan), India (Assam, Arunachal Pradesh, Chhattisgarh, Himachal Pradesh, Jammu and Kashmir,

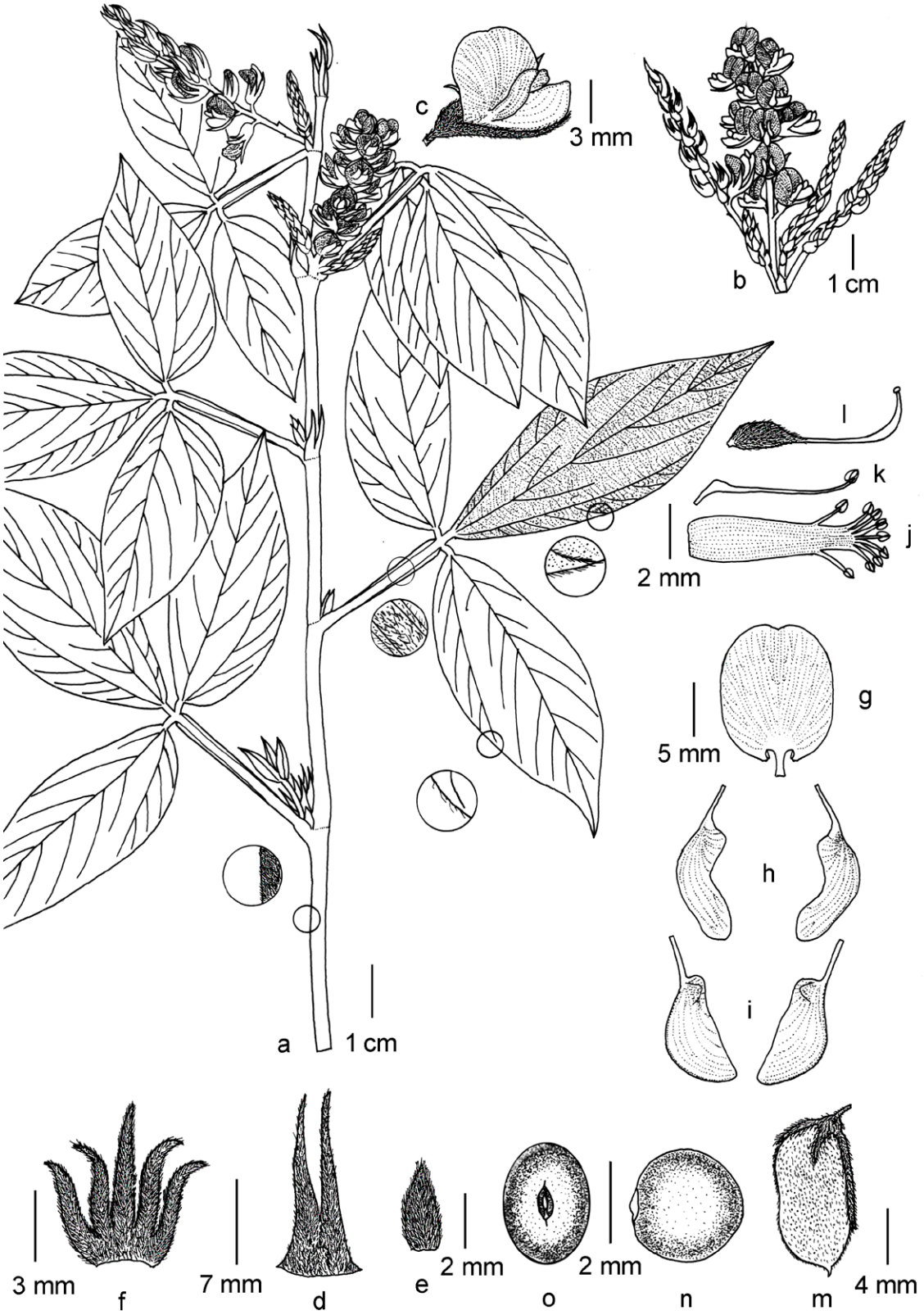


Figure 12. *Flemingia semialata* Roxb. (a) Habit. (b) Inflorescence. (c) Flower. (d) Stipules. (e) Bract. (f) Calyx, dorsal view. (g) Standard. (h) Wing petals. (i) Keel petals. (j) Fused androecium. (k) Free stamen. (l) Gynoecium. (m) Fruit. (n) Seed, lateral view. (o) Seed, dorsal view.

Jharkhand, Madhya Pradesh, Meghalaya, Nagaland, Rajasthan, Sikkim, Uttarakhand and West Bengal), Laos, Myanmar, Sri Lanka, Vietnam. Australia: introduced in Queensland. Africa: introduced in PR Congo..

Flowering and fruiting

August to March.

Habitat and ecology

Flemingia semialata occurs in Sal forests. It also grows in moist forests at altitudes of ca. 500–1000 m asl, in Yunnan up to 2600 m asl. It grows in association with *Ageratum conyzoides* L., *Ampelocissus tomentosa* (Roth) Planch., *Ardisia* species, *Bauhinia vahlii* Wight & Arn., *Costus speciosus* (J.Koenig) Sm., *Dioscorea pubera* Blume, *Grewia eriocarpa* Juss., *Millettia extensa* (Benth.) Benth. ex Baker, *Shorea robusta* C.F.Gaertn., *Syzygium cumini* (L.) Skeels, *Urena lobata* L., *Zingiber* species, etc.

Selection of specimens examined

INDIA, Arunachal Pradesh, Anjaw district, Hayuliang, 22 November 1957, *R.S. Rao 10740* (CAL); 25 November 1958, *R.S. Rao 10812* (CAL); Assam, Kamrup district, Lukithan forest, 26 June 1964, *A.S. Rao 39120* (CAL); s.d., *Simons s.n.* (MH); Bihar, Madhubani district, Mailam, 8 December 1960, *C.L. Malhotra 13398* (BSD); Chhattisgarh, Bilaspur District, s.d., *P. Lal 78901* (BSD); Mungeli district, Lamni, 11 September 2015, *S.K. Gavade & A.P. Tiwari 93* (SUK); Eastern Himalaya, Rongsong, 18 November 13, *G.H. Cave s.n.* (CAL); Himachal Pradesh, Kangra district, Baijnath, 23 September 1960, *M.A. Rau 12640* (BSD); Mangland stream, 29 September 1891, *J.H. Lace 1062* (CAL); Mandi district, 25 September 1984, *S.K. Shrivastav 76139* (BSD); Palampur, 20 October 1984, *P.K. Hajara 76928* (BSD); Madhya Pradesh, Anuppur district, Amarkantak, Maa Ki Bagiya area, *S.L. Bondya & A.N. Shukla 62011* (BSA); 28 October 1960, *J.K. Maheshwari 4268* (CAL), *J.K. Maheshwari 4349* (CAL), *J.K. Maheshwari 4348* (CAL); Sonmala, 15 November 1984, Madhukar 7208 (BAMU); *V.N. Naik 7208* (BAMU); Bastar district, Kutumsar, s.d., *A.N. Singh s.n.* (BSA); Hoshangabad District, Bori Wildlife Sanctuary, November 1988, *W.A. Rodgers 7009* (WII); Mandla district, Kanha Tiger Reserve, 12 September 1982, *J. Lal & A. Kumar 33178* (BSA); Meghalaya, East Khasi Hills district, North-Eastern Hill University, 22 December 2016, *S.K. Gavade 154* (SUK); Shillong, Beadon Falls, 16 August 1918, *U. Kanjilal 2428* (ASSAM); Khasi hills, s.d., *D. Griffith 1108* (DD); s.d., *Gustav Mann s.n.* (DD); Shillong, 26 November 1962, *S. Chaterjee 25235* (CAL); 22 December 2016, *S.K. Gavade 200* (SUK); Pyangtong, 5 November 1938, *S.R. Sharma 18222* (ASSAM); West Jaintia Hills, on the way to Jowai, 15 September 1976, *U. Chatterjee & N.C. Soha 13632* (CAL); Sutnga, 19 November 1969, *N.P. Balakrishnan 50016* (CAL); Khasia Hills, s.d., *J.D. Hooker & T. Thomson s.n.* (MH); Jammu and Kashmir, Reasi district, Katra, 19 October 1986, *A. Swami 1033* (BSD); Jharkhand, Giridih district, Parasnath hills, 30 October 1953, *F.H.W. Kerr 2394A* (BM), 9 October 1995, *S.K. Mukerjee 3914* (CAL); on the way to Hazaribagh to Parasnath, 28 December 1906, H.H. Haines 596 (DD); s.d., *Thomson s.n.* (DD); Latehar district, Netarhat, 28 September 1981, *M.K. Manna & U.P. Saradar 1027* (CAL); Nagaland, Kohima, 22 October 1884, *C.B. Clarke 41738* (US); Rajasthan, Udaipur, October 1963, *L.N. Vyas s.n.* (BSD); Sikkim, 15 October 1870, *C.B. Clarke 13170* (CAL), Mongpo, 5 October 1884, *C.B. Clarke 36454 D* (US), Rangeet river, 3 January 1922, *G.H. Cave s.n.* (CAL); Uttarakhand, Almora district, Chiphluwa forest, March 1951, *D.D. Awasthi 1585* (DD); Ranikhet, 4 November 1917, *H.G. Champion s.n.* (DD); Chamoli District, Nandkeshari, 6 October 1963, *U.C. Bhattacharya 31078* (BSD); Tapovan, September 1980, *B.D. Naithani 53757* (BSD); Dehradun district, Chandrabani, 10 October 2015, *S.K. Gavade 107* (SUK); Dehradun, 4 October 1957, *Y. K. Sarin 3436* (BSD); 1881, *Duthie 1538* (DD); September 1882, *Duthie 2515* (DD); behind the bungalow number 09, *R. Dayal 2653* (DD); Bindal Rao, 22 September 1956, *T.A. Rao 944* (BSD); Chandrabani, 10 October 2015, *S.K. Gavade & P.B. Yadav 99* (SUK); s.d., *K.M.M. Dakshini s.n.* (BSD); Karvapani, March 1898, *U. Kanjilal s.n.* (DD); Lachhiwala, 22 September 1989, 9019 (DD); 7 November 1903, *R.S. Hole s.n.* (DD); Mussoorie, s.d., October 1899, *Duthie s.n.* (DD); Mussoorie, Kempty Falls, 9 October 1960, *H.O. Saxena 1393* (DD); near Birpur, September 1939, *M.B. Raizada s.n.* (DD); near Genetic Nursery, 22 September 1972, *H.B. Naithani 3905* (DD); Sahastradhara, 15 September 1962, *S.K. Malhotra 23818* (BSD); Mathurawala, 3 January 1962, *S.K. Malhotra 19158* (BSD); Mohand, October 1984, *V.S. Murty & A.K. Goal 1115* (BSD); Mothronwala swamp, 12 September 1958, *K.M.M. Dakshini 6215* (BSD); Bimdai, 4 September 1964, *C.R. Babu 34038* (BSD); Rajpur, 30 October 1960, *H.O. Saxena 1437* (DD); 10 September 1961, *H.O. Saxena 2204* (DD); Tiri, 22 January 1942, *M.B. Raizada 15636* (DD); Thano, 2 November 1904, *R.S. Hole s.n.* (DD); Wildlife institute campus, 18 September 1993, *Babu & Shyamlal 4965* (WII); Rispana, 20 September 1964, *C.R. Babu 34798* (BSD); Rajaji National Park, 1984, *W.A. Rodgers 3177* (WII); Nainital district, Jim Corbett National Park, on the way to Sultan, 9 October 1980, *P.C. Pant 72414* (BSD); 15 April 1971, *P.C. Pant 43538* (BSD); Ranibagh, 2 December 1980, *U. Singh 743* (BSA); Pauri Garhwal

district, Adwani road, 20 October 1975, *H.B. Naithani 419* (DD); Pithoragarh district, Gori valley, Baramgaon, 27 August 1900, *Inayat Khan 24334* (DD); Lekghati, 13 October 2013, *M.M. Lekhak s.n.* (SUK); 10 August 2015, *S.K. Gavade & M.M. Lekhak s.n.* (SUK); 1 September 2015, *S.K. Gavade & M.M. Lekhak s.n.* (SUK); 20 September 2015, *S.K. Gavade & M.M. Lekhak 95* (SUK); 13 February 2016, *S.K. Gavade & M.M. Lekhak 125* (SUK); Shandev, September 1990, *B. Balodi 79223* (BSD); Dafia Dhura, 29 August 1973, *C.M. Arora 50095* (BSD); 5 September 1973, *C.M. Arora 52404* (BSD); Rudraprayag district, Gaurikund, *K. Ram 8959* (DD); on the way to Phata to Triyuginarayan, 23 September 1958, *M.A. Rau 8520* (BSD); Uttarkashi district, Naitwar, 13 August 1996, *B. Balodi 89748* (BSD); 17 September 1995, *B. Balodi 88607* (BSD); on the way to Mori to Naitwar, 17 September 1995, *S. Singh 89827* (BSD); Uttar Pradesh, Lakhimpur Kheri district, Dudhwa National Park, 29 October 1979, *U. Shukla 69988* (BSD); December 1986, *W.A. Rodgers 5723* (WII); Saharanpur district, Saharanpur, 10 June 1845, *Thomson s.n.* (DD); Shahjahanpur district, Shahjahanpur, 1877, *Duthie s.n.* (DD); Siwaliks, 18 January 1899, *U. Kanjilal s.n.* (DD); West Bengal, Darjeeling district, Darjeeling, 20 September 1875, *J.S. Gamble 509e* (DD); s.d., *J.D. Hooker & T. Thomson s.n.* (MH); East Bengal, s.d., *D. Griffith 1669* (DD).

Affinities

Flemingia semialata shows close affinities towards *F. macrophylla* and *F. sootepensis* but differs from *F. macrophylla* in its branched raceme, which is longer than the leaf petiole, winged petiole and shiny black seeds. It differs from *Flemingia sootepensis* in having sparsely gland-dotted pod and calyx and shiny black seeds.

Taxonomic note

Flemingia semialata was validly published by Aiton (1812) in Hortus Kewensis. Baker (1876) treated *F. semialata* as a variety under *F. congesta* (≡ *F. macrophylla*), i.e. *F. congesta* var. *semialata*. However, many botanists (Wight 1843; Prain 1897; Haines 1922; Gamble 1928; Mukerjee 1953; Sanjappa 1992) agreed with Roxburgh and recognised *Flemingia semialata* as a distinct species. We also keep *F. semialata* at specific rank.

Nomenclatural notes

Roxburgh described *Flemingia semialata* based on the plants that were growing in Calcutta Botanic Garden. The plants were obtained from the seeds sent by Dr. Buchanan from Nepal (Roxburgh 1832). A search for the type revealed four specimens in relevant herbaria, namely at BR (BR0000005172993), K (K-W001121982) and OXF (OXF00006050, OXF00006051). The specimen at BR was purchased by Martius, the founder of Flora Brasiliensis, from Linnean Society of London in 1863 (Forman 1997). The specimen at K (K-W001121982) bearing the Wallich's catalogue number 5746a, was collected by Roxburgh (Wallich 1831). The other two specimens at OXF also bear a stamp as 'Roxburgh', but the annotations are not by Roxburgh. Hence, they have not been considered here as a part of original material. Among the two specimens, the specimen with annotation "*Hedysarum semialatum*, a new species from Napaul" by the original author was chosen as the lectotype (Gavade et al. 2016b). The specimen at BR (BR0000005172993) serves as the isolectotype.

Flemingia sootepensis Craib, Bull. Misc. Inform. Kew 1911(1): 43

Type: Thailand, (formerly Siam). Chiang Mai, Doi Suthep mountain range, 600–900 m, 16 January 1910, *Kerr 934* (K000980302 image!, lectotype designated by Gavade et al. 2017: 283; isolectotype BM000958671 image!, BM000958672 image!, C10021947 image!, CAL!, E00157794 image!, K000980303 image!, K, P00709078 image! and TCD0016124 image!). Syntypes: Thailand (formerly Siam), Chiang Mai, Doi Sootep mountain range, 1 January 1905, *Hosseus 309* (M0168856 image! and P00709079 image!). (Figures 13, 23m, 24l, 25l and 26l).

Description

Erect shrubs, up to 1.5–2 m tall, with branched stem; stems 0.5–1 cm in diam., mature terete, young angled, hairy; hairs white silky. Leaves digitately trifoliolate, 15–29 cm long, stipulate, petiolate; stipules 2, 18–20(-28) × 2–3(-4) mm, lanceolate, acuminate with equal tips, fused when young, separating at maturity, caducous, basifixed, many nerved, hairy; hairs silky, antrorse; petioles 3.5–7 cm long, distinctly winged, gland dotted beneath, hairy; hairs antrorse; leaflets 3, 11.5–21.6 × 2.7–6.5 cm, lanceolate, the central cuneate at base, lateral oblique at base, margin ciliate, apex mucronate, sparsely hairy on ventral surface, dorsally glabrous, except on veins, gland dotted below; glands orange-red when fresh; petiolules 3–6 mm long, hairy, glandular. Inflorescence axillary raceme; racemes up to 3–6 in cluster. Flowers 0.9–1 cm long, pedicellate, bracteate; pedicels 1–2 mm long, hairy; bracts 4-6 × 2 mm, ovate, acute at apex, many nerved, hairy, margin ciliate. Calyx 7–8 mm long, hairy, dotted with glands; calyx tube 1–1.5 mm long, campanulate, hairy; calyx teeth 5, 6–7 × 1–1.5 mm, lanceolate, subequal, connate for 1/4 of its

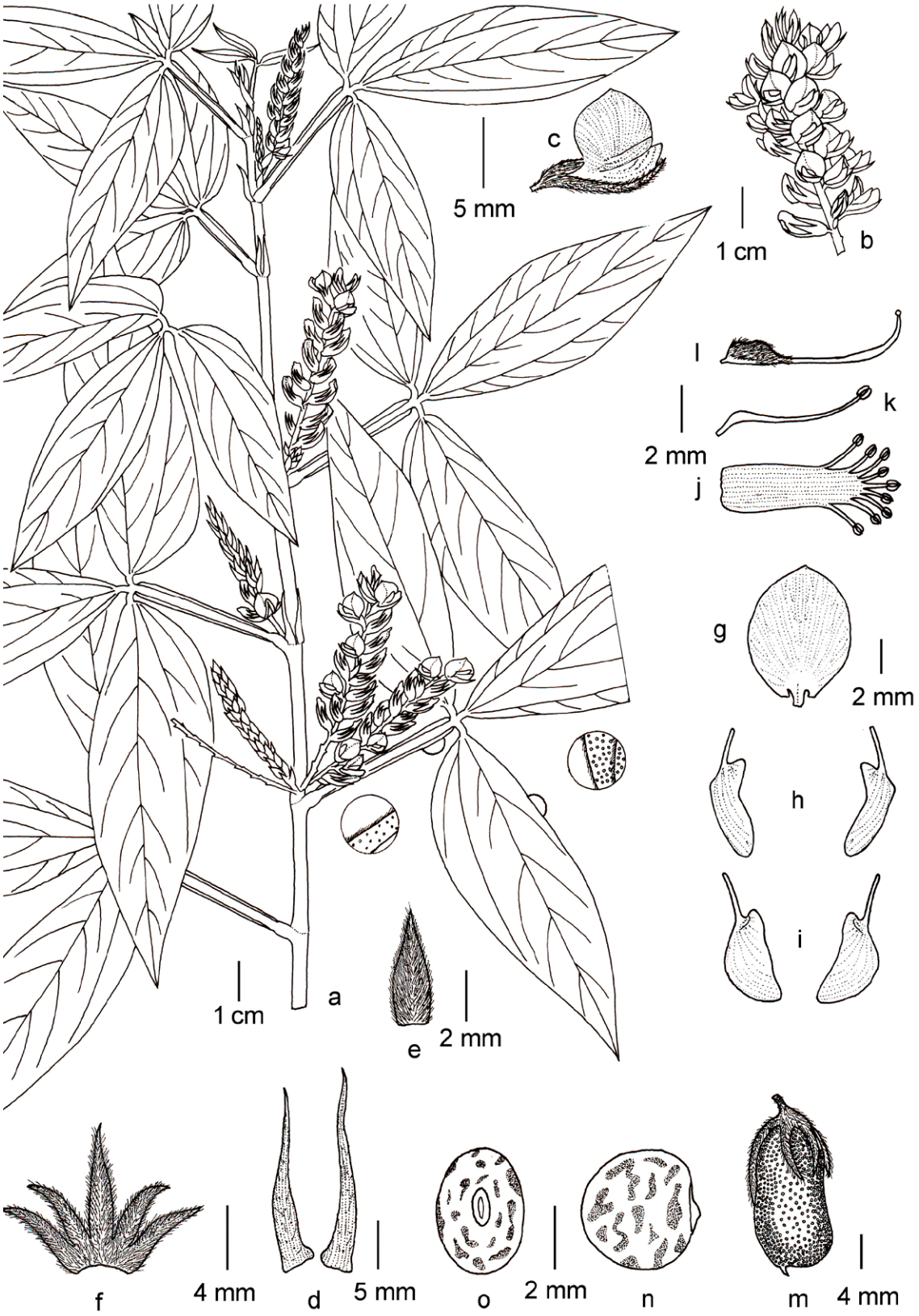


Figure 13. *Flemingia sootepensis* Craib. (a) Habit. (b) Inflorescence. (c) Flower. (d) Stipules. (e) Bract. (f) Calyx, dorsal view. (g) Standard. (h) Wing petals. (i) Keel petals. (j) Fused androecium. (k) Free stamen. (l) Gynoecium. (m) Fruit. (n) Seed, lateral view. (o) Seed, dorsal view.

length, hairy, many nerved, gland dotted more densely at the tip. Corolla pale green with pink or orange striations, often reported as white; standard 8–6 mm, elliptic, apex slightly pointed, glabrous, clawed with 2 auricles; claw 1.5 mm; auricles 1 mm or less; wing petals 7 × 2 mm, oblong; claws 2 mm long; keel petals 8 × 3.5 mm, fused at apex, falcate; claws 2–2.5 mm long. Stamens 10, diadelphous (9+1); staminal tube 4–5 × 1 mm long, anthers uniform, less than 1 mm long, basifixed, filaments of united stamens 1–2.5 mm long, that of free stamens 6–6.5 mm long. Ovary 2 × 1 mm, glandular, hairy; ovules 2; styles 4–5 mm long, glabrous, swollen at middle; stigma globose, hairy. Fruits a pod, 1.6 × 0.6 cm, beaked, turgid, septate between seeds, tomentose, glandular; beak less than 1 mm long; glands orange-red, falling post maturity. Seeds 2, 3 × 3 × 2 mm brown, mottled, shiny, rounded; hilum granular, 1 mm long, position ± central.

Etymology

The specific epithet 'sootepensis' is named after the type locality Chiang Mai, Doi Sootep mountain range.

Distribution

Asia: China (Guangdong, Yunnan), India (Goa, Karnataka and Maharashtra), Laos, Malaysia (Penang), Myanmar and Thailand.

Flowering and fruiting

India: January to March. Elsewhere: October to December.

Habitat and ecology

The species is found along roadsides and on hill slopes in southern parts of the Western Ghats. It also grows in semi-evergreen forests and along streams at 160-1600 m asl. Common associates are *Abutilon persicum* (Burm.f.) Merr., *Ageratum conyzoides* L., *Bambusa bambos* (L.) Voss, *Caryota urens* L., *Eupatorium odoratum* L., *Flemingia strobilifera* (L.) W.T.Aiton, *Helicteres isora* L., *Hemidesmus indicus* (L.) R.Br., *Holigarna grahamii* Kurz, *Ischaemum* species, *Lantana camara* L., *Leucas stelligera* Wall. ex Benth., *Rungia elegans* Dalzell & A.Gibson, *Selaginella* species, *Sida acuta* Burm.f., *Strobilanthes callosa* Nees, *Thespesia lampas* (Cav.) Dalzell & A.Gibson and *Triumfetta pilosa* Roth.

Selection of specimens examined

INDIA, Goa, North Goa district, Mopa Village, 12 July 2015, *S.K. Gavade & M.M. Lekhak 75* (SUK); Karnataka, Uttara Kannada district, Ulvi forest, 5 November 2015, *S.K. Gavade, 130* (SUK); Kerala, Malappuram district, Calicut University campus, 12 February 1982, *A. Rajini, 178* (CALI); Nilambur, 14 January 1989, *N.B. Shreedevi 903* (CALI); Thiruvananthapuram district, Attayar, 22 December 1987, *N. Mohanan 9142* (CALI); Bonacaud, 22 December 1988, *N. Mohanan, 7940* (CALI); Neyyar, 16 November 1988, *M. Beena, 3905* (CALI); 16 November 1988, *M. Sebastian, 1507* (CALI); Maharashtra, Kolhapur district, Tillarinagar, 14 December January 2014, *S.K. Gavade & M.M. Lekhak 9* (SUK); 20 January 2015, *S.K. Gavade 19* (SUK); 15 February 2015, *S.K. Gavade 28* (SUK); 15 March 2015, *S.K. Gavade 36* (SUK!); Tamil Nadu, Salem district, Yercaud, 16 December 1982, *V.T. Nanadkumar s.n.* (CALI). **THAILAND**, Chaiyaphum, 15 December 1971, *C.F. van Beusekom et al. 4313* (BKF, C, L); Chiang Mai, Ban Lawm, 12 January 1991, *J.F. Maxwell 62* (L); Ban Mae Yang Ha, 21 December 1990, *J.F. Maxwell et al. 84* (L); Doi Chiang Dao, 25 December 1921, *N. Put 4539* (L); 28 December 1962, *K. Bunchuai 1275* (L); 10 January 1975, *R. Geesink, P.H. Hiepko & C. Phengklai 8207* (L); 6 January 1989, *J.F. Maxwell 25* (L); Doi Pha Hom Pok National Park, 25 February 1958, *T. Sørensen 1631* (C, L); Doi Suthep-Pui National Park, 8 February 1957, *T. Smitinand 3772* (L); 28 October 1958, *T. Sørensen 5951* (L); 21 November 1987, *J.F. Maxwell 1469* (L); 23 January 1988, *J.F. Maxwell 86* (L); 5 March 1990, *J.F. Maxwell 279* (L); 22 December 1992, *J.F. Maxwell 847* (L); 10 January 1994, *N. Fukuoka & H. Koyama 62123* (L); Fang, 11 January 1975, *R. Geesink 8221* (L); Mae Sao, 11 February 1983, *H. Koyama et al. 33376* (L); 4 January 1991, *J. F. Maxwell 35* (L); Payap, 16 December 1965, *E. Hennipman 3373* (L); Chiang Rai, Doi Huay Nam Rin, 23 December 1994, *J.F. Maxwell 1302* (L); Kuhn Jae National Park, 18 November 1997, *J.F. Maxwell 1374* (L); Kanchanaburi, 15 November 1971, *C.F. van Beusekom 3785* (L); Lampang, Doi Kuhn Dahn National Park, 24 December 1993, *J.F. Maxwell 1531* (L); 28 December 1993, *J.F. Maxwell 1568* (L); Jae Sawn National Park, 2 December 1995, *J.F. Maxwell 1236* (L); 14 February 1996, *J.F. Maxwell 205* (L); Phayao, Doi Luang National Park, 22 December 1997, *O. Petrmitr 179* (L); 26 December 1997, *O. Petrmitr 205* (L); 23 January 1998, *O. Petrmitr 259* (L); 8 March 1998, *J.F. Maxwell 234* (L); 13 February 2001, *J.F. Maxwell 67* (L); 14 November 2001, *W. Sankamethawee 342* (L); 5 April 2003, *K. Kansuntisukmongkol 223* (L); 20 February 2004, *J.F. Maxwell 94* (L); 22 April 2004, *R. Pooma, K. Phattarahirankanok, S. Sirimongkol & M. Phupath 4553* (L); 1 February 2006, *J.F. Maxwell 88* (BKF, L); 1 February 2006, *P. Suvarnakoses 991* (L).

Affinities

Flemingia sootepensis resembles *F. macrophylla* in its habit, inflorescence type, leaf shape, stipule shape and pod shape. However, it differs from the latter in petiole structure, leaflet size and more slender shape, long-acuminate leaflet apex, longer inflorescence, stipule nature and denser glands on the pod. Niyomdham (1992) treated *Flemingia sootepensis* as a variety of *F. macrophylla*, i.e. *F. macrophylla* var. *sootepensis* (Craib) Niyomdham. Based on the perusal of protologue and examination of live specimens of *F. macrophylla*, we decided that *F. sootepensis* is a distinct species.

Nomenclatural notes

Flemingia sootepensis Craib was described by Craib (1911), two specimens, viz. Kerr 934, Hosseus 309 were indicated in the protologue. In search of the type, we could trace eight specimens of Kerr (BM000958671, BM000958672, CAL, E00157794, K000980302, K000980303, P00709078 and TCD0016124) at BM, CAL, E, K, P and TCD respectively. Two more Hosseus's specimens (M0168856 and P00709079) were found at M and P. All these nine specimens were collected from Chiangmai, in evergreen jungle on Doi Suthep, Thailand (Craib 1911). These specimens serve as syntypes and can be considered as original material. Of these, the specimen at K with the barcode number K000980302 agrees well with the description provided in the protologue and was designated as the lectotype (Gavade et al. 2017). The duplicates of Kerr's specimen at BM (BM000958671 and BM000958672), CAL, E (E00157794), K (K000980303), P (P00709078), TCD (TCD0016124) are isolectotypes. Hosseus's specimens at M (M0168856) and P (P00709079) serve as syntypes.

Flemingia stricta Roxb., in W.T. Aiton, Hort. Kew., ed. 2. 4: 349. 1812

Type: India, without precise locality, s.d., *W. Roxburgh s.n.* (G00365326 image!, lectotype designated here; isolectotype G00365327 image! and K000900609 image!)

Roxb., Pl. Coromandel 3(3): 44. t. 248. 1820; Roxb., Fl. Ind. 3: 342. 1832; Wight & Arnott, Prodr. Fl. Ind. Orient. 1: 241. 1834; Wight, Icon. Pl. Ind. Orient. 2(1): 2, t. 329. 1843; Benth. in Miquel, Pl. Jungh. 2: 245. 1852; Baker, in Hook. f., Fl. Brit. India 2: 228. 1876; Kurz, Forest Fl. Burma 2: 375. 1877; Prain, Bengal Pl. 1: 377. 1903; Haines, Bihar Orissa 3: 269. 1922; Gamble, Fl. Madras 1: 378. 1928; Sanjappa, Legumes of India 178. 1992; Saxena & Brahman, Fl. Orissa 1: 531. 1994. (Figures 14, 23n, 24m, 25m and 26m).

(=) *Flemingia stricta* subsp. *pteropus* (Baker) K.K. Khanna & An. Kumar, Indian J. Forest. 24 (2): 223 (2001) **syn. nov.**

Type: Myanmar, Bago, Thondan [Thongdan], on Pegu river, 6 February 1854, *J. McClelland s.n.* (K001097316 image!).

(≡) *Maughania stricta* (Roxb.) Kuntze, Revis. Gen. Pl. 1: 199. 1891; Mukerjee, Bull. Bot. Soc. Bengal 6(1): 15. 1953 (as *Moghania stricta*).

Flemingia stricta Roxb., Hort. Bengal. 56. 1814 *nom. nud.*

Description

Erect shrubs, up to 1–3.2 m tall, with branched stem; stems 10–15 mm in diameter, young triangular, mature terete, hairy; hairs silky, antrorse. Leaves digitately trifoliolate, 25–38 cm long, stipulate, petiolate; stipules 2, 9–10 × 2–2.5 cm, lanceolate, acuminate with equal tips, fused when young, splitting at maturity, persistent, basifixed, many nerved, hairy; petioles 6–10 cm long, distinctly winged, gland-dotted, hairy; leaflets 3, 17–30 × 7–11 cm, broad lanceolate, acuminate at apex, the central cuneate at base, lateral oblique at base, margin ciliate, apex mucronate, glabrous on both surfaces, except on veins, dorsally gland-dotted; glands orange-red; petiolules 6–7 mm long, hairy, gland-dotted. Inflorescences an axillary and terminal raceme; racemes 1–2 in cluster, 9–12 cm long, equal or longer than the petiole. Flowers 1.3–1.5 cm long, pedicellate, bracteate; pedicels 3–4 mm long, hairy; bracts 15–16 × 2.5–3 mm, linear, acute at apex, many nerved, hairy, gland-dotted. Calyx 10–11 mm long, hairy, gland-dotted; calyx tube 3–4 mm long, campanulate, hairy; calyx teeth 5, 7–8 × 2–3 mm, lanceolate, subequal, lower one the longest, connate for 1/4 of its length, hairy, many nerved, gland-dotted. Corolla pale yellow with red striations; standard 1–11 × 8.5–9 mm, rounded, apex retuse, glabrous, clawed with 2 auricles; claw 1.8–2 mm long; auricles 2, 1 mm or less than 1 mm; wing petals 8.8–9 × 2.8–3 mm, oblong, falcate; claw 2.8–3 mm long; keel petals 1–11 × 4–4.5 mm, falcate, fused at apex; claw 2.8–3 mm long. Stamens 10, diadelphous (9+1); staminal tube 7.5–8 × 1–1.5 mm, anthers uniform, less than 1 mm long, basifixed, filaments of united stamens 2–3 mm long, that of free stamens 9.5–10 mm long. Ovary 2–2.4 × 1– 1.5 mm, gland-dotted, hairy; ovules 2; style 9–10 mm long, glabrous, swollen at middle; stigma globose, hairy. Fruits a pod, 16–17 × 7–7.5 mm, beaked, turgid, slightly septate between seeds or not, hairy, sparsely gland-dotted; beak 1 mm long; glands black, withering post maturity. Seeds 2, 4 × 4 × 3 mm brown, mottled, shiny, rounded; hilum granular, 1 mm long, position ± central.

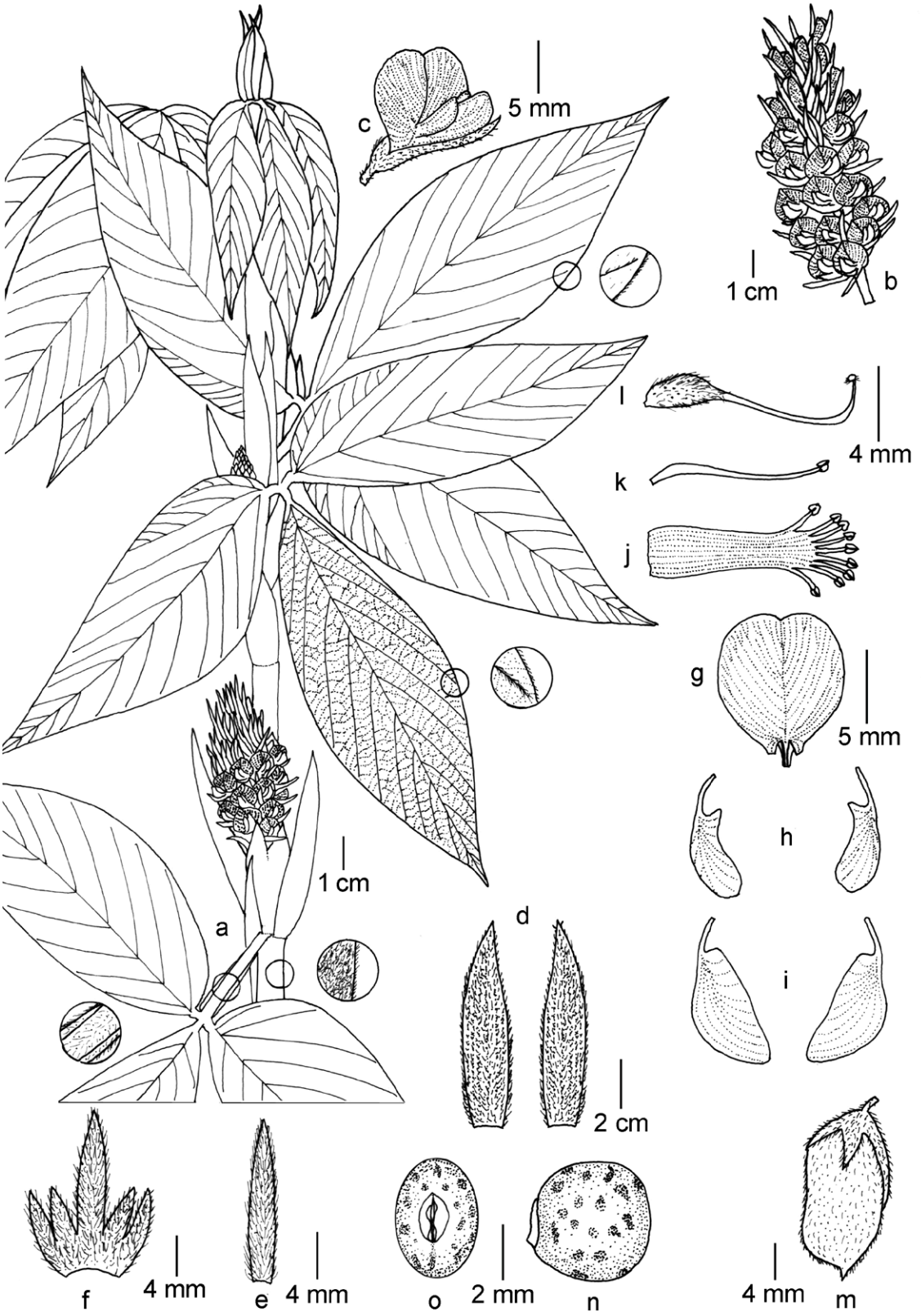


Figure 14. *Flemingia stricta* Roxb. (a) Habit. (b) Inflorescence. (c) Flower. (d) Stipules. (e) Bract. (f) Calyx, dorsal view. (g) Standard. (h) Wing petals. (i) Keel petals. (j) Fused androecium. (k) Free stamen. (l) Gynoecium. (m) Fruit. (n) Seed, lateral view. (o) Seed, dorsal view.

Etymology

The specific epithet 'stricta' refers to the straight and tall habit.

Distribution

Bangladesh, Cambodia, China (Guangdong, Yunnan), India (Andhra Pradesh, Assam, Chhattisgarh, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Orissa, Uttar Pradesh, Sikkim, Tamil Nadu, Telangana, Tripura and West Bengal), Indonesia (Java), Jamaica, Laos, Myanmar, Thailand, Vietnam.

Flowering and fruiting

January to April.

Habitat and ecology

Flemingia stricta is found along the streams in forests of ca.150–650 m asl. It grows in association with *Cyperus pangorei* Roxb., *Lasia spinosa* (L.) Thwaites and *Polygonum glabrum* Willd., etc. In Myanmar, altitude varies from 20 to 1000 m asl.

Selection of specimens examined

INDIA, Andhra Pradesh, Chittoor district, Satyavedu, 14 July 2008, *MVS & VSR 31010* (BSID); East Godavari district, Sesharagi hills, 14 February 1947, *Narayanswami & party 122* (CAL); Ethakonda, 11 February 1947, *Narayanswami & party 122* (CAL); Kurnool district, Gundla Brahmeswara, *B. Ravi Prasad Rao & B. Sadasivaiah 34153* (BSID); Visakhapatnam district, near Chintapalli, 7 March 1962, *D. C. S. Raju 65* (CAL); Assam, April 1902, *A.C. Chatarjee 5342* (BSI); Goalpara district, Duma Duar, December 1890, *Dr. King's collector s.n.* (CAL); Hojai district, Lumding, 20 February 1901, N. Gill 65 (CAL); Kamrup Metropolitan district, Guwahati, s.d., *J. W. Master 678* (CAL); Chhattisgarh, Bastar district, s.d., *A.N. Singh s.n.* (BSA); Dantewada district, Bailadila, 13 February 1963, *G. Panigrahi & Arora 6839* (BSA); Jashpur district, Narayanpur, 5 October 1941, *H.F. Mooney 1955* (DD); Narayanpur district, Abujmarh, 22 May 1963, *G.P. Roy 31984* (BSA); Jharkhand, Chota Nagpur, s.d., *J.J. Wood s.n.* (CAL); Karnataka, Uttara Kannada district, Sirsi forest, 23 February 2016, *S.K. Gavade s.n.* (SUK); 4 February 2017, *S.K. Gavade 184* (SUK); Madhya Pradesh, Betul district, Dharakhoh reserve forest, 16 April 1997, *A. Kumar 51090* (BSA); Hoshangabad district, Pachmarhi, Mahadev, 27 December 1962, *G. Panigrahi 6587* (CAL); Maharashtra, Gadhchiroli district, Bamhani,16 February 2015, *V. Kahalkar & S.K. Gavade 26* (SUK); *S.K. Gavade 129* (SUK); Manipur, Imphal East district, Nambar forest, February 1906, *A. Meebold 5342* (BSI); Tengnoupal district, Moreh, 22 January 1953, *D.B. Deb 686* (CAL); Meghalaya, East Khasi Hills, Borapani, 23 February 2016, *S.K. Gavade 131* (SUK); 3 February 2017, *S.K. Gavade 183* (SUK); Thoyung, 15 March 1885, *C.B. Clarke 37587 A* (CAL); West Garo Hills, s.d., *T.D. Srivastav 1646* (CAL); Mizoram, Mamit district, 27 February 1984, *D.B. Deb 3422* (CAL); Orissa, Ganjam district, Khondbunta, February 1884, *J.S. Gamble 13793* (CAL, K); Jajapur district, Jaraka, 19 March 1964, *S. Kapoor & party 71300* (NBRI); Mayurbhanj district, Bhanjabasa, 13 February 1958, *G. Panigrahi 12272* (CAL); *12268* (CAL); on the way to Jenabil to Kabatghai, 27 November 1979, *A.R.K. Sastri & S.G.R. Singh 12344* (BSID); Sambalpur district, Ushakothi Wildlife Sanctuary, 24 March 1964, *S. Kapoor & party 71390* (NBRI); Peninsula, s.d., *R. Wight 801* (CAL); Uttar Pradesh, Allahabad, Botanical Survey of India, Central Regional Centre garden, 8 November 1962, *M.J. Hanfi 5302* (BSA); *C.M. Arora 5302* (BSA); 6 February 1963, *O.P. Mishra 5331* (BSA); 30 January 2016, *A.P. Tiwari 123* (SUK); Sikkim, 15 May 1901, *Dr. Prain's Collector 104* (CAL); Tamil Nadu, Chennai district, on the way to Bokoi hills, Lakshmipuram, s.d., *N. Rama Rao & D. Narasimhan 84231* (BSID); Nagapattinam district, Tharangambadi, s.d., *B. Heyne Wallich Catalogue Number 5745C* (K-W001121978); Telangana, Medak district, Gouraram, 20 February 1983, *P.V. Sreekumar & N. Rama Rao 76956* (BSID); Warangal district, Mallur Gutta, 22 February 2002, *R.K. Premanath 110966* (BSID); Tripura, Khowai district, Teliamura, 21 February 1960, *D.B. Deb 2249* (CAL); North Tripura district, on the way to Hmanpui, 22 January 1960, *D.B. Deb 27006* (CAL); West Tripura, Agartala, Abhoynagar, 27 December 1914, *P.M. Debbarman 385* (CAL); Charilan, 4 March 1960, *D.B. Deb 2489* (CAL); West Bengal, Kolkata district, Botanical Garden Calcutta, s.d., *Anon s.n.* (LINN-HS1212-1); s.d., *F. Buchanan-Hamilton, Wallich Catalogue Number 5745a* (K-W001121975 and 001121976); s.d., *s.coll. Wallich Catalogue Number 5745d* (K-W001121979); Darjeeling district, Peshok, 1900, *G.H. Cane 165* (CAL); Jalpaiguri district, Apalchand Forest, 21 February 1975, *J.K. Sikdar 28* (CAL); Chapramari Wildlife Sanctuary, s.d., *Jayasree, Bhattacharjee & party 32432* (CAL); Puruliya district, Badgaon, 13 March 1964, *S.N. Biswas 57* (CAL); s.d., R. Thompson 102 (CAL); s.d., *s.coll. 485* (CAL); s.d., s.coll. *Wallich Catalogue Number 5745B* (K-W001121977).

Affinities

Flemingia stricta is closely related to *F. praecox* but differs from it in its large stipules, broad lanceolate leaves and robust inflorescence. The general appearance is like *F. macrophylla*.

Taxonomic note

Flemingia stricta is a very distinct species. Baker (1876) described a new variety under *F. stricta*, i.e. *F. stricta* var. *pteropus* Baker. Khanna and Kumar (2001) raised the rank of this variety and made it *F. stricta* subsp. *pteropus*. However, it seems that they did not see the type (*McClelland s.n.*, housed at K) of *F. stricta* var. *pteropus*. The specimen Anand Kumar 51090, was studied critically by us. We have found that it is conspecific to *F. stricta*. So, *F. stricta* subsp. *pteropus* Khanna & Kumar is proposed here as a new synonym of *F. stricta*.

Nomenclatural notes

Flemingia stricta was described by Roxburgh in his "Plants of the Coast of Coromandel" which was published in 1820. Aiton (1812) published *F. stricta* Roxb. in his "Hortus Kewensis; or, a Catalogue of the Plants Cultivated in the Royal Botanic Garden at Kew" and he ascribed the name and its description to Roxburgh so the correct name is *F. stricta* Roxb. as per Article 46, example 24 of ICN (Turland et al. 2018).

In search of the type specimen we could locate three specimens, one at K (K000900609) and two at G (G00365326 and G00365327) and an illustration of Roxburgh which can be considered as an original material. All the three specimens were collected by Roxburgh and bear Roxburgh's handwriting as '*Hedysarum strictum*'. The specimen at G (G00365326) is complete and better than the other two. As per articles 9.11 and 9.12 of Shenzhen Code (Turland et al. 2018), specimen at G (G00365326) is selected and designated here as lectotype.

Flemingia wallichii Wight & Arn., Prodr. Fl. Ind. Orient. 1: 242. 1834

Type: India, East Peninsular region, s.d., *B. Heyne, Wallich Catalogue Number 5746g* (K-W001122002 image!, lectotype designated here; isolectotype K).

Benth. in Miquel, Pl. Jungh. 2: 245. 1852; Baker, in Hook. f., Fl. Brit. India 2: 229. 1876; Kurz, Forest Fl. Burma 2: 374. 1877; T. Cooke, Fl. Bombay 2: 393. 1902; Talbot, Forest Fl. Bombay 1: 420. 1909; Gamble, Fl. Madras 1: 379. 1928; Sanjappa, Legumes of India 179. 1992. (Figures 15, 23o, 24n, 25n and 26n).

(≡) *Maughania wallichii* Kuntze, Revis. Gen. Pl. 1: 199. 1891; Mukerjee, Bull. Bot. Soc. Bengal 6(1): 18. 1953 (as *Moghania wallichii*).

Description

Erect shrubs, up to 1.2–1.8 m tall, with profuse branching; stems 4–5 mm in diameter, young triangular, mature terete, densely hairy; hairs silky, antrorse. Leaves digitately trifoliolate, 4–16 cm long, stipulate, petiolate; stipules 2, 9–10 × 3.5–4 mm, lanceolate, acuminate with equal tips, fused when young, splitting at maturity, caducous, basifixed, many nerved, hairy; petioles 2–5 cm long, slightly winged, gland-dotted, hairy; leaflets 3, 3.2–12 × 1–4.5 cm, obovate to lanceolate or rhomboid, acute at apex, the central cuneate at base, lateral oblique at base, margin ciliate, apex mucronate, hairy and dorsally gland-dotted; glands orange-red; petiolules 2–3 mm long, hairy, gland-dotted. Inflorescences an axillary and terminal raceme; racemes 2–4 in cluster, capitate, 3–6 cm long, equal or longer than the petiole. Flowers 14–15 mm long, pedicellate, bracteate; pedicels 2–3 mm long, hairy; bracts 4–5 × 3–4 mm, ovate, acute at apex, many nerved, hairy, gland-dotted. Calyx 1.1–12 mm long, hairy, gland-dotted; calyx tube 1–2 mm long, campanulate, hairy; calyx teeth 5, 7–10 × 1–2 mm, subequal, lower one the longest as well as broader, lanceolate, connate for 1/6 of its length, hairy, many nerved, gland-dotted. Corolla pink; standard 8.5–9 × 6.5–7 mm, rounded, apex mucronate, glabrous, clawed with 2 auricles; claw 2–2.5 mm long; auricles 1 mm or less than 1 mm; wing petals 9–9.5 × 2.5–3 mm, falcate; claw 2–2.5 mm long; keel petals 9.5–1 × 3.5–4 mm, slightly falcate, fused at apex; claw 2.5–3 mm long. Stamens 10, diadelphous (9+1); staminal tube 6.5–7 × 1 mm, anthers uniform, less than 1 mm long, basifixed, filaments of united stamens 1.5–2.5 mm long, that of free stamens 8.5–9 mm long. Ovary 1.8–2 × 0.8–1 mm, gland-dotted, hairy; ovules 2; style 8.5–9 mm long, glabrous, swollen at middle; stigma globose, hairy. Fruits a pod, 15.5–16 × 7.5–8 cm, included within calyx, beaked, turgid, slightly septate between seeds or not, densely hairy, sparsely gland-dotted; beak 1 mm long; glands orange-red, withering post maturity. Seeds 2, 4 × 4 × 3 mm, brown, mottled, shiny, rounded; hilum granular, 1 mm long, position ± central.

Etymology

The specific epithet 'wallichii' honours Nathaniel Wallich (1786-1854), a Danish physician and botanist, who worked in India from 1807-1846.

Distribution

Asia: China (Yunnan), India (Andhra Pradesh, Karnataka, Kerala, Maharashtra and Tamil Nadu), Laos, Myanmar and Vietnam.

Flowering and fruiting

November to March.

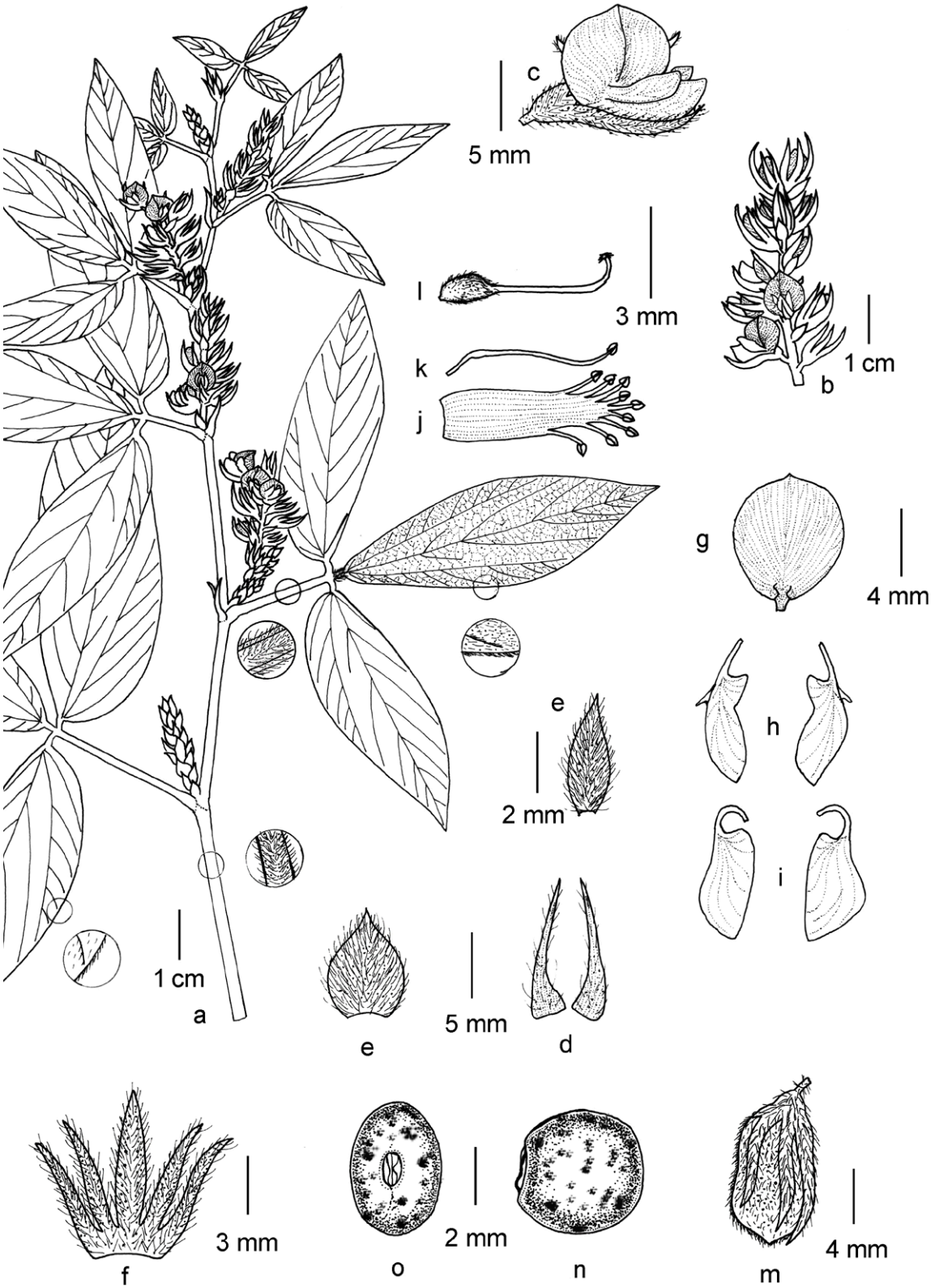


Figure 15. *Flemingia wallichii* Wight & Arn. (a) Habit. (b) Inflorescence. (c) Flower. (d) Stipules. (e) Bract. (f) Calyx, dorsal view. (g) Standard. (h) Wing petals. (i) Keel petals. (j) Fused androecium. (k) Free stamen. (l) Gynoecium. (m) Fruit. (n) Seed, lateral view. (o) Seed, dorsal view.

Habitat and ecology

Flemingia wallichii grows in dry deciduous forests and open grasslands as well as slopes of small mountains at an altitude of ca. 800–900 m asl. It grows in association with *Acacia concinna* DC., *Asparagus racemosus* Willd., *Clerodendrum viscosum* Vent., *Flemingia strobilifera* (L.) W.T.Aiton, *Gnidia glauca* (Fresen.) Gilg, *Lantana camara* L., *Mallotus philippensis* (Lam.) Mull.Arg., *Moullava spicata* (Dalzell) Nicolson, *Stachytarpheta jamaicensis* (L.) Vahl, *Terminalia elliptica* Willd. and *Ziziphus rugosa* Lam. In China, it is reported from 1600-1900 m asl.

Additional specimens examined

INDIA, Andhra Pradesh, Prakasam district, Gundlakamma, 1 April 1965, *J.L. Ellis 23843* (MH); Karnataka, Belgaum district, Hemmadaga, 4 November 2015, *S.K. Gavade 113* (SUK); 12.5 km E of Kunkumbi, 29 January 1980, *Kameswara Rao 39* (ICRISAT, WAG); 12.5 km S of Kunkumbi, *id. 55* (ICRISAT, WAG); Chamarajanagar district, Gopalaswamy Hills, 3 February 1979, *K.P. Sreenath & P. Prakash 5710* (JCB); Dharwad district, Dharwad, December 1918, *Sedgwick's Collector 4972* (CAL); Handibhadangnath, 6 March 2015, *S.K. Gavade & M.M. Lekhak 32* (SUK); Kodagu district, Brahmagiri hills, *R.H.B. s.n.* (MH); Uttara Kannada district, 10 May 1884, *W.A. Talbot s.n.* (BSI); Dandeli, 1888, *W.A. Talbot s.n.* (BSI); s.d., February 1892, *s.coll. s.n.* (BSI); Kerala, Idukki district, Puliyanmala, 1 February 2012, *M.V. Krushnaraj 71523* (TBGRI); Vagamon, 20 February 2008, *M.V. Krishnaraj 61802* (TBGRI); Kollam district, Chandanthode, 22 December 1979, *V.S. Ramachandran 65337* (MH); 24 February 1979, *V.S. Ramachandran 61361* (MH); Palakkad district, Parambikulam tiger reserve, *K.M. Sebastine 15667* (MH); Maharashtra, Kolhapur district, Panhala, 1 January 2015, *S.K. Gavade 18* (SUK); 16 January 2015, *S.K. Gavade 19* (SUK); Man Parale, 31 July 2016, *S.K. Gavade s.n.* (SUK); Satara district, Bhalekarwadi, 29 December 2014, *S.K. Gavade 17* (SUK); *S.K. Gavade 114* (SUK); *S.K. Gavade 168*; Tamil Nadu, Coimbatore district, Siruvani, 3 January 1978, *N.C. Nair 41473* (MH); Nilgiris district, on the way to Nadugani to Gudalur, 24 February 1973, *E. Vajravelu 43721* (MH).

Affinities

Flemingia wallichii is allied to *F. grahamiana* but differs from it in having obovate to lanceolate or rhomboid leaves, ovate bracts, pinkish corolla and pod which is included within the calyx.

Taxonomic note

Flemingia wallichii has been synonymized under *F. macrophylla* by some online databases (ILDIS 2005; The Plant List 2013). But many earlier workers such as Baker (1876), Kurz (1877), Cooke (1902), Talbot (1909), Gamble (1928), Mukerjee (1953) and Sanjappa (1992) treated *F. wallichii* as a distinct species. Critical analysis of live specimens, type and protologue confirm that *F. wallichii* is a distinct species.

Nomenclatural notes

Flemingia wallichii was described by Wight and Arnott (1834) from East Peninsular India based on Heyne's collection having Wallich Catalogue Number 5746g. We could trace the type at K (K-W001122002). This specimen (K-W001122002) is designated as lectotype [as per articles 9.11 and 9.12 of Shenzhen Code (Turland et al. 2018)] as it tallies with the description provided in the protologue.

Flemingia wightiana Graham ex Wight & Arn., Prodr. Fl. Ind. Orient. 1: 242. 1834

Type: India, East Peninsular region, s.d, *R. Wight 815* (E00157782 image!, lectotype designated here; isolectotype K001122004 image!, MH00002049 image!).

Benth. in Miquel Pl. Jungh. 2: 245. 1852; Baker, in Hook. f., Fl. Brit. India 2: 229. 1876; Prain in J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 69(2): 441. 1897; Gamble, Fl. Madras 1: 379. 1928; Sanjappa, Legumes of India 176. 1992; Saxena & Brahman, Fl. Orissa 1: 533. 1994. (Figures 16, 23p, 24o, 25o and 26o).

(=) *Flemingia ferruginea* Benth. & Hook.f. Gen. Pl. 1(2): 544. 1865.
Type: Myanmar, Tong Dong, 1826, Wallich Catalogue Number 5750 (K001122003 image!).

(≡) *Flemingia congesta* var. *wightiana* Baker, in Hook. f., Fl. Brit. India 2: 229. 1876.

(≡) *Maughania wightiana* (Graham ex Wight & Arn.) Mukerjee, Bull. Bot. Soc. Bengal 6(1): 16. 1953 (as *Moghania wightiana*)

Flemingia wightiana Graham, Numer. List n. 5751. 1831, *nom. nud.*

Description

Erect shrubs, up to 1.2–1.6 m tall, with profuse branching; stems 3–10 mm in diameter, young triangular, mature terete, hairy; hairs silky, antrorse. Leaves digitately trifoliolate, 10–22 cm long, stipulate, petiolate;

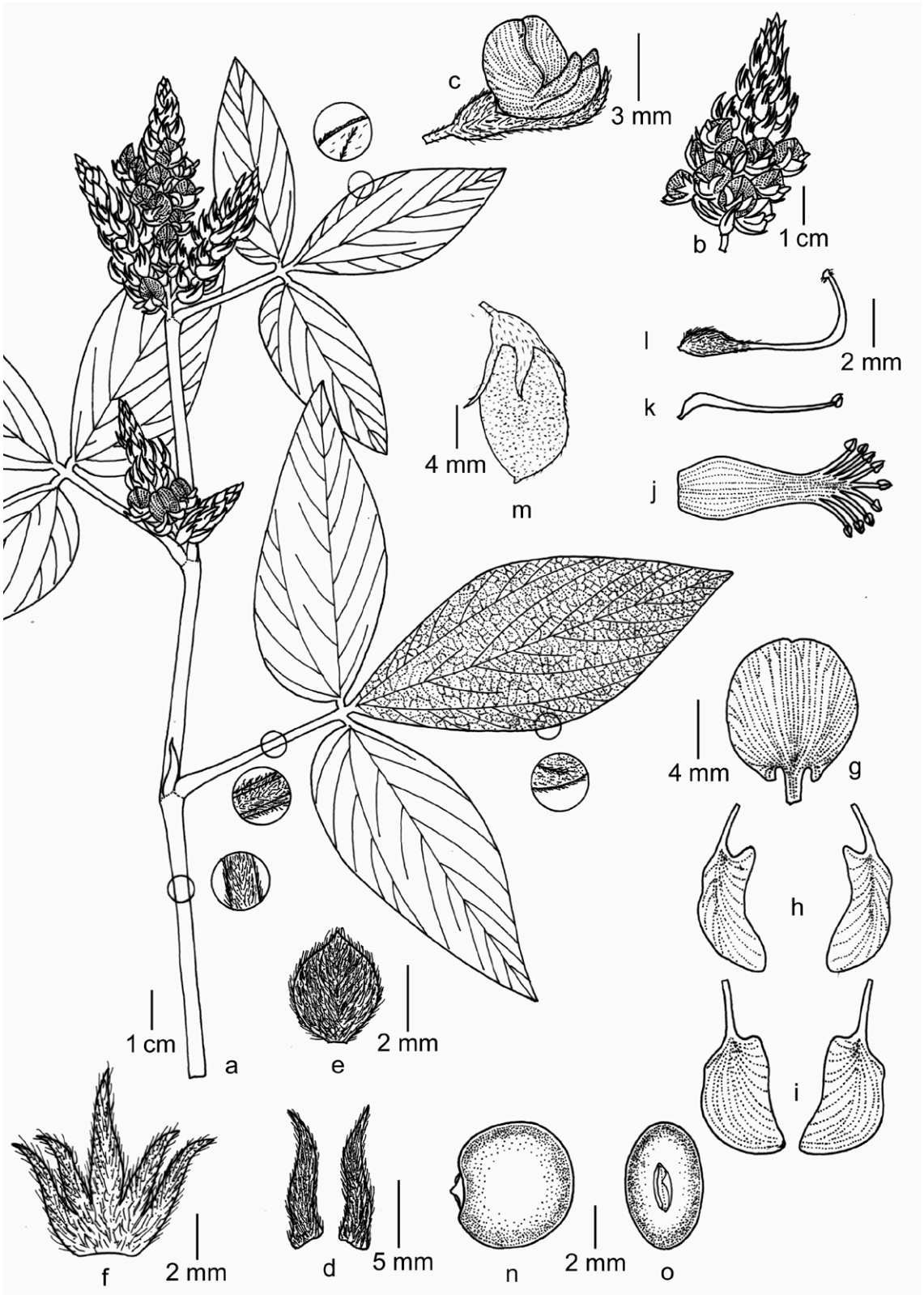


Figure 16. *Flemingia wightiana* Graham ex Wight & Arn. (a) Habit. (b) Inflorescence. (c) Flower. (d) Stipules. (e) Bract. (f) Calyx, dorsal view. (g) Standard. (h) Wing petals. (i) Keel petals. (j) Fused androecium. (k) Free stamen. (l) Gynoecium. (m) Fruit. (n) Seed, lateral view. (o) Seed, dorsal view.

stipules 2, 10–11 × 3–3.5 mm, lanceolate, acuminate with equal tips, fused when young, splitting at maturity, caducous, basifixed, many nerved, hairy; petioles 2.5–6 cm long, grooved, not distinctly winged, gland-dotted, hairy; leaflets 3, 7–14 × 3–6 cm, oblong to lanceolate, acute at apex, the central cuneate at base, lateral oblique at base, margin ciliate, apex mucronate, hairy and gland-dotted on both surfaces, dorsally densely tomentose; glands orange-red; petiolules 2–4 mm long, hairy, gland-dotted. Inflorescences an axillary and terminal raceme; racemes 2–5 in cluster, densely imbricate, cone like, 2–8 cm long, equal or longer than the petiole. Flowers 1–1.1 cm long, pedicellate, bracteate; pedicels 1.5–2.5 mm long, hairy; bracts 2.5–3 × 1.5–2.5 mm, rounded, acute at apex, many nerved, hairy, gland-dotted. Calyx 9–10 mm long, hairy, gland-dotted; calyx tube 2–2.5 mm long, campanulate, hairy; calyx teeth 5, 5–7 × 1.5–2 mm, lanceolate, subequal, lower one the longest, connate for 1/4 of its length, hairy, many nerved, gland-dotted. Corolla white with pink striations; standard 8–8.5 × 5.5–6 mm, rounded, apex slightly retuse, glabrous, clawed with 2 auricles; claw 2–2.5 mm long; auricles 1 mm or less than 1 mm; wing petals 8–8.2 × 2–2.2 mm, oblong; claw 2–2.5 mm long; keel petals 7–8 × 2.5–3 mm, slightly falcate, fused at apex; claw 2–2.2 mm long. Stamens 10, diadelphous (9+1); staminal tube 5.5–6 × 1 mm, anthers uniform, less than 1 mm long, basifixed, filaments of united stamens 1–2 mm long, that of free stamens 6.5–7 mm long. Ovary 1.8–2 × 0.8–1 mm, gland-dotted, hairy; ovules 2; style 6–7 mm long, glabrous, swollen at middle; stigma globose, hairy. Fruit a pod, 1.6–1.7 × 6–6.5 cm, beaked, turgid, slightly septate between seeds or not, densely hairy, sparsely gland-dotted; beak 1 mm long; glands orange-red, withering post maturity. Seeds 2, 4 × 3 × 2.5 mm black, rounded; hilum granular, 1 mm long, position ± central.

Etymology

The specific epithet 'wightiana' honours Robert Wight (1796-1872), a British surgeon and botanist.

Distribution

Asia: Bhutan, India (Andhra Pradesh, Chhattisgarh, Karnataka, Kerala, Orissa and Tamil Nadu).

Flowering and fruiting

December to April.

Habitat and ecology

Flemingia wightiana is found on hill slopes at an altitude of ca. 1200–1400 m asl. It grows in association with *Argyreia cuneata* Ker Gawl., *Asparagus racemosus* Willd., *Bambusa bambos* (L.) Voss, *Curculigo orchioides* Gaertn., *Dioscorea bulbifera* L., *Lantana camara* L., *Pterocarpus marsupium* Roxb., *Rubus niveus* Thunb., *Stachytarpheta jamaicensis* (L.) Vahl, *Strobilanthes kunthiana* T.Anderson ex Benth., *Syzygium cumini* (L.) Skeels, *Terminalia cuneata* Roth etc.

Additional specimens examined

INDIA, *R. Wight 802* (C, GH, LE, MEL, W); Andhra Pradesh, Chittoor district, Talakona, 13 March 1987, *D. Ranga Charyalu 1343* (CAL); Prakasam district, Nallamalas Hills, Gundlakamma river area, 1 April 1965, *J.L. Ellis 23843* (CAL); Chhattisgarh, Dantewada district, Bailadila, 12 February 1963, *G. Panigrahi 6991* (CAL), *G. Panigrahi 6870* (CAL); Karnataka, Chamarajanagar district, Gopalaswamy Hills, 3 February 1979, *K.P. Sreenath & P. Prakash 5720* (CAL); Gundal dam, 6 July 1930, *V. Narayanaswami 3665* (MH); Kerala, Idukki district, Mannavan Chola, 25 February 2003, *M.B. Reena 89074* (MH); Palakkad district, Chulliyar dam, 5 February 1990, *K. Ravikumar 92524* (MH, BSID); Puthur plateau, *K.M. Matthew 54732* (RHT); Sholayur, above Eswaran estate, 23 April 1977, *E. Vajravelu 49751* (MH); Tamil Nadu, Anaimalai Hills, s.d., *s.coll. s.n.* (MH); Coimbatore district, Kurudi malai, 6 October 1970, *M.V. Vishwanathan 789* (MH); Rangaswamy koil, 24 January 1931, *R. Raju & Naganathan 4920* (MH); Sowripalayam, Palani road, 21 March 1985, *K.M. Matthew 41184* (RHT); Velliangiri, 23 February 1932, *S.R. Raju & Ratnavelu 293* (MH); Dindigul district, Mannavanor, 2 December 1985, *K.M. Matthew & N. Rajendran 43557* (RHT); Pallangi Kombai, 9 February 1992, *K.M. Matthew 54715* (RHT); Sirumalai, 7 February 1959, *J. Pallithanam 4348* (RHT); Vilpatti to Palani path, 22 March 1987, *K.M. Matthew 48667* (RHT); Dharmapuri district, Chitteri Hills, Peria Bettumalai, 12 August 1978, *K.M. Matthew 16396* (RHT); 9 January 1980, *K.M. Matthew 25609* (RHT); Krishnagiri district, Guthirayan hills, 22 March 1980, *K.M. Matthew 27248* (RHT); Nilgiris district, Bokkapuram reserve forest, 19 February 1972, *B.D. Sharma 39859* (MH); Kottakombai, 30 July 1970, *E. Vajravelu 35167* (MH); Kukal shola, 3 December 1970, *G.V. Subbarao 37443* (MH); Mudumalai National Park and Wildlife Sanctuary, Benne forest, 19 January 1961, *B.V. Shetty 11930* (CAL); on the way Anaikatti to Ebbanad, 14 March 1972, *G.V. Subbarao 40218* (MH); on the way from Kodanad to Kotagiri, 25 October 1956, *K. Subramanyam 1156* (CAL); *K. Subramanyam 1154* (MH); Ramanathapuram district, Mudaliaruthu, 20 February 1979, *S.R. Srinivasan 61008* (CAL); *N.C. Nair 61008* (MH); Salem district, on the way to Karadu to Yercaud,

Lady's seat, 22 January 1966, *S. Karthikeyan 26984* (CAL); Palamalai, 19 February 1986, *K.M. Matthew 44131* (RHT); 12 January 1987, *K.M. Matthew 48278* (RHT); 4 February 1996, *K.M. Matthew 55081* (RHT); Yercaud, Shevaroy hills, 11 July 2016, *S.K. Gavade 135* (SUK); 19 January 2017, *S.K. Gavade 172* (SUK); 2 February 2017, *S.K. Gavade 188* (SUK); Shevaroy Temple, 31 October 1981, *K.M. Matthew, S.J. Britto & N. Rani 28535* (RHT); Tirunelveli district, on the way to Neterikal, 21 September 1916, *s.coll. s.n.* (MH); Mahendragiri, March 1884, *J.S. Gamble 13718* (DD); Tiruppur district, Kilanavayal to Manjampatti hills track, 5 February 1986, *K.M. Matthew & N. Rajendran 44018* (RHT); West Bengal, Jaldapara National Park, 17 December 1995, *S. Chanda & S.K. Mandal 1197* (CAL).

Affinities

Flemingia wightiana is allied to *F. grahamiana* but differs from it in having a grooved petiole and densely tomentose and oblong lanceolate leaves.

Taxonomic note

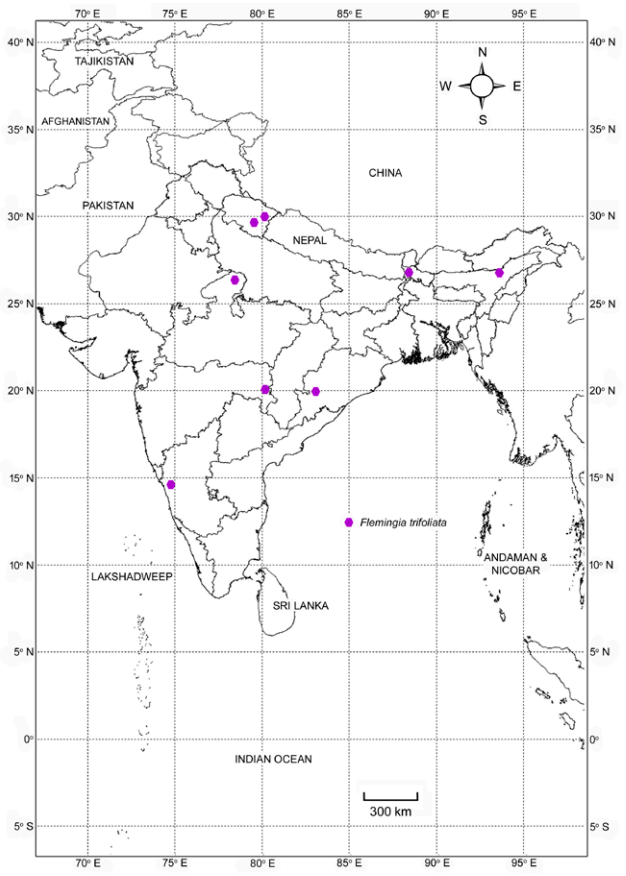
Flemingia wightiana was treated as a variety under *F. congesta* (*F. congesta* var. *wightiana*) by Baker (1876). Prain (1897), Gamble (1928) and Mukerjee (1953) followed Wight and Arnott (1834) and treated *F. wightiana* at the rank of species. We agree with Wight and Arnott (1834) and consider this taxon as a distinct species.

Nomenclatural notes

The binomial *Flemingia wightiana* was first proposed by Graham (Wallich 1831) in Wallich catalogue based on Wight's collection which was later validly published by Wight and Arnott (1834). In the protologue, Wight and Arnott (1834) mentioned Wallich catalogue Number 5751 and 815. In search of type specimens, we could trace three specimens, one each at E (E00157782), K (K001122004) and MH (MH00002049). All the three specimens were collected by Wight from East Peninsular region, India and serve as syntypes. As per articles 9.11 and 9.12 of Shenzhen Code (Turland et al. 2018), we selected and designated the specimen E00157782 from E which is most complete and matches well with the description provided in the protologue, as the lectotype.

Flemingia subg. **Lepidocoma** (Jungh.) Baker

Flemingia subg. **Lepidocoma** (Jungh.) Baker in Hook. f. Fl. Brit. India 2: 229. 1876 (Map 4).



Map 4. Distribution of subgenus *Lepidocoma* (Jungh.) Baker in India.

Type: *Lepidocoma trifoliatum* Jungh.

Erect shrubs, leaves trifoliolate, inflorescence dense globose heads, bracts large, involucrate.

Flemingia trifoliata (Jungh.) C.Y. Wu, J. W. China Border Res. Soc. 16. 175. 1946 (Figure 17, 23q and 24p).

Bas.: *Lepidocoma trifoliatum* Jungh., Reisen durch Java 338. 1845
Type: Indonesia, Java, Mt. Lawu and Solo river, s.d., *Junghuhn 107* (K001081985 image!, lectotype designated by van der Maesen 2012).

Van der Maesen, Webbia 67(1): 33-36. 2012.

(=) *F. capitata* Zoll. ex Miquel, Fl. Ind. Bat. 1: 166. 1855.
Type: Indonesia, Java, southern plains, *Zollinger & Moritzi 2670* (BM, G).

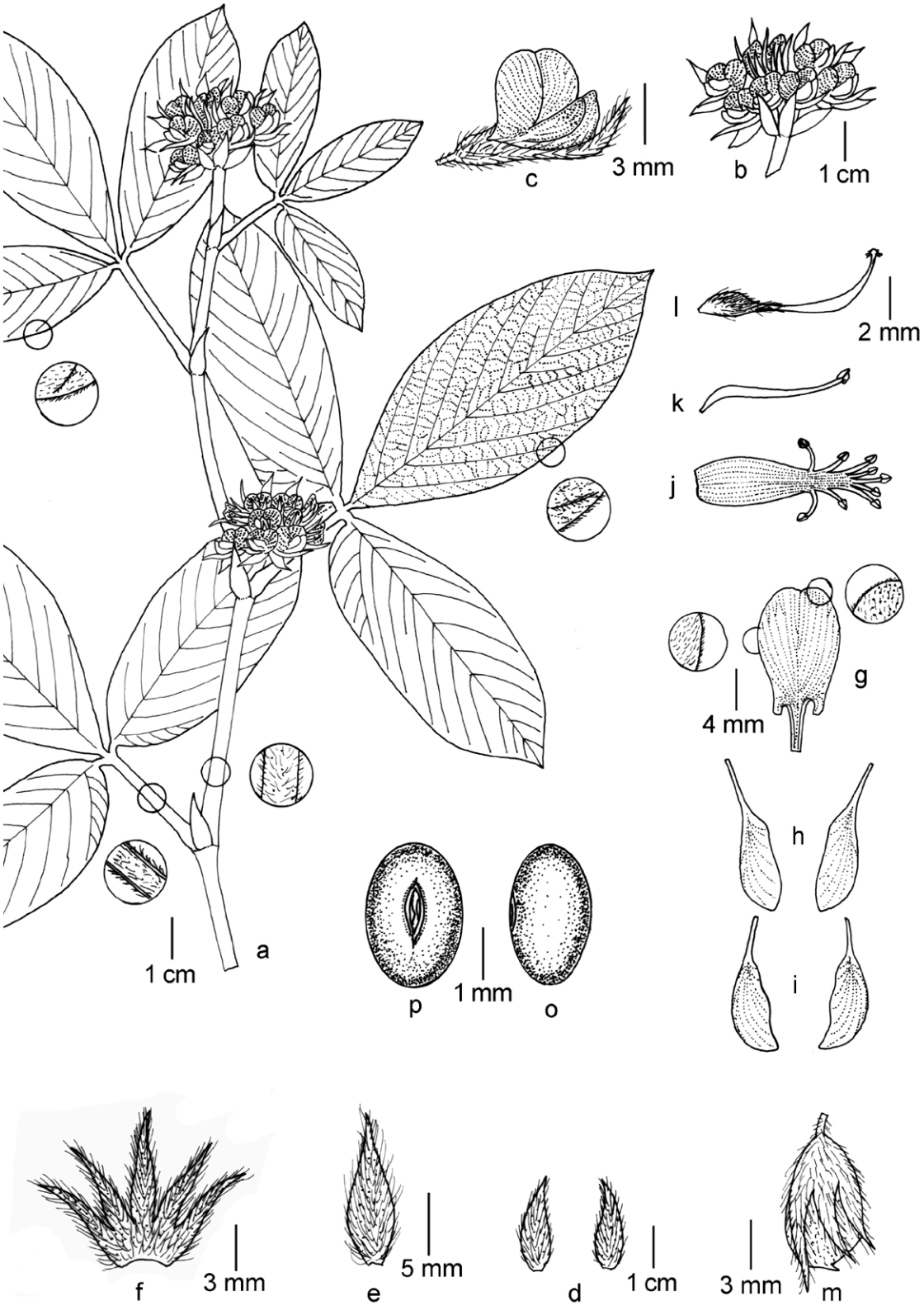


Figure 17. *Flemingia trifoliata* (Jungh.) C.Y.Wu (a) Habit. (b) Inflorescence. (c) Flower. (d) Stipules. (e) Bract. (f) Calyx, dorsal view. (g) Standard. (h) Wing petals. (i) Keel petals. (j) Fused androecium. (k) Free stamen. (l) Gynoecium. (m) Fruit. (n) Seed, lateral view. (o) Seed, dorsal view.

(≡) *Flemingia involucrata* Benth., in Miquel, Pl. Jungh. 2: 246. 1852.

(≡) *Maughania involucrata* Kuntze, Revis. Gen. Pl. 1: 199. 1891; Mukerjee, Bull. Bot. Soc. Bengal 6(1): 21. 1953 (as *Moghania involucrata*).

Baker, in Hook. f., Fl. Brit. India 2: 229. 1876; Prain, Bengal Pl. 1: 377. 1903; T. Cooke, Fl. Bombay 2: 393. 1902; Talbot, Forest Fl. Bombay 1: 421. 1909; Haines, Bihar Orissa 3: 270. 1922; Sanjappa, Legumes of India 176. 1992; Saxena & Brahman, Fl. Orissa 1: 527. 1994; Kothari in N.P. Singh et al., Fl. Maharashtra, Dicot. 2: 685. 2001 (Figure 17, 23q, 24p).

Lespedeza involucrata Wall., Numer. List n. 5742.1831, *nom. nud.*

Flemingia capitata Zoll. & Mor., Nat. Geneesk. Archief III: 64. 1864, *nom. nud.*

Description

Erect shrubs, up to 0.8–1.5 m tall, with branched stem; stems 4–5 mm in diameter, young triangular, mature terete, hairy. Leaves digitately trifoliolate, 8–13 cm long, stipulate, petiolate; stipules 2, 20–22 × 2–2.5 mm, lanceolate, acuminate with equal tips, fused when young, splitting at maturity, persistent, basifixed, many nerved, hairy; petioles 1–3.5 cm long, grooved, gland-dotted, hairy; leaflets 3, 5–8 × 2.5–3.5 cm, elliptic to obovate, shortly acuminate at apex, the central cuneate at base, lateral oblique at base, margin ciliate, apex mucronate, hairy on both surfaces, densely hairy on veins, dorsally gland-dotted; glands orange-red; petiolules 2–3 mm long, hairy, gland-dotted. Inflorescence an axillary and terminal raceme; racemes 2–4 in cluster, 4–6 cm long, capitate, equal or longer than the petiole. Flowers 1–1.5 cm long, pedicellate, bracteate; pedicels 1–2 mm long, hairy; bracts 8–1 × 3–4 mm, ovate, acuminate at apex, many nerved, hairy, gland-dotted. Calyx 12–14 mm long, hairy, gland-dotted; calyx tube 2.5–3 mm long, campanulate, hairy; calyx teeth 5, 12–13 × 0.8–1 mm, lanceolate, subequal, lower one the longest, connate for 1/5 of its length, hairy, many nerved, gland-dotted. Corolla purple or mauve; standard 10–12 × 7–8 mm, obovate, apex retuse, hairy, gland-dotted dorsally, clawed with 2 auricles; claw 3–4 mm long; auricles 1 mm or less than 1 mm; wing petals 9–10 × 2.5–3 mm, oblong; claw 3–3.5 mm long; keel petals 9–10 × 2.5–3 mm, boat shaped, fused at apex; claw 4.5–5 mm long. Stamens 10, diadelphous (9+1); staminal tube 6–6.5 × 1 mm, anthers uniform, less than 1 mm long, basifixed, filaments of united stamens 2–4 mm long, that of free stamens 8–9 mm long. Ovary 1.8–2 × 0.8–0.1 mm, gland-dotted, hairy; ovules 2; style 8–9 mm long, glabrous, swollen at middle; stigma globose, hairy. Fruits a pod, 7–8 × 3.5–4 mm, beaked, turgid, hairy, sparsely gland-dotted; beak 0.5–0.8 mm long; glands orange, withering post maturity. Seeds 1, 2 × 3 × 2 mm, black, rounded; hilum granular, 1 mm long, position ± central.

Etymology

The specific epithet 'trifoliata' refers incorrectly to its compound leaf having three leaflets (it should have been "trifoliolata").

Distribution

Asia: Cambodia, China, India (Assam, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Sikkim, Uttarakhand and West Bengal), Indonesia, Laos, Myanmar, Papua New Guinea, Thailand, Vietnam. Australia: Northern Territory, Queensland and West Australia

Flowering & fruiting

April to July.

Habitat and ecology

It grows in damp grasslands and open forests having sandy clay at altitudes of ca. 300–1200 m asl, elsewhere at lower altitudes from 40 m. It grows in association with *Imperata* species.

Additional specimens examined

AUSTRALIA, Queensland, Cook district, Near Cooktown, SE end of Airfield, 15 May 1970, *S.T. Blake 23247* (L1957924). **INDIA**, Dhupdora, 18 November 1802, *F. Buchanan-Hamilton 1694, Wallich Catalogue Number 5742a* (E00157792 & K-W001121968); Assam, s.d., *Jenkins s.n.* (DD); Nagaon district, Kaziranga National Park, 3 December 1912, *U.N. Kanjilal 1996* (ASSAM); Karnataka, Uttara Kannada district, Birchy, 27 November 1889, *W.A. Talbot 2061* (BSI, DD); Dandeli, 5 January 1888, *W.A. Talbot 1584* (BSI, DD); Nincholi, April 1854, W.A. Talbot s.n. (BSI, DD); Kumaon, s.d., R. *Blinkworth s.n., Wallich Catalogue Number 5742b* (K-W001121969); Madhya Pradesh, Bhind district, Baran, October 1951, *C.E. Hewett 21* (DD); Maharashtra, Chandrapur district, Palmi, 21 December 1889, *J.F. Duthie 9405* (BSI & DD); Odisha, Kalahandi district, Molipodar, 23 December 1948, *H.F. Mooney 3315* (DD); Nuapada district, Khariar, 16 April 1949, *H.F. Mooney 3315* (DD); 3 October 1949, *H.F. Mooney 3691* (DD); Uttarakhand, Nainital district, Haldwani, Joula-

sal, 29 November 1925, *B.B. Osmaston 1274* (DD); West Bengal, Darjeeling District, Naxalbari, 10 December 1878, *J.S. Gamble 327c* (DD). **INDONESIA**, Java Barat, Indramayu, Plosokerep, 3 May 1936, *van Steenis 8168* (L0898706).

Affinities

Flemingia trifoliata shows resemblance to *F. gracilis*, *F. nilgheriensis* and *F. rollae* in having head or capitate type of raceme. It can be differentiated from afore mentioned species by its larger leaflets, larger inflorescence and 0.8–1.5 m tall erect nature.

Taxonomic note

Flemingia trifoliata is a very distinct species.

Nomenclatural notes

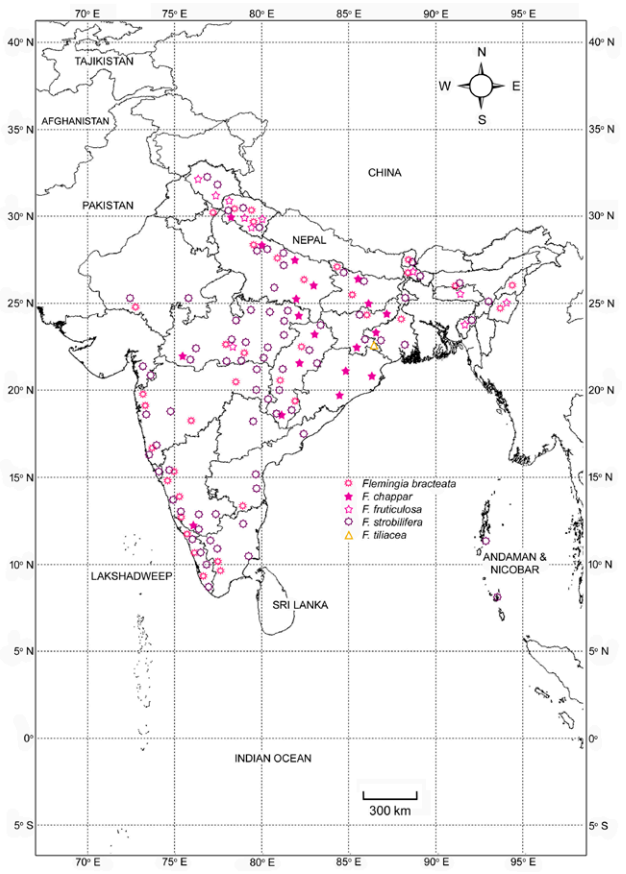
Wallich (1831) proposed a new name *Lespedeza involucrata* in his catalogue without any description based on the collection of Buchanan-Hamilton (5742a) and Blinkworth (5742b). Junghuhn (1845) made a new name *Lepidocoma trifoliatum* based on his collection from Indonesia for the same taxon. Bentham (1852) made a new combination *Flemingia involucrata* based on the Wallichian name *Lespedeza involucrata*. But *L. involucrata* is a *nomen nudum*, which bears no description at all. So the combination made by Bentham has to be changed by using epithet trifoliata of Junghuhn's binomial *L. trifoliatum* as it was validly published with ultra short description which is valid according to article 36 of ICN (van der Maesen 2012). This was done by Wu in 1946; however, the new combination *F. trifoliata* was overlooked until van der Maesen's publication in 2012. Van der Maesen (2012) noticed the new combination made by Wu (1946) during the Flora Malesiana treatment.

Flemingia subg. **Ostryodium** (Desv.) Baker

Flemingia subg. **Ostryodium** (Desv.) Baker in Hook. f. Fl. Brit. India 2: 226. 1876 (Map 5).

Erect or diffuse shrubs, leaves unifoliolate, bracts thin membranous, large folded.

Type: *Hedysarum strobiliferum* L.



Map 5. Distribution of subgenus *Ostryodium* (Desv.) Baker in India.

Key to the species of subg. *Ostryodium*

1. Leaflets ovate or linear-lanceolate, apex acute..... 2
1. Leaflets cordate, apex acuminate.....*F. chappar*
2. Erect shrubs 3
2. Trailing shrubs.....*F. fruticulosa*
3. Bracts persistent 4
3. Bracts caducous .....*F. nudiflora*
4. Plant tall up to 1.2–3.2 m in height; leaflets ovate with 12–20 mm long petiole, lateral veins 7-8(-10) pairs..... .....*F. strobilifera*
4. Plant tall up to 0.8–1 m in height; leaflets linear-lanceolate with 2–4 mm long petiole, lateral veins 4-6 pairs..... .....*F. bracteata*

Flemingia bracteata (Roxb.) Wight, Icon. Pl. Ind. Orient. 2(1): 14, t. 268. 1843

Bas.: *Hedysarum bracteatum* Roxb, Fl. Ind. 3: 351. 1832
Type: flowering specimen in Roxburgh drawing number 1612 (K image!, lectotype designated by Ali 1977: 225). Syntypes: India, witout precise locality, s.d., *W. Roxburgh s.n.* (BR0000005172306 image!, BR0000005172634 image!, BR0000005172962 image!, BR0000005172979 image!, BR0000005173303 image!, and E00157788 image!, K),

Benth. in Miquel, Pl. Jungh. 2: 245. 1852; Kurz, Forest Fl. Burma 2: 372. 1877; Prain in J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 69(2): 437. 1897; T. Cooke, Fl. Bombay 2: 391. 1902; Prain, Bengal Pl. 1: 377. 1903; Talbot, Forest Fl. Bombay 1:418. 1909; Haines, Bot. Bihar Orissa 3:268. 1922; Gamble, Fl. Madras 1: 378. 1928; Saxena & Brahman, Fl. Orissa 1: 525. 1994. (Figure 18, 23r, 24q and 25p).

(≡) *Flemingia strobilifera* var. *bracteata* Baker, in Hook. f., Fl. Brit. India 2: 227. 1876

(≡) *Maughania strobilifera* var. *bracteata* Kuntze, Revis. Gen. Pl. 1: 199. 1891. (*Moghania strobilifera* var. *bracteata*).

(≡) *Maughania bracteata* Mukerjee, Bull. Bot. Soc. Bengal 6(1): 11. 1953. (as *Moghania bracteata*).

Flemingia chlorostachys Wall., Numer. List n. 5756. 1831, *nom. nud.*

Description

Erect shrubs, up to 0.8–1m tall, with branched stem; stems 3–6 mm in diameter, young triangular, mature terete, hairy; hairs silky, antrorse. Leaves unifoliolate, 10–19 cm long, stipulate, short petiolated; stipules 2, 17–20 × 1.5–2 mm, ensiform, falcate, acuminate with equal tips, fused when young, splitting at maturity, persistent, basifixed, many nerved, hairy; petioles 3–27 mm long, grooved, hairy, gland-dotted; leaflets 1, 7–17 × 2.8–5.2 cm, linear lanceolate, rounded or cordate at base, apex acute, glabrous on both surfaces, hairy on nerves dorsally, lateral nerves in 4-6 pairs; gland-dotted; glands minute, orange-red; petiolules 2–4 mm long, hairy, gland-dotted. Inflorescences an axillary and terminal racemes; racemes consisting of small cymes enclosed by membranous bracts, in two series. Flowers 10–11 mm long, pedicellate, bracteate; pedicels 1.5–2 mm long, hairy; bracts 1.7–2 × 2.2–3 cm, broadly orbicular-ovate, mucronate at apex, many nerved, papery, hairy, gland-dotted; exterior bracts small, 5–5.5 × 1.5–2 mm, lanceolate, persistent. Calyx 5–6 mm long, hairy, gland-dotted, hairs antrorse; calyx tube 1.5–2 mm long, campanulate, hairy; calyx teeth 5, 3.5–4 × 0.8–1 mm, lanceolate, subequal, lower one the longest, connate for 1/3 of its length, many nerved, hairy, gland-dotted. Corolla cream or pinkish; standard 7.5–8 × 11–12 mm, rounded to obcordate, apex retuse, glabrous, clawed with 2 auricles; claw 1.5–2 mm long; auricles 1 mm or less than 1 mm; wing petals 7–7.5 × 3–3.5 mm, oblong, slightly falcate; claw 2–2.5 mm long; keel petals 6–6.5 × 3–3.5 mm, boat-shaped, slightly falcate, fused at apex at lower side; claw 2–2.5 mm long. Stamens 10, diadelphous (9+1); staminal tube 4.5–5 × 1– 1.5 mm, anthers uniform, less than 1 mm long, basifixed, filaments of united stamens 2–2.5 mm long, that of free stamens 5–5.5 mm long. Ovary 1.8–2 × 1 mm, gland-dotted, hairy; ovules 2; styles 5–5.5 mm long, glabrous, swollen at middle; stigma globose, hairy. Fruit a pod, 1.1–1.2 × 6–6.5 mm, beaked, turgid, slightly septate between seeds or not, hairy, sparsely gland-dotted; beak 1 mm long; glands orange-red, withering post maturity. Seeds 2, 3 × 3 × 2 mm, rounded, mottled, shiny; hilum granular, 1 mm long, position ± central.

Etymology

The specific epithet 'bracteata' refers to its thin, dry, membranous bracts.

Distribution

Asia: China (Kwangtung, Yunnan), India (Assam, Bihar, Chhattisgarh, Goa, Haryana, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Nagaland, Orissa, Rajasthan, Sikkim, Tamil Nadu, Uttar Pradesh, Uttarakhand and West Bengal), Myanmar, Nepal, Thailand, Vietnam.

Flowering and fruiting

September to February.

Habitat and ecology

Flemingia bracteata is commonly found along the roadsides in mixed forests and also on hill slopes of open forests at an altitude of ca. 400–1000 m asl. It grows in association with *Amorphophallus* species, *Byttneria herbacea* Roxb., *Cajanus scarabaeoides* (L.) Thouars, *Gardenia resinifera* Roth, *Grewia hirsuta* Vahl, *Leea asiatica* (L.) Ridsdale, *Murdannia nudiflora* (L.) Brenan, *Phoenix acaulis* Roxb., *Phyllanthus virgatus* G. Forst., *Shorea robusta* C.F.Gaertn. and *Vigna sublobata* (Roxb.) Bairig., Panda, B.P. Choudhury & Patnaik.

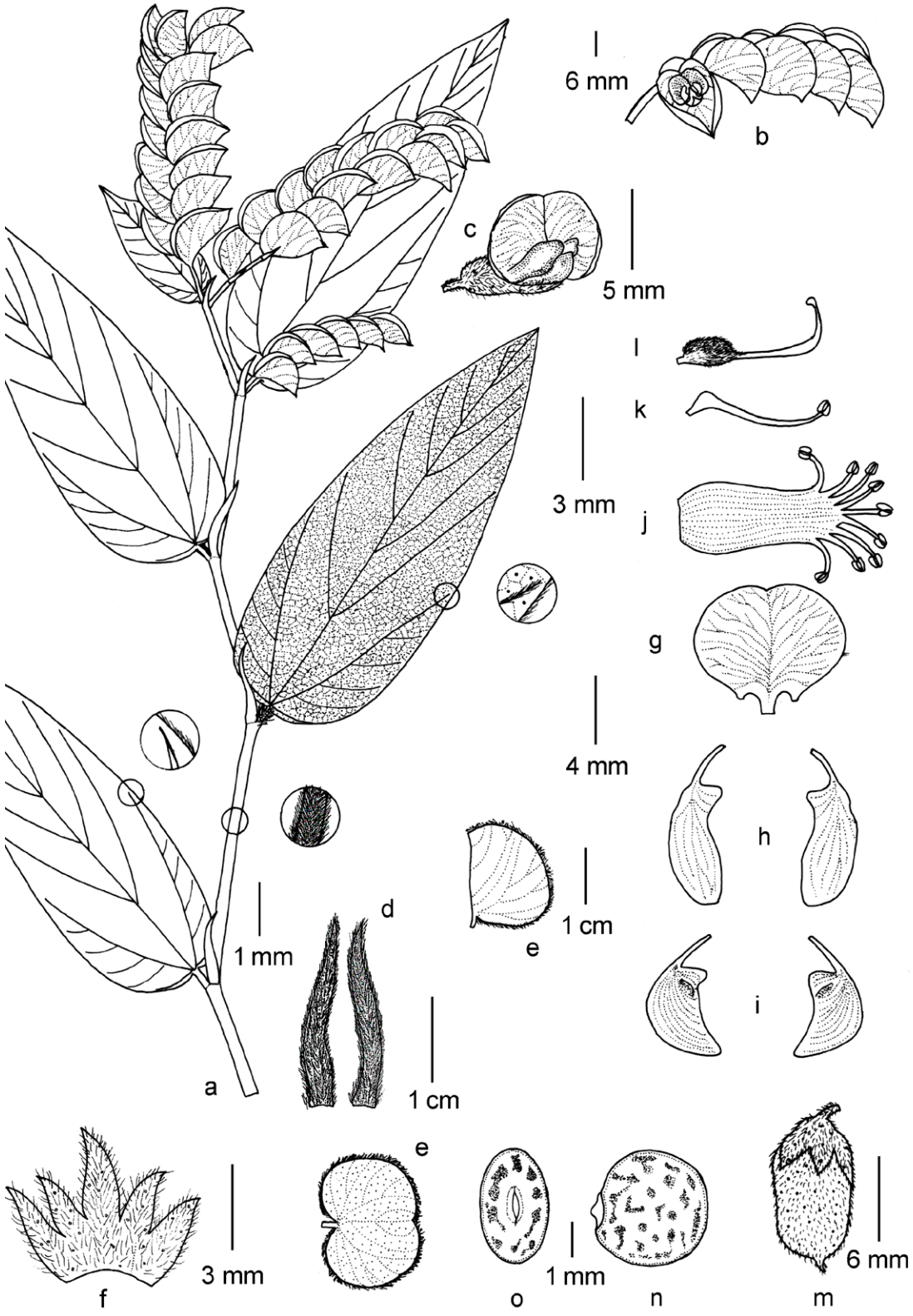


Figure 18. *Flemingia bracteata* (Roxb.) Wight. (a) Habit. (b) Inflorescence. (c) Flower. (d) Stipules. (e) Bract. (f) Calyx, dorsal view. (g) Standard. (h) Wing petals. (i) Keel petals. (j) Fused androecium. (k) Free stamen. (l) Gynoecium. (m) Fruit. (n) Seed, lateral view. (o) Seed, dorsal view.

Additional specimens examined

INDIA, 5 January 1990, *J.F. Duthie 9406* (BSI); January 1882, *W.A. Talbot 150* (CAL); Andhra Pradesh, Chittoor district, Lakshmipuram, Sumigoda, 22 October 1986, *N.R. Rao & D. Narasimhan 84395* (BSID); Assam, s.d., *Simson s.n.* (DD); Goalpara district, Dudnai, 16 December 1960, *G. Panigrahi 22647* (ASSAM); Kamrup district, Hatigaon, 27 January 1933, *D. Nath 13246* (ASSAM); Khasi and Jaintia Hills, 6 December 1938, *S.R. Sharma 17186* (ASSAM); Bihar, Madhubani, Ganguli, 23 February 1961, *S.S. Ramam 824* (CAL); West Champaran district, Bhikhna Thori, 16 March 1958, *J.G. Srivastava 48969* (LWG); Chhattisgarh, Bastar district, Kanger Ghati National Park, 15 September 2002, *A.K. Jha & K.K. Khanna 56106* (BSA); 15 January 2004, *A.K. Jha 57425* (BSA); Bilaspur district, Bilaspur, 22 February 1957, *P.C. Nanda 1189* (CAL); Jashpur district, Jashpur Nagar, 26 December 1964, *C.M. Arora 7242* (CAL); 9 July 1990, *B. Lal & R.L.S. Sikarwar 8616* (LWG); Mungeli district, Achanakmar Wildlife Sanctuary, 11 September 2015, *S.K. Gavade & A.P. Tiwari 91* (SUK); Raigarh district, Khondra village, 9 September 2015, *S.K. Gavade & A.P. Tiwari 89* (SUK); Goa, South Goa, Ordofond, 18 April 1963, *K.C. Kanodia 88127* (BSI); on the way to Ordofond to Bhatpal, 11 November 1962, *S.R. Rolla 84677* (BSI); Haryana, 11 December 1997, *S. Kumar 93240* (BSD); Yamuna Nagar district, Kalesar National Park, 28 December 1919, *R.N. Parker s.n.* (DD); 29 December 1919, *R.N. Parker s.n.* (DD); Jharkhand, Chota Nagpur, December 1881, *J.S. Gamble s.n.* (DD); Giridih district, Parasnath, 5 October 1956, *V. Chandra & party 33800* (LWG); 2 October 1873, *C.B. Clarke 20233B* (CAL); September 1949, *R.C. Bhardwaj s.n.* (DD); Karnataka, Chikkamagaluru district, Baba Budangiri, 22 October 1964, *R.S. Raghavan 103811* (BSI); 2 December 1978, *S.R. Ramesh & K.R. Keshava Murthy 4800* (JCB); Kodagu district, Abbey Falls, 20 October 1963, *A.S. Rao 94968* (BSI); Brahmagiri hills, 15 November 1978, *V.S. Ramachandran 58746* (MH); December 1907, *E. Blatter 10349* (BLAT); Nagarhole National Park, 2 November 1963, *A.S. Rao 95445* (BSI); Uttara Kannada district, Anmod, 6 February 1950, *J. Fernandez 983* (BLAT); Castle Rock, 24 October 1902, *G.A. Gammie 15883* (BSI); 18 December 1953, *H. Santapau 17648* (BLAT); Dandeli, 25 December 1955, *D.P. Panthaki 2449* (BLAT); *D.P. Panthaki 2450* (BLAT); 26 December 1955, *D.P. Panthaki 2475* (BLAT); Gund, 27 December 1955, *D.P. Panthaki 2484* (BLAT); 4 November 1962, *H.K. Mazumdar 163* (BARO); Ramanguli, 8 January 1951, *J. Fernandez 2063* (BLAT); Sirsi, October 1991, *C. McCann 34579* (BLAT); Shivamogga district, Jog Falls, 16 January 1950, *J. Fernandes 747* (BLAT); 18 January 1950, *J. Fernandes 788* (A,BLAT); Someshwara Wildlife Sanctuary, 6 February 1961, *R.S. Raghavan 69377a* (BSI); Kerala, Alappuzha, Microwave Station, 8 November 1981, *V.S. Raju 71208* (MH); Idukki district, Kulamavu, 24 September 1978, *B. Ramanujan 58746* (MH); Kuttikkanam, 27 November 1967, *K. Vivekananthan 29382* (CAL); 24 September 1972, *B.D. Sharma 41647* (MH); on the way to Kuttikkanam to Peermade, 27 November 1962, *K. Vivekananthan 29382* (MH); Peermade, 2 November 1970, *Sreedaran Nambiar M.K. 144* (CALI); 9 December 1970, *Sivadasan M. 548* (CALI); 9 December 1970, *Prabhakaran A. 1549* (CALI); Vandiperiyar, 26 August 1985, *K.M. Matthew 18505* (RHT); Kollam district, on the way to Punalur to Chalakodu, 5 May 1976, *Jose A. 18333* (CALI); Kozhikode district, Kadalundi, 6 June 1989, *Babu A. 44363* (CALI); Pavangad, 28 October 1945, *J.L. Ellis 25748* (CAL & MH); Malappuram district, Nilambur, s.d., *Kadeejakutty 275* (CALI); 9 December 1988, *Santa S. 3651* (CALI); 10 December 1988, *Jayakumar E. 2114* (CALI); *Premlatha 3251* (CALI); Vatakara, 11 December 1990, *Bindu A. 3012* (CALI); Palakkad district, Kanjirakadavu, 14 January 1981, *P. Matthew 25692* (CALI); Nelliyampathy, 12 December 1996, *K. Radha Laxman 29025* (TBGT); on the way to Valiyaparathode, 15 January 1980, *N.C. Nair 65470* (CAL); Pathanamthitta district, Kakki, 30 July 1991, *S. Binu 2132* (TBGT); on the way to Pampa dam to Anathode, 28 January 1986, *K.M. Matthew 18761* (RHT); Pannikkunnur, 26 January 1992, *R. Chandrasekaran 96677* (MH); Wayanad district, Chandanathode, 18 November 1982, *N. Sasidharan 2554* (KFRI); Wyanad forest, 6 November 1985, *Breezy George 7420* (CALI); 21 September 1990, *Preena G. 4604* (CALI). Madhya Pradesh, 3 March 1980, *S.K. Das Das 961* (CAL); Anuppur district, Kapil Dhara, 27 October 1960, *J.K. Maheshwari 4175* (CAL); Balaghat district, Baihar, 9 February 1949, *R.L. Fleming 826* (DD); on the way to Nagarwada to Lamta, 12 January 1961, *J.K. Maheshwari 4436* (CAL); Seta Dongi, 10 May 1958, *H. Santapau 22491* (BLAT); Chhindwara district, Patalkot, 1 October 1985, *R.P. Dwivedi 2945* (LWG); Dindori district, Dhurkuta, 27 February 1984, *B. Lal & party 2383* (LWG); *B.S. Kalakoti 2383* (LWG); Hoshangabad district, Pachmarhi, 18 February 1891, *J.F. Duthie 10375* (CAL, DD); Little falls, 10 October 1969, *V.N. Naik 552* (BAMU); Rajat Prapat, 20 September 2002, *R. Sharma 56592* (BSA); Jabalpur district, Jabalpur, s.d., *R.S. Hole s.n.* (DD); December 1901, *Forest Division Officer 57* (CAL); Kaimur Range, 10 February 1959, *K.M. Sebastine 7695* (CAL, MH); Mandla district, Bichhiya, 7 February 1961, *J. Joseph 12236* (MH); Kanha National Park, 9 March 1962, *J.K. Maheshwari 4720* (CAL); 11 March 1962, *J.K. Maheshwari 4809* (CAL); 12 March 1962, *J.K. Mahesh-*

wari s.n. (CAL); Surguja district, Bargaon, 20 July 1990, *B. Lal & R.L.S. Sikarwar* 8753 (LWG); Lakhanpur, 5 November 1998, *V. Kumar & M.K. Shukla 608* (LWG); Maharashtra, Bombay, 25 December 1953, *Kaul & party 5867* (LWG); Kolhapur district, Parale Maan, 3 September 2016, *S.K. Gavade 138* (SUK); Mumbai Suburban district, Borivali National Park, 29 October 1955, *P.S. Herbert 860* (BLAT); 19 February 1956, *P.S. Herbert 1398* (BLAT); *P.S. Herbert 1409* (BLAT); *P.S. Herbert 1410* (BLAT); *P.S. Herbert 1411* (BLAT); 24 October 1956, *P.S. Herbert 2542* (BLAT); Nashik district, Trimbakeshwar, 10 November 1976, *V.N. Naik 2905* (BAMU); Osmanabad district, Osmanabad, 10 October 1964, *N.V. Ingle s.n.* (BAMU); Pune district, Khandala, 15 March 1945, *H. Santapau 6125* (BLAT); 29 January 1955, *P.V. Bole 1311a* (BLAT); Raigad district, Matheran, 10 January 1959, *N.A. Irani 2781* (BAMU); Rambagh picnic spot, 26 February 1959, *N.A. Irani 2989* (BLAT); Thane district, Khardi, 22 February 1903, *G.A. Ryan 526* (BSI); Meghalaya, Ri Bhoi district, on the way to Umsning to Noonmati, 11 May 1965, *J. Joseph 37572* (ASSAM); Manipur, Imphal East district, Imphal, 9 April 1962, *J.G. Srivastava 81989* (LWG); Nagaland, Naga Hills district, Naga hills, 1935, *N.L. Bor 2856* (DD); Odisha, Kandhamal district, Kandhamal, 11 December 1962, *G.S. Rao 30150* (ASSAM); Mayurbhanj district, Simlipal National Park, *S.L. Kapoor & party 73139* (LWG); on the way to Baliguda to Kotagad, *S.L. Kapoor & party 64927* (LWG); Rajasthan, Sirohi district, Mount Abu, Gomukh, 14 April 1960, *S.K. Jain 62112* (BSI); Sikkim, s.d., *S. Kurz s.n.* (CAL); East Sikkim, Majitar, 2 January 1994, *G.P. Sinha 8578* (BSHC); South Sikkim district, Jorethang, 5 December 1996, *S.K. Jana 18958* (BSHC); Manpur, 4 January 1994, *G.P. Sinha 10759* (BSHC); Melli, 17 December 1981, *P. Chakraborty 1970* (CAL); 18 December 1981, *P. Chakraborty 1970* (BSHC); Tamil Nadu, Coimbatore district, Anaimalai hills, Kadamparai, 9 December 1913, *C.E.C. Fischer 3672* (CAL); Dindigul district, Kodaikanal, 12 February 1982, *Geetha H. 36095* (CALI); 10 March 1982, *Manimohan P. s.n.* (CALI); Sirumalai, December 1937, *s.coll. s.n.* (RHT); Madura District, on the high way, 6 September 1925, *K.C. Jacob 17527* (MH); Nilgiris district, Gudalur, 11 March 1969, *D.B. Deb 31652* (MH); Telangana, Yadadri-Bhuvanagiri district, 6 December 1984, *R.R.V. Raju 2380* (BSID); Uttar Pradesh, Bahraich district, 26 November 1987, *K.K. Singh & team 6911* (LWG); Murtiha forest range, 10 November 2002, *S.D. Maluja 224587* (LWG); Nishan Gara, 12 November 2002, *S.D. Maluja 224634* (LWG); 4 October 1956, *H. Pirson 1474* (BLAT); 12 February 1965, *O.P. Misra 7945* (BSA, CAL); 26 November 1987, *K.K. Singh 6911* (LWG); Balrampur district, Soheleva, 18 October 2005, *K.K. Khanna 59964* (BSA); East Soheleva, 9 January 2007, *K.K. Khanna 68703* (BSA); Gorakhpur district, Campierganj, 20 January 2007, *K.K. Khanna 66548* (BSA); Lakhimpur Kheri district, Dhyanpur, 8 August 1980, *J. K. Maheshwari & party 277* (LWG); Mailani, 17 December 1960, *C.L. Malhotra 13376* (BSD); Pilibhit district, Mala forest, 9 December 1949, *D.D. Awasthi 304* (DD); Saharanpur district, Datt, 19 June 1955, *J.G. Srivastava 6981* (LWG); Sant Kabir Nagar district, Bakhira Bird Sanctuary, 19 January 2007, *K.K. Khanna 68534* (BSA); Sonbhadra district, Pipri dam site area, 11 March 1970, *G. Panigrahi 12078* (BSA); Uttarakhand, Champawat district, Reetha Sahib, 29 October 2012, *K. Ambrish 120879* (BSD); Dehradun district, Chandrabani forest, 10 October 2015, *S.K. Gavade 106* (SUK); Dehradun, s.d., *Janson s.n.* (DD); August 1895, *P.W. Mackinnon s.n.* (CAL); August 1996, U. C. Kanjilal s.n. (DD); 13 March 1954, *G.S. Srivastava 6864* (LWG); 22 October 1991, *A. Prakash & party 210609* (LWG); Kandoli, 29 September 1961, *S.K. Malhotra 17386* (BSD); Karwapani, 06 December 1956, *T.A. Rao & Y.K. Sarin 1237* (BSD); Lachhiwala, 5 October 1922, *K. Ram s.n.* (DD); 8 December 1956, *G.S. Puri 40041* (BSI); 12 November 1968, *B.D. Naithani 38541* (BSD); Laxman Siddh, 6 October 1973, *H.B. Naithani s.n.* (DD); Mothrowala, 12 September 1958, *K.M.M. Dakshini 6218* (BSD); Nakronda, 2 February 1957, *M.A. Rao 1614* (BSD); Rajaji National Park, 1984, *W.A. Rodgers 2835* (WII); Rajpur, 10 December 1956, *G.S. Puri 10121* (BSI); 9 December 1960, *H.O. Saxena 15019* (DD); Rispana, 30 August 1964, *C.R. Babu 34002* (BSD); Timli forest, 11 December 1954, *V. Chandra & party 43033* (LWG); Haridwar district, Motichur, 13 December 1912, *A.E. Osmaston 16* (DD); 14 November 1995, *A. Prakash 107867* (LWG); Nainital district, Haldwani, 1 March 1953, *Kaul & party 19613* (LWG); Jim Corbett National Park, 16 September 1970, *P.C. Pant 43296* (BSD); 19 November 1972, *K.P. Janardhanan 51101* (BSD); 28 September 1972, *K.P. Janardhanan 51276* (BSD); Bijrani, 22 October 2000, *H.C. Pande 222004* (LWG); Dhikala, 14 September 1970, *P.C. Pant 43233* (BSD); Gargia, 6 September 1970, *P.C. Pant 43020* (BSD); Malani, 5 November 1999, Tariq Hussain, *217212* (LWG); Sandigaon, 23 December 1999, T.S. Rana, *B. Datt & H.C. Pande 220236* (LWG); Ramnagar, T.B. forest, *V. Chandra & party 47847* (LWG); Pithoragarh district, 17 November 1989, *B. Datt 202537* (LWG); Bansagar, s.d., *B. Balom 75661* (BSD); Bastiyadhar, 14 November 1989, *B. Datt 202448* (LWG); Garhwal, 1869/70, *G. King s.n.* (CAL); Kumaon, 1871, *G. King s.n.* (CAL); West Bengal, Alipurduar District, Chilapata forest, Banya-6, 15 December 1995, *S. Chandra & S.K. Mandal 1148* (CAL); Darjeeling district, Darjeeling, 14 December 1876, *C.B. Clarke 31731*

(CAL); Sukna, 9 November 1976, *J.S. Gamble 1759b* (DD).

Affinities

Flemingia bracteata is allied to *F. strobilifera* but differs from it in the presence of narrow cordate leaflets, short petiole, ensiform persistent stipules and broadly orbicular-ovate bracts.

Taxonomic note

Flemingia bracteata is a distinct species but Baker (1876) and Kuntze (1891) treated it as a variety under *F. strobilifera*. Subsequent workers, viz. Kurz (1877), Prain (1897, 1903), Cooke (1902), Talbot (1909), Haines (1922), Gamble (1928), Mukerjee (1853) and Saxena and Brahman (1994) treated *F. bracteata* as a distinct species. Sanjappa (1992) and Kothari (2001) and Do and Gao (2020) synonymised *F. bracteata* under *F. strobilifera*. Our findings have revealed that *F. bracteata* is a distinct species and not conspecific to *F. strobilifera* although they are looking quite similar. Determinations often resulted in *F. strobilifera*.

Nomenclatural notes

Ali (1977) lectotypified the binomial *Flemingia bracteata* and designated Roxburgh's drawing number 1612 as type. *Flemingia bracteata* is based on *Hedysarum bracteatum* which was described by Roxburgh in 1832. In 'Flora Indica', Roxburgh (1832) mentioned that this species was sent to the Calcutta Garden by Dr. W. Carey from Dinajpoor (Dinajpur, now in Bangladesh). Further, he added that the species is a native of Bengal and grows luxuriantly and flowers in winter. However, while describing the species, Roxburgh did not indicate the type. In the search of type specimens in relevant herbaria (BM, BR, E, K (K-W), LIV, OXF and LINN), we found five herbarium sheets in BR which were purchased by Martius, founder of 'Flora Brasiliensis', from LINN (Forman 1997). All these sheets had been collected by Roxburgh and constitute original material. Two sheets (BR0000005172306 and BR0000005172962) bear the label upon which "*Hedysarum bracteatum*" is written in Roxburgh's handwriting. One of the sheets (BR0000005173303) is labeled as "Kusrunt, lanced leaves, flowering in August, *Hedysarum bracteatum*". Another two sheets (BR0000005172634 and BR0000005172979) bear only the stamp of Martius herbarium. Additionally, one specimen at E (E00157788) also bears a label upon which "*Hedysarum bracteatum*" is written in Roxburgh's hand and hence it also forms a part of the original material. All the sheets mentioned above serve as syntype.

Flemingia chappar Buch.-Ham. ex Benth. in Miquel Pl. Jungh. 2: 244. 1852

Type: India, West Bengal, Calcutta Botanical Garden, s.d., *s.coll. s.n., Wallich Catalogue Number 5757b* two specimens (Thuan mentions locality as Inde Orientale), first-step lectotype designated by Thuan 1979: 142; K-W001122032 image!, second-step lectotype designated here; isolectotypes K-W001122039 image!, L0018981 image! and P00709067 image!). Syntypes: Myanmar, Taong Dong, 24 November 1826, *N. Wallich, Wallich Catalogue Number 5757d* (BM000958674 image!, E00157796 image!, K-W001122034 image! and K-W001122035 image!). India, Uttar Pradesh, Barabanki district, Ganjariya, 22 November 1810, *F. Buchanan-Hamilton s.n., Wallich Catalogue Number 5759a* (E00157797 image! and K-W001122030 image!); Raebareli district, Lalganj, s.d., *F. Buchanan-Hamilton s.n., Wallich Catalogue Number 5759a* (K-W001122031 image!). Uttarakhand, Dehradun, April 1825, *N. Wallich, Wallich Catalogue Number 5757c* (K-W001122033 image!).

Baker, in Hook. f., Fl. Brit. India 2: 227. 1876; Kurz, Forest Fl. Burma 2: 371. 1877; Prain in J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 69(2): 438. 1897; Prain, Bengal Pl. 1:377. 1903; Haines, Bot. Bihar Orissa 3: 267. 1922; Gamble, Fl. Madras 1: 378. 1928; Babu, Herbac. Fl. Dehra Dun 148. 1977; Sanjappa, Legumes of India 175. 1992. (Figure 19, 23s, 24r and 25q).

(≡) *Maughania chappar* (Buch.-Ham. ex Benth.) Kuntze, Revis. Gen. Pl. 1: 199. 1891; Mukerjee, Bull. Bot. Soc. Bengal 6(1): 13. 1953. (as *Moghania chappar*).

Description

Erect shrubs, up to 0.8–1 m tall, with branched stem; stems 4–10 mm in diameter, terete, hairy; hairs silky, antrorse. Leaves unifoliolate, 7–16 cm long, stipulate, petiolate; stipules 2,8–9 × 2.5–3 mm, lanceolate, acuminate with equal tips, fused when young, splitting at maturity, basifixed, caducous, many nerved, hairy; petioles 2–4 cm long, terete, hairy, gland-dotted; leaflets 1, 5–13 × 6–10 cm, broadly cordate, rounded or cordate at base, apex acuminate, glabrous on both surfaces, hairy on nerves dorsally, gland-dotted; glands orange-red; petiolules 3–5 mm long, hairy, gland-dotted. Inflorescences an axillary and terminal raceme; racemes comprising small cymes enclosed by membranous bracts, in two series. Flowers 10–11 mm long, pedicellate, bracteate; pedicels 2–3 mm long, hairy; bracts 2.5–2.6 × 4–4.2 mm, reniform, mucronate at apex, many nerved, glabrous, gland-dotted. Calyx 4–5 mm long,

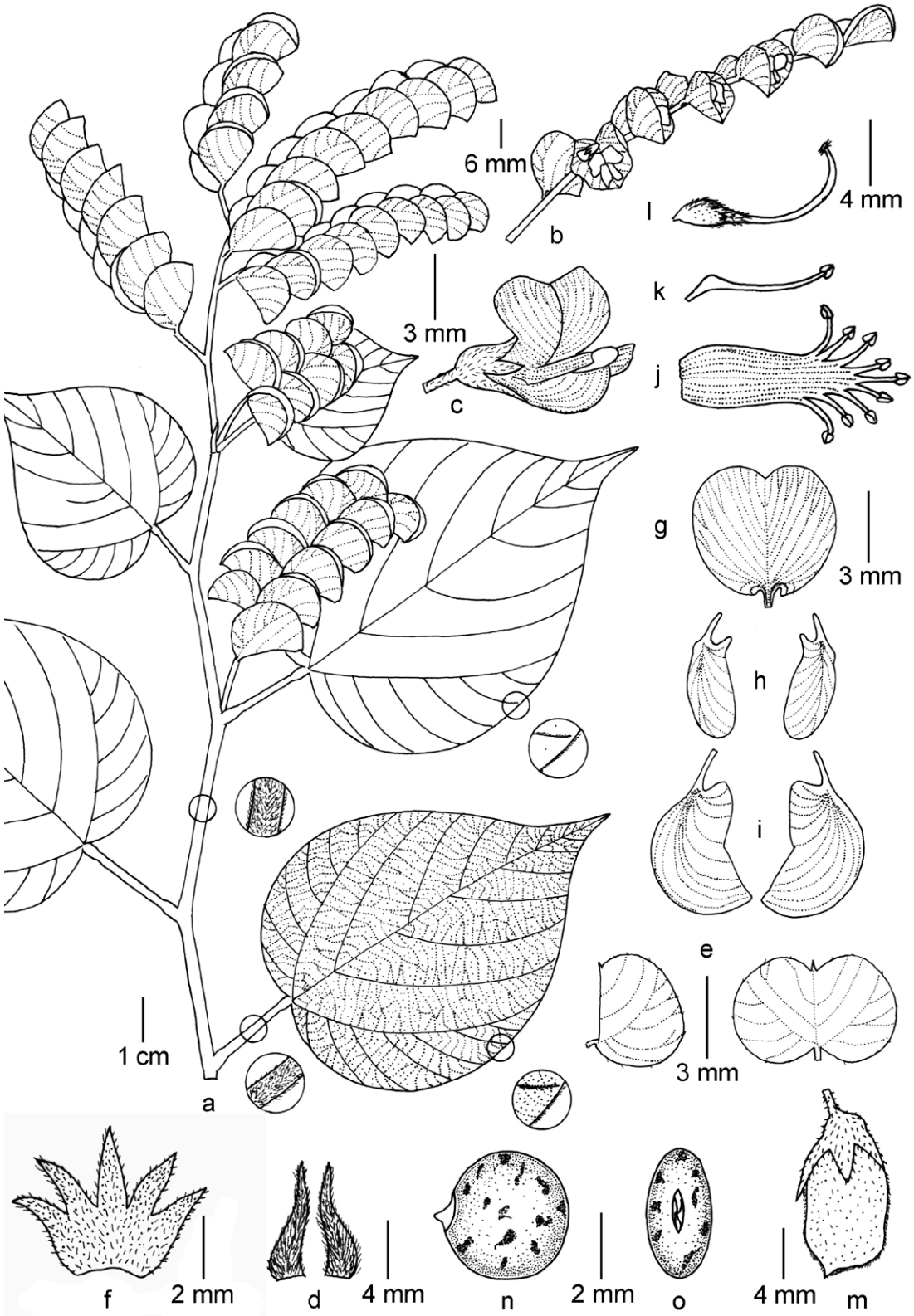


Figure 19. *Flemingia chappar* Buch.-Ham. ex Benth. (a) Habit. (b) Inflorescence. (c) Flower. (d) Stipules. (e) Bract. (f) Calyx, dorsal view. (g) Standard. (h) Wing petals. (i) Keel petals. (j) Fused androecium. (k) Free stamen. (l) Gynoecium. (m) Fruit. (n) Seed, lateral view. (o) Seed, dorsal view.

hairy, gland-dotted; calyx tube 1.5–2 mm long, campanulate, hairy; calyx teeth 5, 2–3 × 0.8–1 mm, lanceolate, subequal, lower one the longest, connate for 1/2 of its length, many nerved, hairy, gland-dotted. Corolla white with green striations; standard 6–6.5 × 6–6.5 mm, rounded to obovate, apex retuse, glabrous, clawed with 2 auricles; claw 1.5–2 mm long; auricles 1 mm or less than 1 mm; wings petals 6–6.5 × 2–2.5 mm, oblong; claw 1.5–2 mm long; keel petals 9–9.5 × 4–4.5 mm, boat-shaped, slightly falcate, fused at apex at lower side; claw 2–2.2 mm long. Stamens 10, diadelphous (9+1); staminal tube 7–7.5 × 1 mm, anthers uniform, less than 1 mm long, basifixed, filaments of united stamens 2–2.5 mm long, that of free stamens 8–8.5 mm long. Ovary 0.8–2 × 1 mm, gland-dotted, hairy; ovules 2; styles 7–7.5 mm long, glabrous, swollen at middle; stigma globose, hairy. Fruits a pod, 1.2–1.4 × 6–6.5 mm, beaked, turgid, slightly septate between seeds or not, hairy, sparsely gland-dotted; beak 1 mm long; glands orange-red, withering post maturity. Seeds 2, 4 × 4 × 2.5 mm, rounded, mottled, shiny; hilum granular, 1 mm long, position ± central.

Etymology

The specific epithet 'chappar' refers to its thin, dry, membranous bracts.

Distribution

Asia: Cambodia, India (Bihar, Chhattisgarh, Karnataka, Jharkhand, Madhya Pradesh, Odisha, Uttar Pradesh, Uttarakhand and West Bengal), Myanmar, Nepal, Thailand.

Flowering and fruiting

December to March.

Habitat and ecology

Flemingia chappar is found on hill slopes in open forests at an altitude of ca. (300-) 600–1000 m asl. It grows in association with *Bauhinia malabarica* Roxb., *B. vahlii* Wight & Arn., *Cassia fistula* L., *Ficus racemosa* L., *Pueraria tuberosa* (Roxb. ex Willd.) DC., *Shorea robusta* C.F.Gaertn. and *Terminalia alata* B.Heyne ex Roth.

Additional specimens examined

INDIA, December 1907, *A. Meebold s.n.* (BSI); s.d., *R.C. Srivastava 43360* (BSA); Chota Nagpur, November 1880, *J.S. Gamble 8764* (CAL); s.d., *J.J. Wood s.n.* (CAL); Bihar, Muzaffarpur district, Motipur, 12 March 1964, *G. Panigrahi 2845* (BSA, CAL); 22 November 1964, *G. Panigrahi & O.P. Mishra 6532* (BSA); 7 December 1986, *K.K. Khanna & R. Saran 38561* (BSA, CAL); Nalanda district, Palaman, 25 September 1981, *M.K. Mano & P. Sahaddar 958* (BSA); Chhattisgarh, Balrampur-Ramanujganj district, Ramanujganj, 15 March 1974, *G.S. Gupta 18807* (BSA); Jashpur district, Jashpur, 21 April 1965, *G. Panigrahi & C.M. Arora 8804* (BSA & CAL); Jashpur Nagar, 4 May 1964, *C.M. Arora 3893* (BSA & CAL); Kutma nala, 31 March 1976, *N.C. Balakrishnan 24402* (BSA); on the way to Kunkuri to Lawakera, 14 February 1974, *N.C. Balakrishnan 19900* (BSA); Raigarh district, Dharamjaygarh, 22 December 1964, *C.M. Arora 7151* (BSA, CAL); Sukhamuda, 9 February 1974, *N.C. Balakrishnan 19781* (BSA); Kumarata, Pataklota forest, 15 June 2016, *S.K. Gavade 133* (SUK); 1 January 2017, *S.K. Gavade 169* (SUK); 26 January 2017, *S.K. Gavade 181* (SUK); Surguja district, Ambikapur, 17 November 1972, *G.S. Gupta 17120* (BSA); Pratappur, s.d., *A.K. Srivastava s.n.* (BSA); Sabag, 21 February 1976, *G.S. Gupta 24105* (BSA); Karnataka, Kodagu district, Abbey Falls, *T.A. Rao & B.C. Banerjee 11719* (CAL); Jharkhand, Dumka district, Silingi, Bonsloi river, 21 December 1957, *G. Panigrahi 12078* (CAL); Giridih district, Parasnath hills, 13 October 1982, *G.N. Tribedi 708* (CAL); 21 November 1891, *D. Prain 129805* (CAL); Gumla district, Kurdega, 20 February 1981, *K.C. Malick 9746* (CAL); Hazaribagh district, Canary hills, 10 November 1964, *K.K. Kanodia 1050* (CAL); Hazaribagh, 9 October 1873, *C.B. Clarke 21036* (CAL); Sahibganj district, Borio, 12 December 1957, *G. Panigrahi 11705* (CAL); Singhbhum district, Goelkera, 27 December 1960, *G.V.S. Rao 22740* (CAL); Tholkabad, s.d., *B.L. Jain s.n.* (BARO); Madhya Pradesh, Sidhi district, Kushmi, 22 December 2015, *A.P. Tiwari 119* (SUK); Singrauli district, on the way to Mohgarhi to Kushanhiya, 24 February 1971, *G.S. Gupta 14578* (BSA, CAL); Sarai reserve forest, 30 January 1971, *G.S. Gupta 14476* (CAL); Dhar district, Barda, 21 January 1964, *G. Panigrahi & V.N. Singh 2407* (CAL); on the way to Barda to Chitrangi, 21 January 1964, G. Panigrahi 2407 (BSA); Odisha, s.d., *G. Panigrahi s.n.* (ASSAM); Angul district, Satkosia wildlife sanctuary, 16 November 2002, *D. Hazra & D. Das 19322* (BSID); Balasore district, Kuldiha wildlife Sanctuary, 24 January 1986, *Anitha M.P. 5339* (CALI); *Baby Jaylekha 7940* (CALI); Gettha P. 6734 (CALI); *Jeena Majeed 8346* (CALI); *Naseem P.A. 5563* (CALI); *Vaisa A.K. 7036* (CALI); 25 January 1986, *Breezy George 7566* (CALI); *Karthiayani K.P. 6349* (CALI); 27 January 1986, *Neena C. 8960* (CALI); Raj Nilgiri, 25 January 1986, *A.K. Pradeep 5934* (CALI); Dhenkanal district, Ramial dam site, 19 March 1975, *A.R.K. Sastry 11105* (BSID); Ganjam district, Gullery, January 1884, *J.S. Gamble 13733* (CAL); Mayurbhanj district, Bhanjabasa, 13 February 1958, *G. Panigrahi 123225* (CAL); Manchabandha, 12 December 1940, *s.coll. s.n.* (DD); Sambalpur district, Hatigirdha, 4 November

1986, *S. Panda & A.P. Das 276* (CAL); Usakulhi reserve forest, 25 February 1987, *S. Panda & A.P. Das 539* (CAL); *S. Panda & A.P. Das 567* (CAL); Uttar Pradesh, Allahabad district, Lehari, 1 November 1963, *C.M. Arora 1430* (BSA); Bagpat district, Tikri forest, 9 October 2004, *s.coll. 107206* (LWG); Bahraich district, Chakiya forest block, 11 February 1959, *M.A. Rau 8234* (BSA, BSD); Nishan Gara, 1 October 1956, *H. Pirson 1426* (BLAT); on the way to Rupaidiha to Chakiya, 7 February 1965, *O.P. Mishra 7706* (BSA, CAL); Balrampur district, West Soheleva, 10 January 2007, *K.K. Khanna 68722* (BSA); Balrampur, February 1848, *Inayat Khan 20968* (DD); Gonda district, Narhena, 30 May 1898, *Harsukh 21514* (CAL); Gorakhpur district, Campierganj, 20 January 2007, *K.K. Khanna 66526* (BSA); Chamokha, 4 April 1898, *Harsukh 21513a* (CAL); Gorakhpur, 23 March 1898, *Inayat Khan 21513* (DD); Gorakhpur T. Ghats, 24 November 1987, *K.K. Singh & party 6921* (LWG); Pakari, 6 November 1963, *C.M. Arora 1562* (BSA); Jaunpur district, Gulra, 29 November 1954, *Hiralal 16671* (LWG); Lakhimpur Kheri district, Andesh Nagar, 7 December 2004, *B.K. Shukla 61464* (BSA); Mailani, 2 November 1905, *R.S. Hole s.n.* (BSD, DD); 17 December 1960, *C.L. Malhotra 13375* (BSD); Maharajganj district, Domakhand, 24 January 1968, *J.K. Maheshwari 81534* (LWG); Madhulia, 15 January 1992, *S.L. Kapoor 8* (LWG); Madwalia forest, 26 February 2004, *B. Datt 222353* (LWG); Mirzapur district, Hati nala, 11 December 1961, *U.C. Bhattacharya 18347* (BSA, BSD); 23 December 1970, *G. Panigrahi 13647* (BSA); Rampur district, Abdullaganj, 5 July 1954, *V. Chandra & party 11941* (LWG); Shravasti district, Bhinga, Bankatwa, 6 March 2010, *S.D. Maliya 226679* (LWG); Sonbhadra district, Pipri Dam Forest, 11 March 1970, *G. Panigrahi 12071* (BSA); Uttarakhand, Garhwal district, Kansrao, February 1942, *M.B. Raizada s.n.* (DD); Haridwar district, Motichur, 14 November 1995, *A. Prakash 107865* (LWG); December 1895, *J.S. Gamble 25637* (CAL, DD); 19 December 1912, *B.B. Osmaston 15* (DD); *B.B. Osmaston 8237* (DD); *B.B. Osmaston 8235* (DD); Tirsal forest, February 1989, *A. Smythes s.n.* (DD); West Bengal, Bankura district, Biharinath hill, 12 June 1910, *S. Kurz s.n.* (CAL); Manbhum district, Manbhum, s.d., *J. Campbell s.n.* (CAL); Medinipur district, Rangamati, 2 March 1975, *S.K. Moti 1165* (CAL); Purulia district, Ayodhya hills, 16 May 1963, *U. Chatterjee 54* (CAL); 25 December 1958, *G.S. Gupta 2063* (CAL); Upper dam, 6 March 1997, *T.K. Paul 704* (CAL).

Affinities

Flemingia chappar is allied to *F. paniculata* but differs from it in the presence of papery folded bract, racemes comprising small cymes and cordate leaflets.

Taxonomic note

Flemingia chappar is a very distinct species.

Nomenclatural notes

The binomial *Flemingia chappar* was proposed by Buchanan-Hamilton (Wallich 1831) in Wallich catalogue which was later validly published in 'Plantae Junghuhnianae' by Bentham (1852). While describing the species, Bentham cited the specimen with Wallich Catalogue Number 5757 in the protologue.

Thuan (1979) in his treatment of *Flemingia* in Flore du Cambodge, Laos, Vietnam mentioned "Wallich 5757B, Inde orientale (holo-, K; iso-, P)". According to Art. 9.10 of the ICN (Turland et al. 2018), this is an error to be corrected, and this should be regarded as the selection of a lectotype. Similarly, the duplicates at K, L and P should serve as isolectotypes. While searching for the type, we could locate twelve specimens of Wallich Catalogue Number 5757, viz. 5757a, 5757b, 5757c and 5757d (Wallich 1831). We found that there are three sheets of 5757a which were collected by Buchanan-Hamilton. Out of these three, one at E (E00157797) was collected from Gunjoriya (now Gunjaria, Uttar Pradesh) and two at K (K-W001122030 and K-W001122031) were collected form Lalganj (Uttar Pradesh). One sheet each pertaining to 5757b were located at K, L and P. The first sheet at K (K-Wall.) has two specimens, viz. K-W001122032 and K-W001122039. Sheets at L (L0018981) and P (P00709067) were collected from Calcutta Botanic Garden by an unknown collector. The sheet bearing collection number 5757c at K (K-W001122033) which is from Dehradun, India, was collected by Wallich. Collection number 5757d is represented by four specimens mounted on three sheets: one sheet each at BM (BM000958674) and E (E00157796). The third at K bears two specimens (K-W001122034 and K-W001122035). These four specimens were collected by Wallich from Taong Dong, Myanmar. Thuan's mention of 5757b as holotype should be considered as a first-step typification according to Art. 9.17 Ex.14. of the Shenzhen Code (Turland et al. 2018). Consequently, the designation is here narrowed by selecting the specimen (K-W001122032) referred by Thuan as "holotype" as second step lectotype as per Art. 9.17 of ICN (Turland et al. 2018). The duplicates of 5757b (K-W001122039, L0018981 and P00709067) become isolectotypes. The remaining specimens serve as syntypes.

Flemingia fruticulosa Wall. ex Benth. in Miquel, Pl. Jungh. 2: 245. 1852

Type: Nepal, without precise locality, 1821, *s.coll. s.n. Wallich catalogue Number 5756a* (K001122023 image!, lectotype designated by Ali 1977: 225; isolectotype CAL163049!, CAL163050!, BM000884630 image!, G00365320 image!). Syntype: India, Himachal Pradesh, Sirmore, s.d., *G. Govan s.n., Wallich catalogue Number 5754 b* (K001122024 image!). (Figure 20 and 23t).

Prain in J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 69(2): 438. 1897.

(≡) *Flemingia strobilifera* var. *fruticulosa* (Wall. ex Benth.) Baker, in Hook. f., Fl. Brit. India 2: 227. 1876.

(≡) *Maughania fruticulosa* (Wall. ex Benth.) Mukerjee, Bull. Bot. Soc. Bengal 6(1): 12. 1953 (as *Moghania fruticulosa*).

Description

Trailing shrubs, up to 40–60 cm long, with branched stem; stems 2.5–4 mm in diameter, terete, hairy; hairs silky, antrorse. Leaves unifoliolate, 5.4–7.4 cm long, stipulate, petiolate; stipules 2, 10–11 × 1.8–2 mm, lanceolate, acuminate with equal tips, fused when young, splitting at maturity, persistent, basifixed, many nerved, hairy; petioles 2–3 cm long, grooved, gland-dotted, hairy; leaflets 1, 5.4–7.4 × 3.2–14.6 cm, ovate to elliptic, cordate or subcordate at base, apex acute, glabrous on both surfaces, hairy on nerves dorsally, gland-dotted; glands orange-red; petiolules 2–2.5 mm long, hairy, gland-dotted. Inflorescences an axillary and terminal raceme; racemes comprising 3-4 flowers enclosed by membranous bracts, in two series. Flowers 8–9 mm long, pedicellate, bracteate; pedicels 1.5–2 mm long, hairy; bracts 2–2.5 × 3–3.8 mm, persistent, reniform, retuse, mucronate at apex, many nerved, hairy, gland-dotted. Calyx 5.5–6.5 mm long, hairy, gland-dotted; calyx tube 1.8–2 mm long, campanulate, hairy; calyx teeth 5, 3–4 × 0.8–1 mm, lanceolate, subequal, lower one the longest, connate for 1/3 of its length, many nerved, hairy, gland-dotted. Corolla white; standard 6–6.5 × 7–7.5 mm, cordate, apex retuse, glabrous, clawed with 2 auricles; claw 1.5–2 mm long; auricles 1 mm or less than 1 mm; wing petals 6.5–7 × 2.5–2.8 mm, oblong; claw 2.5–2.8 mm long, auricled; keel petals 6.5–7 × 3–3.5 mm, boat shaped, slightly falcate, fused at apex at lower side; claw 2–2.2 mm long. Stamens 10, diadelphous (9+1); staminal tube 5–5.5 × 1 mm, anthers uniform, less than 1 mm long, basifixed, filaments of united stamens 1.5–2 mm long, that of free stamens 6.5–7 mm long. Ovary 1.5–1.8 × 0.8–1 mm, gland-dotted, hairy; ovules 2; styles 6.5–7 mm long, glabrous, swollen at middle; stigma globose, hairy. Fruits a pod, 10–1.2 × 5–5.5 mm, beaked, turgid, slightly septate between seeds or not, hairy, sparsely gland-dotted; beak 1 mm long; glands orange-red, withering post maturity. Seeds 2, 2.5 × 2.5 × 2.5 mm, rounded, mottled, shiny; hilum granular, 1 mm long, position ± central.

Etymology

The specific epithet 'fruticulosa' refers to its trailing shrubby habit.

Distribution

Asia: China (Yunnan), India (Himachal Pradesh, Madhya Pradesh, Manipur, Meghalaya, Tripura, Uttar Pradesh, Uttarakhand and West Bengal), Nepal, Pakistan.

Flowering and fruiting

June to December.

Habitat

Flemingia fruticulosa is found on hill slopes at high altitude (20-3750 m asl).

Selection of specimens examined

INDIA, Himachal Pradesh, Chamba district, Dalhousie, s.d., *C.B. Clarke 33A* (CAL); 10 September 1874, *C.B. Clarke 22076* (CAL); September 1880, *J.K. Dummoa 20* (DD); Panchpula, 21 September 1984, *Harender 11946* (BSD); on the way Ura chouki to Chamba, s.d., *J.H. Lace 1439* (CAL); Chamoli district, Gwaldam, 26 September 1963, *U.C. Bhattacharyya 30806* (BSD); Nandkeshari, 6 October 1963, *U.C. Bhattacharyya 31091* (BSD); Kangra district, 21 September 1896, *G.A. Gammie 18659* (DD); Mandi district, Sundar Nagar, 29 August 1977, *S.K. Murti & P. Prasad 62183* (BSD); Sirmaur district, Sarhan, 8 September 1974, *J.N. Vohra 54330* (BSD); Shillai, 7 August 1986, *R.S. Karki 82235* (BSD); Shimla district, Shimla, s.d., *s.coll. s.n.* (DD); August 1884, *J.R. Drummond 2521* (DD); Waterfall, 26 August 1877, *J.S. Gamble 4903B* (CAL); 13 September 1954, *R. Singh 15855* (LWG); 22 August 1977, *Maveli s.n.* (DD); Theog, 28 July 1958, *H. Lal & party 51787* (LWG); Madhya Pradesh, Hoshangabad district, Bori Wildlife Sanctuary, Kobra Nallah, 7 February 1978, *P.C. Pant 27246* (BSA); Manipur, s.d., *D.B. Deb s.n.* (CAL); 20 March 1952, *D.B. Deb 244* (CAL); Meghalaya, West Garo Hills, Garo hills, November 1926, *J.G. Saler 3907* (DD); North West Himalaya, s.d., *D. Brandis 3834* (CAL); October 1905,

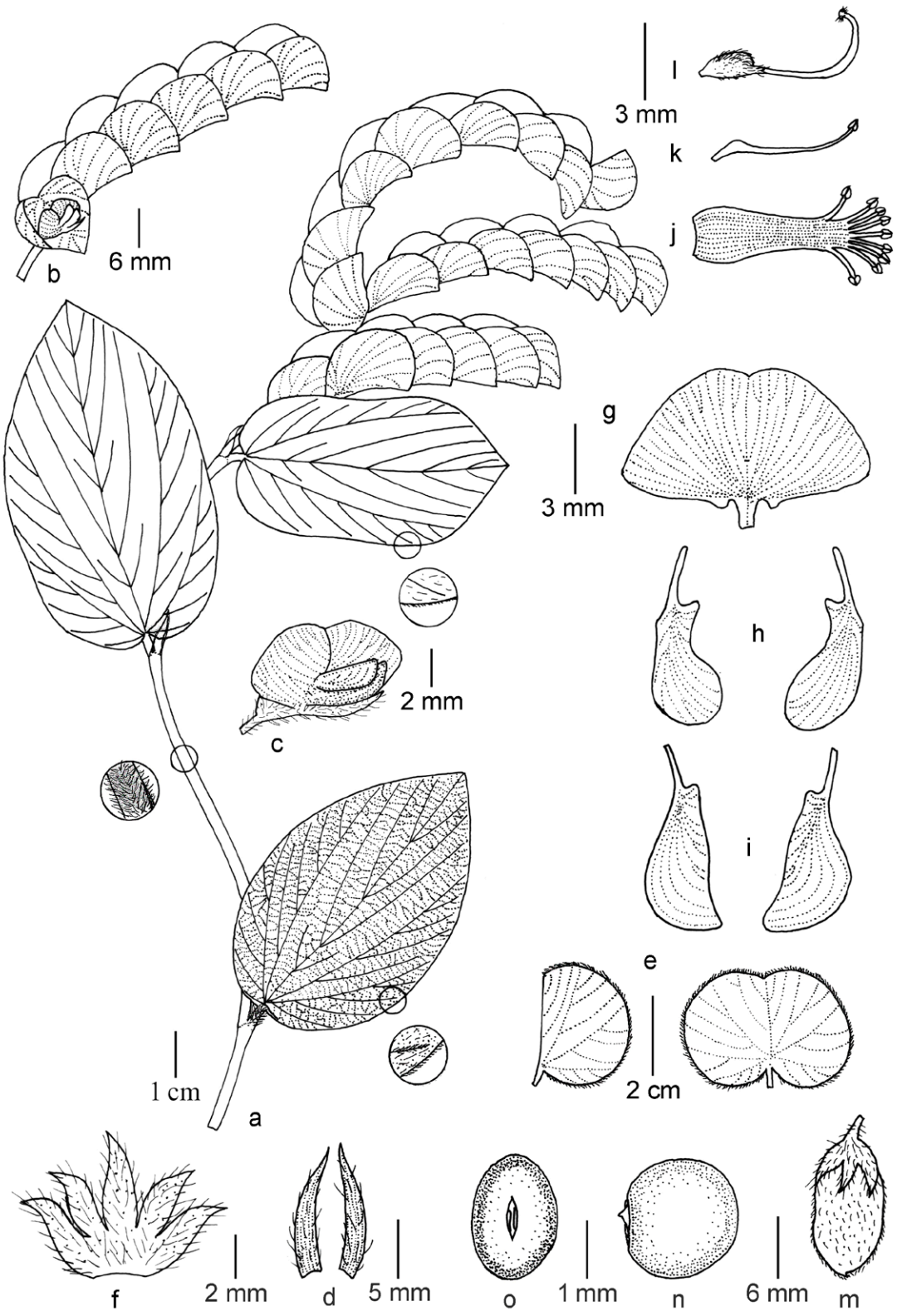


Figure 20. *Flemingia fruticulosa* Wall. ex Benth. (a) Habit. (b) Inflorescence. (c) Flower. (d) Stipules. (e) Bract. (f) Calyx, dorsal view. (g) Standard. (h) Wing petals. (i) Keel petals. (j) Fused androecium. (k) Free stamen. (l) Gynoecium. (m) Fruit. (n) Seed, lateral view. (o) Seed, dorsal view.

A.K. Meebold 1446 (CAL); Tripura, 28 February 1961, *D.B. Deb 2808* (CAL); West Tripura, Agartala, 21 February 1960, *D.B. Deb 2558* (CAL); Uttar Pradesh, Mau district, Chakra, 28 September 1936, *M.B. Raizada 7421* (DD); Uttarakhand, Almora district, Almora, 2 October 1957, *T.A. Rao 4706* (BSD); Dinapani, 13 October 1975, *J.N. Vohra 57898* (BSD); on the way to Agar to Newalgaon, 21 September 2000, *B.P. Uniyal 96820* (BSD); on the way to Girgam to Tejam, 17 November 1958, *J.G. Srivastava & party 53897* (LWG); Ranikhet, 4 October 1914, *A.E. Osmaston 444* (DD); 2 November 1967, *K.M. Balapure & party 90146* (LWG); 30 September 1975, *B.M. Wadhwa 57245* (BSD); Bageshwar district, Kausani, 5 December 2013, *K. Ambrish 121043* (BSD); Loharkhet, 19 September 1957, *T.A. Rao 4190* (BSD); 25 September 2002, *O. Kakri 98638* (BSD); Dehradun district, Chakrata, 25 September 1958, *K.C. Sahni 26796* (DD); Karwapani, 6 December 1956, *T.A. Rao & Y.K. Sarin 1237* (CAL); Mussoorie, July 1845, *P.W. Mackinnon s.n.* (CAL); July 1897, *J.F. Duthie 147* (DD); 8 September 1960, *H.O. Saxena 1141* (DD); 4 November 1960, *H.O. Saxena 1488* (DD); 23 September 1961, *H.O. Saxena 2270* (DD); January 1985, *W.A. Rodgers 3689* (WII); Thangam, September 1993, *B. Balodi & M. Singh 86760* (BSD); Kumaon, s.d., *R. Strachey & J.E. Winterbottom 4* (BM000958664); Nainital district, Ahuora, October 1950, *T. D'Souza s.n.* (BLAT); Nainital, s.d., *C. Maries 32* (CAL); April 1883, *J.F. Duthie 3955* (DD); September 1876, *Davidson s.n.* (DD); Pauri Garhwal district, s.d., *s.coll. s.n.* (BSD); 19 August 1978, *G. Panigrahi 64993* (BSD); Bagrigar, 27 October 1967, *K.M. Balapue & party 91295* (LWG); Pauri, 11 September 1972, *H.B. Naithani 3688* (DD); Pithoragarh district, 19 August 1988, *T. Husain 207854* (LWG); Askot, 3 September 1971, *C.M. Arora 45506* (CAL); Dafia Dhura, 2 September 1973, *C.M. Arora 53244* (BSD); Didihat, 30 September 1925, *C.M. Arora & R. Prasad 56662* (BSD); Maitli, 1 October 2001, *M.S. Pundir 97036* (BSD); Patela village, 13 October 1982, *R.P.S. Pundir 798* (ICRISAT, WAG); Rudraprayag district, Gauri Kund, 10 October 1965, *N.C. Nair 35846* (BSD); 18 September 1975, *A.S. Rao 56329* (BSD); Kaliphat Malla, 20 October 1914, *Hira Singh 276* (DD); Madhyamaheshwar, 1 September 1974, *K.M. Balapure 101533* (LWG); Tehri Garhwal district, Deolong, 22 September 1979, *A.K. Goal 67969* (BSD); Jarmala, Tans forest, 4 September 1955, *K.C. Sahni 21874* (DD); Kamaserai, 10 October 1979, *G. Singh 1082* (CAL); on the way to Jakhmolla, 19 October 1970, *B.D. Naithani 42224* (BSD); near Rangalgarh, 25 September 1954, *K.G. Sahani 21433* (DD); 26 September 1954, *K.G. Sahani 21466* (DD); Uttarkashi district, Barkot, 19 September 1995, *S. Singh 89981* (BSD); 28 July 2002, *K.N. Nair & B. Datt 223200* (LWG); on the way to Naitwar, 1 October 1995, *B. Balodi 89729* (BSD); on the way to Naitwar to Lachhar, 30 September 1990, *T. Husain 212462* (LWG); Mahidanda, 27 October 1966, *M.A. Rao 33564* (BSD); Naitwar, 30 December 1995, *T.S. Rane & B. Datta 215892* (LWG); West Bengal, Darjeeling district, Darjeeling 1955, *S. Sinha & party 224* (LWG).

Affinities

Flemingia fruticulosa is allied to *F. strobilifera* but differs from it by its trailing habit, short petiole, ovate-elliptic leaflets and persistent stipules.

Taxonomic note

Flemingia fruticulosa was described as a distinct species in 1852. Baker (1876) considered *F. fruticulosa* as a variety under *F. strobilifera*. Sanjappa (1992) synonymised *F. fruticulosa* under *F. strobilifera*. After critical analysis of type and protologue, we have come to the conclusion that *F. fruticulosa* is distinct and should be considered at the rank of species.

Nomenclatural notes

Ali (1977) typified the binomial *Flemingia fruticulosa* and designated Wallichian specimen 5754a (K001122023) as type in the Flora of West Pakistan. The binomial *Flemingia fruticulosa* first appeared in Wallich's catalogue (1831). Bentham (1852) validly published the name based on Wallich's specimen (Wallich 5754). Bentham did not mention any type in the protologue. He mentioned only the catalogue number 5754. Wallich's types are mainly at K (K-W) and considerable sets are at BM, CAL, E and G (Stafleu and Cowan 1988). The search for Wallich's type led to the finding of seven sheets in different herbaria [BM, CAL, E, G and K (K-W)]. Two sheets were found at CAL (CAL163049 and CAL163050). These sheets were collected by Wallich from Nepal and bear catalogue numbers 5754 and 5754a, respectively. Two sheets are present at K (K-W) of which one sheet 5754a (K001122023) is Wallich's collection from Nepal in 1821 while the second sheet 5754b (K001122024) was collected by Dr. Govan from Sirmore (now Sirmaur, Himachal Pradesh). Amongst the other three sheets, the first sheet was traced at BM which bears two different gatherings. The left handed upper specimen 5754a (BM000884630) was collected by Wallich from Nepal while the right handed lower specimen (BM000958664) was collected by Strachey and Winterbottom from Bintai, Kumaon. Another sheet (G00365320) traced at G is a duplicate of Wallich's collection from Nepal. The sheet at E has annotations in pencil handwriting as "should be 5754". This sheet hence cannot be taken as an original material. The sheet at K

(K-W) (K001122023) is well preserved and shows annotations which exactly match with the details given in Wallich's Catalogue. The remaining sheets which were collected by Wallich from Nepal must be considered as isolectotypes and the specimen collected by Dr. Govan from Sirmore constitutes a syntype.

Flemingia strobilifera (L.) W.T. Aiton, Hortus Kew., ed. 2. 4: 350. 1812

Bas.: *Hedysarum strobiliferum* L., Sp. Pl. 2: 746. 1753; Roxb, Fl. Ind. 3: 351. 1832
Type: Sri Lanka, without precise locality, s.d., *P. Hermann s.n.* (BM000621979 image!, lectotype designated by Fawcett & Rendle, 1920: 75).

Wight & Arn. Prodr. Fl. Ind. Orient. 1: 243. 1834; Wight, Icon. Pl. Ind. Orient. 1(1): 14, t. 267. 1840; Benth. in Miquel, Pl. Jungh. 2: 244. 1852; Baker, in Hook. f., Fl. Brit. India 2: 227. 1876; Kurz, Forest Fl. Burma 2: 371. 1877; Prain in J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 69(2): 437. 1897; Prain, Bengal Pl. 1:377. 1903; T. Cooke, Fl. Bombay 2: 390. 1902; Talbot, Forest Fl. Bombay 1: 418. 1909; Haines, Bot. Bihar Orissa 3: 268. 1922; Gamble, Fl. Madras 1: 377. 1928; Sanjappa, Legumes of India 179. 1992; Saxena & Brahman, Fl. Orissa 1: 532. 1994. Kothari in N.P. Singh et al., Fl. Maharashtra, Dicot. 2, 685. 2001. (Figures 21; 23u; 24s; 25r).

(≡) *Zornia strobilifera* Pers., Syn. Pl. 2(2): 319. 1807.

(≡) *Maughania strobilifera* (L.) J.St.-Hil. ex Kuntze, Revis. Gen. Pl. 1: 199. 1891; Mukerjee, Bull. Bot. Soc. Bengal 6(1): 10. 1953 (as *Moghania strobilifera*).

Description

Erect shrubs, up to 1.2–3.2 m tall, with branched stem; stems 4–40 mm in diameter, young triangular, mature terete, hairy; hairs silky, antrorse. Leaves unifoliolate, 7–20 cm long, stipulate, petiolate; stipules 2, 7–17 × 2–3 mm, slightly falcate, acuminate with equal tips, fused when young, splitting at maturity, caducous, basifixed, many nerved, hairy; petioles 12–20 mm long, grooved, gland-dotted, hairy; leaflet 1, 6–18 × 3.4–8 cm, broad ovate, rounded or cordate at base, apex acuminate, glabrous on both surfaces, hairy on nerves dorsally, lateral nerves (6)8-10 pairs; gland-dotted; glands minute, orange-red; petiolules 2–5 mm long, hairy, gland-dotted. Inflorescences an axillary and terminal raceme; racemes comprising small cymes of 2–3 flowers enclosed by membranous bracts, in two series. Flowers 8–10 mm long, pedicellate, bracteate; pedicels 2–2.2 mm long, hairy; bracts 1.6–2.8 × 2.6–3 cm, reniform, acute at apex, many nerved, papery, hairy, gland-dotted; exterior bracts, small 2–2.2 × 1–1.2 mm, lanceolate, persistent; Calyx 6–7 mm long, hairy, gland-dotted; calyx tube 1–1.5 mm long, campanulate, hairy; calyx teeth 5, 3–5.2 × 1–1.5 mm, subequal, lower one the longest, lanceolate, connate for 1/5 of its length, hairy, many nerved, gland-dotted. Corolla white with pink striations; standard 8–8.5 × 7–7.5 mm, obcordate, apex retuse, glabrous, clawed with 2 auricles; claw 1 mm long; auricles 1 mm or less 1 mm; wing petals 5–6 × 1–1.5 mm, oblong, slightly falcate; claw 1.5–2 mm long; keel petals 7–7.5 × 2–2.5 mm, boat shaped, slightly falcate, fused at apex at lower side; claw 2–2.2 mm long. Stamens 10, diadelphous (9+1); staminal tube 5–6 × 1 mm, anthers uniform, less than 1 mm long, basifixed, filaments of united stamens 1.5–2 mm long, that of free stamens 6–7 mm long. Ovary 1.8–2 × 1 mm, gland-dotted, hairy; ovules 2; styles 6–6.2 mm long, glabrous, swollen at middle; stigma globose, hairy. Fruits a pod, 1.2–1.3 × 6–7 mm, beaked, turgid, slightly septate between seeds or not, hairy, sparsely gland-dotted; beak 1 mm long; glands orange-red, withering post maturity. Seeds 2, 3 × 3 × 2.8 mm, rounded, mottled, shiny; hilum granular, 1 mm long, position ± central.

Etymology

The specific epithet 'strobilifera' refers to its thin, dry, membranous cone-like bracts that enclose flowers and fruits completely.

Distribution

Asia: Bangladesh, Bhutan, Brunei, Cambodia, Caroline Islands, China (Hubei, Yunnan), Guam, India (Andaman and Nicobar Islands, Andhra Pradesh, Assam, Bihar, Chhattisgarh, Goa, Gujarat, Himachal Pradesh, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Nagaland, Rajasthan, Sikkim, Tamil Nadu, Telangana, Tripura, Uttar Pradesh, Uttarakhand and West Bengal), Indonesia (Java, Lesser Sunda Islands, Kalimantan, Moluccas, Sulawesi, Sumatra, Timor), Malaysia, Myanmar, New Caledonia, Nepal, Papua New Guinea, Philippines, Singapore, Sri Lanka, Taiwan, Thailand, Vietnam. Australia (Queensland). Central America.

Flowering and fruiting

January to April.

Habitat and ecology

Flemingia strobilifera is a common species that grows throughout India. It is found to be growing along

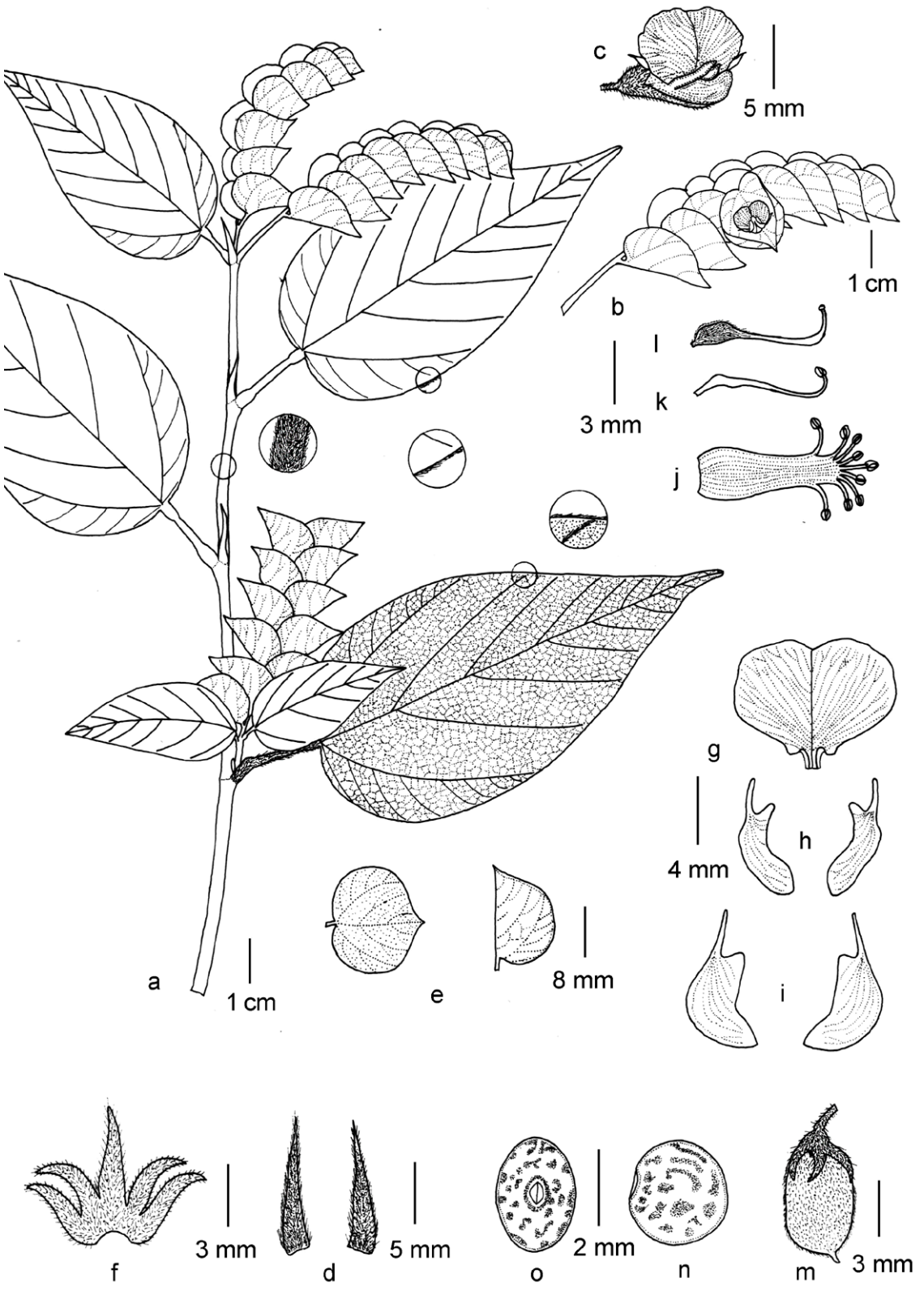


Figure 21. *Flemingia strobilifera* (L.) W.T.Aiton. (a) Habit. (b) Inflorescence. (c) Flower. (d) Stipules. (e) Bract. (f) Calyx, dorsal view. (g) Standard. (h) Wing petals. (i) Keel petals. (j) Fused androecium. (k) Free stamen. (l) Gynoecium. (m) Fruit. (n) Seed, lateral view. (o) Seed, dorsal view.

the roads, in open forests and grasslands at an altitude of ca. 600–1500 m asl. On Malesian islands, it is reported from sea level upwards. It grows in association with *Achyranthes aspera* L., *Amorphophallus* species, *Clematis gouriana* Roxb. ex DC., *Diploclisia glaucescens* (Blume) Diels, *Flemingia sootepensis* Craib, *Haplanthodes verticillatus* (Roxb.) R.B.Majumdar, *Leea indica* (Burm. f.) Merr., *Pavetta tomentosa* Roxb. ex Sm., *Rubia cordifolia* L., *Synedrella nodiflora* Gaertn., *Terminalia chebula* Retz., *Triumfetta* species and *Zingiber neesanum* (J. Graham) Ramamoorthy.

Selection of specimens examined

INDIA, s.d., B. Heyne s.n., *Wallich Catalogue Number 5753c* (K-W001122018); s.d., *W. Roxburgh s.n., Wallich catalogue Number 5753* (K-W001122015); s.d., R. *Wight 799* (CAL, GH, LE, W); *G. King s.n.* (CAL); April 1903, *H.H. Haines 616* (CAL); 25 July 1936, *J.W. Helfer 149* (CAL); 14 November 1953, *D.B. Deb 1223* (CAL); Andaman and Nicobar Islands, March 1897, *R.L. Heinig s.n.* (BSA, CAL); 12 December 1900, *R.L. Heinig 216* (CAL, US); 20 March 1901, *D. Prain's collector 43* (CAL); Kamorta district, Kamorta, April 1952, *B. Subramanyam 23194* (DD); Nicobar district, KamortaIsland, 22 May 1977, *N. Bhargava 5038* (CAL); Katchal, 22 April 1974, *P. Chakraborty 1133* (CAL); Malacca, 1 March 1974, *N.G. Nair 926* (CAL); North and Middle Andaman district, Long island, 24 February 1936, *S. Gupta 6033* (DD); February-March 1934, *K. Ram 3694* (DD); South Andaman district, Jirkatang, 25 January 1978, *N.G. Nair 926* (CAL); South Andaman, 12 December 1900, *R.L. Heinig 216* (DD); Andhra Pradesh, Nellore district, on the way to Koruturu, 7 March 1962, *D.C.S. Raju 88* (CAL); Prakasam district, Gundlakamma, 30 March 1965, *J.E. Ellis 23802* (MH); Visakhapatnam district, Galikonda, 16 March 1965, *G.V. Subba Rao 22661* (MH); 51 km to Sileru from Chintapalli, 24 March 1977, *L.J.G. van der Maesen 2722* (ICRISAT, WAG); Assam, 1879, *F.E.L. Fischer 235* (CAL); 1879, *F.E.L. Fischer 8180* (ASSAM); Cachar district, Borail Wildlife Sanctuary, 17 February 2012, *A.B. Hussain 892* (ASSAM); Goalpara district, *Gustav Mann s.n.* (ASSAM); Damra, December 1890, *G. King s.n.* (CAL); Goalpara, February 1879, *O. Mann s.n.* (DD); on the way Dudhnai, 16 December 1960, *G. Panigrahi 22647* (CAL); Kamrup district, Chandubi Lake, 20 October 1965, *A.S. Rao 42484* (ASSAM); Sivasagar district, Gargaon, 2 March 1914, *U.N. Kanjilal 3532* (ASSAM, CAL); Meteka, 1 March 1913, *U. Kanjilal 2124* (ASSAM); Sivasagar, 1891, *S.E. Peal 374* (CAL); Bihar, Muzaffarpur district, Motipur, 7 December 1986, *K.K. Khanna & S. Saran 38563* (BSA, CAL); West Champaran district, Gobardhana, 14 November 1963, *B.V. Shetty 289* (CAL); Chhattisgarh, Balrampur-Ramanujganj district, Ramanujganj, 16 March 1974, *G.S. Gupta 18902* (BSA); Bastar district, Cave area, 28 December 1971, *C.R. Das 15008* (BSA); on the way to Teerathgarh falls, *N.P. Balakrishnan & A.N. Henry 11896* (CAL); Bilaspur district, Sadapani, 20 April 2005, *S.L. Bondya, S. Mishra & A.N. Shukla 62392* (BSA); Dantewada district, Abujmarh, 6 March 1984, *G.P. Roy & S.K. Dixit 35536* (CAL); 17 November 1984, *G.P. Roy & S.K. Dixit 36219* (BSA, CAL); Bailadila, 13 February 1963, *G. Panigrahi 6836* (BSA, CAL); 15 February 1963, *G. Panigrahi & C.M. Arora 1012* (BSA, CAL); Jashpur district, Jashpur Nagar, 26 December 1964, *G. Panigrahi & C.M. Arora 7242* (BSA); Kondagaon district, Kondagaon, 5 January 1972, *C.R. Das 15100* (BSA); Mungeli district, Achanakmar Wildlife Sanctuary, Jalda forest, 23 April 2005, *S.L. Bandya, S. Misra & A.N. Shukla 62460* (BSA); Kirdijhar, 17 January 2005, *K.P. Singh, G.P. Sinha & S.L. Bondya 62929* (BSA); Lamni, 13 February 1972, *G. Panigrahi 15415* (BSA, CAL); Rudra Ganga, 31 December 2004, *S.L. Bondya, A.N. Shukla 62063* (BSA); Sadapani forest, *S.L. Bondya, S. Misra & A.N. Shukla 62392* (BSA); Narayanpur district, Markabeda, 6 March 1984, *G.P. Roy & S.K. Dixit 35536* (BSA); Raigarh district, Boro, 8 February 1974, *N.C. Radhakrishnan 19770* (BSA); 4 April 1976, *N.C. Radhakrishnan 24568a* (BSA); Panchakki, 9 July 1990, *B. Lal & R.L. S. Sikarwar 8616* (LWG); Rajnandgaon district, Niwaspur, 6 November 1974, *P.C. Pant 21589* (BSA); Surguja district, Ambikapur, 16 November 1972, *G.S. Gupta 17114* (BSA); Batparganala, 26 March 1974, *G.S. Gupta 20069* (BSA); Kalyanpur, 19 November 1999, *S.B. Pathak & V. Kumar 721* (BSD); Goa, Chota Dudhsagar falls, 2 March 1970, *K.C. Sahani 1644* (DD); Gujarat, 2 February 1962, *S.J. Bedi 1084* (BARO); Dang district, Dang, s.d., *A. Asrana 5427* (BLAT); 2 April 1958, *Deshmukh 32363* (CAL); Waghai, 23 October 1955, *D.P. Panthaki 2346* (BLAT); 11 February 1956, *D.P. Panthaki 2524* (BLAT); *D.P. Panthaki 2525* (BLAT); N.A. Irani 1698 (BLAT); 24 December 1957, A. Asrana 5238 (BLAT); Kheda district, Sunda, 22 December 1963, *G.L. Shah 10736* (BLAT); Navsari district, Unai, 8 March 1954, *H. Santapau 18213* (BLAT); Surat District, Varachha, 2 October 1976, *s.coll. 470* (BARO); Himachal Pradesh, Kangra district, Nihari, 2 October 1977, *P. Lal 63290* (BSD); Jammu & Kashmir, Rajouri district, Sunderbani, 22 September 1996, *B.P. Uniyal 92356* (BSD); Jharkhand, Chota Nagpur Plateau, 22 October 1873, *C.B. Clarke 20984* (CAL); Giridih district, Parasnath hills, 21 October 1934, *K. Bisvas 2136* (CAL); 19 November 2003, *V. Ranjan & K.L. Maity 33616* (CAL); Saraikella and Kharaswan district, Chandil hills, 19 January 2001, *D. Das 28678* (CAL); Karnataka, Belgaum district, Belgaum, 30 January 1980, *L.J.G. van der*

Maesen 3999 (CAL,WAG); Bhimgargh, 1 February 2017, *S.K. Gavade 185* (SUK); Castle Rock, 1 February 2017, *S.K. Gavade 186* (SUK); Chorla, 29 January 1980, K.K. Rao 55 (CAL); 7 March 1997, *M.K. Janarthanam & S. Rajkumar 599* (GOA); Khanapur, s.d., *B.S. Ahuja 47607* (BSI); Kankumbi, 29 January 1980, *K.K. Rao 38* (CAL); Shirasangi, 10 April 1998, *M.P. Nayar 153026* (BSI); Chikkamagaluru district, Bharatnall, 21 October 2017, *S.K. Jain 28234* (CAL); Hassan district, Bisle, 23 April 1958, *S.D. Mahajan 34899* (BSI); Kodagu district, Nagarhole National Park, 6 February 1979, *P. Prakash & K.P. Sreenath 5996* (JCB); Sampaje, 29 January 1976, *B.C. Banerjee 11405* (CAL); Mysore district, Marnhalli, February 1908, *A. Meebold 8472* (CAL); Shimoga district, Agumbe, 10 March 1960, *R.S. Rao 61266* (CAL); Jog falls, 7 May 1956, *G.S. Puri 2081* (BSI); Onake Abbi Falls, 6 March 1984, *G.P. Roy & S.K. Dixit 35536* (CAL); Sitanadi, 9 November 1960, *R.K. Arora 2763* (CAL); Kodachadri hills, 8 March 1979, *K.R. Keshava Murthy & B.R. Ramesh 6182* (CAL); Someshwara Wildlife Sanctuary, 6 February 1961, *R.S. Raghavan 69403* (CAL); Udupi district, Mookambika Wildlife Sanctuary, 20 December 2007, *P.G. Diwakar & R.K. Singh 193756* (BSI); Uttara Kannada district, Castle Rock, 21 December 1953, *S.J. Kapadia 427* (BLAT); Dandeli, 25 December 1955, *D.P. Panthaki 2447* (BLAT); *D.P. Panthaki 2448* (BLAT); Devimane Ghats, 26 March 1949, *J. Fernandes 237* (A, BLAT); Kadra, 2 March 1951, *J. Fernandes 2204* (A, BLAT); on the way to Dandeli to Gund, 9 February 1980, *K.P. Sreenath & S.R. Ramesh 10815* (CAL); Uttara Kannada, 1882, *W.A. Talbot s.n.* (DD); Yellapura, 27 December 1955, *D.P. Panthaki 2485* (BLAT); 28 December 1955, *D.P. Panthaki 2485* (BLAT); Kerala, Idukki district, Kulamavu, 24 September 1981, *C.N. Mohanan & B. Ramanujan 71934* (CAL); Kurisumala, 13 September 1984, *V.T. Antony 754* (MH); Thekkady, 22 December 1974, *K. Vivekananthan 45648* (MH); Kottayam district, Kanjirappally, December 1910, *A. Meebold 19912792* (CAL); Malappuram district, Calicut University campus, 25 December 1986, *V. Usha 3175* (CALI); Nilambur, 21 January 1953, *K.M. Vaid 23438* (DD); 2 January 1957, *M.B. Raizada s.n.* (DD); 3 January 1957, *M.B. Raizada s.n.* (DD); Poolakkaparai, 25 February 1970, *J.L. Ellis 33567* (CAL); Palakkad district, Kodumudi, 1 February 1989, *A.N. Kumar 1496* (MH); Kumbidi, 9 March 1982, *C. Sathish Kumar 10501* (CALI); Palakkad, 22 December 1916, *s.coll. 14224* (MH); Pathanamthitta district, Maniyar, s.d., *A.N. Kumar 1496* (CALI); Moozhiar, 23 December 1988, *N. Anukumar 1216* (CAL); Thiruvananthapuram district, on the way to Agasthyarkoodam, 20 February 1979, *M. Mohanan 59306* (CAL); Thrissur district, Kollathirumedu, 12 November 1988, *N. Sasidharan 4994* (KFRI); on the way to Poringalkuthu to Sholaiyar forest, 25 November 1982, *K. Ramamurthy 75512* (CAL, MH); Poringalkuthu, 4 February 1984, *K. Ramamurthy 72752* (CAL); Peechi, 9 January 1984, *N. Sasidharan & C. Renuka 2556* (KFRI); Poringalluttu, 4 February 1984, *K. Ramamurthy 72752* (MH); Vazhachal falls, 14 January 1953, *J. Fernandes 144* (BLAT); Wayanad district, 25 January 1986, *V.A. Jessy 2298* (CALI); Wayanad, 25 January 1986, *Jessy V.A. 2298* (CALI); Chandanthode, November 1937, *N.L. Bor 8511b* (DD); Lakkidi, 20 March 1984, *R.T. Balakrishnan 40056* (CAL); Madhya Pradesh, Anuppur district, on the way to Pasan to Semera, February 1972, *S.K. Murthy 15349* (CAL); Balaghat district, Lamta, 14 January 1961, *J.K. Maheshwari 4498* (CAL); Mukki, 24 January 1961, *S.K. Jain* (BSA); 23 September 1973, *V.J. Nair 18978* (BSA); Supkhar, 25 September 1973, *V.J. Nair 18426* (BSA); Betul district, Bori, 23 December 1962, *G. Panigrahi 6359* (BSA, CAL); Chhindwara district, Chhota Mahadev falls, 9 May 1958, *H. Santapau 22433* (BLAT); Pench river, 23 March 1975, *L.K. Banerjee 22226* (BSA); Dhar district, on the way to Barda to Chitrangi, 21 January 1964, *G. Panigrahi 2410* (BSA); Hoshangabad district, Bee falls, 12 November 2000, *K.K. Khanna & A. Kumar 53664* (BSA); on the way to Madai, 25 October 1970, *G. Panigrahi 12922* (BSA, CAL); Indore district, Indore, 6 April 1911, *W. Biscoe 2767* (DD); Jabalpur district, Baghraji, 10 March 1962, *K.M. Sebastian 13904* (BSA); Jabalpur, January 1903, *R.S. Hole s.n.* (CAL); Kaimur range, 10 February 1959, *C.M. Arora 1498* (BSA); Katani district, Antaria, 14 April 2005, *S.L. Bondya, S. Misra & A.N. Shukla* 62288 (BSA); 30 September 2005, *S.L. Bondya & A.N. Shukla 63510* (BSA); Khargone district, Berehha forest, 14 February 1987, *M. Prasad 39514* (BSA); Mandla district, Kanha Tiger Reserve, 12 September 1982, *J. Lal & A. Kumar 33175* (BSA); on the way to Motinala to Bhiradongri, 16 January 1961, *S.K. Jain 2922* (BSA); Narsinghpur district, Narsinghpur, 29 January 1978, *P.C. Pant 27017* (BSA); Panna district, Pandav falls, 15 March 1983, *R. Lal 34116* (BSA); 26 November 2003, *N.R. Suman 58218* (BSA); Panna National Park, s.d., *N.R. Sunnar & R. Kumar 52052* (BSA); Rewa district, 13 November 1971, G.S. Gupta 16270 (BSA); Kharra, 13 November 1971, *G.S. Gupta 16270* (BSA); Sagar district, Rahatgarh, 2 March 1960, *K. Subramanyam 10146* (BSA, CAL, MH); Satna district, Maihar, Tons river bank, 19 March 1994, *R. Prasad 47697* (BSA); Sehore district, Budhni, 28 January 1945, *E. Moyes 231* (CAL); Sidhi district, Gandhigram, 22 October 1962, *G. Panigrahi 5565* (BSA); Kanhaigarh, 28 January 1971, *G.S. Gupta 14420* (CAL); Marvai hills, 23 January 1971, *G.S. Gupta 14274* (BSA); Mohgashi, 24 February 1971, *G.S. Gupta 14573* (CAL); Seoni district, Aurapani, 15 February 1972, *G.*

Panigrahi 15479 (BSA, CAL); Karmajhiri, 17 March 1978, *L.K. Banerjee 28599* (BSA); Shahdol district, on the way to Pasan to Semara, 11 February 1972, *G. Panigrahi 15349* (BSA); Singrauli district, Dhawai, 21 January 1964, *G. Panigrahi 2410* (CAL); Mara, 12 December 1995, *S.K. Srivastava 47993* (BSA); Umaria district, Bandhavgarh National Park, 13 January 1997, *S.K. Srivastava 45666* (BSA); Umaria mala, 19 January 1971, *G.S. Gupta 14151* (BSA); Maharashtra, Bombay, 22 February 1951, *J. Fernandes 2168* (CAL); Concan, s.d., *J.E. Stocks s.n.* (CAL, MH); Bhandara district, Nagzira wildlife sanctuary, Tiger road, 18 November 2002, *D.N. Patil 182853* (BSI); Chandrapur district, Chincholi, 15 January 1891, *J.F. Duthie 10376* (DD); Yenkatapur, 19 January 1890, *J.F. Duthie 9403* (CAL); *J.F. Duthie 9406* (DD); Colaba district, Penu, February 1917, *E. Blatter 11313* (BLAT); Gondia district, Navegaon National Park, 2 February 1956, *P.S. Herbert 1340* (BLAT); 24 November 2002, *D.N. Patil 183204* (BSI); Kolhapur district, Ajara, s.d., *N.B. Gaikwad s.n.* (SUK); Gaganbawda, 2 August 2015, *S.K. Gavade 86* (SUK); Lead Botanical Garden, 10 February 2015, *S.K. Gavade 24* (SUK); Patgaon, 27 April 1966, *B.G. Kulkarni 108524* (BSI); Ramghat, 28 January 1980, *N.K. Rao 16* (CAL); Tillarinagar, 18 February 2015, *S.K. Gavade 28* (SUK); Mumbai Suburban district, Borivali, 14 January 1955, *D.P. Panthaki 2206* (BLAT); Sanjay Gandhi National Park, 12 February 1955, *P.S. Herbert 542* (BLAT); 2 February 1956, *P.S. Herbert 1338* (BLAT); *P.S. Herbert 1339* (BLAT); Nashik district, Brahmagiri, s.d., *s.coll. s.n* (BLAT); Harsul, 7 February 1983, *P.C. Narasimhan 165393* (BSI); Igatpuri, 4 January 1917, *E. Blatter 12376* (BLAT); 27 December 1958, *G.L. Shah 10202* (BLAT); *G.L. Shah 10203* (BLAT); *H. Santapau 22951* (BLAT); Pune district, Bhimashankar, 25 February 1961, *K.P. Janardhanan 69268* (BSI); Khandala, 7 May 1912, *s. coll. 10991* (BLAT); March 1917, *s. coll. 11936* (BLAT); *H. Santapau 11148* (BLAT); 26 December 1940, *H. Santapau 1024* (BLAT); 23 January 1942, *H. Santapau 102106* (DD); 29 December 1942, *H. Santapau 1431* (BLAT); 31 December 1942, *H. Santapau 1475* (BLAT); 23 January 1943, *H. Santapau 1505* (BLAT); *H. Santapau 1506* (BLAT); 21 March 1943, *H. Santapau 1727* (BLAT); 16 January 1944, *H. Santapau 3588* (BLAT); 15 March 1944, *H. Santapau 3795* (BLAT); *H. Santapau 3796* (BLAT); 20 January 1945, *H. Santapau 5780* (BLAT); 28 February 1945, *H. Santapau 6055* (BLAT); *H. Santapau 6056* (BLAT); *H. Santapau 6057* (BLAT); *H. Santapau 6058* (BLAT); 16 February 1946, *H. Santapau 8659* (BLAT); *H. Santapau 8660* (BLAT); 26 December 1951, *H. Santapau 13981* (BLAT); *H. Santapau 13981* (BLAT); 29 January 1955, *P.V. Bole 1311* (BLAT); 23 March 1958, *Y.A. Merchant 554* (BLAT); 21 March 1959, *P.S. Toor 52530* (BSI); 12 January 1961, *S.J. Saldanha 6551* (BLAT); 25 February 1961, *C.J. Saldanha 6552* (BLAT); Nandgaon, 29 January 1964, *B. Reddy 95764* (CAL); on the way to Ambavane to Dongarwadi, 2 February 1964, *B. Reddy 95915* (CAL); on the way to Ambavane to Lonavala, 21 December 1963, *B. Reddy 93204* (CAL, MH); 2 February 1964, *B. Reddy 95915* (BSI); on the way to Pune to Bhimashankar, 26 February 1961, *K.P. Janardhanan 69631* (BSI); on the way to Pune to Mumbai, 16 February 1957, *S.K. Jain 11857* (BSI); Lohagad, October 1918, *E. Blatter 10616* (BLAT); Pune, College of Science, s.d., *s.coll. s.n.* (BLAT); Purandar, December 1917, *E. Blatter 11767* (BLAT); 27 December 1944, *H. Santapau 5685* (BLAT); 23 December 1945, *H. Santapau 8193* (BLAT); Warak, 21 March 1963, *S.R. Rao 87318* (BSI); Raigad district, Matheran, s.d., *S. Pandey s.n.* (BLAT); 28 March 1918, *E. Blatter 10741* (BLAT); 31 March 1957, *G.S. Puri 14038* (BSI); 20 January 1962, *U. Nanda 530* (BLAT); *U. Nanda 559* (BLAT); 6 December 1958, N.A. Irani 2624 (BLAT); 25 March 1998, *s.coll. 10026* (BLAT); Panorama point, 25 March 2004, *S.G. Pradhan & S.K. Das Das 188993* (BSI); hill point, 16 February 2006, *S.C. Majumdar & S.K. Das Das 190940* (BSI); on the way Nesal to Matheran, 24 January 1949, *J. Fernandes 60* (BLAT); Ratnagiri district, Kumbharli Ghat, 17 February 1979, *R.K. Kochhar 154319* (BSI); on the way to Ratnagiri to Dajipur, 28 June 1957, *G.S. Puri 20115* (BSI); Ratnagiri, February 1922, *R.D. Geland 357* (BLAT); Satara district, Koyna Wildlife Sanctuary, 8 February 1979, *R.K. Kochhar 153026* (BSI); 12 February 1979, *R.K. Kochhar 158355* (BSI); Mahabaleshwar, s.d., *T. Cooke s.n.* (BLAT); 8 April 1951, *H. Santapau 12384* (BLAT); 16 March 1997, *M. Ezekiel 12851* (BLAT); on the way to Pratapgad, 19 February 1964, *K.C. Kanodia 87075* (BSI); Sindhudurg district, Amboli Ghat, 18 May 1965, *R.D. Pataskar 105237* (BSI); Chaukul, 30 April 1966, *B.G. Kulkarni 108561* (BSI); Dukanwad, 13 February 1970, *B.G. Kullear 120075* (BSI); Ghonsari, 4 March 1970, *B.G. Kullear 120418* (BSI); Konal, 30 April 1971, *B.G. Kulkarni 129420* (BSI); Nandos, March 2001, *N.D. Gawade 2303* (BLAT); *N.D. Gawade 2304* (BLAT); *N.D. Gawade 2305* (BLAT); Thane district, Kasara, 14 April 1957, 14 April 1957, *S.K. Jain 14741* (BSI); Mumbra, 26 January 1954, *K.V. Shenoy 2069* (BLAT); *K.V. Shenoy 2078* (BLAT); *K.V. Shenoy 2086* (BLAT); *K.V. Shenoy 2103* (BLAT); 30 March 1954, *K.V. Shenoy 2517* (BLAT); Manipur, 31 August 1952, *D.B. Deb 510* (CAL); Bishnupur district, Bishnupur, February 1906, *A. Meebold s.n.* (CAL); Meghalaya, Garo Hills, s.d., *T.D. Srinivasan 1529* (CAL); *T.D. Srinivasan 1960* (CAL); Khasi hills, 19 February 1885, *C.B. Clarke 37280* (CAL); East Khasi Hills district, Barapani, 11 September 1970, *A.S. Rao 38639* (CAL); West Jaintia Hills district, Dawki,

2 March 1938, G.K. Deka 16357 (ASSAM); Jowai, December 1893, *G. King s.n.* (CAL); Nagaland, Naga hills, 29 September 1948, *S.K. Mukerjee 3544* (CAL); Odisha, Rayagada district, Hatipathar, s.d., *G. Panigrahi 20667* (CAL); Sambalpur district, 4 November 1986, Hatigirdha, S. Panda & A.P. Das 256; Kapildhara, 7 April 1988, *S. Panda & A.P. Das 1091* (CAL); Sundergarh district, 23 April 2005, *S.L. Bondya, S. Mishra & A.N. Shukla 62460* (BSA); Rajasthan, Kota district, Sitabari forest, 17 May 1965, *B.M. Wadhawa 9321* (CAL); Sirohi district, Mount Abu, *s.coll. 12073* (BLAT); Sikkim, West Sikkim district, on the way to naya bazaar to Soreng, 10 February 1996, *B.K. Sukla 18605* (BSHC); Tamil Nadu, Coimbatore district, Coimbatore, 13 January 1951, *S.K. Jain & R.C. Bhardwaj 22606* (DD); Nilgiris district, Kodamalai, 11 December 1962, *G.V.S. Rao 30150* (CAL); Mudumalai National Park and Wildlife Sanctuary, 18 November 1958, *K.M. Sebastine 7365* (CAL); Benne forest, 20 January 1961, *B.V. Shetty 11949* (CAL, MH); Pandalur, 11 January 1903, *C.A. Barber 5595* (CAL, MH); Pudukkottai District, Kodivayal, 26 February 1973, *E. Vajravelu 43733* (MH); Telangana, Warangal District, Jakaram, 26 January 2001, *R.K. Premanath 112711* (MH); Pakhal, 26 February 1963, A.N. Henry 15934 (MH); 24 March 1999, R.K. Premanath 108252 (MH); Tripura, West Tripura district, Agartala, s.d., *D.B. Deb 1341* (CAL); Uttar Pradesh, Barabanki district, Banki, 22 February 1966, *G. Panigrahi & R. Saran 10553* (BSA); Bahraich district, Dharmapur, 15 March 1964, *G. Panigrahi & O.P. Misra 2902* (CAL); Nishangarh, 12 February 1965, *O.P. Misra 7945* (BSA); Rupaidiha, 6 February 1965, *O.P. Misra 7880* (BSA, CAL); Sahore, 9 March 1964, *G. Panigrahi & O.P. Misra 2787* (BSA, CAL); Suhelwa, 12 May 1917, *S. Ram 577* (DD); Lakhimpur Kheri district, 1 May 1898, *Inayat Khan 21512* (CAL, DD); Dhyanpur, 8 March 1980, *J.K. Maheshwari & party 277* (LWG); Gola Gokarannath, 5 December 2004, *B.K. Shukla 61343* (BSA); *B.K. Shukla 61391* (BSA); Mailani, 17 December 1960, *C.L. Malhotra 13376* (BSD); Gorakhpur district, Phareuda reserve forest, 31 October 1963, *C.M. Arora 1416* (BSA & CAL); Jalaun district, Dhamna, 15 March 1964, *G. Panigrahi 2902* (BSA); Pilibhit district, Mahof, 10 December 2004, *B.K. Shukla 61565* (BSA); Sonbhadra district, Pipri, 11 March 1970, *G. Panigrahi 12078* (BSA); Renusagar, 24 December 1970, *G. Panigrahi 13670* (BSA); Hathinala forest, 12 March 1970, *G. Panigrahi 12083* (CAL); Uttarakhand, Dehradun district, Dehradun, 16 January 1942, *M.B. Raizada 15604* (DD); 3 May 1993, *A. Prakash 210499* (LWG); 4 March 1999, P.*W. Mackinnon s.n.* (CAL); Raipur, 16 November 1977, *L.J.G. van der Maesen 2981* (CAL); Lakhamandal, 12 November 1968, *B.D. Naithani 38541* (BSD); Lachhiwala, April 1937, M.B. Raizada s.n. (DD); Haridwar district, Chilla Wildlife Sanctuary, 19 November 1995, *A. Prakash 215717* (LWG); Nainital district, Haldwani, 28 May 1919, *R. Singh 11022* (DD); Jim Corbett National Park, Sultan, 15 November 1972, *K.P. Janardhanan 50113* (CAL, BSD); Kopa Basanta, 6 February 1989, *H. Singh 7840* (LWG); West Bengal, Howrah district, Calcutta Botanical Garden, *F. Buchanan-Hamilton s.n.*, *Wallich Catalogue Number 5753b* (K-W001122016 and K-W001122017); Jalpaiguri district, Murti, 4 December 1996, *J. Bhattacharya 24470* (CAL); Nadia district, Hanskhali, 23 February 1975, *J.K. Sikdar 100* (CAL); Purulia district, on the way to Baghmundi to Ajodhya hills, 19 June 1968, *K.C. Malick 493* (CAL).

Affinities

Flemingia strobilifera and *F. bracteata* show close similarities in their morphology. However, *F. strobilifera* differs from *F. bracteata* by ovate unifoliolate leaves, long petiole, lanceolate caducous stipules, and semi-reniform bracts.

Taxonomic note

Baker (1876) treated *Flemingia bracteata*, *F. fluminalis*, *F. fruticulosa* as varieties under *F. strobilifera*, but Mukerjee (1853) treated *F. bracteata*, *F. fluminalis* and *F. fruticulosa* as species again. Sanjappa (1992) synonymized *F. bracteata* and *F. fruticulosa* under *F. strobilifera*. After studying the type, protologue and live specimens of *F. bracteata*, *F. fluminalis*, *F. fruticulosa* and *F. strobilifera*, we have come to conclusion that these species are different from each other and have to be treated at distinct specific rank.

Nomenclatural notes

Linnaeus (1753) described *Flemingia strobilifera* based on a specimen collected by Hermann from Sri Lanka. In 1920, Fawcett and Rendle lectotypified the binomial *F. strobilifera* and designated Hermann's specimen as lectotype.

Flemingia nudiflora (Haines) S.K. Gavade, Maesen & Lekhak, **comb.** et **stat. nov.** (Figure 22).

Bas.: *Flemingia strobilifera* var. *nudiflora* Haines, Haines, Bot. Bihar Orissa 3: 268. 1922.
Type: India, Bihar, Singbhum, Saitba Forest, March 1916, *H.H. Haines 4655* (K image!, lectotype designated here).

(=) *Flemingia tiliacea* Niyomdham, Nordic J. Bot. 343. 1992. **syn. nov.**

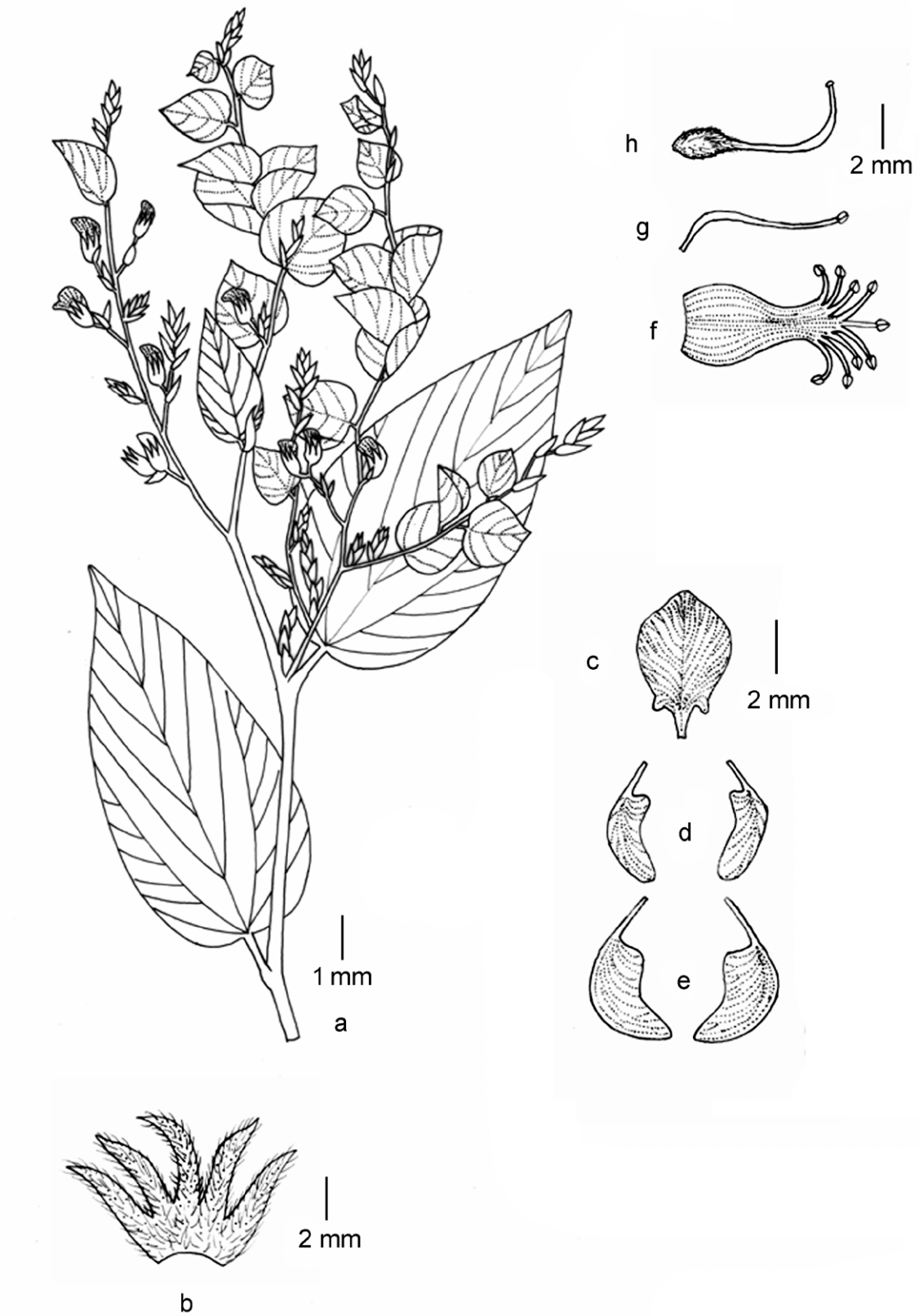


Figure 22. *Flemingia nudiflora* (Haines) S. K. Gavade, Maesen & Lekhak. (a) Habit. (b) Calyx-dorsal view. (c) Standard. (d) Wing petals. (e) Keel petals. (f) Fused androecium. (g) Free stamen. (h) Gynoecium.

Type: Thailand, Chiang Mai prov., between Hue San and Chiang Rai, at 525 m, 6 January 1922, *J.F.C. Rock 1819* (holotype A image!; isotype US image!).

Description

Erect shrubs, 1–2 m tall, with branched stem; stem 4–6 mm in dimeter, young triangular, mature terete, hairy; hairs silky, antrorse. Leaves unifoliolate, 6–17.5 cm long, stipulate, petiolate; stipules 2, 5–10 mm long, ensiform, acuminate with equeal tips, fused when young, splitting at maturity, caducous, basifixed, many nerved, hairy; petioles 5–25 mm, hairy; leaflets 1, 5–15 × 2.5–6 cm, narrowly ovate to oblong, truncate or rounded to cordate at base, apex acute to acuminate, base truncate or rounded to cordate, glabrous on ventral surface, dorsally hairy, hairy on nerves, lateral nerves in 7–9 pairs; gland-dotted; petiolules 2–4 mm long, hairy. Inflorescences terminal and axillary panicles of either 1 or else 5–20 cm long flowers of short panicles at first hidden by foliaceous bracts. Flowers 8–9 mm long, pedicellate, bracteate, pedicel 2 mm long, hairy; bracts 1.5–3 × 2–3 cm, folded, broadly orbicular-ovate, mucronate at apex, many nerved, papery, hairy, gland- dotted; basal bracts ovate-acuminate, striate. Calyx 5–6.5 mm long hairy, gland-dotted, hairs antrorse; calyx tube 1.5–2 mm long, campanulate, hairy; calyx teeth 5, 3.5–4.5 × 1–1.5 mm, lanceolate, equal, connate for 1/3 of its length, many nerved, hairy, gland-dotted. Standards 6–6.5 × 4–4.5 mm, broadly obovate, emarginate; glabrous, clawed with 2 auricles; claw 1 mm long; auricles less than 1 mm; wing petals 5.5–6 × 2–2.5 mm, oblong, slightly falcate; claw 2–2.5 mm long; keel petals 6–6.5 × 3–3.5 mm, oblong, falcate, fused at apex at lower side; claw 1.5–2 mm long. Stamens diadelphous (9+1); staminal tube 5–6 × 1– 1.5 mm, anthers uniform, less than 1 mm long, basifixed, filaments of united anthers 1.2–2 mm, that of free 5.5–6 mm long; Ovary 1.5–2 × 1 mm, gland-dotted, hairy; ovules 2; styles 3–3.5 mm long, glabrous, swollen at middle; stigma globose, hairy. Stigma capitate. Fruits unknown.

Distribution

Asia: India (Andaman and Nicobar Islands and Bihar), Thailand (Chiang Mai).

Flowering

January to March.

Taxonomic notes

Haines (1922) described a new variety under *F. strobilifera*, i.e. *F. strobilifera* var. *nudiflora* Haines from Bihar, India. We raised the varietal rank of *Flemingia strobilifera* var. *nudiflora* to species level and made the new combination *F. nudiflora*. *Flemingia tiliacea* was described by Niyomdham from Thailand in 1992. In the protologue, Haines mentioned the collection locality (Singbhum, Saitba Forest) of the specimen without any collection number. The specimen Haines 4655 housed at K bears the label 'Singbhum, Saitba Forest' indicating that this is an original material. Niyomdham used the same specimen as paratype along with the holotype J.F.C. Rock 1819. After critical examination, both *Flemingia nudiflora* and *F. tiliacea* are identical in their morphology. Hence, we propose *Flemingia tiliacea* as a new synonym for *F. nudiflora*.

The terminal inflorescences are similar to that of *F. strobilifera*, but with slightly larger almost glabrous bracts that hardly cover the flowers which are situated close to the petiole of the foliaceous bracts. The more basal inflorescences have no foliaceous bracts, or these may have fallen off, giving this species the looks of *F. paniculata* Wall. ex Benth. The (simple) leaves of *F. nudiflora* are similar to those of *F. strobilifera*, narrower ovate-elliptic than the ovate leaf blade of *F. paniculata*. The label of H.H. Haines 4655, the type of *F. nudiflora* indeed mentions *Flemingia strobilifera* × *paniculata*? and this describes the situation perfectly.

Nomenclatural notes

Flemingia strobilifera var. *nudiflora* was described by Haines (1922) from Singbhum, Bihar. While describing the variety, he mentions a specimen 'Haines 4655'. In search of a type we could locate a single sheet at K. The sheet is well matched with the protologue and hence as per articles 9.11 and 9.12 of Shenzhen Code (Turland et al. 2018) designated as lectotype.

Specimens examined

INDIA: Andaman and Nicobar Islands, S. Andamans, 28 January 1904, *C.G. Rogers 47* (K, LY); Assam, 1891, *G. King's collector s.n.* (CAL, US).

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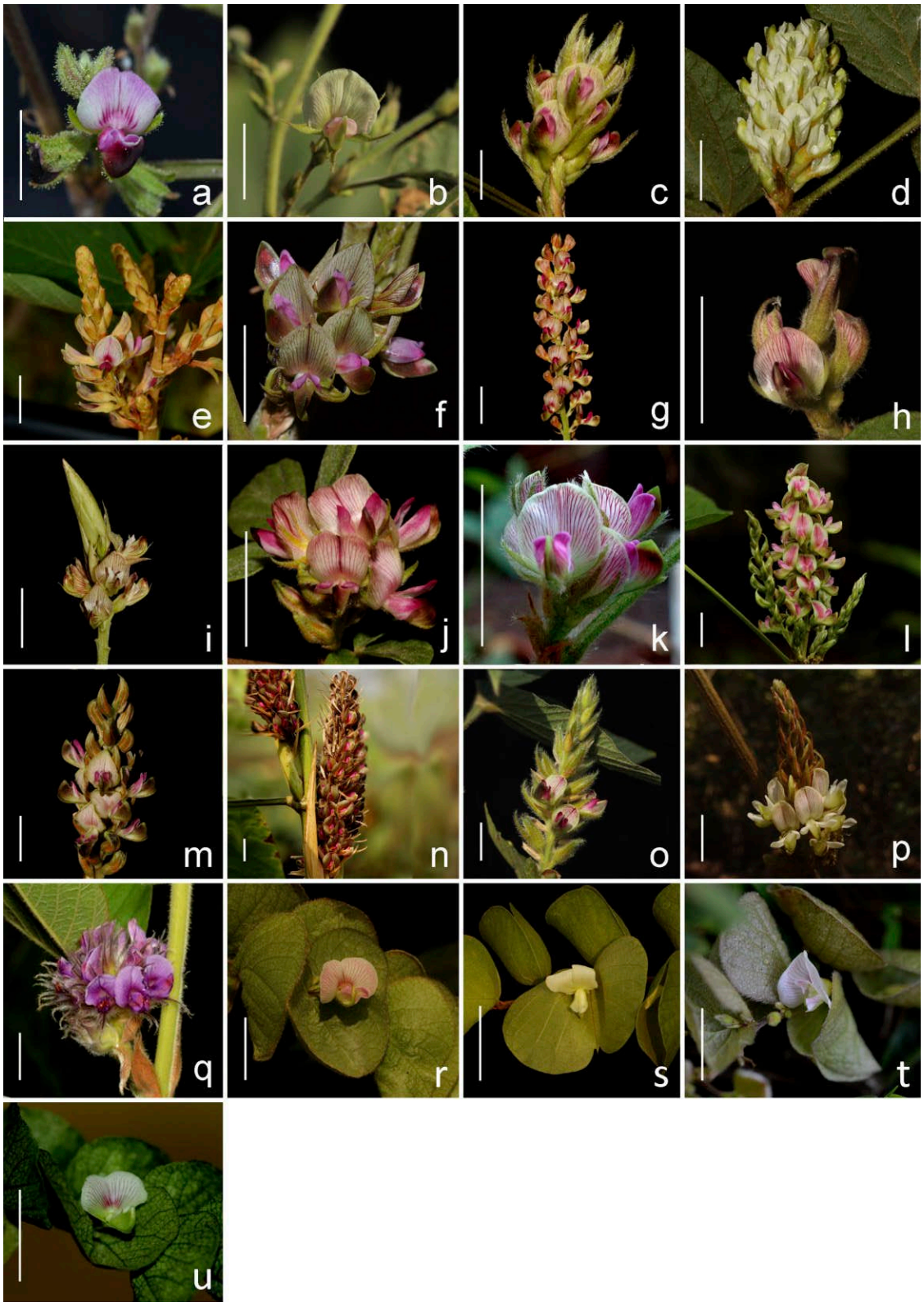

Figure 23. Inflorescence diversity in *Flemingia*. (a) *F. lineata*; (b) *F. paniculata*; (c) *F. angustifolia*; (d) *F. grahamiana*; (e) *F. latifolia*; (f) *F. macrophylla*; (g) *F. nana*; (h) *F. parviflora*; (i) *F. praecox* var. *robusta*; (j) *F. procumbens*; (k) *F. prostrata*; (l) *F. semialata*; (m) *F. sootepensis*; (n) *F. stricta*; (o) *F. wallichii*; (p) *F. wightiana*; (q) *F. trifoliata*; (r) *F. bracteata* ; (s) *F. chappar* ; (t) *F. fruticulosa* ; (u) *F. strobilifera*. Scale bars = 1 cm.

Figure 24. Infructescence diversity in *Flemingia*. (a) *F. lineata*; (b) *F. paniculata*; (c) *F. angustifolia*; (d) *F. grahamiana*; (e) *F. macrophylla*; (f) *F. nana*; (g) *F. parviflora*; (h) *F. praecox* var. *robusta*; (i) *F. procumbens*; (j) *F. prostrata*; (k) *F. semialata*; (l) *F. sootepensis*; (m) *F. stricta*; (n) *F. wallichii*; (o) *F. wightiana*; (p) *F. trifoliata*; (q) *F. bracteata*; (r) *F. chappar*; (s) *F. strobilifera*. Scale bars = 2 cm.

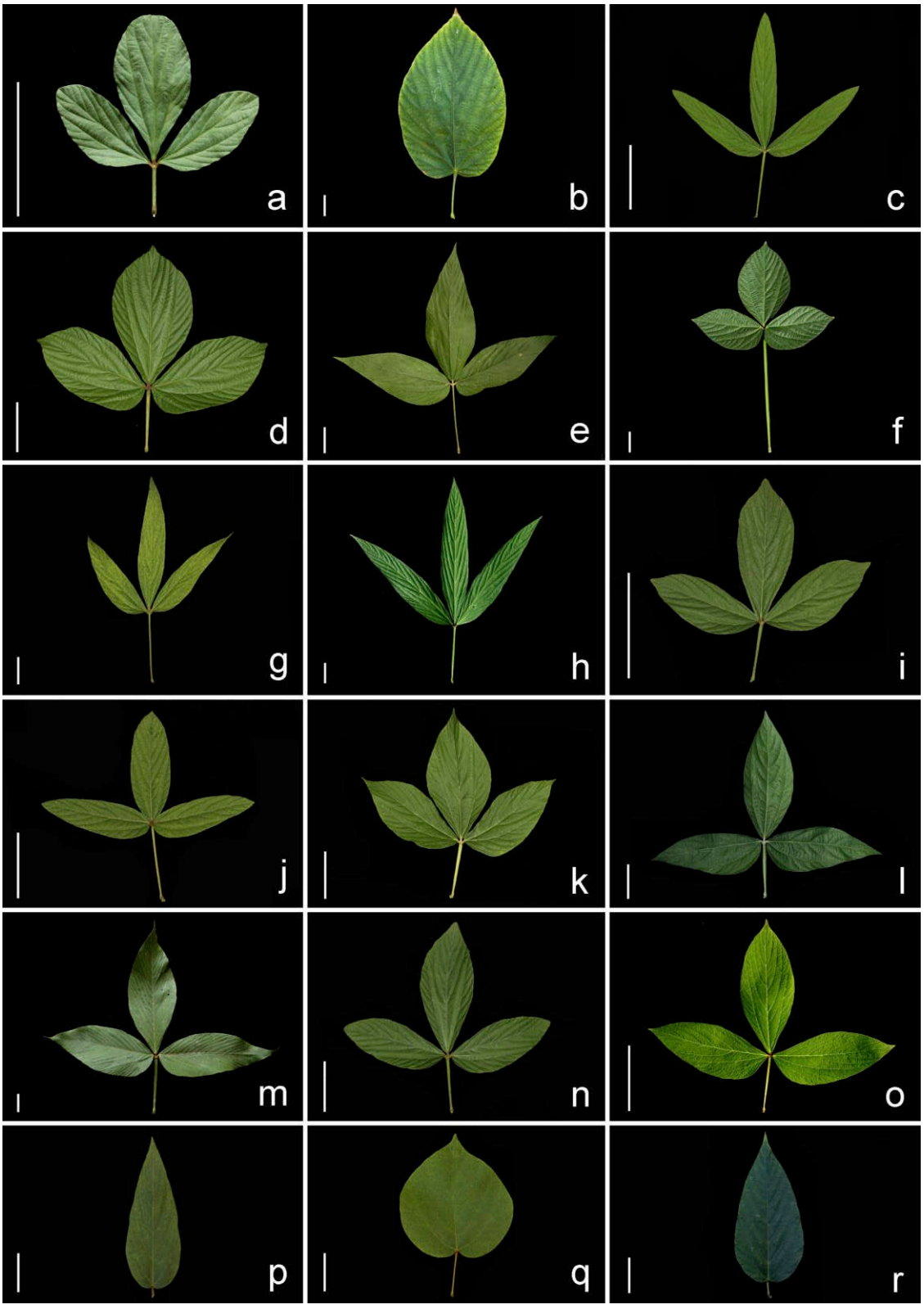

Figure 25. Leaf variation (ventral surface) in *Flemingia*. (a) *F. lineata*; (b) *F. paniculata*; (c) *F. angustifolia*; (d) *F. grahamiana*; (e) *F. macrophylla*; (f) *F. nana*; (g) *F. parviflora*; (h) *F. praecox* var. *robusta*; (i) *F. procumbens*; (j) *F. prostrata*; (k) *F. semialata*; (l) *F. sootepensis*; (m) *F. stricta*; (n) *F. wallichii*; (o) *F. wightiana*; (p) *F. bracteata*; (q) *F. chappar*; (r) *F. strobilifera*. Scale bars = 4 cm

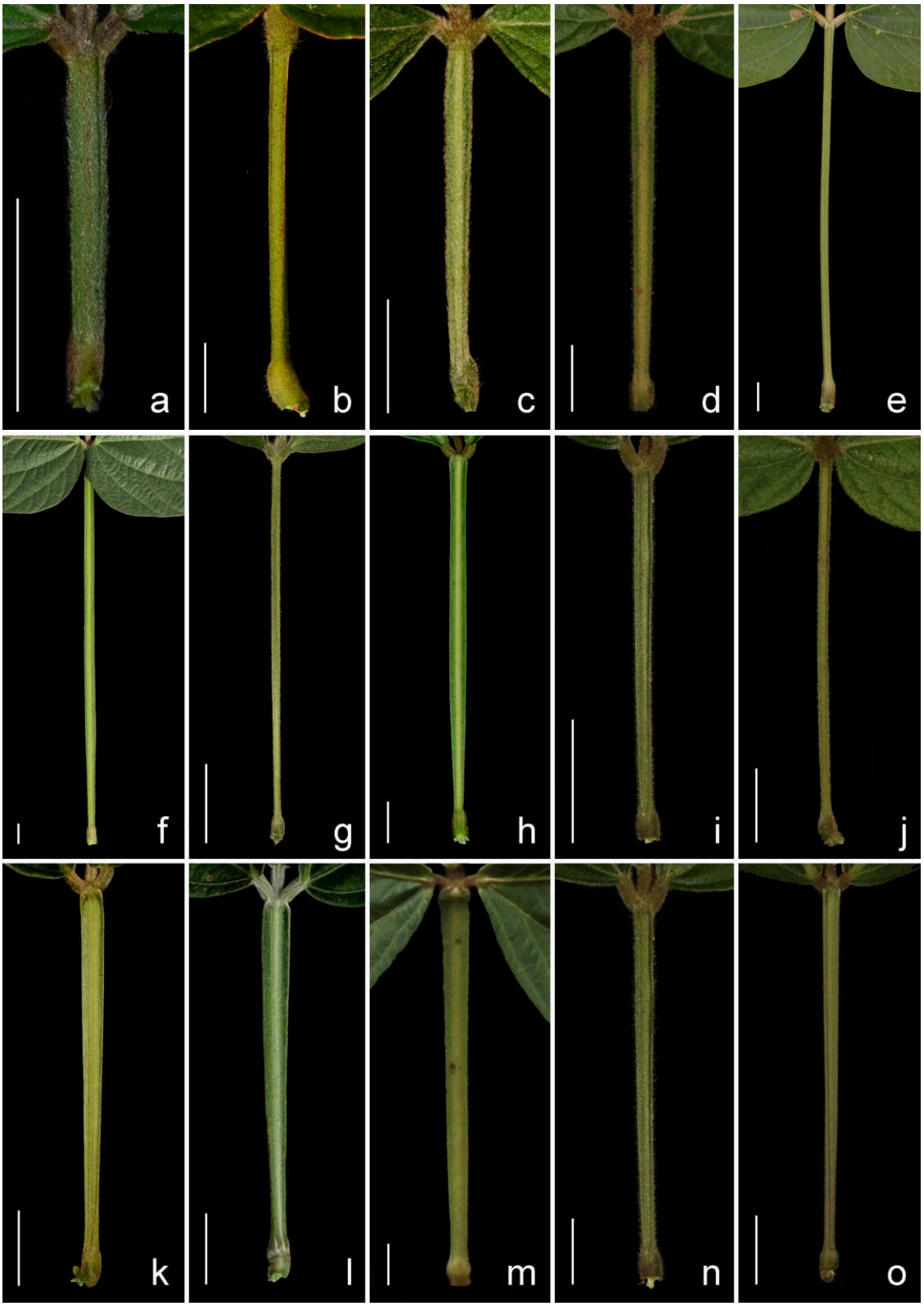

Figure 26. Petiole variation (ventral surface) in *Flemingia*. (a) *F. lineata*; (b) *F. paniculata*; (c) *F. angustifolia*; (d) *F. grahamiana*; (e) *F. macrophylla*; (f) *F. nana*; (g) *F. parviflora*; (h) *F. praecox* var. *robusta*; (i) *F. procumbens*; (j) *F. prostrata*; (k) *F. semialata*; (l) *F. sootepensis*; (m) *F. stricta*; (n) *F. wallichii*; (o) *F. wightiana*. Scale bars = 1 cm

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A taxonomic and phylogenetic study of some *Lecidella* species from Pakistan

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Abstract. In this study, a number of species of the genus *Lecidella* were collected from different areas of Pakistan and characterized using morpho-anatomical and molecular techniques. The present work revealed that collected specimens belong to four species of *Lecidella.* Among which *L. tumidula* is a new record for Pakistan while *L. carpathica*, *L. patavina* and *L. stigmatea* are being reported here from new localities, from Pakistan, representing their wider distribution. Complete morpho-anatomical descriptions, ecology and distribution, along with ITS-based molecular analysis is provided.

Keywords: Khyber Pakhtunkhwa, Lecanoraceae, *Lecidella*, phylogeny, Pakistan.

INTRODUCTION

The genus *Lecidella* Korb. (Lecanoraceae), established by Korber in 1855, is comprised of 80 species (Zhao *et al.* 2015). This genus of crustose lichens is mainly characterized by black lecidiene apothecia with persistent proper excipulum and *Lecidella*-type asci (Zhao et al. 2015). It is a cosmopolitan genus, frequently found in temperate latitudes on wood, bark or rock (Kantvilas and Elix 2013). This group of lichenized ascomycetous fungi is usually regarded as taxonomically difficult due to a high degree of variation in morphological characters. In such cases, molecular study has played a significant role in systematics and species delimitation (Zhao et al. 2015).

Pakistan is located in western South Asia between 24–37° N latitude and 62–75° E longitudes. The country is well known for its geographical and climatic variations which is linked with rich biodiversity (IUCN 2006). The lichen diversity in this region is probably very high but little known due to the lack of surveys in many areas (Ahmad et al. 1997; Aptroot and Iqbal 2012). So far, 375 lichen species have been reported from Pakistan (Ahmad 1965; Aptroot and Iqbal 2012; Habib et al. 2017; Khan et al. 2018; Habib and Khalid 2019). In the past, attempts were made to describe the lichen diversity of the country using morpho-anatomical techniques (Ahmad 1965; Iqbal et al. 1978; Aptroot and Iqbal 2012). Recently, molecular techniques have also

been used to study lichen flora of Pakistan (Habib et al. 2017; Khan et al. 2018; Habib and Khalid 2019).

From Pakistan, five species of *Lecidella* have been reported so far, viz; *L. carpathica* Korb., *L. euphorea* (Florke) Hertel, *L. pulveraceae* (Florke) Th.Fr., *L. patavina* (A.Massal.) Knoph & Leuckert, and *L. stigmatea* (Ach.) Hertel & Leuckert (Aptroot and Iqbal 2012). In the present study, different species of *Lecidella* have been collected from different areas of Pakistan. Use of morpho-anatomical techniques along with phylogenetic analysis led to identification of four different species. *L. tumidula* (A.Massal.) Knoph & Leuckert has been collected and described for the first time from Pakistan which made an addition to the lichen flora of this country. Now, the number of *Lecidella* species reported from Pakistan has been raised from five to six.

MATERIALS AND METHODS

Morphological and chemical studies

Collections were made during a lichen survey of Chikar, Muzaffarabad (Azad Jammu and Kashmir), Parachinar, and Fairy Meadows (Gilgit Baltistan) in 2017 and 2018. Morphological characters were observed under a stereomicroscope (Meiji Techno, EMZ-5TR, Japan). Standard microscopy and spot tests (Hale 1979) were used for identification. Measurements were made from free hand section of apothecia mounted in water on a glass slide. The sections were observed using a compound microscope (MX4300H, Meiji Techno Co., Ltd., Japan). Minimum twenty measurements in water were made for each diagnostic feature.

DNA extraction and PCR amplification

We used thallus material along with apothecial material to extract fungal DNA using a 2% CTAB protocol (Gardes and Bruns 1993). The primer pair ITS1F (Grades and Bruns 1993) and ITS4 (White et al. 1990) was used to amplify the internal transcribed spacer (ITS) region under PCR conditions used by Khan et al. (2018). PCR products were visualized in a 1 % agarose gel using ethidium bromide (Sambrook and Russell 2001). PCR products were sequenced from BGI, China.

Phylogenetic analysis

The ITS regions of all specimens were amplified and sequenced. Bio-edit sequence alignment editor was used to reassemble forward and reverse sequences (Hall 2005). Sequences of other *Lecidella* species based on initial BLAST searches and those used in a study on phylogeny of *Lecidella* by Zhao et al. (2015) were used in phylogenetic analysis (Table 1). The multiple sequence alignment was performed using MAFFT v7 with all parameters set to default values (Katoh and Standley 2013). The ends of the alignment were trimmed to nearly an equal number of sites for all sequences. All gaps were treated as missing data. Maximum Likelihood analysis was performed with MEGA6 using a GTR model for bootstrapping (Tamura et al. 2013). One thousand rapid bootstrap replicates were run to infer the evolutionary history of each species.

The length of the final aligned file was 541 nucleotides, of which 355 sites were conserved, 181 were variable, 156 were parsimony informative and 25 were singleton, *Rhizoplaca porterii* and *R. parilis* (HM577376, HM577309) were chosen as an outgroup (Zhao *et al.* 2015).

RESULTS

Lecidella tumidula (A.Massal.) Knoph & Leuckert, Biblthca Lichenol. 68: 131. 1997. (Figure 1, A-E; Figure 5; A-D).

Description

Thallus crustose, continuous, up to 3 cm in diameter, up to 0.6 mm thick, granulose to rimose. Colour: light greyish green to light olive green, dull to weakly glossy. Apothecia: rounded, semi-immersed, sessile, 0.5–1 mm, frequently present, strongly constricted at base. Margins: thin, continuous, concolorous to disc, distinct when young, indistinct when mature. Disc: black, smooth, glossy, pruinose, flat to convex. Exciple: black, 40–50 µm thick. Epihymenium: blackish, 30–36 µm tall. Hymenium: hyaline, 80–86 µm tall. Hypothecium: dark reddish brown, 30–40 µm tall. Paraphyses: aseptate, hyaline, rarely anastomosing or branched, apex swollen, 2–4 µm wide. Asci: clavate, 8-spored, 58–78 µm × 10–14 µm. Ascospores: simple, hyaline, narrowly ellipsoid to ovoid, 10–12 µm × 5–7 µm.

Spot Tests

All negative (diploicin and lichexanthone reported according to literature but not examined in our specimen).

Substrate and ecology

L. tumidula was found on bark of *Quercus incana* W. Bartram in dry temperate forest, at an altitude of 1,705

Table 1. Specimens used in phylogenetic analysis of *Lecidella* species.

ITS Accession No-	Specimen Name	Country	Voucher No-
KT453736	*Lecidella tumidula*	China	ZX XL0009 (Zhao *et al.* 2015)
KT453737	*Lecidella tumidula*	China	ZX 20129166-2 (Zhao *et al.* 2015)
HQ650596	*Lecidella tumidula*	USA	404720 (Schmull *et al.* 2011)
KT453750	*Lecidella elaeochromoid*	China	ZX 20141142 (Zhao *et al.* 2015)
KT453746	*Lecidella elaeochromoid*	China	ZX 20114966-2 (Zhao *et al.* 2015)
KT453748	*Lecidella effugiens*	China	ZX 20141269-2 (Zhao *et al.* 2015)
KT453747	*Lecidella effugiens*	China	ZX 20141148-2 (Zhao *et al.* 2015)
AF517929	*Lecidella meiococca*	Sweden	Ekman 3101 (BG) (Ekman & Tonsberg, 2002)
KT453743	*Lecidella euphorea*	China	ZX XL0387 (Zhao *et al.* 2015)
KT453742	*Lecidella euphorea*	China	ZX 20140638 (Zhao *et al.* 2015)
KX132994	*Lecidella flavosorediata*	Switzerland	980812 (Mark *et al.* 2016)
KX132965	*Lecidella flavosorediata*	Switzerland	980812 (Mark *et al.* 2016)
JN873903	*Lecidella wulfenii*	Austria	Tuerk 39666 (Ruprecht *et al.* 2012)
MN387031	*Lecidella elaeochroma*	Poland	272987 (Singh *et al.* 2019)
MN387029	*Lecidella elaeochroma*	Poland	272987 (Singh *et al.* 2019)
HQ287871	*Lecidella greenii*	Antarctica	Herbarium Tuerk 43015 (Lumbsch *et al.* 2011)
JN873884	*Lecidella greenii*	Antarctica	Tuerk 33612 (Ruprecht *et al.* 2012)
MK970672	*Lecidella greenii*	Antarctica	T48787 (Wagner *et al.* 2019)
HQ605934	*Lecidella patavina*	Turkey	574971 (Basaran *et al.* 2014)
KT453767	*Lecidella patavina*	China	ZX 20140501-2 (Zhao *et al.* 2015)
MK620163	*Lecidella stigmatea*	Argentina	UR00128 (Ruprecht *et al.* 2019)
MK620136	*Lecidella stigmatea*	Argentina	UR00080 (Ruprecht *et al.* 2019)
KT453764	*Lecidella stigmatea*	China	ZX 20140086-2 (Zhao *et al.* 2015)
KT453765	*Lecidella stigmatea*	China	ZX 20140045-2 (Zhao *et al.* 2015)
KT453760	*Lecidella stigmatea*	China	ZX 20140519-2 (Zhao *et al.* 2015)
KT453763	*Lecidella stigmatea*	China	ZX 20140507-2 (Zhao *et al.* 2015)
KT695322	*Lecidella carpathica*	Canada	BIOUG24047-H06 (Telfer *et al.* 2015)
KT695353	*Lecidella carpathica*	Canada	BIOUG24047-E02 (Telfer *et al.* 2015)
JN873899	*Lecidella siplei*	Antarctica	Tuerk 35895 (Ruprecht *et al.* 2012)
JN873896	*Lecidella siplei*	Antarctica	Tuerk 32991 (Ruprecht *et al.* 2012)
JN873898	*Lecidella siplei*	Antarctica	Tuerk 33457 (Ruprecht *et al.* 2012)
JN873897	*Lecidella siplei*	Antarctica	Tuerk 33449 (Ruprecht *et al.* 2012)
HM577376	*Rhizoplaca porterii*	USA	55145 (BRY-C) (Leavitt *et al.* 2011)
HM577309	*Rhizoplaca parilis*	USA	55078 (BRY-C) (Leavitt *et al.* 2011)

m, dominant vegetation including *Pinus gerardiana* Wall. ex D. Don, *Quercus ilex* L., *Juniperus macropoda* Boiss. and *Picea smithiana* Boiss, temperature ranges between 6–16 ºC, average annual rainfall 300–500 mm.

Distribution

Temperate areas of Asia including China (Zhao et al. 2015), have also been reported from Europe and North America (Nash et al. 2004). Here it is been reported for the first time from Pakistan.

Material examined

PAKISTAN: Khyber Pakhtunkhwa Province: Kurram District, Parachinar: 33°90' N, 70°08' E; 1,705 m; on bark of *Quercus incana* W. Bartram, 18 August 2018, *A.N. Khalid & K. Habib*; LAH36399; (GenBank accession no. MT139651).

Lecidella carpathica Korb., Parerga lichenol. (Breslau) 3: 212. 1861. (Figure 2, A-F; Figure 5; E-H).

Description

Thallus crustose, effuse, rimose areolate to subsquamulose, dull, up to 5 cm wide, up to 300 µm thick. Areoles: scattered to crowded, smooth or rough, up to 0.5 mm in diameter, irregular in outline. Colour: pale green to grey green. Apothecia: sessile, semi-immersed, constricted at base, scattered to crowded, up to 1 mm in diameter. Disc: black, plane, flat to moderately con-

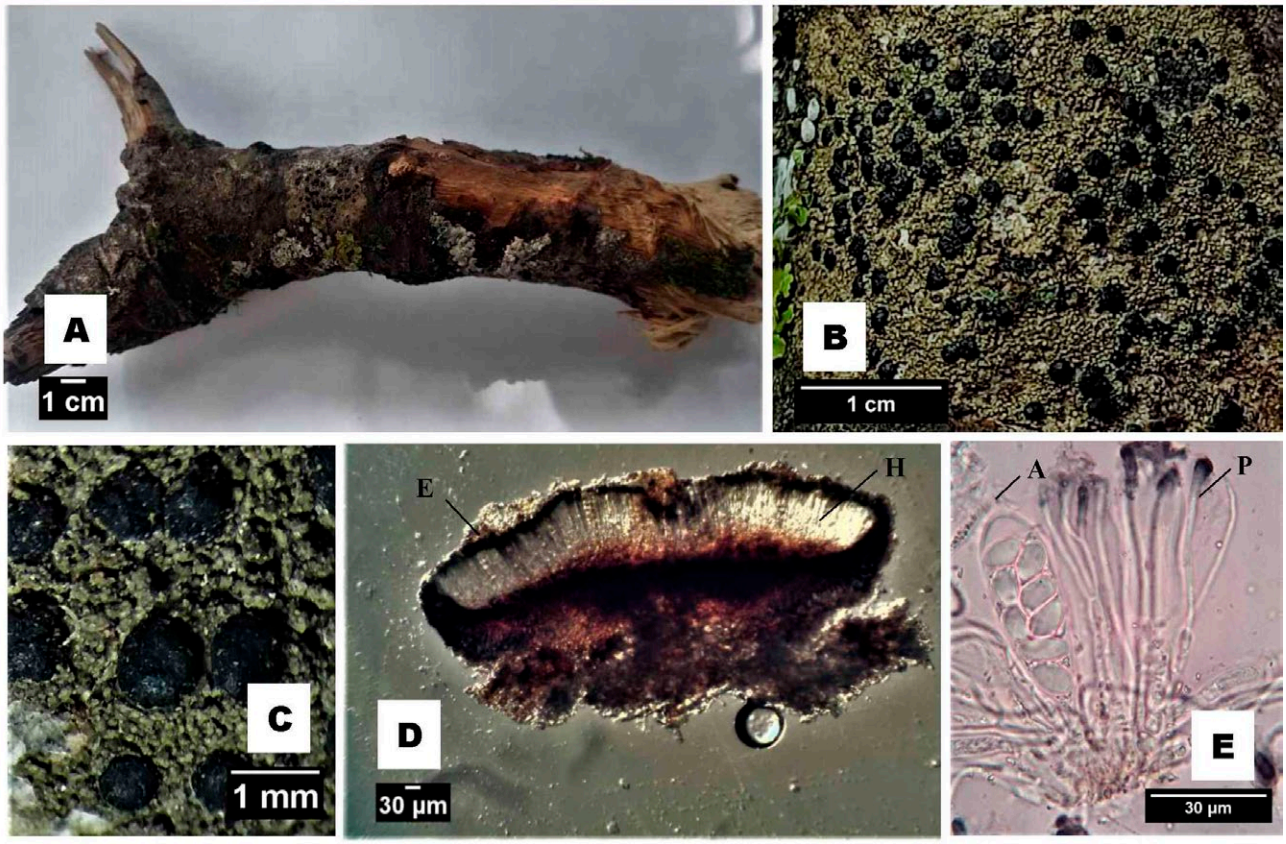

Figure 1. *Lecidella tumidula.* **(A & B)** showing crustose thallus and abundant apothecia (**C)** pruinose apothecia; (**D)** Cross section of an apothecium (H: Hymenium; E: Epihymenium); (**E)** showing ascus and paraphyses (A: Ascus; P: Paraphyses).

vex, pruinose. Margins: distinct, entire or flexuose, up to 0.9 mm wide. Exciple: bluish green to black, 20–30 µm thick. Epihymenium: pale brown to dark brown, 15–20 µm tall. Hymenium: hyaline, 65–90 µm tall. Hypothecium: pale brown to brown, 30–45 µm tall. Paraphyses: aseptate, hyaline, rarely anastomosing or branched, sometimes slightly swollen apically, up to 2 µm wide. Asci: clavate, 45–60 x 13–15 µm, 8-spored. Ascospores: simple, hyaline, ellipsoid to ovoid, 10–14 x 6–8 µm.

Spot tests

K+ yellow, C–, KC–, P–

Substrate and ecology

L. carpathica was found on rock (saxicolous), in moist temperate forest at an altitude of 234 m, temperature ranges between -2–37 °C, average annual rainfall 1,500–1,600 mm, with dominant tree species *Pinus wallichiana* A.B. Jacks., *Picea smithiana* Boiss., *Abies pindrow* Royle., *Quercus incana* W. Bartram and *Q. dilatata* Lindl. ex Royle.

Distribution

Widespread including Africa, Europe, Australia, Macaronesia, New Zealand (Smith et al. 2009), UK, USA, Ukraine (Oxner 1968; Kondratyuk et al. 1998; 2003), temperate parts of Asia (Nash *et al.* 2004), China (Zhao et al. 2015), India (Singh & Sinha 2010) and Pakistan (Nasim et al. 2004).

Material examined

PAKISTAN: Azad Jammu & Kashmir: Chikar, 34° 9' N, 73° 41' E, 234 m; on rock; 18 August 2018, *K. Habib*; LAH36400; (Genbank accession no. MT139649).

Lecidella patavina (A.Massal.) Knoph & Leuckert, in Knoph, Bibliotheca Lichenol. 36: 116. 1990. (Figure 3, A-G; Figure 6; A-D).

Description

Thallus indistinctly crustose, inconspicuous, intermingled with rock particles, up to 4 cm in diameter.

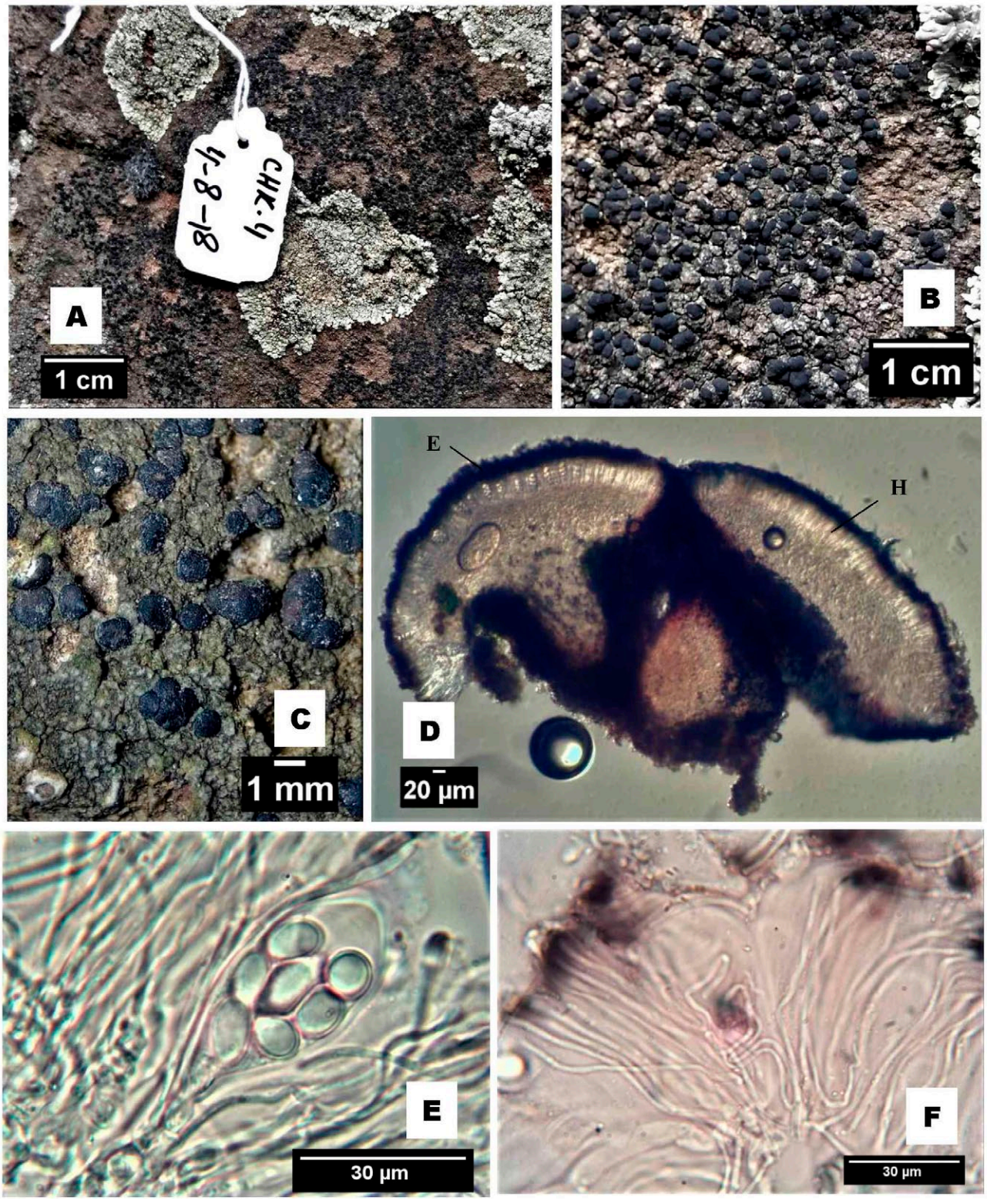

Figure 2. *Lecidella carpathica.* **(A & B)** Crustose thallus showing abundant apothecia; **(C)** black, pruinose apothecia; **(D)** Cross section of an apothecium (H: Hymenium; E: Epihymenium); **(E)** Ascus; **(F)** Paraphyses.

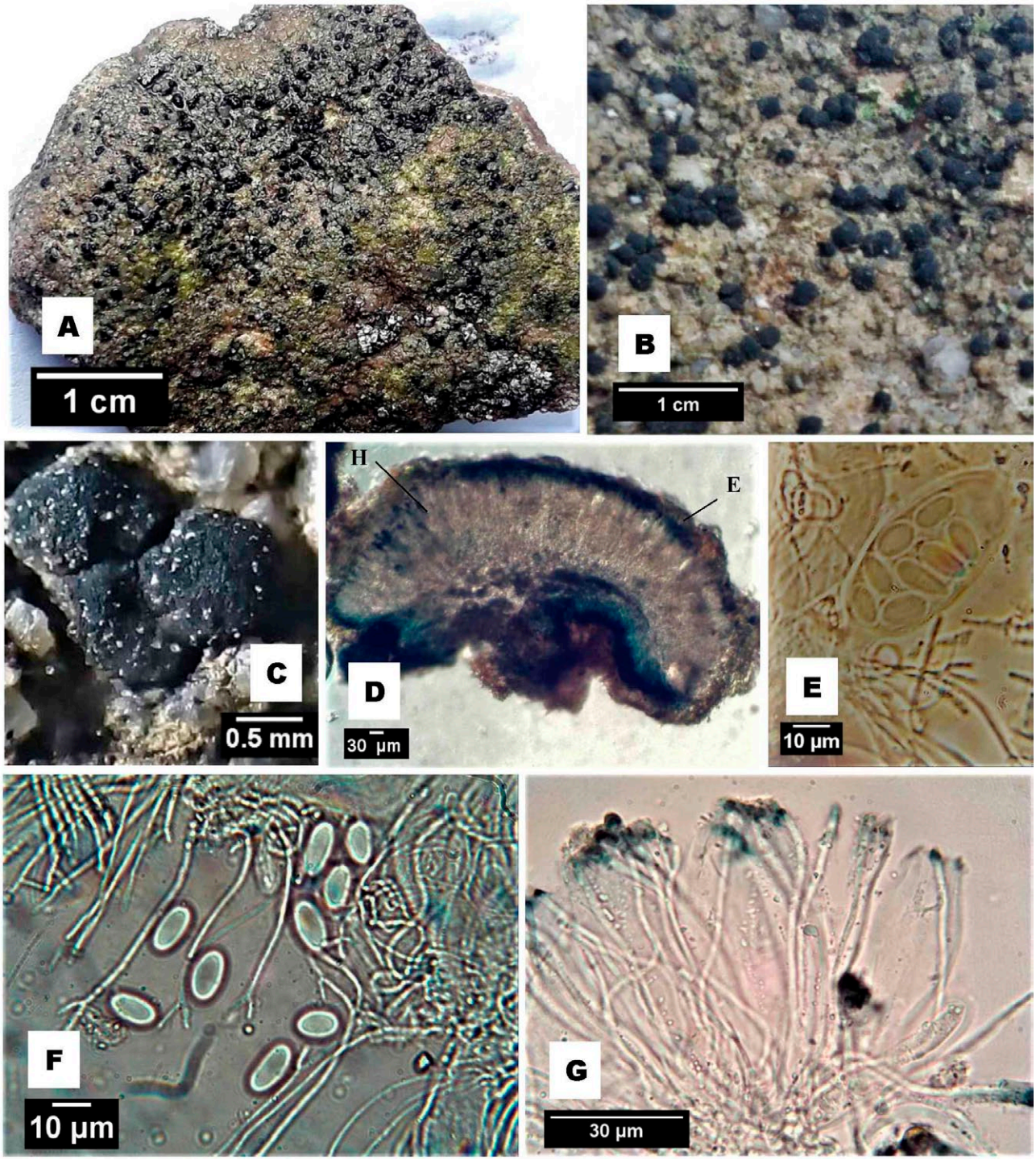

Figure 3. *Lecidella patavina.* **(A & B)** Crustose thallus showing abundant apothecia; **(C)** black, pruinose fascicle of apothecia; **(D)** Cross section of an apothecium (H: Hymenium; E: Epihymenium); **(E)** Ascus; **(F)** Ascospores; **(G)** Paraphyses.

Colour: light green to dark green. Apothecia: rounded to irregular, 0.2–1.5 mm in diameter, sessile, constricted at base, frequent, separate, rarely fascicle. Margins: thin, continuous, concolorous to disc, distinct when young, indistinct when mature. Disc: black, flat to strongly convex, smooth and slightly glossy, slightly pruinose. Exci-

ple: bluish green, 40–50 µm thick. Epihymenium: dark blue with blackish tint, 20–30 µm tall. Hymenium: hyaline to grey, 110–120 µm tall, inspersed. Hypothecium: hyaline to brown, 90–110 µm tall. Paraphyses: hyaline, aseptate, apically branched, not anastomosing, apex slightly swollen, 1–2 µm wide. Asci: clavate, 8-spored, 30–67 µm × 12–20 µm. Ascospores: hyaline, simple, narrowly ellipsoid to ovoid, 9–13 µm × 5–6 µm.

Spot Test

K+ (Slight yellow), C–, KC–, P– (atranonin or lichexanthone might be predicted).

Substrate and ecology

L. patavina was found on nutrient enriched siliceous rocks near water falls, in moist temperate forest at an altitude of 1,705 m, temperature ranges between -2–37 ºC, average annual rainfall 1,500– 1,650 mm, with dominant tree species *Cedrus deodara* (Roxb. ex Lambert) G.Don, *Pinus wallichiana* A.B. Jacks., *Picea smithiana* Boiss., *Abies pindrow* Royle., *Quercus incana* W.Bartram, *Q. dilatata* Lindl. ex Royle. and *Q. semecarpifolia* Sm.

Distribution

Mainly arctic-alpine, UK, N.W. Scotland (Smith et al. 2009), Africa, Antarctica, Europe, USA, (Knoph and Leuckert 2004; Knudsen and Kocourková 2012), Ukraine (Vondrak et al. 2010), temperate parts of Asia (Nash et al. 2004), China (Zhao et al. 2015) and Pakistan (Aptroot and Iqbal 2012).

Material examined

PAKISTAN: Khyber Pakhtunkhwa Province: Kurram District, Parachinar: 33°90' N, 70°08' E; 1705 m; on rock; 18 August 2018, *A.N. Khalid & K. Habib*; LAH3640; (GenBank accession no. MT139652).

Lecidella stigmatea (Ach.) Hertel & Leuckert, Willdenowia 5: 375. 1969. (Figure 4, A-G; Figure 6; E-H).

Description

Thallus crustose, areolate or rimose-areolate to verruculose-areolate, 7–8 cm in diameter, up to 0.2 mm thick, rarely thick up to 0.6 mm. Areoles: indistinct to distinct, flat to slightly convex, angular to irregular in outline, 0.2–0.6 mm in diameter. Surface: finely granulose, rough, dull. Colour: greyish to grey to brownish grey. Apothecia: lecideine, black, sessile, 0.4–0.9 mm in diameter. Disc: black, flat to somewhat convex, pruinose. Margins: distinct, thin, becoming excluded. Exciple: 78–88 µm thick, bluish green to brown. Epihymenium: dark brown, 12–16 µm high. Hymenium: hyaline, 75–80 µm tall, not inspersed. Hypothecium: hyaline to brown, 65–75 µm tall. Paraphyses: aseptate, hyaline, rarely anastomosing or branched, slightly swollen apically, up to 1.2 µm wide. Asci: lecanoral-type, clavate, 8-spored, 40–57 x 14–18 µm; Ascospores: simple, hyaline, thick and smooth wall, ellipsoid to ovoid, 9–14 x 5–8 µm.

Spot tests

K+ yellow, C–, KC–, P– (atranonin, zeorin, lichexanthone or norlichexanthone might be predicted).

Substrate and ecology

L. stigmatea was found on bark of *Pinus wallichiana* A.B. Jacks., in moist temperate forest, with dominant tree species *Cedrus deodara* (Roxb. ex Lambert) G.Don, *Pinus wallichiana* A.B. Jacks., *Picea smithiana* Boiss., *Abies pindrow* Royle., *Quercus incana* W. Bartram, *Q. dilatata* Lindl. ex Royle. and *Q. semecarpifolia* Sm. at an altitude of 3,300 m, temperature ranges between -2–37 ºC, average annual rainfall 1650 mm.

The second collection of *L. stigmatea* was found on a rock (saxicolous), close to water falls, in moist temperate forest at an altitude of 2,900 m, temperature ranges between -2–37 ºC, average annual rainfall 1,500– 1,650 mm.

Distribution

Probably cosmopolitan, including UK, USA, Antarctica, Australia (Smith et al. 2009), Ukraine (Oxner 1968, Kondratyuk *et al.* 1998, 2003), temperate parts of Asia (Nash et al. 2004), China (Zhao et al. 2015), India (Singh & Sinha 2010) and Pakistan (Ahmad 1965).

Material examined

PAKISTAN: Gilgit Baltistan, Fairy Meadows: 35°23' N, 74°35' E; 3300 m; on bark of *Pinus wallichiana* A.B. Jacks., 18 July 2017, *A.N. Khalid & M. Khan*; LAH36402; (GenBank accession no. MT139653); Azad Jammu & Kashmir: District Muzaffarbad, Peer Chanasi: 34°2' N, 73°33' E; 2900 m; on rock; 18 August 2018, *K. Habib*; LAH36403; (Genbank accession no. MT139650).

Key to Genus *Lecidella* in Pakistan

1a. On Bark ..... *L. tumidula*

1b. On rock, Cortex K-, C 2

1c. On rock, or on bark, Cortex K+, C 3

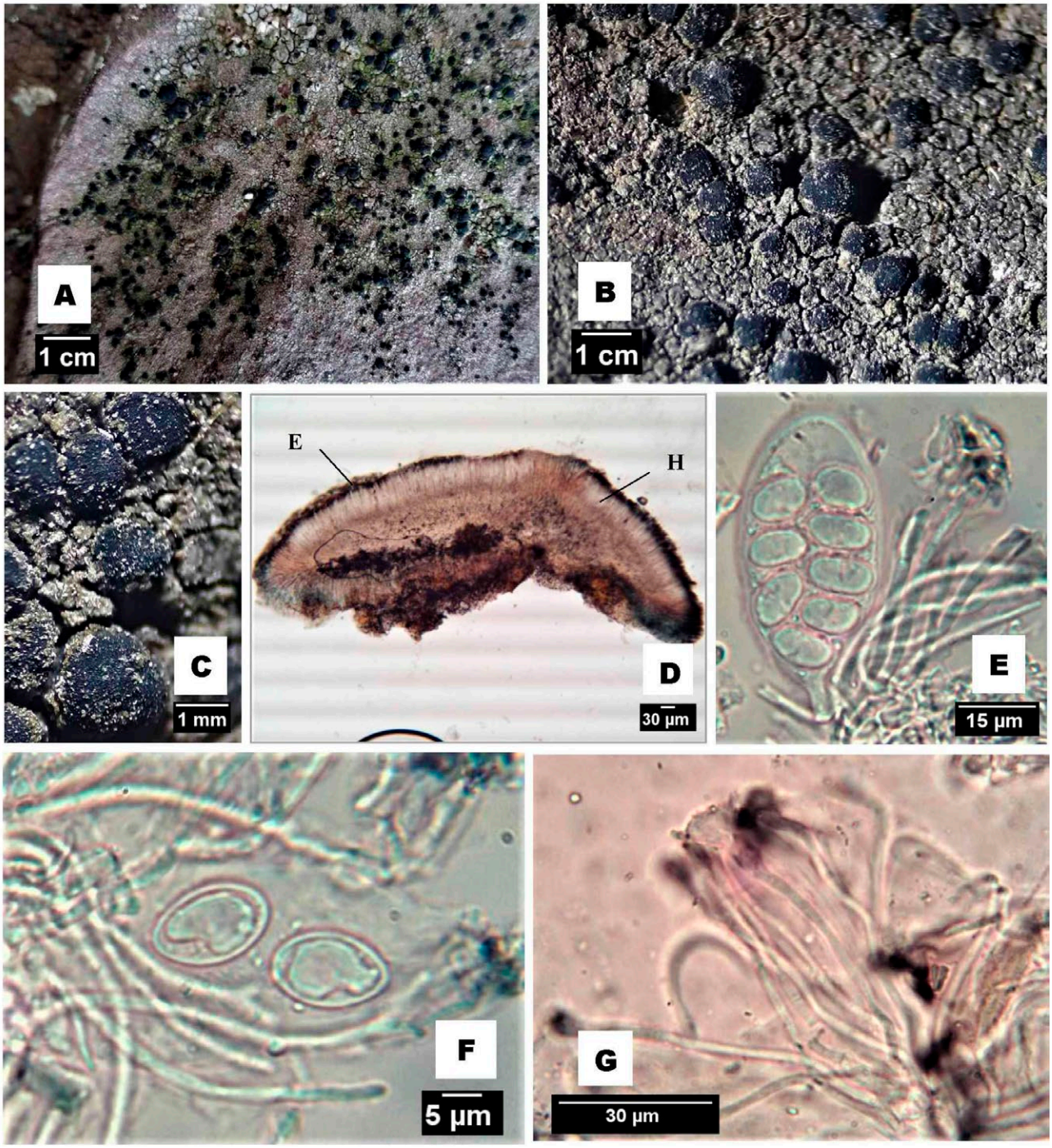

Figure 4. *Lecidella stigmatea.* **(A & B)** Crustose thallus showing abundant apothecia; **(C)** black, pruinose disc of apothecia; **(D)** Cross section of an apothecium (H: Hymenium; E: Epihymenium); **(E)** Ascus; **(F)** Ascospores; **(G)** Paraphyses.

1d. On rock, Cortex K+, C 4

2a. Thallus crustose, areolate, epihymenium 15–20 µm tall, hypothecium brownish grey, on rock ..... *L. carpathica*

2b. Thallus crustose, granulose, epihymenium 30–36 µm tall, hypothecium dark reddish brown, on bark ..... *L. tumidula*

3a. Thallus rimose-areolate, paraphyses rarely branched, exciple greenish black, hymenium not inspersed ... *L. stigmatea*

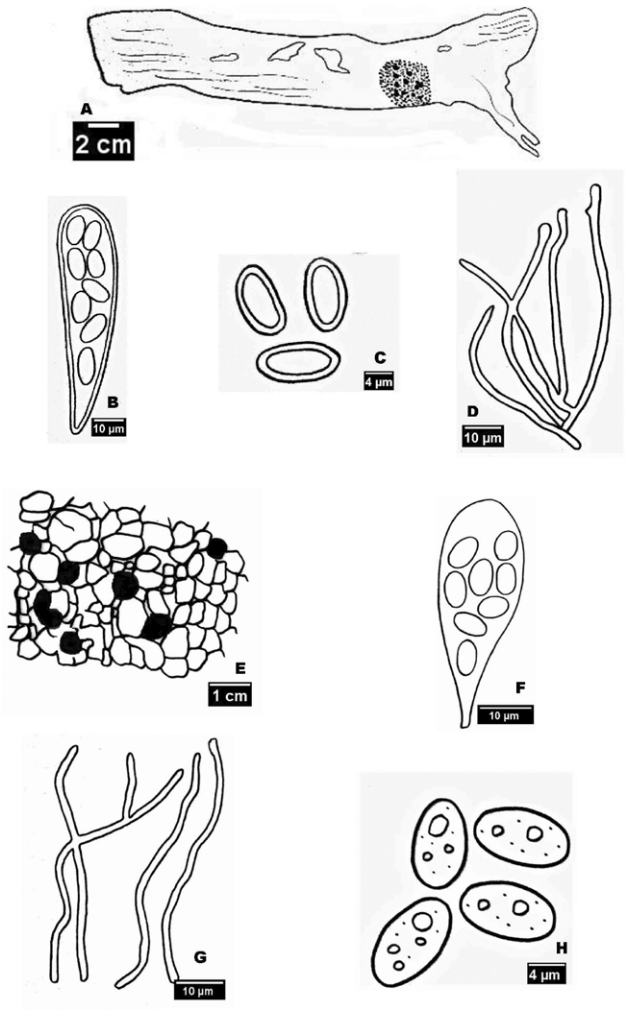

Figure 5. (A-D): Line drawings of *Lecidella tumidula* **A:** Granulose thallus; **B:** Ascus; **C:** Ascospores; **D:** Paraphyses; **(E-H):** Line drawings of *Lecidella carpathica* **E:** Crustose-areolate thallus; **F:** Ascus; **G:** Paraphyses; **H:** Ascospores.

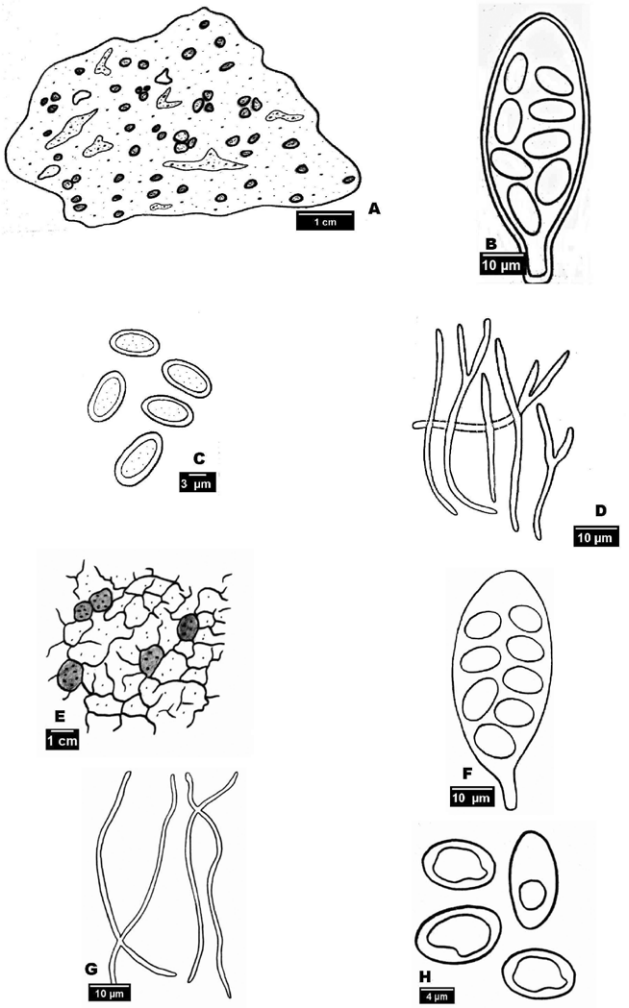

Figure 6. (A-D): Line drawings of *Lecidella patavina* **A:** crustose thallus **B:** Ascus; **C:** Ascospores; **D:** Paraphyses; **(E-H):** Line drawings of *Lecidella stigmatea* **E:** Rimose-areolate thallus; **F:** Ascus; **G:** Paraphyses; **H:** Ascospores.

3b. Thallus inconspicuous, paraphyses mostly branched, exciple bluish green, hymenium inspersed.....*L. patavina*

4a. Thallus crustose, granulose to rimose-areolate, hymenium 55–100 µm tall.....*L. euphorea*

4b. Thallus sorediate, farinose, hymenium 60–70 µm tall,..... .....*L. pulveraceae*

Discussion

The present study of the genus *Lecidella* from northern Pakistan revealed one new record for the lichen flora of Pakistan while other *Lecidella* species have been collected from new localities thus indicating their wide distributional range in Pakistan.

In the ITS-based phylogenetic analysis, the Pakistani collection of *L. tumidula* (PR–112) clustered with specimens of the same taxon reported from China (Accession no. KT453736, KT453737) with strong support (99%, Fig. 7) and formed a sister group relationship with *L. tumidula* collected from USA (Accession no. HQ650596) that was wrongly reported in GenBank (Schmull et al. 2011), but after re-examination it was *L. tumidula* (Zhao *et al.* 2015).

Morphological comparison also confirms its identity as *L. tumidula* (Nash et al. 2004) except the presence of a pruinose disc in the specimen collected from Pakistan. There is only one nucleotide difference between the Pakistani collection and the Chinese *L. tumidula* specimen. It is also the second report of this taxon from Asia after China (Zhao et al. 2015).

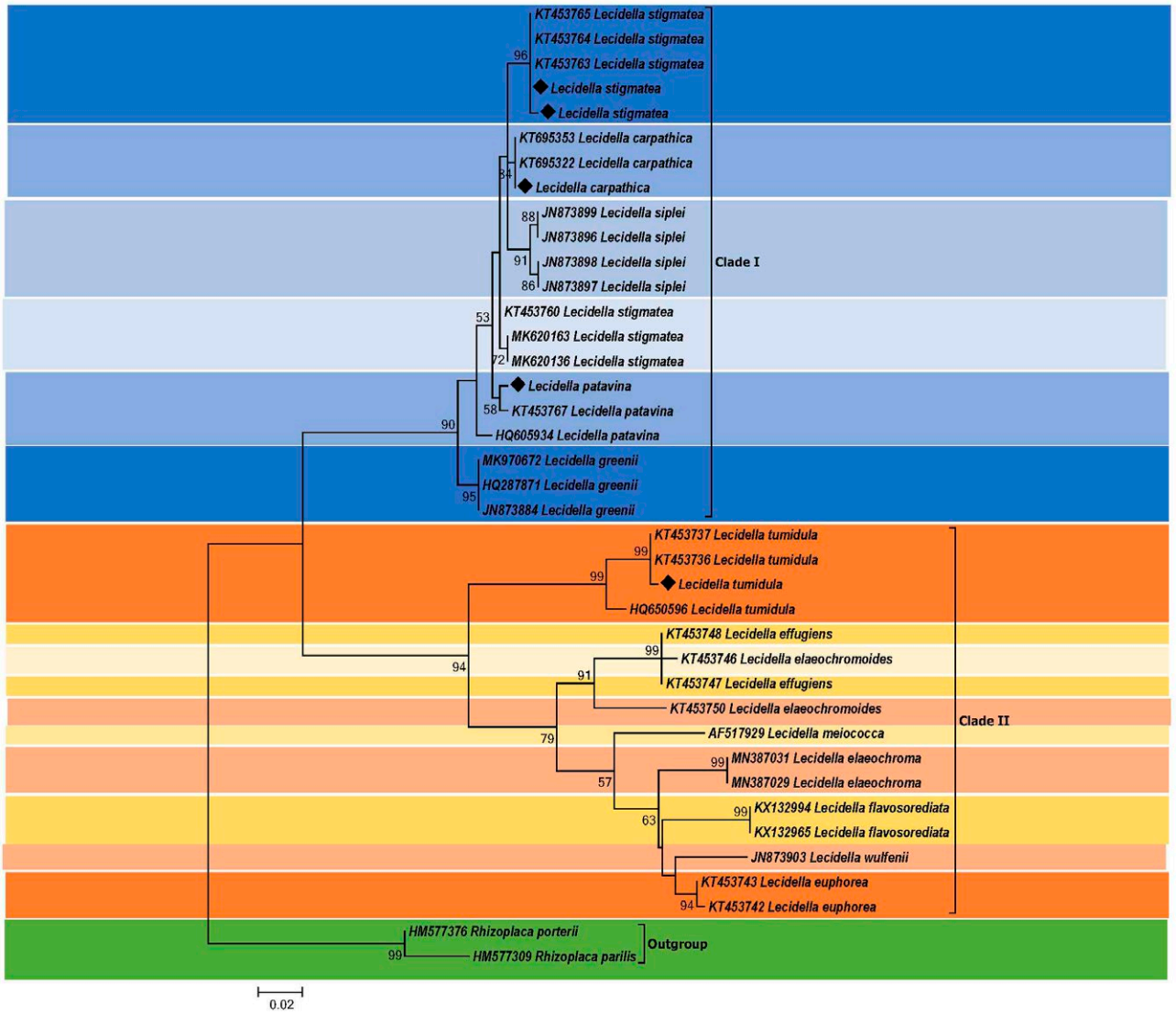

Figure 7. Phylogenetic analysis of species of *Lecidella,* comprised of 39 sequences. This tree has been inferred using maximum likelihood method. The bootstrap values based on 1000 replicates are shown below the branches. Sequences generated from local collection are marked with ◆.

In the phylogenetic analysis, the ITS sequence of *Lecidella carpathica* (CHK-04) clustered with ITS sequences of *L. carpathica* collected from Canada (KT695322, KT695353). Morphological comparison also confirms its identity as *L. carpathica* (Nash *et al.* 2004). There is only one nucleotide difference between Pakistani and Canadian *L. carpathica* (KT695322, KT695353). Previously, it was reported from dry temperate forest of Kalam (Swat), Pakistan at an elavation of about 2,001 m. a.s.l. The new collection is from moist temperate forest of AJK state, found at an elevation of 2,900 m. a.s.l.

The ITS sequence of *Lecidella patavina* (PR-11) clustered with a Chinese collection of *L. patavina* (Accession no. KT453767) in the phylogenetic analysis and made a sister branch with *L. stigmatea* (Ach.) Hertel & Leuckert. Morphologically, both *Lecidella* species are similar in having the same chemistry, a crustose epilithic thallus with a black disc of apothecia (Basaran et al. 2014) but differ due to the presence of the conspicuous and thicker thallus in the latter.

There are also two nucleotide difference between Pakistani and Chinese collection of *L. patavina* (KT453767). From Pakistan, it was previously reported but locality was not recorded. Here it is described from high elevation in Parachinar i.e. 1,705 m. a.s.l., where it is widespread in warm and temperate climates.

The ITS sequence of *Lecidella stigmatea* (MKF–7 and PC–34), clustered with *L. stigmatea* reported from China (KT453763, KT453764, KT453765). The *L. stigmatea* (MK620163, MK620136) in our tree formed separate subclade. Results from phylogenetic analysis of *L. stigmatea* requires revision between specimens identified as *L. stigmatea* from Argentina, are distantly related to samples of our clade. Morphologically our specimen is similar to the Sonoran *L. stigmatea,* in having rimose-areolate thallus and lecideine apothecia (Nash et al. 2004). From Pakistan, this taxon has previously been reported from dry temperate forest of Kalam (Swat), Pakistan, at an elavation of about 2,001 m. a.s.l. but recent collections are from moist temperate forests of Azad Jammu & Kashmir and Gilgit Baltistan, at high elevations 2,900 m and 3,300 m. a.s.l. respectively.

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Ophiorrhiza meenachilarensis, a new species of Rubiaceae from southern Western Ghats, India

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Abstract. A new species of *Ophiorriza* (Rubiaceae) from southern Western Ghats, India is here described and illustrated. *Ophiorriza meenachilarensis* is similar to *O. eriantha,* from which it differs in its herbaceous habit (vs. shrubby habit), densely villous-hirsute stem (vs. pubescent-glabrous stem), entire stipule (vs. bifid stipule), short-peduncled cymes (vs. comparatively long-peduncled cymes), unscented flowers (vs. scented flowers) and corolla tube with a ring of hairs at the middle of the tube (vs. corolla tube without a ring of hairs). A detailed description, illustrations, ecological observations, and geographic distribution are provided.

Keywords: Ophiorrhizeae, Camptothecin, Kerala, Rubioideae, Vagamon hills.

INTRODUCTION

Ophiorriza L. is a predominantly herbaceous genus that belongs to the tribe Ophiorrhizeae, subfamily Rubioideae, Rubiaceae (Bremer and Manen 2000). It is a species-rich genus consisting of 318 species, one subspecies and five varieties (WCSPF 2019) chiefly distributed in wet tropical forests of South-East Asia, extending to Australia, New Guinea and the Pacific Islands (Darwin 1976; Chen and Taylor 2011). The genus is taxonomically complicated and has been less-studied by taxonomists except Darwin (1976), Lo (1990), Halford (1991), Deb and Mondal (1997) and Tao and Taylor (2011). Deb and Mondal (1997) revised the genus in the Indian subcontinent, and recognized 47 species and 9 varieties from India. Since Deb and Mondal (1997), seven species have been added to the flora of India (Ramamurthy and Rajan 1985; Khan et al. 1998; Hareesh et al. 2015a,b, 2017a,b, 2018). Western Ghats is one of the diversity centres of *Ophiorrhiza* species followed by the north-eastern Himalayas. Nearly 21 taxa are distributed in the evergreen forest of the Western Ghats (Deb and Mondal 1997; Nayar et al. 2014).

Ophiorrhiza species are commercially important as source of Camptothecin (CPT), a potential anticancer drug. Rajan et al. (2016) screened 11 species and 3 varieties of *Ophiorrhiza* from the southern Western Ghats and

found that *O. mungos* L. (396.54 µg/g, dr. wt.) and *O. rugosa* Wall. var. *angustifolia* (373.19 µg/g, dr. wt.) are the two best known sources of CPT, while *O. rugosa* var. *decumbens* (18.55 µg/g, dr. wt.) and *O. hirsutula* (17.14 µg/g, dr. wt.) showed moderate contents of CPT.

While conducting floristic explorations in the Vagamon hills of southern Western Ghats, the authors came across a few populations of a densely hairy species of *Ophiorrhiza* growing in moist shady areas of an evergreen forest patch in Kottayam-Idukki districts border. After critical study and comparison with other species of *Ophiorrhiza* and scrutiny of literature, it turned out to be quite different taxa from known species hence described as new to science and illustrated here. Final author conducted systematic screening of CPT in the newly described species and found that the CPT level is zero.

Ophiorrhiza meenachilarensis Robi & Balan, **sp. nov**. (Figures 1 and 2)

Type: India, Kerala, Kottayam district, Vagamon Hills, ± 1000 m, 17 June 2018, *A.J. Robi & Anoop P. B. 16881* (holotype, MH!; isotypes, KFRI, MBGH!).

Diagnosis

Ophiorrhiza meenachilarensis shows similarities with the southern Western Ghats endemic species *O. eriantha* Wight, but differs by its herbaceous habit, villous-hirsute indumentum on stem, leaves and inflorescence, unlobed stipules, unscented flowers, glabrous hypanthium, lanceolate, bristly calyx lobes, corolla tube with a ring of hairs within, basally inserted stamens, ovate-orbicular style branches and areolate exotesta of the seeds with a number of tubercles.

Description

Erect herbs, 30–45 cm tall; stem unbranched or with a few branches, terete, densely villous-hirsute throughout; internodes 2–5 cm long. Stipules ovate, acuminate at apex, entire, 8–12 × 3–4 mm, bristly outside, caducous. Leaves in unequal pairs; petioles 1.2–3.5 cm long, densely hairy; leaf blades obovate-elliptic, 8–17.5 × 2.5–6 cm, attenuate at base, acuminate at apex, sometimes subfalcate, chartaceous, sparsely appressed pilose above, densely so beneath especially along the veins, margins hirsute, hairs up to 2.5 mm long; lateral veins 8–12 (–14) pairs, close, prominent beneath. Inflorescence axillary and terminal, a corymbose cyme, 1.5–2.5 cm across; peduncles 0.1–2 cm long at anthesis and 2–3 cm long at fruiting, stout, rusty villous. Flowers 1-1.2 cm long; bracts and bracteoles similar, linear-lanceolate, 6–8 × 0.7–1 mm, bristly along margins and outside, persistent. Pedicels 1–2 mm long. Hypanthium obovoid, 0.8–1 × 0.6 mm. Disc bilobed, 0.4–0.5 mm tall, glabrous. Calyx lobes lanceolate, 2–2.5 × 0.4–0.5 mm, bristly outside. Corolla infundibuliform, hispid outside; tube 7–8 mm long, patent-pubescent outside, appressed pubescent and with a ring of hairs at the middle of the tube inside; lobes ovate-lanceolate, 2.5–3 × 1.5–2 mm, acute-subacuminate, shortly keeled. Stamens included, inserted at the base of corolla tube; filaments 1–1.5 mm long; anthers linear-oblong, 1.5–1.6 × 0.4 mm. Style filiform, as long as corolla tube, glabrous, lobes 2, ovate-orbicular, 1 × 0.8 mm. Capsules obcordate in outline, 4–5 × 6–7 mm, laterally compressed, hispid, green. Seeds many, irregularly angled, *ca* 0.4 × 0.3 × 0.3, brown; exotesta areolate, wall of the areoles with a number of tubercles.

Etymology

The specific epithet refers to the type locality in Kottayam district of Kerala state, where the Meenachilar River originates.

Distribution and habitat

This species is currently known only from the type locality, Vagamon hills, Kerala, India. It is growing in moist shady areas of evergreen forest at an elevation of ± 1000 m altitude, in association with *Chassalia curviflora* Thwaites, *Clidemia hirta* (L.) D. Don, *Ophiorrhiza pectinata* Arn., *Ophiorrhiza jacobii* Hareesh, Salish, G. Joseph & M. Sabu, among other species.

Phenology

Flowering and fruiting during May to September.

Conservation status

Ophiorrhiza meenachilensis is so far known only from two collections at the type locality, Vagamon Hills of Western Ghats, with an extent of occurrence estimated to be less than 10 km^2. Extensive field surveys are needed to assign appropriate threatened category of IUCN (2012), therefore it is classified as Data Deficient (DD) according to IUCN standards.

Notes

Ophiorrhiza meenachilarensis is similar to *O. eriantha* in its broad, elliptic, acuminate leaves, short, congested, more or less hairy, corymbose cyme, long, linear and persistent bracts and bracteoles and broadly infundibuliform corolla with spreading lobes. In addition to the diagnostic characters, the new species differs from the latter by its

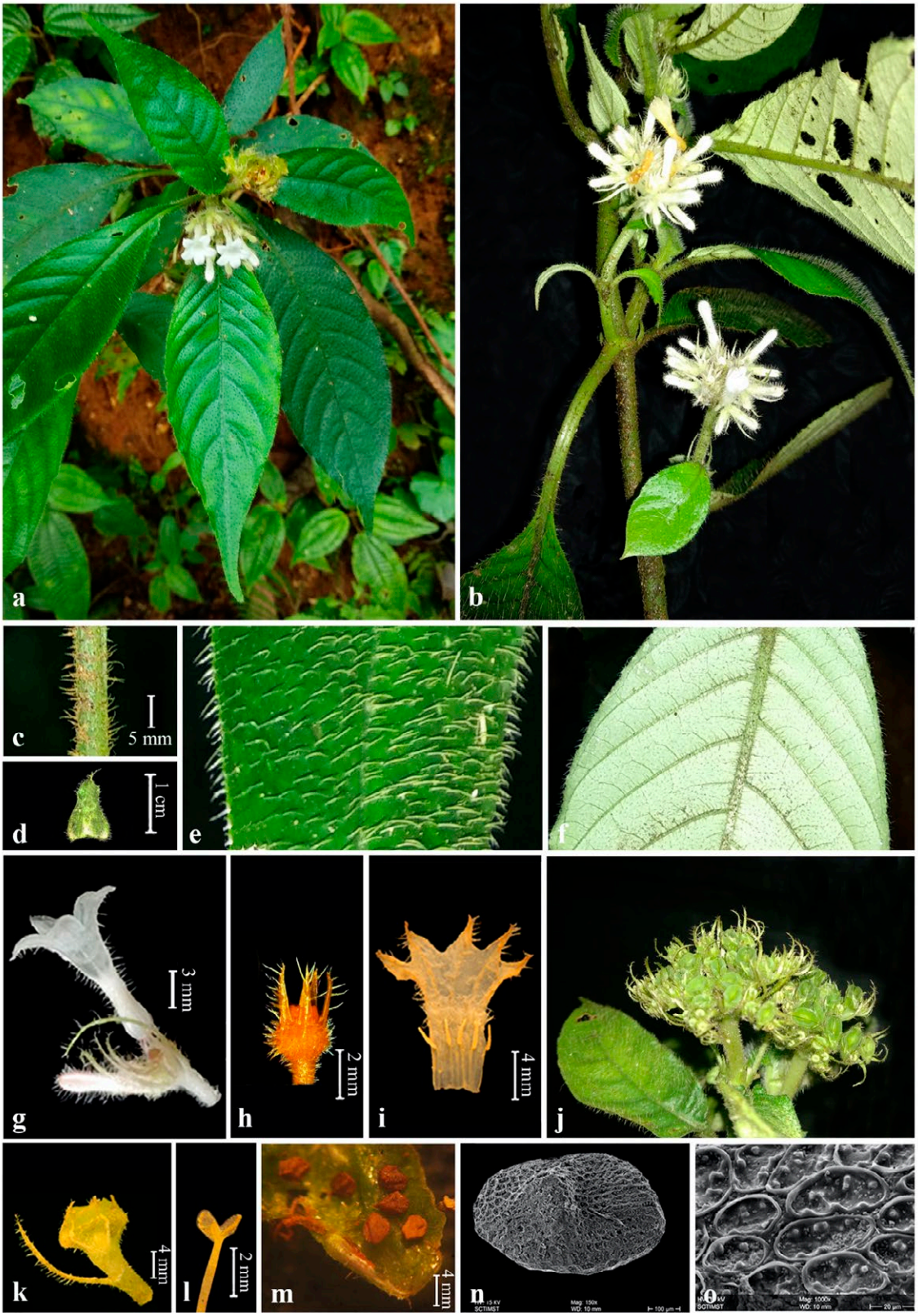

Figure 1. *Ophiorrhiza meenachilarensis* sp. nov. (a,b) Habit. (c) Stem. (d) Stipule. (e) Leaf: upper surface. (f) Leaf: Lower surface. (g) Flower. (h) Calyx. (i) Corolla split opened. (j) Infructescence. (k) Capsule. (l) Stigma. (m) Seeds. (n,o) SEM images of Seed.

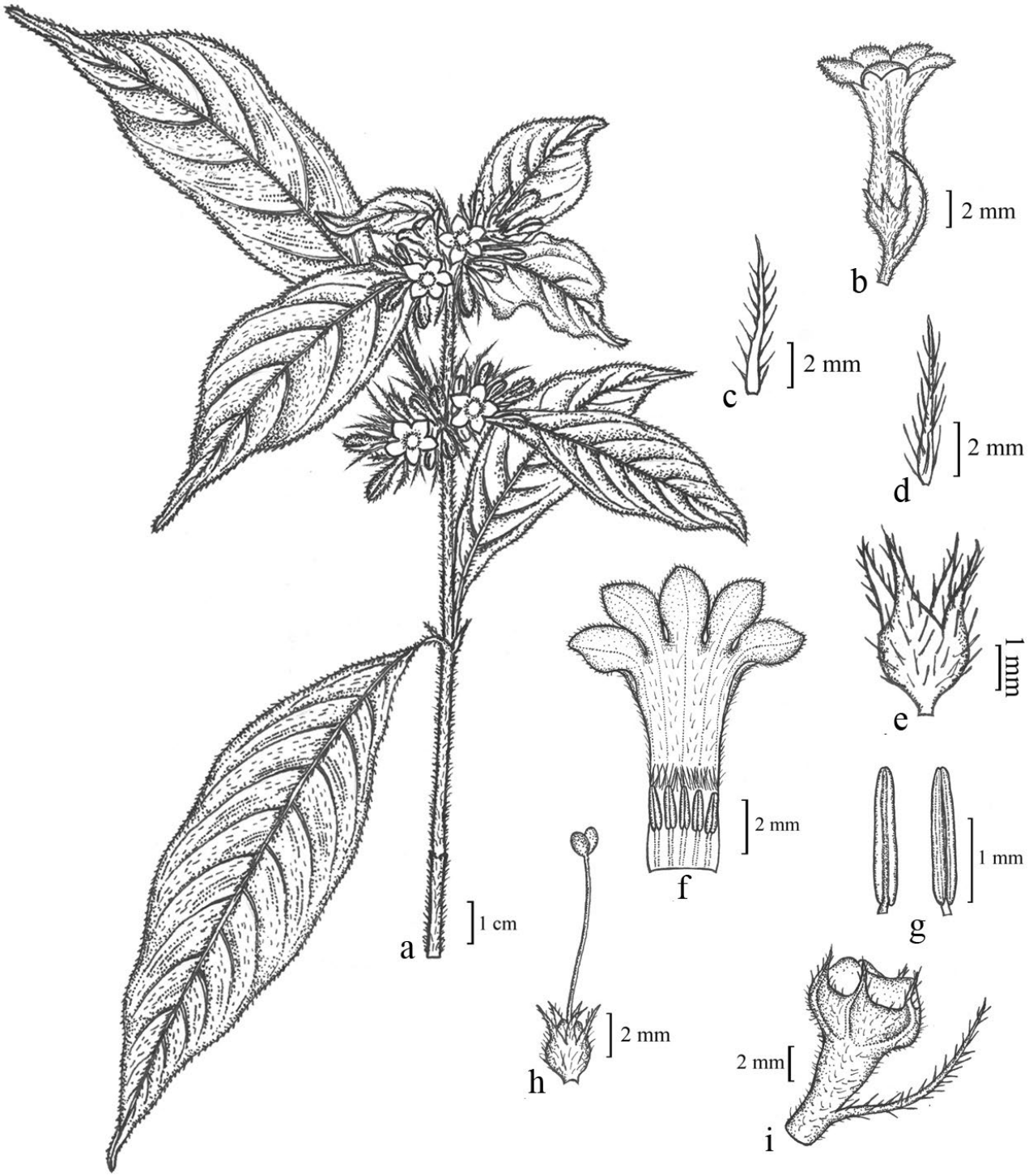

Figure 2. *Ophiorrhiza meenachilarensis*. sp. nov. (a) Habit. (b) Flower. (c) Bract. (d) Bracteole. (e) Calyx. (f) Split opened corolla. (g) Stamens. (h) Pistil. (i) Capsule. Drawn by Anoop P. Balan from *A.J. Robi & Anoop P. Balan 16881* (MBGH).

densely villous-hirsute stem (vs. pubescent-glabrous stem), ovate, acuminate, entire stipule (vs. lanceolate, bifid stipule), sparsely-densely pilose leaves with hirsute margins (vs. glabrous-puberulous leaves), up to 3 cm long peduncled cyme (vs. 4–5.5 cm long peduncled cyme), 1–1.2 cm long, unscented flowers (vs. 2.5–2.7 cm long, fragrant

Table 1. Morphological comparison of *Ophiorrhiza meenachilarensis*. with *O. eriantha.*

	O. meenachilarensis	*O. eriantha*
Habit	Herb, 30–45 cm tall	Subshrub, 45–90 cm tall
Stem	Densely villous-hirsute	Pubescent or glabrescent
Stipule	0.8–1.2 cm long, ovate, acuminate, entire at apex, bristly outside	0.5–1.5 cm, lanceolate, bifid at apex, puberulous-glabrous outside
Lamina	Obovate-elliptic, sparsely appressed pilose above, densely so beneath, margins hirsute	Elliptic-lanceolate, glabrous above, puberulous beneath
Peduncle	1.0–2 cm long at anthesis and 2–3 cm long at fruiting stage	0.3–4 cm long at anthesis and 4–5.5 cm long at fruiting stage
Flowers	1–1.2 cm long, unscented	2.5–2.7 cm long, fragrant
Bracts	0.6–0.8 cm long, bristly	10–17 mm long, pubescent
Bracteoles	0.6–0.8 cm long, bristly	6–10 mm long, pubescent
Hypanthium	Glabrous	Pubescent
Calyx lobes	Lanceolate, 2–2.5 mm long, bristly outside	Subulate, 1.5–2 mm long, pubescent outside
Corollas	White, hispid outside, appressed pubescent inside with a ring of hairs at the middle of the tube; tube 6–8 mm long	Pinkish-white, villous outside, glabrous inside without a ring of hairs; tube 16–22 mm long
Stamens	Inserted at the base of corolla tube; filaments 0.5–1.0 mm long; anthers 1.5–1.6 mm long	Inserted at the middle of the corolla tube; filaments 2–2.75 mm long; anthers 3–3.5 mm long
Style	As long as corolla tube	1/4th of the length of the corolla tube
Style branches	Ovate-orbicular, obtuse	Lanceolate, acute
Capsules	4–5 × 6–7 mm, hispid	2.5–3.25 × 7–8.5 mm, pubescent
Seeds	0.4 × 0.3 mm, irregularly angled; exotesta areolate and the wall of areole with tubercles	0.6 × 0.5 mm, 4–6 angled; exotesta areolate and the wall of the areole with branched projections

flowers), glabrous hypanthium (vs. pubescent hypanthium), lanceolate, bristly calyx lobes (vs. subulate, pubescent calyx lobes), ovate-orbicular stigmatic lobes (vs. lanceolate, acute lobes) and areoles of exotesta with tubercles (vs. areoles with branched projections). A morphological comparison of the two species is summarized in Table 1.

Additional specimens examined

INDIA, Kerala, Kottayam district, Vagamon Hills, ± 1000 m asl, 7 July 2018, *Anoop P. B. 16896* (MBGH!).

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Vochysia tepuiandina (Vochysiaceae), a new species from the sub Andean Cordillera forests

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Abstract. *Vochysia tepuiandina* is here described and illustrated. It occurs in southern Ecuador and northern Peru, and is associated with the disjunct "Andean Tepuis" forests found within the Andean piedmont and of the Amazonian forests. This species is placed in the *Vochysia* section *Ciliantha* subsection *Ferrugineae*. It is compared with the similar species *V. angustifolia* and *V. sprucei*.

Keywords: disjunt, diversity, *Vochysia* sect. Ferrugineae, Andean tepuis.

INTRODUCTION

The arboreal genus *Vochysia* Aubl. (Vochysiaceae) is widely distributed in Neotropical forests from Mexico to Paraguay, with more than 145 species, of which more than 60% is found in Amazon forests (Marcano-Berti 2013; Huamantupa-Chuquimaco 2017). Within *Vochysia* 4 sections are recognized: *Apopetala*, *Ciliantha*, *Pachyantha* and *Vochysiella* (Stafleu 1948; Marcano-Berti 2013), within the *Ciliantha* section, the *Ferrugineae* sub section is one of the most diverse with 29 species (Huamantupa-Chuquimaco 2017). The Amazon forests located at the Andean piedmont are recognized worldwide as diversity hotspots. They occur in several countries including Bolivia, Colombia, Ecuador and Peru (Myers et al. 2000). These areas integrate as well with sub-Andean mountain ranges where disjoint formations known as Andean Tepuis are found. These forests are associated mainly with white-sand soils, which has been hypothesized to be related to the Tepuis of the Guyana Shield (Neill et al. 2007). They are distributed mainly in Colombia, Ecuador and Peru. The ones located in Ecuador are part of the Cordillera del Kutuku whereas in Peru they distribute along the cordilleras del Cóndor, Escalera, Kampankis and Azul (Neill et al. 2012, 2014). These areas have been described as biologically rich and with high endemism (Neill et al.

2014; Huamantupa-Chuquimaco and Neill 2018). Is in this region where the new species *Vochysia* described in this document occurs.

MATERIALS AND METHODS

The specimens examined were collected as a product of different collaborative projects. These projects include botanical and ecological collections on the Andean and Amazon forests in Ecuador and Peru, such as the permanent plots monitored by RAINFOR, the Missouri Botanical Garden-Perú (MBG) and others. The fertile specimens were analyzed in the HOXA, MO, NY and USM herbaria (acronyms according to Thiers 2019).

The morphological terminology follows the specialized literature of Stafleu (1948) and Marcano-Berti (2014), complemented with specific terminologies from Payne (1978), Font Quer (1989), Beentje et al. (2001), Schmid et al. (2002), and Ellis et al. (2009).

The species conservation status was assessed using GeoCat software (http://geocat.kew.org; Bachman et al. 2011), following IUCN (2017) criteria. Species distribution maps were prepared with ArcGIS 10.2 (ESRI 2013 *Vochysia tepuiandina* Huamantupa).

TAXONOMIC TREATMENT

Vochysia tepuiandina Huamantupa, **sp. nov.** (Figures 1, 2).

Type: Ecuador, Zamora-Chinchipe, Yantzaza, Región de la Cordillera del Cóndor, Cuenca del Río Machinaza, Campamento las Peñas, Parcela 5, 03°46'S, 078°29'W – 03°45'S, 078°30'W, 1400–1840 m, 24 Nov. 2008 (fl.), *W. Quizhpe, F. Tello, B. Medina, W. Zeas & L. Andrade 3237* (holotype, QCNE!; isotype, MO!).

Diagnosis

This species has leaves with 11–15 secondary veins on each side of the midrib, leaf apex acuminate, cincinni 1–2 (generally 1), indumentum of sepals and petals tomentose, staminodes absent; it differs from *T. angustifolia*, which has 30–40 secondary veins on each side of midrib, obtuse or retuse leaf apex, 2–3 cincinni, and sepals and petals glabrous, and staminodes 0.5–1.0 cm long.

Description

Tree to 30 m tall. *Stem* sub terete, quadrangular, scabrous; young branches with distal internodes densely tomentulose, hairs dark brown. *Stipule* deltoid-triangular, 1.3–1.6 × 1.0–1.3 mm, tomentose. *Leaves* opposite; petioles 0.5–1.2 cm long, 1.5–2.3 mm diameter at base, subterete, slightly canaliculated, scabrous to densely villose in young leaves; blades lanceolate, oblong-elliptic, elliptic, 3.1–10.1 × 1.0–3.1 cm, acute at base; acuminate at apex; acumen 0.6–1.0 cm long; adaxial surface glabrous to sparsely scabrous, when present the sparcely hairs are more expressed on the veins; abaxial surface scabrous in old leaves, densely and minutely tomentose-villose in young leaves, hairs white-brown, ca. 0.15 mm long; coriaceous; venation pinnate; midvein impressed and conspicuous on the abaxial surface; secondary veins 8–15 on each side of midrib, impressed on adaxial surface and slightly prominent on the abaxial surface; tertiary veins slightly impressed on the adaxial surface and slightly prominent on the abaxial surface, brochidodromous. *Inflorescence* terminal, sometimes also axillary; thrysoid, 3–7 cm long, densiflorus, erect, main axis densely tomentulose, tomentose, with reddish brown hairs; a compound raceme with cincinni most frequently uniflorous, or 1–2-flowered; peduncles 4–7.1 mm, densely tomentulose. Pedicels 2.5–3 mm long, densely tomentose. *Flower* buds elongate, slightly recurved, navicular, 5–8 mm long, round at apex, densely pilose-tomentose; 1–2 bracteoles, subulate ca. 2.0–2.5 mm long, densely tomentose. *Flowers* orange-yellow, together with the spurred sepal 0.9–1.2 cm long, nearly straight to navicular; spur terete, straight no curved, apex rounded, 1–1.5 × 0.8-1.0 mm, forming an angle of 80–90˚ with the pedicel, densely tomentose; dorsal sepal 6–6.5 × 2.8-3.1 mm, outer surface densely tomentose, inner surface glabrous with the border ciliate; smaller sepals oblong-deltoid, 1.9–2.1 × 1.7–1.9 mm, outer surface densely tomentose, inner surface sparsely tomentulose; petals 3, unequal, oblong-lanceolate, oblong, the larger and central petal 2.5–3.5 × 1–1.7 mm, outer surface densely brown-reddish tomentose, more dense in the apex, hairs ca. 1.5 mm long; the 2 smaller petals with the same shape, 1.9–2.5 × 1.2–1.9 mm, outer surface scabrous, with some hairs in the base and middle vein, inner surface glabrous, border ciliate, hairs ca. 0.7-0.8 mm long. Stamens 6.5–7.1 mm long, straight to slightly curved; filaments 0.5–0.6 mm, sparsely ciliate-tomentulose in the base; anthers 5.5–6.5 mm long, conduplicate, slightly incurved to navicular, each side of the anther ± 0.8 mm long, ciliate-tomentulose, more dense in the borders, glabrous on the apex. Staminodes unknown. *Ovary* glabrous, 0.7–1.0 mm long; style 4.6–5.0 mm long; stigma terminal, slightly capitate-sagitate. *Fruit* unknown.

Etymology

The epithet "tepuiandina" is named after the habitat in the "Andean Tepuis" from the sub Andean cordilleras

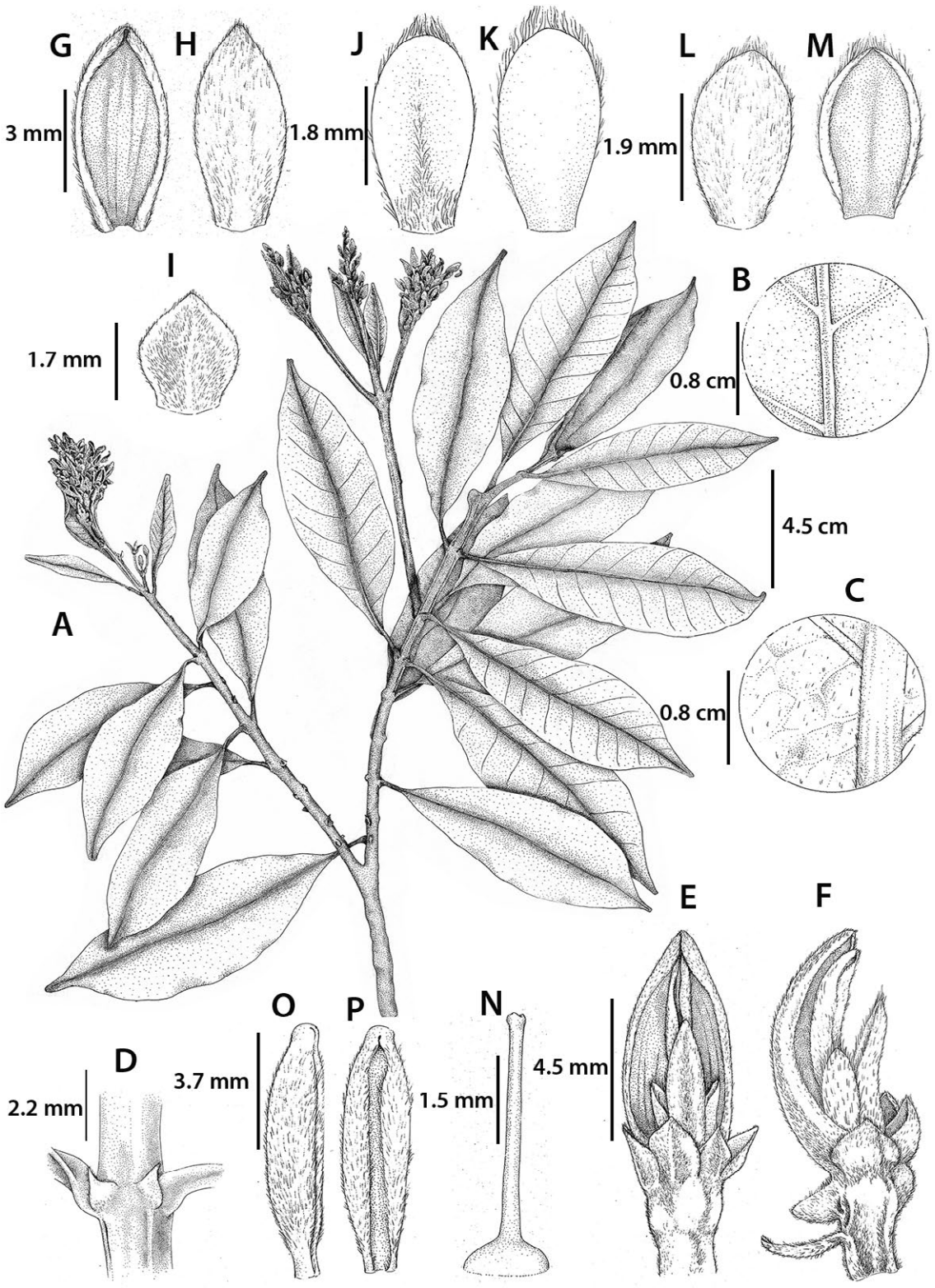

Figure 1. *Vochysia tepuiandina*. **A.** Habit with inflorescence, **B.** Leaf adaxial surface (close-up), **C.** Leaf abaxial surface (close-up), **D.** Stipule, **E.** Flower, front view, showing petals and sepals, **F.** Flower, lateral view. **G, H.** Dorsal sepal, internal and external surface, **I.** Smaller sepal, **J, K.** Large petal internal and external surface, **L, M.** Smaller petals, **N.** Ovary and style, **O.** Anther and **P.** Anther. Illustration by N. Sánchez, from *W. Quizhpe & al. 3237*.

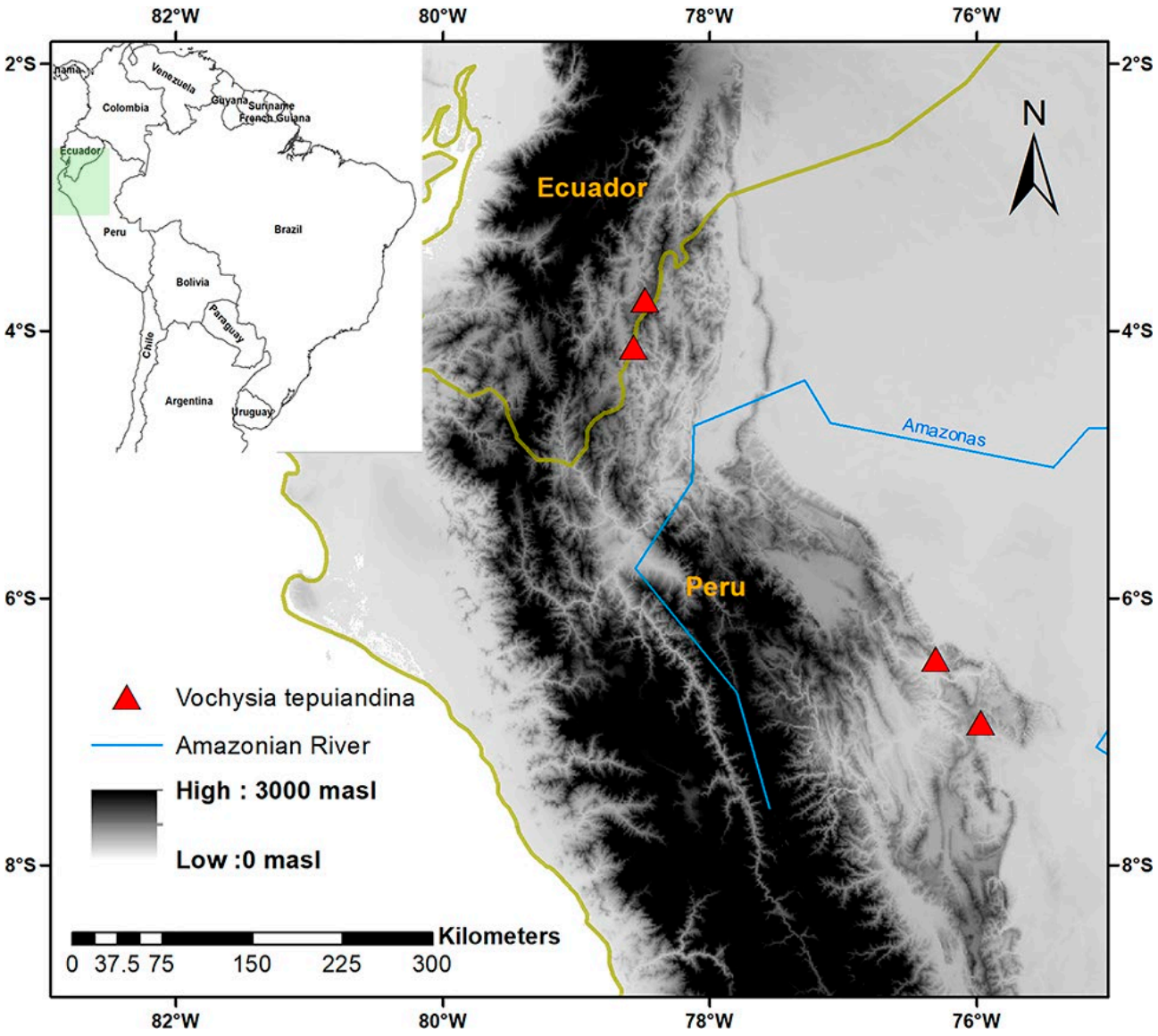

Figure 2. Geographic distribution of *Vochysia tepuiandina* (▲) in the sub Andean mountains (Andean tepuis) in Ecuador and Peru.

preferred by this species. These habitats have quarzitic stone formations similar to the Tepuis of the Guiana Shield, distributed along mountain ranges between the north-central of Peru to southern Ecuador.

Distribution and ecology

Vochysia tepuiandina is known from the "Andean Tepuis" group of disjunct mountains associated to sandy outcrops related to Guiana Shield Tepuis ranging from Venezuela and Guyana, in Ecuador and Peru, This mountain region is distributed and interconnected from the southern of Ecuador to northern Peru, belonging to what is known as Cordillera del Condor, then continues to Cordillera Azul and Cerro Escalera in Loreto and San Martin region in the northern Peru. The altitudes range between 1240 and 1840 m above sea level.

Phenology

Flowering specimens were collected between October and December.

Conservation status

Vochysia tepuiandina is only known from the Cordillera del Cóndor, Cordillera Azul and Cordillera Escalera and in the surroundings of these areas, a region

Table 1. Characters separating *Vochysia tepuiandina* from *V. angustifolia* and *V. sprucei.*

Character	*V. tepuiandina*	*V. angustifolia*	*V. sprucei*
Number of secondary veins on each side of midrib	11–15	30–40	16–24
Indumentum on leaf abaxial surface	glabrous	glabrous	sparcely stiff-ferrugineous, with brown-orange puberulence
Leaf apex	acuminate	obtuse, retuse	obtuse
Inflorescence length	3–7 cm	8–14 cm	7–12 cm
Number flowers in cincinni	1(–2)	2–3	2–3
Sepals indumentum	tomentose	glabrous	glabrous
Spur shape and dimensions	globose, 1.0–1.5 × 0.8–1 mm	elongated, 6.0–8.0 × 1–1.2 mm	elongated, 5.0–6.0 × 1.0–1.2 mm
Petal indumentum in the outer surface	tomentose	glabrous	glabrous
Staminodes	absent	0.5–1.0 cm long	1.0–1.5 cm long

that is part of southern Ecuador and continuing to northern Peru. Based on the IUCN (2017) criteria and it geographic distribution, which was calculated using the Geocat Software (2017), the extent of occurrence (EOO) of *V. tepuiandina* is 7,966 km² and its area of occupancy is 16 km², therefore this species, according to IUCN (2017) standards is classified as Endangered (EN).

Remarks

Vochysia tepuiandina belongs to *Vochysia* sect. *Ciliantha* subsect. *ferrugineae*. All the species of this group are characterized principally by brown stems and bark, sometimes exfoliating, stipules always present, leaves in whorls or opposite, young branches and leaves ferruginous-pilose on the abaxial face, inflorescences terminal and sometimes axillary, flowers with 3 petals, rarely one, petals and stamen pilose-ciliate along the margins and base, style and glabrous ovary (Stafleu 1948). Therefore, *Vochysia tepuiandina* can be differentiated from *V. angustifolia* Ducke (1932). The latter species is a medium-sized tree, to 15 m tall, with lanceolate stipules, leaf blades with more of 30 secondary veins on each side of midrib, clearly glabrous on the abaxial surface, cincinni with 2-3 flowes, and sepal and petals are glabrous; and is commonly restricted to seasonally inundated forests, river banks in the Rio Negro and Amazonas basin. On the other hand, *Vochysia tepuiandina* is markedly a large tree up to 30 m tall, with leaf blades with less than 15 secondary veins on each side of midrib, cincinni with 1-2 flowers, and sepals and petals densely tomentose. It is more commonly distributed in montane forests associated to poor sandy soils. Another similar specie is *Vochysia sprucei* Warming (1875), which is described from the Cerro Pelado mountains in Tarapoto province, relatively close to Cerro Escalera, Peru; it differs from *T. tepuiandina* by the leaves that are sparsely stiff-ferruginous and with brown-orange puberulence on the abaxial surface, with more of 16 secondary veins on each side of midrib, obtuse at apex, sepals and petals glabrous, and presence of staminodes. A comparison of morphological characters of these three species is presented in Table 1.

Specimens Examined

ECUADOR: Zamora-Chinchipe: Yantzaza. 03°46'S, 78°29'W, 1400–1840 m, 12 Oct. 2008, *W. Quizhpe & al. 3142* (QCNE, MO); Nangaritza, Faldas de la Cordillera del Cóndor. 04°07'S 078°34'W, 1600–1680 m, 5 Dec. 1990, *W. A. Palacios & D. A. Neill 6535* (QCNE, MO). **PERÚ**: Loreto: Ucayali, Pampa Hermosa. Parque Nacional Cordillera Azul, 6°55'41.80"S 75°57'56.20"W, 1497 m, 26 Mar. 2018, *Y. Soto & al. 1159* (HOXA). San Martín: Tarapoto, Cordillera Escalera, Bosque de tierra firme, 6°27'7.54"S, 76°18'0.49"W, 1256 m, 6 Feb. 2017, *H. Flores, & H. Vásquez 1352* (HH).

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V. tepuiandina. Special thanks go to Roosevelt García by the review the manuscript and the English text.

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Tachigali inca (Caesalpinioideae – Leguminosae), a new species of giant tree from Amazonian forests

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Abstract. The new species *Tachigali inca* is described and illustrated. It grows in lowland 'terra firme' forest of Amazonian Brazil, in the sub-Andean Amazon region of Peru, and in northeastern Bolivia. The species differs markedly from its most closely related species (*T. amarumayu, T. prancei* and *T. setifera*, all belonging to the "setifera group"), by the large cylindrical domatia on the leaf rachis, and by the brown-orange pulverulent indumentum on the abaxial surface of the leaflets and the young twigs; on older branches the indumentum becomes darker, degrades and then breaks off. It also differs by its linear petals with the upper half densely tomentose, the hairs forming small tufts.

Keywords: Amazon region, ant domatia, Fabaceae, taxonomy.

INTRODUCTION

Tachigali Aubl. is a neotropical genus of leguminous trees widely distributed from the south of Mexico to southern Brazil and Bolivia. It is a member of subfamily Caesalpinioideae (LPWG 2017). *Tachigali* contains an estimated 75 species and is most speciose and morphologically diverse in the Amazon forest (Dwyer 1954, 1957a, 1957b; van der Werff 2008), with approximately 60 species (Huamantupa-Chuquimaco et al. 2019; van der Werff 2013).

Tachigali was first described by Aublet (1775), since then until recent years with several studies and others recently has been discovering up to an estimate of about 90 species, with more than 75% found in the Amazon region (Huamantupa-Chuquimaco et al. 2019; Huamantupa-Chuquimaco et al., unpubl. data). *Tachigali* is among the tree genera with the widest distri-

bution in the Amazon region, for example *T. paniculata* and *T. vaupesiana* are recognized as hyperdominant tree species (ter Steege et al. 2013, 2019). The Amazon region below the foothills of the eastern slopes of the Andes (Eva et al. 2005) is considered as a global biodiversity hotspot (Myers et al. 2000), and here the diversity of *Tachigali* is high. For example, the Amazonian forest of Cusco in southern Peru is home to 12 species of the genus (Huamantupa-Chuquimaco et al. 2016).

Tachigali also presents several specimens collected and monitored in permanent tree plots (Baker et al. 2014), however when they are collected without flowers or fruits they are difficult to identify, for example in RAINFOR plots in Peru they can only be determined up to a just over 50% (Baker et al. 2017). Recently, emphasis has been given to studying species complexes within *Tachigali*. One of these is the informal group "setifera" group comprising three species: *T. amarumayu, T. prancei*, and *T. setifera*, which has the shared morphological characteristics of the linear petals with an apical tuft of tomentose hairs and the abaxial surface of the leaflets with radially grouped hairs forming circles (Huamantupa-Chuquimaco et al. 2019). The group is supported in a preliminary molecular analysis which also reveals several undescribed species (Huamantupa-Chuquimaco et al., unpubl. data).

Here we describe a new species of *Tachigali* related to the "setifera group" from the Amazon forests of Bolivia, Brazil, and Peru.

MATERIALS AND METHODS

We conducted fieldwork at a number of localities in 'terra firme' forest of the Amazon region of Bolivia, Brazil, and Peru. In addition, we examined specimens in the following herbaria: Bolivia (LPB, USZ), Brazil (CEN, IAN, MG, RB, RON, UB), Peru (AMAZ, CUZ, MOL, SUMPA, USM), and the USA (F, MO, NY), (acronyms according to Thiers et al. 2019).

The morphological terminology follows the specialized Leguminosae literature, including Polhill & Raven (1981), van der Werff (2008), and LPWG (2017). Indumentum terminology follows Font-Quer (1989), Beentje et al. (2001), and Schmid et al. (2002), complemented by Ellis et al. (2009), Payne (1978), and Theobald et al. (1979). The conservation status was assessed using GeoCat software (http://geocat.kew.org; Bachman et al. 2011), following IUCN (2019) criteria. The Amazon region was delimited using the proposal of Eva et al. (2005), And the species distribution map was prepared using ArcGIS 10.2 (ESRI 2013).

Tachigali inca Huamantupa, H.C. Lima & D. B.O.S. Cardoso, **sp. nov.** (Figures 1-3).

Type: Peru. Cusco: La Convención, Echarati, Bajo Urubamba, Comunidad nativa Camana. 11°59'16.39"S, 73°7'44.66"W, 466 m, 01 May. 2014 (fl.), *I. Huamantupa, W. Candia & J. Condori, 17675* (holotype, CUZ!; isotypes, USM!, MOL!, RB!).

Diagnosis

Tachigali inca differs from the most closely related species *T. amarumayu*, *T. prancei*, and *T. setifera* by having trunk fenestrate (vs. not in the others three), brown-orange pulverulent indumentum with some black dots, and in mature leaflets the indumentum having turned black on the abaxial surface of the leaflets (vs. the radially grouped hairs forming circles indumentum, on the abaxial surface of the leaflets), and the cylindrical, slightly ribbed laterally domatia immersed in the leaf rachis and on part of the petiole (vs. domatia absent).

Description

Tree to 40 m tall; trunk right fenestrate, slightly canaliculated, cortex red, with cream colored wood; buttress roots 50–90 cm long; twigs terete to sub-terete, smooth, slightly sulcate, glabrous or black pulverulence. *Stipules* foliose; 2(–3) lobate, persistent, but on old branches fugacious, petiole 4.0–8.0 mm long, blade oblong, ovate, obovate, or cordate, slightly revolute, major lobe 1.2–2.1 × 1.5–2.5 cm, minor lobe 0.7–1.5 × 0.6–1.8 cm, 3–6 pairs of veins, glabrous with brown–orange pulverulence. *Leaves* 18–32 cm (–48 cm, on juvenile specimens); petiole 4.5–11.0 cm long, terete, ribbed, puberulous and black punctate, with domatia; rachis 12.0–35.0 cm long, terete to semi-terete, canaliculate, with black appressed pilosule of minute hairs. *Domatia* 6.5–12.0 cm long, on young leaves 10.0–20.0 cm long, 0.5–1.5 cm diameter, cylindrical, slightly bulging in the central part, commonly laterally ribbed, placed from below the first basal pair of leaflets on the petiole then along the leaf rachis. *Leaflets* in 4–7 pairs; petiolules 4.0–10.5 mm long, terete, minutely to sparsely tomentulose; leaflet blade 6–31 × 8–11.5 cm, lanceolate, oblong-lanceolate, or elliptic; coriaceous; base symmetrical, slightly rounded to cuneate, apex 0.8–1.7 cm long, acuminate and caudate; margin entire; slightly undulate; adaxial surface glabrous, lustrous or scabrous on the central vein; abaxial surface brown-orange pulverulent, with sparse, stiff ferruginous hairs on the veins and some black gland dots on the mature leaflets; in old leaflets the pulverulence turns black, degrades and then breaks off; secondary veins in 8–15 (–21, in young

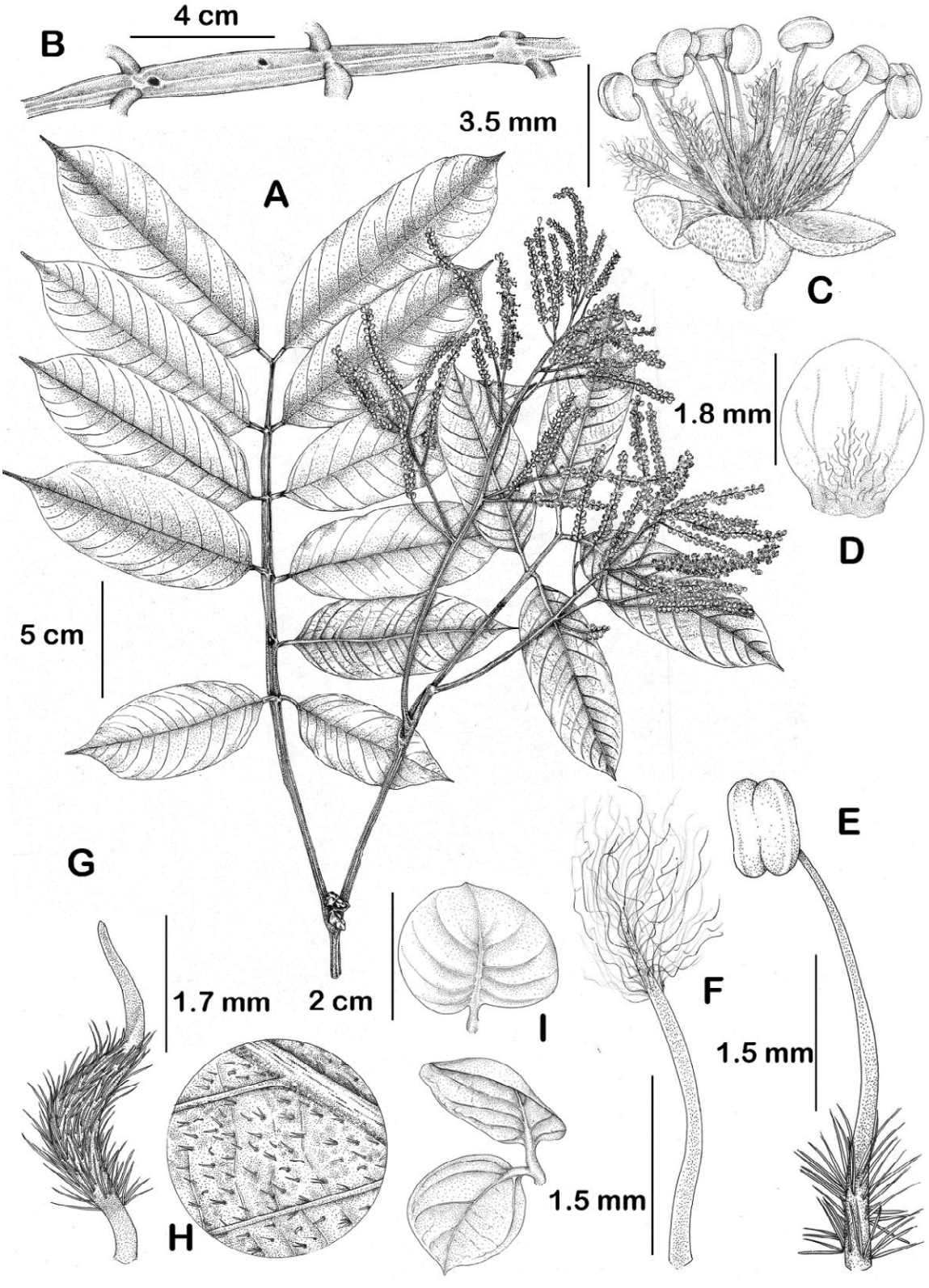

Figure 1. *Tachigali inca*, **A.** Flowering branchlet, **B.** Domatia on leaf rachis, **C.** Flower, **D.** Sepal (inner surface), **E.** Stamen, **F**. Petal, **G.** Gynoecium (ovary, style, stipe), **H.** Hairs on the abaxial surface of a leaflet, **I.** Foliose stipule (adaxial and abaxial surfaces). Line drawing by S. Sans from the specimen *Huamantupa et al. 17675*.

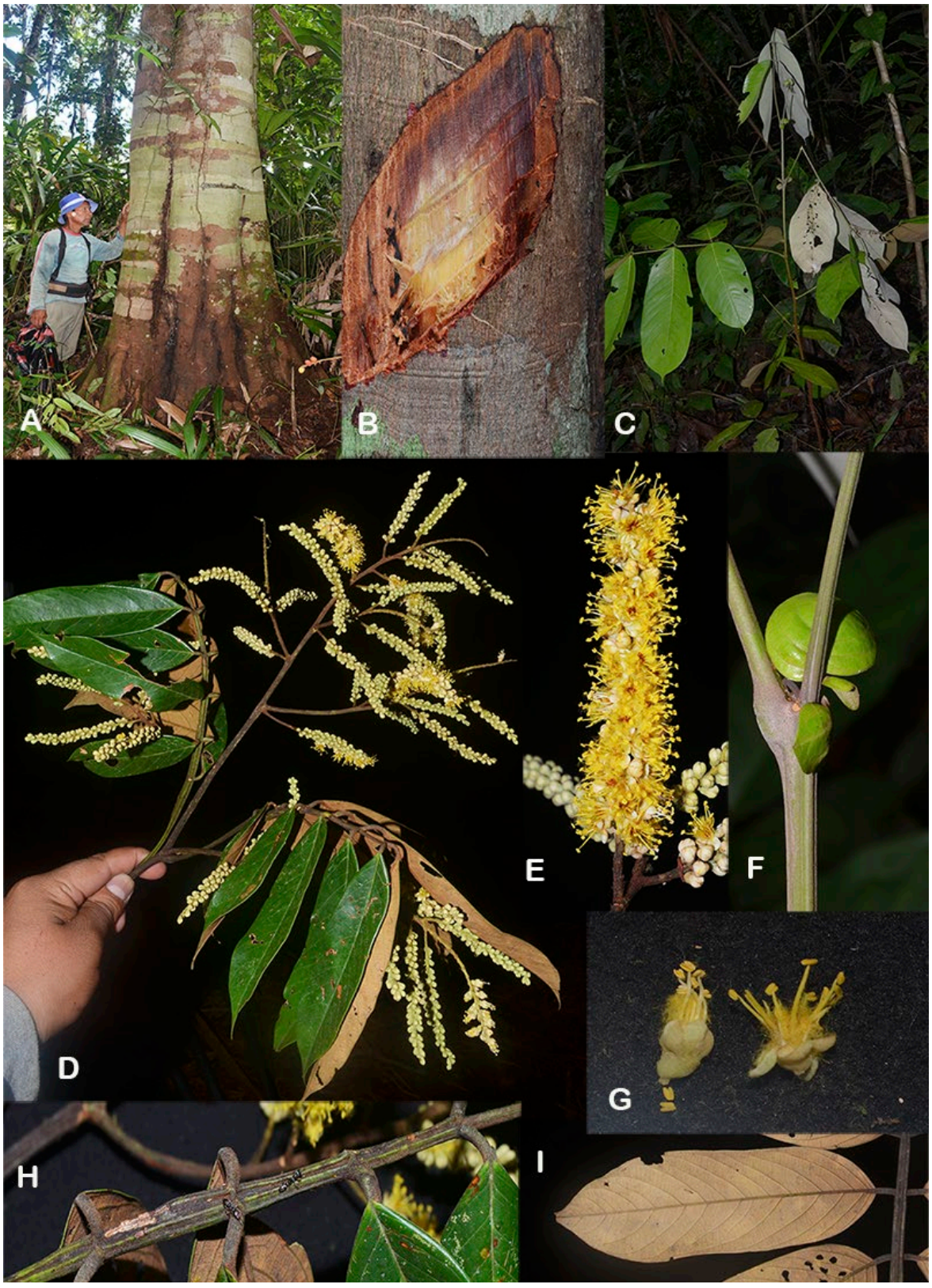

Figure 2. *Tachigali inca*, **A.** Trunk, **B.** Cortex, **C.** Seedling, **D.** Flowering branchlet**, E.** Part inflorescence, **F**. Stipule, **G.** Flowers, **H.** Domatia, **I.** Pulverulent indumentum on the under surface of a leaflet. Photographs by the first author based on the specimen *Huamantupa et al. 20310.*

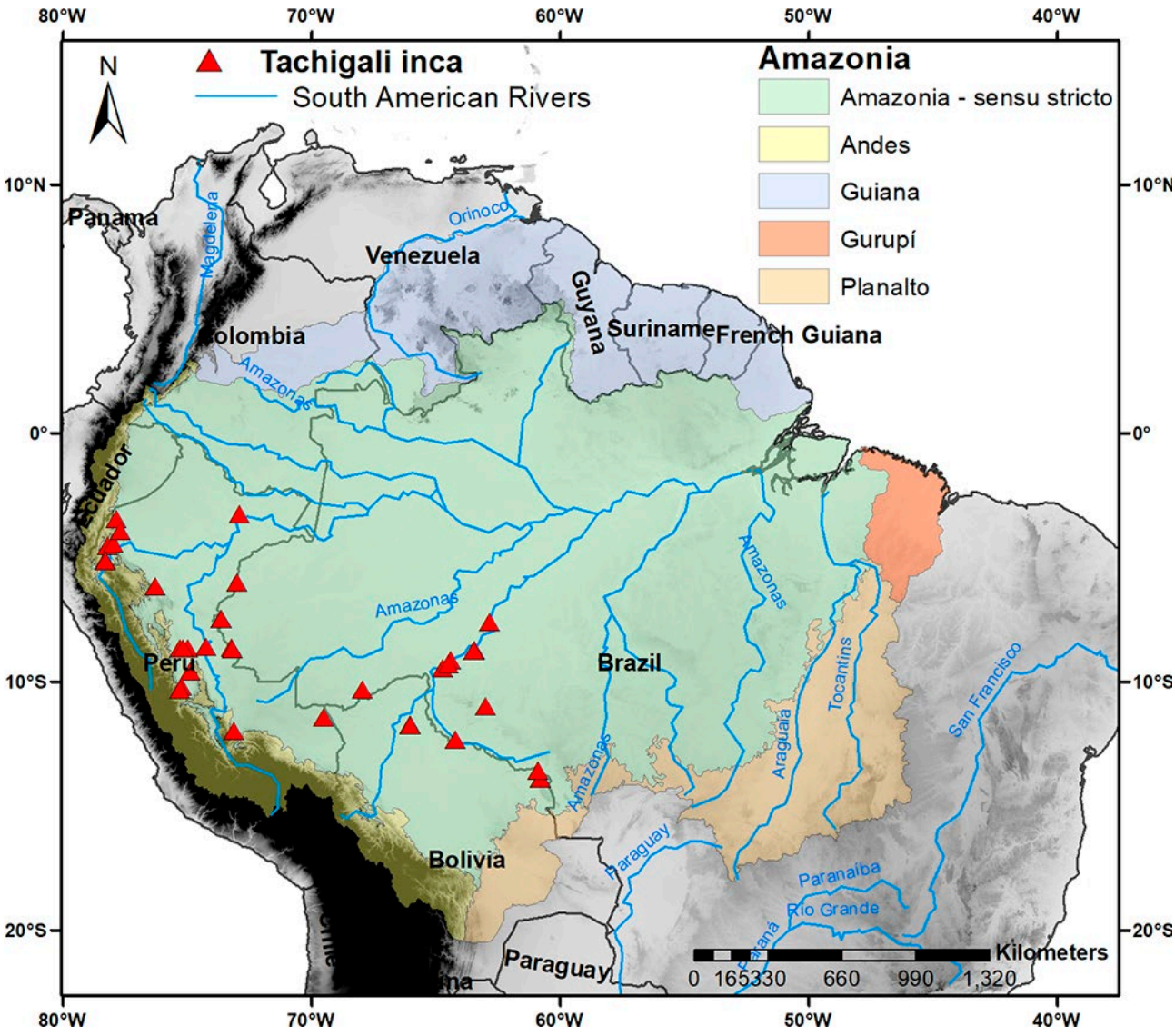

Figure 3. Distribution of *Tachigali inca* in terra firme forest of Amazonian region.

leaflets) pairs, impressed on the upper surface, conspicuous and arcuate; tertiary veins on the abaxial surface slightly conspicuous, scalariform; quaternary veins on the abaxial surface inconspicuous. *Inflorescence* panicle 18–28 cm long, main axis terete, ribbed, minutely brown-tomentulose; bracts not seen. *Flower* 6–7 mm long; buds densely white sericeous; sessile or pedicel up to 0.5 mm long; bracteoles 5.0–6.5 × 1.0–1.3 mm, subulate, sparsely tomentose, early caducous; hypanthium 1.7–2.0 × 1.6–1.9 mm, cupular, slightly symmetrical, densely white sericeous; sepals 2.3–2.7 × 1.8–2.4 mm, oblong or oblong–elliptic, inner surface sparsely tomentose with yellow hairs (0.5–0.8 mm long), more dense in the middle, outer surface densely white villose, margin ciliate; petals 2.9–3.2 × 0.2–0.3 mm yellow-orange, linear, glabrous from the base to the middle and the upper half densely tomentose forming tufts (hairs 2–2.5 mm long); stamens 10, monomorphic, filaments slightly variable, 4.0–5.0 mm long, densely tomentose with stiff brown hairs from the base to the middle; anthers 1.0–1.3 × 0.6–0.8 mm, elliptic, glabrous; ovary 1.8–2.0 × 1.0–1.4 mm, oblong, slightly gibbous, sparsely pubescent, with stiff red-brown hairs; stipe 1.0–1.5 mm long, attached in middle of hypanthium; style 1.5–1.8 mm long, glabrous, sigmoid; stigma apiculate. *Fruit* 5.0–7.5 × 1.8–2.5 cm, crypto-samara, ellipsoid, exocarp black, glabrous. *Seeds* 1–2 per fruit.

Etymology

The epithet "inca" is named in honor to the Inca culture, who inhabited a large part of the Amazon at the base of the eastern Andes and part of central-southern Amazon, in which *Tachigali inca* is distributed.

Distribution and ecology

Tachigali inca is well distributed in Amazonian terra firme forest region, especially along the Andean foothills of Peru at a maximum of 700 meters elevation, and part of central-southern Amazon, into the north-west of Bolivia, and extending to the low Amazon of western Brazil in the states of Acre, Amazonas, Mato grosso and Rondônia (Fig. 3). *Tachigali inca* inhabits forests associated with clay soils and white sands.

Phenology

Collected in flower from January to May, in fruit from May to November. During flowering the entire tree crown is yellow and attracts many pollinators, including bees and butterflies.

Conservation status

Based on the extent of occurrence estimated at 1,024,042.723 km^2, the Conservation status of *T. inca* is provisionally assessed as being of Least Concern (LC). However, in some areas such as central Amazonian of Peru, the white sand forests where it lives are threatened by the oil palm crops that are being implemented in recent years.

Common names and uses

Tachigali inca species are known in Brazil as 'tachi' or 'taxi' (meaning ant), as mentioned on the field label of *Campbell 6419* collection. In Peru, common names of *T. inca* include 'tangarana', and 'palisanto' (*Gutierrez 43*) and 'ucshaquiro colorado' (*Begazo 111*). These three names refer to the presence of ants with strong formic acid that live in the domatias. The hard wood and straight trunk is ideal for local construction timber (Huamantupa-Chuquimaco et al. 2016).

Remarks

Tachigali inca differs from other species in the "setifera group" (*T. amarumayu*, *T. prancei* and *T. setifera*), mainly by its trunk being irregularly fenestrate; the abaxial surface of leaflets with a brown-orange pulverulent indumentum, which on old leaflets gradually degrades and detaches until the surface becomes a dark color (this characteristic has not been seen in any other species of the genus); and the cylindrical, slightly ribbed domatia immersed in the leaf rachis and on part of petiole (Fig. 2, Table 1), a type of domatia that is unknown in all other species of *Tachigali*. The other three species of the "setifera group" do not have a fenestrate trunk, their leaflets abaxial surfaces have sparsely or densely radiate clusters of hairs, with some additional free ferruginous hairs on the veins, and they all lack domatia. *Tachigali amarumayu* also has leaflets in 5–11 (often 8) pairs, and secondary veins on each leaflet in 11–23 pairs (Huamantupa-Chuquimaco et al. 2019). *Tachigali prancei* shares stamens and petals of a similar type with *T. inca* (table 1). Additional comparison between the four species is presented in Table 1.

Previously van der Werff (2008) considered some specimens of *T. inca* to belong within *T. setifera* sensu lato, by the similar leaflets shape and petals indumentum. Historically, other taxonomists have treated the majority of the specimens of *T. inca* as either *T. amarumayu, T. setifera* or *T. vasquezii* (Baker et al. 2017).

In a recent phylogenetic analysis, the "setifera group" is supported as distinct from all other *Tachigali* species and is geographically associated with species from the Amazon region of the eastern Andean foothills (Huamantupa-Chuquimaco et al., unpubl. data).

Additional Specimens Examined

BOLIVIA: Beni: Vaca Diez, *B. K. Boom 4431* (LPB, NY), *B. M. Boom 4393* (MO), *B. M. Boom 4394* (MO). Santa Cruz: Velasco, *P. L. Arroyo 644* (MO, USZ), *P. L. Arroyo 672* (MO, USZ), *C. A. F. Fuentes 1698* (USZ), *A. Soto 519* (MO, USZ); **BRAZIL**: Acre: Mâncio Lima, *D. G. Campbell 6419* (MO), *D. G. Campbell 8283* (MO), *D. G. Campbell 8312* (BR, NY), *D. G. Campbell 8346* (MO), *D. G. Campbell 8369* (MO), *D. G. Campbell 8370* (MO), *D. G. Campbell 8376* (MO), *D. G. Campbell 8450* (MO), *C. A. Ferreira 8736* (HUFAC, MO, NY). Amazonas: *B. Rosa 44-85* (MO); Novo Aripuanã, *C. A. Cid Ferreira 5925* (INPA, MG, NY, RB). Mato Grosso: Aripuanã, *N. A. Rosa 2074* (F, NY, RB). Rondônia: Porto Velho, *M.R. Cordeiro 620* (IAN, MG, MO, NY), *G. T. Prance 6435* (NY); Costa Marques, Porto Velho, *C. A. Cid Ferreira 7453* (MO, NY), *M. F. Simon 1422* (CEN, IAN, INPA, NY, RB, RON), *M. F. Simon et al. 1275* (CEN, IAN, RB, RON); Vilhena, *J.U.M. dos Santos 765* (MG); **PERU**: Amazonas: Bagua, *S. C. Díaz 8326* (AMAZ), *S. C. Díaz 8430* (MO); Condorcanqui, *A. E. Ancuash, 275* (MO), *V. Huashikat 514* (MO), *V. Huashikat 654* (MO), *G. R. P. Rojas 97* (MO). Loreto: Maynas, *A. H. Gentry 18691* (AMAZ, MO), *R. C. Grández 2997* (MO). Cusco: Paucartambo, Kosñipata, Chontachaca, *I. Huamantupa 23120* (CUZ). Madre de Dios: *C. J. Ruiz 27* (MO, MOL). Pasco: Oxapampa, *R. B. Foster 7985* (MO), *A. H. Gentry 41578*

Table 1. Characters separating *Tachigali inca* from the morphologically related *T. amarumayu, T. prancei*, and *T. setifera.*

Character	*Tachigali inca*	*Tachigali amarumayu*	*Tachigali prancei*	*Tachigali setifera*
Leaflet number (pairs)	(2–) 4–7	5–11	6–8	5–7
Indumentum type on lower surface of the leaflets	sparsely stiff ferrugineous hairs on the veins, some black gland dots, and with brown-orange pulverulence.	radially grouped hairs forming circles, without pulverulence	radially grouped hairs forming circles, without pulverulence	radially grouped hairs forming circles, without pulverulence
Leaflet base	equilateral, slightly rounded, or cuneate	equilateral, rounded, acute, or subcordate	inequilateral, rounded, to sub-cordate	equilateral, acute
Tertiary vein prominence abaxially	inconspicuously raised	conspicuously raised	conspicuously raised	inconspicuously raised
Quaternary vein prominence abaxially	inconspicuous	conspicuously raised	conspicuously raised	inconspicuously raised
Stipules	foliose, slightly revolute, persistent, on old branches caducous, 2– (3) lobed	foliose, regularly revolute, persistent	foliose, caducous on old branches	foliose, revolute, persistent
Domatia in the leaf rachis and petiole	cylindrical, slightly ribbed laterally, immersed in the rachis and part of petiole.	absent	absent	absent
Pedicel length	sessile–0.5 mm	sessile–0.5 mm	0.5–2.0 mm	0.5–1.0 mm
Petal indumentum	glabrous from base to middle and densely yellow tomentose in tufts on the upper half	sparse except for a tuft of cream–colored flexuous hairs at the apex	sparse except for a tuft of cream–colored flexuous hairs at the apex	dense, yellow
Length of the hairs on the petals	1.5–2.0 mm	ca. 0.8–1.1 mm	ca. 0.7–0.9 mm	ca. 0.6–0.7 mm

(MO). San Martín: Lamas, *I. Huamantupa et al. 20253* (CUZ, SUMPA), *I. Huamantupa et al. 20310* (CUZ). Ucayali: *G. S. Hartshorn 1739* (MO), *S. L Wherrem 81* (MO); Coronel Portillo, *Aquino 2* (MO), *N. Begazo 111* (MO), *N. Begazo 129* (MO), *A. H. Gentry 29425* (MO).

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A new orange-fruited species of *Monstera* (Araceae: Monsteroideae) from Panama

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Abstract. *Monstera alcirana,* endemic to Panamá, is described and illustrated using a color plate based on photographs of the vegetative and reproductive structures of living material. This species is the fourth of the very small species of *Monstera* in Central America. It is morphologically similar to *M. obliqua*, *M. minima* and *M. gambensis* but differs by has short internodes, thickly coriaceous blade and peduncle longer than the length of the leaf.

Keywords: Aroids, Central America, *Monstera obliqua*, Panamanian flora.

INTRODUCTION

Monstera, a climbing aroid genus best known for its often perforated leaf blades, remains rather poorly understood in the Neotropics as a whole, though progress has recently been made for Mexico and Central America (Grayum 2003; Cedeño-Fonseca 2019; Cedeño-Fonseca et al. 2018, 2020a, 2020b), including the recent publication of several new species in the region: *Monstera anomala* Zuluaga & Croat, *M. integrifolia* Zuluaga & Croat, *M. limitaris* M. Cedeño, *M. guzmanjacobiae* Díaz Jim., M. Cedeño, Zuluaga & Aguilar-Rodr., *M. croatii* M. Cedeño & A. Hay and *M. gambensis* M. Cedeño & M.A. Blanco (Cedeño-Fonseca et al. 2018; Zuluaga & Cameron 2018; Cedeño et al. 2020b; Díaz-Jiménez et al. 2020). Costa Rica and Panama are the centre of diversity of the genus, principally in the Talamanca mountain range below 2300 m elevation (Madison 1977; Cedeño-Fonseca et al. 2020a), and particularly the Caribbean slope.

Hitherto, *Monstera obliqua* Miq., was the only known species in Costa Rica and Panama with an orange fruiting spadix (Madison 1977; Grayum 2003; Cedeño-Fonseca 2019). This species is most common from the south of Panama, mainly in the Chocó biogeographic region, and throughout the

Amazon basin, where orange spadix is more frequent in the genus (Madison 1977). Other species with orange fruiting spadix are *Monstera praetermissa* E.G. Gonç. & Temponi, endemic to Bahia, Brazil (Gonçalves & Temponi 2004), and *Monstera xanthospatha* Madison endemic to the Cordillera Occidental and the Cordillera Central of the Andes in Colombia (Madison 1977). *Monstera obliqua* itself appears to be a large and variable species complex with orange fruiting spadices. Most probably some populations of *M. obliqua* in the Amazonian basin might be resolved as separate species with further research.

Here we describe and illustrate a new species endemic from Panama with an orange fruiting spadix, and we include an extensive documentation of the populations of *M. obliqua* in Costa Rica and Panama.

TAXONOMIC TREATMENT

Monstera alcirana Croat, M. Cedeño, Zuluaga & O. Ortiz **sp. nov.**

Type: Panamá. Coclé: along ridge of Cerro Gaital, N slopes of mountains near La Mesa, N of El Valle; 28 April 1982, 8°40'N, 80°7'W, 800–900 m, *Knapp & Dressler 4880* (holotype, MO; isotypes, K, PMA, US).

Diagnosis

Monstera alcirana is recognised by its small, entire, thickly coriaceous leaves lacking fenestrations, petioles with deciduous sheath, primary lateral veins arising from the midrib at 35–45°, peduncle longer than the leaf, spathe creamy yellow on both surfaces, and the orange spadix when the fruits are ripe.

Description

Nomadic vine with appressed-climbing habit. Seedlings: foliose. Juvenile plants: **stems** smooth, terete, dark-green; **internodes** 1.5–2.5 cm long, 4–6 mm diam.; **petiole** conspicuous, light green, smooth, 4–9 cm long, sheathing to the base of the blade; **petiole sheath** slightly persistent or completely deciduous; **blades** oblong-elliptic to lanceolate, attenuate at the base, coriaceous, 3–6 × 3–4 cm, not appressed to the phorophyte; **fenestrations** absent. Adult plants: **stems** dark green, smooth, terete or slightly flattened; **internodes** 0.5–3 cm long, 5–10 mm diam.; **anchor roots** black and corky, with black root hairs; **feeder roots** black and corky, with black root hairs; **petiole** light green, smooth, 5–15 cm long, sheathing to the base of the geniculum; **petiolar sheath** deciduous; geniculum bulky, 0.5–1 cm long; **blades** narrow, lanceolate, oblong-elliptic or ovate, attenuate at the base, obtuse or short-acuminate at apex, thickly coriaceous, drying yellowish, 7.5–25 × 3–10 cm, 2.4–3.5 times longer than wide, with the base slightly decurrent on the geniculum; **midrib** sunken adaxially, convex abaxially; **primary lateral veins** 4–7 per side, departing from midrib at 35–45°, strongly sunken adaxially, raised abaxially; **tertiary veins** inconspicuous; **collective veins** not visible; **fenestrations** absent; **margins** entire. Inflorescences on ascending stems; **peduncle** smooth, 10–38 cm long, 2–4 mm diam.; **spathe** light-green during development, cream on both surfaces at the anthesis; **spadix** white during development, cream at the anthesis, 3–5.2 cm long, 0.7–1 cm diam.; **flowers** 3–4 mm long; stamens with laminar filaments, 1.5–4 mm long; anthers 0.5–1 mm long; ovary quadrangular and ribbed, 1.5–2.5 × 1.5–2 mm; style hexagonal, 1–2 × 2–2.5 mm; stigma linear; basal sterile flowers 1.5–3 mm long; **berries** with orange-green stylar cap, greenish during development; pulp white; **seeds** green or black, spherical, 2–4 mm long.

Etymology

The species is named in honor of Alcira Pérez de Gómez a Venezuelan botanist from Barquisimeto who did her Master's thesis under the direction of Tom Croat at St. Louis University in St. Louis.

Distribution and habitat

Monstera alcirana is endemic to Panama to the Comarca Guna Yala and Provinces of Coclé, Panamá, Colón and Veraguas, at 350–1000 m, in *Tropical wet forest* and *Premontane rain forest* life zones (Holdridge 1967).

Conservation status

Monstera alcirana occurs in nine localities of which four are in protected areas (Chagres National Park, Cerro Gaital Natural Monument, General de División Omar Torrijos Herrera National Park and Santa Fe National Park). The principal threat to this species is the habitat loss due to urban expansion and extensive livestock activities, which were observed mainly in those locations devoid of protection. We calculate an Extent of Occurrence of 9236 km^2 and an Area of Occupancy of 80 km^2, therefore, we suggest considering *M. alcirana* as a vulnerable species [VU, B1ab(i,ii,iii,iv)].

Phenology

Flowering has been recorded in January–April, July, November, and fruiting in January–May, and July.

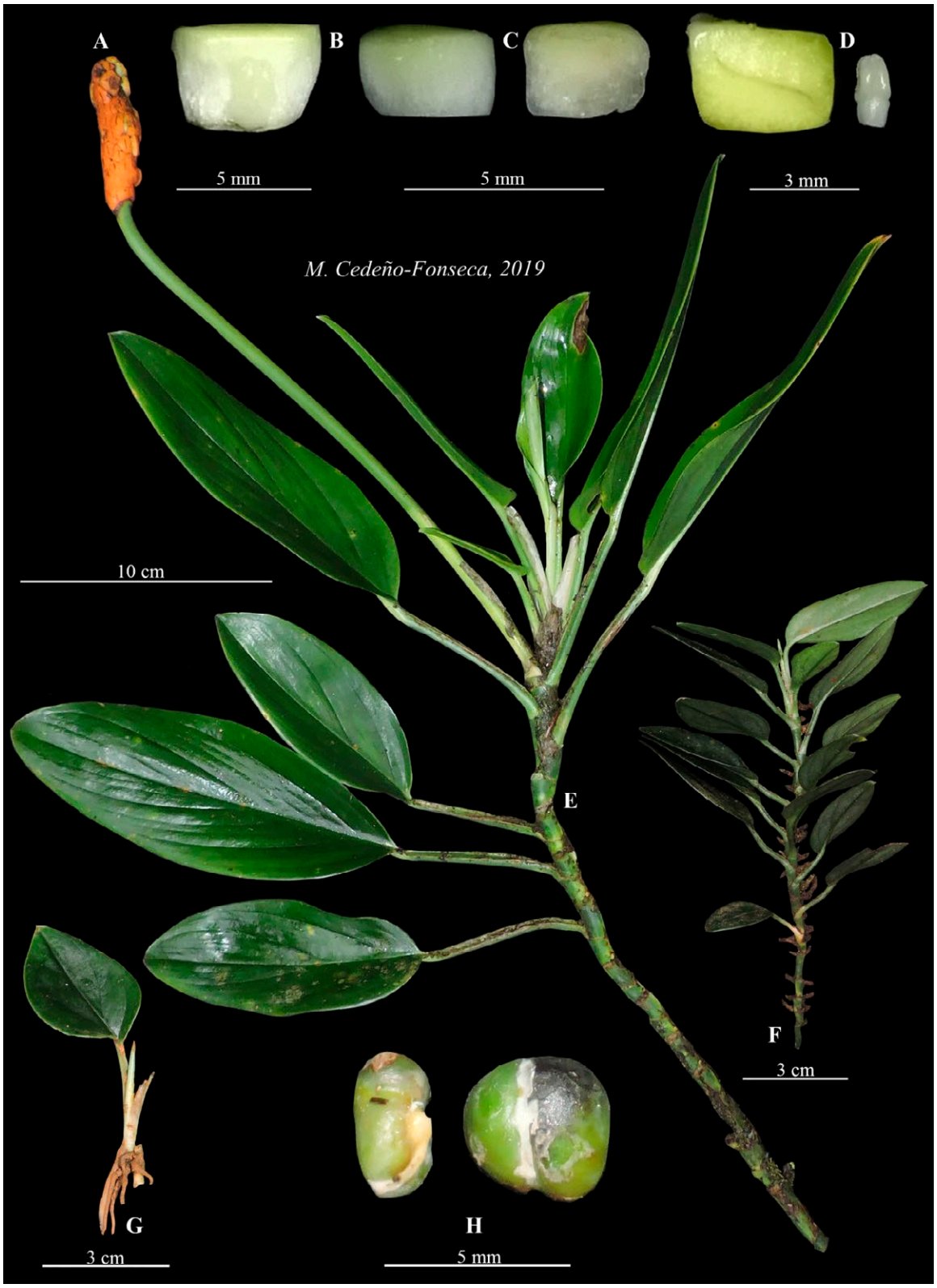

Figure 1. *Monstera alcirana sp. nov*. **A.** Infructescence. **B.** Fertile flower. **C.** Sterile flower in lateral view (left) and in longitudinal section (right). **D.** Stylar plate, top view (left), and individual stamen (right). **E.** Adult plant. **F.** Juvenile plant. **G.** Seedling. **H.** Seeds. Images by M. Cedeño-Fonseca.

Figure 2. *Monstera alcirana sp. nov*. **A.** Juvenile plant. **B.** Pre-adult plant. **C.** Adult plant without inflorescence. **D.** Adult plant with infructescence. Images by M. Cedeño-Fonseca.

Notes

The new species is a member of sect. *Monstera* (*sensu* Madison, 1977), and is unusual in the genus in having leaves that are somewhat like *Stenospermation*, and indeed the species was long confused with that genus (Gómez, 1983).

The species superficially resembles *Stenospermation*, it is impossible to confuse *M. alcirana* with any other species of *Monstera*. It is similar to *M. obliqua* in having the same color of the spathe and spadix, but it differs because *M. alcirana* has short internodes 0.5–3 cm long (vs. 2–10 cm long), thickly coriaceous blade (vs. a thinly coriaceous blade), peduncle 10–38 cm long (vs. 10–17 cm long), and the juvenile with small leaf blade 3–6 × 3–4 cm (vs. 7–13 × 2–4 cm). The pre-adult and adult plants of *M. alcirana* are very similar to the juvenile plant of *M. standleyana* G.S. Bunting.

The other species that can be confused *M. alcirana* is *M. minima* Madison, but *M. minima* is only known from the type locality in the Comarca Guna Yala (formerly San Blas), Panama, and from Colombia. The key differences are that *M. alcirana* has an orange fruiting spadix (vs. an apparently creamy fruiting spadix), and a thickly coriaceous leaf blade, 7.5–25 × 3–10 cm (vs. a thinly coriaceous blade 9–14 × 2.0–4.0 cm), obtuse or short-acuminate at apex (vs. long-acuminate at the apex). *Monstera alcirana* is the fourth diminutive species of *Monstera* in Central America, together with *M. minima* Madison, *M. obliqua* Miq., and the recently published species *M. gambensis* M.Cedeño & M.A.Blanco (Cedeño-Fonseca et al. 2020b). *Monstera alcirana* differs from the latter species in having a smooth petiole (vs. rough petiole), the petiole sheath deciduous (vs. persistent and involute), and the fruiting spadix orange when ripe (vs. yellow when ripe).

Additional specimens studied (paratypes):

PANAMA: Coclé, La Mesa above El Valle; in forest on both sides of junction with road to Cerro Pilon, ca. 800 m, 21 Jul 1974, *T.B. Croat 25390* (MO). Along road between Llano Grande and Coclesito (N of Pintada), 4 mi. N of Llano Grande, 600 m, 28 Jan 1980, *T. Antonio 3561* (MO). 27 km N of Penonome on road to Coclesito in forest reserve at Continental Divide, ca. 300 m, 20 Feb 1978, *B. Hammel 1635* (MO). Vicinity el Valle de Antón, at forested flat area near Finca Macarenita at La Mesa, 08°36'N, 80°07'W, 800 m, 6 Jul 1994, *T.B. Croat & G.H. Zhu 76665A* (MO). Parque Nacional General de División Omar Torrijos Herrera, Caño Sucio, camino hacia el Alto Tífe, bosque húmedo con suelos muy rocosos, 8°42'55"N, 80°38'12"W, 243 m, 18 Jul 2013, *O. Ortiz et al. 1416* (MO, PMA). **Colón**: East Santa Rita Ridge, 11 January 1968, *M.D. Correa & R.L. Dressler 595* (MO). Near Agua Clara rainfall station, Santa Rita Ridge, 9°20'N, 79°48'W, 23 Apr 1970, *R.B. Foster 1752* (PMA). Along ridge of Cerro Gaital, N slopes of mountains near La Mesa, N of El Valle, Premontane rainforest, 08°38'00"N, 80°08'30"W, 800–900 m, 28 Apr 1982, *S. Knapp & R. J. Schmalzel 4880* (MO). Flotation Molly, 8°51'12"N, 80°38'18"W, 139 m, 21 May 2014, *S. Castillo 402* (PMA). Distrito de Donoso, área de Concesión Minera Panamá, Pipeline Road, 8°53'46"N, 80°38'50"W, 127 m, 6 May 2013, *O. Ortiz et al. 1310* (MO, PMA). **Panamá,** Between 6–12 km north of El Llano on Cartí road, forest and roadside, 09°15'32"N, 078°57'42"W–09°16'32"N, 078°55'49"W, 365 m, 13 Jan 1978, *B.E. Hammel 889* (MO). Cerro Jefe, ca. 1000 m, *J.D. Dwyer 9480* (MO). El Llano-Cartí Road, 17.5 km from Inter-American Highway, wet forest, 09°17'45"N, 78°55'59"W, 350 m, 14 Feb 1975, *S.A. Mori et al. 4605* (MO). Altos de Pacora, northwest of Cerro Jefe, 09°16'30"N, 79°18'50"W, 650–750 m, 8 Nov 1979, *T. Antonio 2502* (MO). 16–18 km from Interamerican Highway on the El Llano-Cartí Road, 09°17'50"N, 78°56'03"W, 400 m, 28 Mar 1974, *E. L. Tyson & M. H. Nee 7342* (MO). 8.2 miles from the Pan-American Highway on the El Lano-Cartí Road, 09°14'N, 79°00"W, 6 Jul 1982, *S. Knapp 5917* (MO). Beyond Goofy Lake along road to Cerro Jefe, 9°14'N, 79°21'W, 4 Jan 1968, *M.D. Correa et al. 567* (MO, PMA). Campo Tres, 3 miles NE of Altos de Pacora, 500–800 m, 10 Mar 1973, *R.L. Liesner 523* (MO, PMA). Road to Cartí (San Blas), 15.5 kn north of El Llano, 09°21'30"N, 78°58'00"W, ca. 400 m, 13 Feb 1973, *P. Busey 366* (MO). La Eneida, región of Cerro Jefe, 9°14'N, 79°21'W, 650 m, 15 Jan 1973, *R.L. Dressler 4253* (PMA). El Llano-Cartí Rd. km. 17.4, Tropical wet forest, 9°19'N, 78°55'W, 350 m, 1 Jul 1985, *G. de Nevers 5922* (MO, PMA). Altos de Cerro Azul, sendero el Cantar, 500 m, 16 Sept 2015, *O. Ortiz et al. 2515* (MO, PMA). **Veraguas**, Santa Fe, Río Piedra, bosque secundario maduro, camino cerca del río, 8°44'06"N, 80°46'21"W, 370 m, 16 Dec 2013, *A. Morris & L. Martínez 2062* (PMA). Santa Fe, Parque Nacional Santa Fe, área del Río Veraguas, bosque achaparrado, trocha sobre filo de un cerro, dosel con una altura aproximada de 25 m, con presencia de *Colpothrinax*, 8°41'21"N, 80°50'09"W, 539 m, 8 Feb 2014, *L. Martínez et al. 1672* (PMA).

Monstera obliqua Miq., *Linnaea* 18: 79. 1844

Type: Surinam, Vredenburger-Zandrits, October 1842, *Focke 719* (holotype, U; photos: BH, SEL!).

(=) *Monstera falcifolia* Engler, *Bot. Jahrb.* 37: 117. 1905. Type: BRAZIL. Amazonas, Jurua Miry, July 1901, *Ule 5622* (holotype, B; photos: BH, GH, US; isotypes, K, L!, MG; photo: BH).

(=) *Monstera fendleri* Engler, *Bot. Jahrb.* 37: 117. 1905. Type: TRINIDAD. 1877-1880, *Fendler 736* (holotype, K!; isotypes: NY, P).

(=) *Monstera sagotiana* Engler, *Bot. Jahrb.* 37: 117. 1905. Type: FRENCH GUIANA, Karouany, *Sagot 609* (holotype, BM; photo: BH).

(=) *Monstera snethlagei* Krause, *Notizbl. Bot. Gart. Berlin-Dahlem* 9: 272. 1925. Type: BRAZIL, Maranhão, Jury-assu, Mta. de Allegria, Ketterpflanze im Igapowald, gelb, Hüllblatt ebenfalls gelb, 14 November 1923, *Snethlage 327* (holotype, B; photos: BH, GH, US).

Description

Nomadic vine with appressed-climbing habit. Seedlings: foliose. Juvenile plants: **stems** smooth, dark green; **internodes** 3–5 cm long, 2–5 mm diam.; **petiole** conspicuous, dark green, smooth 5–11 cm long, sheathing to the base of the geniculum; **petiole sheath** deciduous; **blades** lanceolate, truncate at the base, acuminate at apex, sub-coriaceous, 7–13 × 2–4 cm, not appressed to the phorophyte; **fenestrations** absent. Adult plants: **stems** smooth, light to dark green; **internodes** 2–10 cm long, 3–5 mm diam.; **cataphylls** light-green, deciduous but leaving dry fragments on peduncles; **anchor roots** black; **feeder roots** black; **petiole** light green, smooth, 5–18 cm long, sheathing to the geniculum, **petiole sheath** deciduous; geniculum smooth, 3–5 mm long; **blades** lanceolate to narrowly elliptical, cuneate at the base, acuminate at apex, membranous to sub-coriaceous, drying blackish, reddish, light brown or greyish, 12–23 × 3–10 cm, not decurrent on geniculum; **midrib** ribbed adaxially, convex abaxially; **primary lateral veins** 4–8, obscure adaxially, prominent abaxially, departing midrib at 35–50°; **tertiary veins** inconspicuous; **collective veins** not visible; **fenestrations** absent or scarcely developed (in Central America); **margins** entire. INFLORESCENCES on ascending stems, 1–3 simultaneously at flowering time, arranged in the axils of the leaves or cataphylls; **peduncle** smooth, 10–17 cm long, 5–6 mm diam.; **spathe** acuminate, light-green during development, yellow externally and white internally at anthesis, the margins towards the apex involute, deciduous at the end of the anthesis, up to 4 cm longer than the spadix; **spadix** with green style margins and white at the medial part during development, cream at anthesis, 3–5 × 0.5–1 cm; flowers 4–7 mm long; stamens with laminar filaments, 1–2 mm long; anthers 1–2 mm long; ovary square and ribbed, 1.5–2 × 1.5–2 mm; style square or hexagonal, 1.5–2 × 2.5–3 mm; stigma linear; basal sterile flowers scarce or absent; **berries** with a moss-green stylar cap during development, mature stylar cap orange; pulp white; **seeds** black, 3–5 mm long.

Distribution and ecology

Monstera obliqua ranges from Costa Rica to Bolivia, Venezuela, the Guianas, Brazil, and Trinidad & Tobago. In Costa Rica it grows at 0–100 m elevation, in *Tropical wet forest* life zones, but in Panama it grows at 0–1410 m, in *Tropical moist forest, Tropical lower montane wet forest* and *Montane moist forest* life zones (Holdridge 1967).

Phenology

In Costa Rica and Panama, flowering has been recorded in July and November, and fruiting in January, March, July and November.

Notes

The species is a member of sect. *Monstera* (*sensu* Madison, 1977), characterized by its small elliptic-lanceolate, inequilateral blades which have entire margins, usually lack perforations, its inflorescences with peduncles that are as long as or longer than petioles (but not the whole leaf) and by its dark orange, small fruiting spadix.

Monstera obliqua in Costa Rica is only known from the southeast Caribbean watershed. It is not common, and possible to find only in primary and secondary forests, at 0–100 m. Most populations have leaf blades without perforations: only the populations in the region of Sixaola have fenestrate blades. This species is the only *Monstera* with orange ripe fruit in Costa Rica, (Figure 3).

However, the situation for Panama is different: *M. obliqua* is very common along to the Caribbean slope, at 0–1410 m, growing in *Tropical wet forest, Tropical moist forest, Tropical lower montane wet forest,* and *Montane moist forest* life zones (Holdridge 1967). The most common morphotype is one with the leaf blades without perforations similar to the plant from Costa Rica, but the only difference is the much wider altitudinal distribution. (Figure 4–5). *Monstera obliqua* in Panama grows in rocks where it can develop to the adult phase and producing inflorescences. (Figure 4A-B). Some plants from the Cerro Azul in Panamá have coriaceous leaf blades, with the indistinct primary lateral veins in both surfaces and prominently thick geniculum and peduncles (Figure 4F-G, 5).

Monstera obliqua has never been recorded for Costa Rica and Panama with perforated and membranaceous

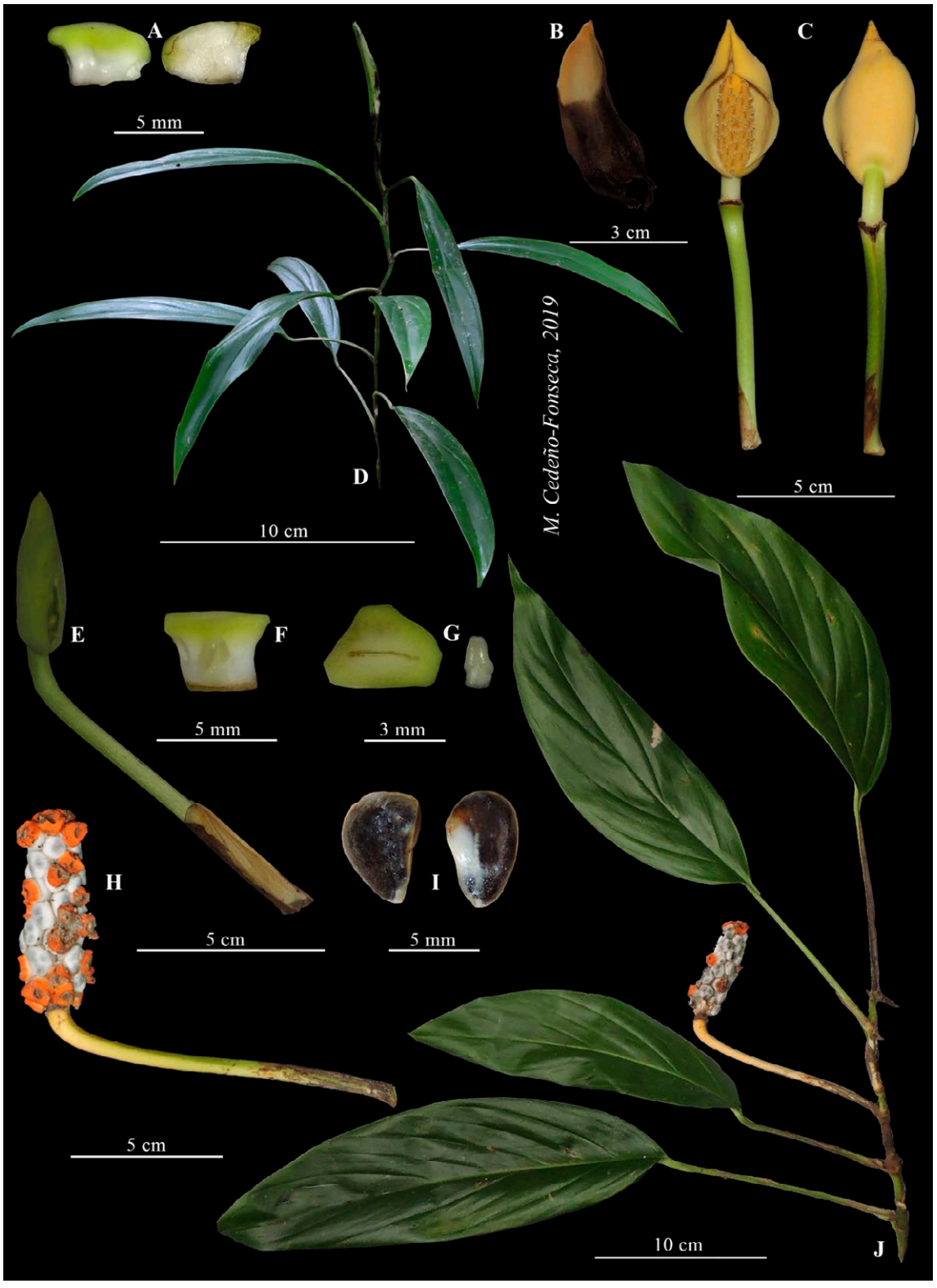

Figure 3. *Monstera obliqua* from Costa Rica. **A.** Sterile flower in lateral view (left) and in longitudinal section (right). **B.** Spathe anomaly. **C.** Front and back views of open inflorescence. **D.** Juvenile plant. **E.** Developing inflorescence. **F.** Fertile flower. **G.** Stylar cap, top view (left), and individual stamen (right). **H.** Mature infructescence, stylar cap detached toward the apical part. **I.** Seeds. **J.** Adult plant. Images by M. Cedeño-Fonseca.

Figure 4. Different morphotypes of *Monstera obliqua* from Panama. **A.** Plant in adult phase with infructescence growing on rocks in the Caribbean in Bocas del Toro. **B.** Plant in adult phase with infructescence growing on rocks in the Pacific in Santa Fe. **C.** Adult plant growing 3 m above the ground on trees in Santa Fe. **D.** Adult plant with a white spathe growing 1 m above the ground on a shrub in the Cope. **E.** Juvenile individual growing in the Cope. **F.** Adult plant with inflorescence and infructescence growing on trees in Cerro Azul. **G.** Inflorescence with creamy spathe in Cerro Azul. **H.** Adult plant with infructescence growing 2 m above the ground in Santa Rita. Images by M. Cedeño-Fonseca.

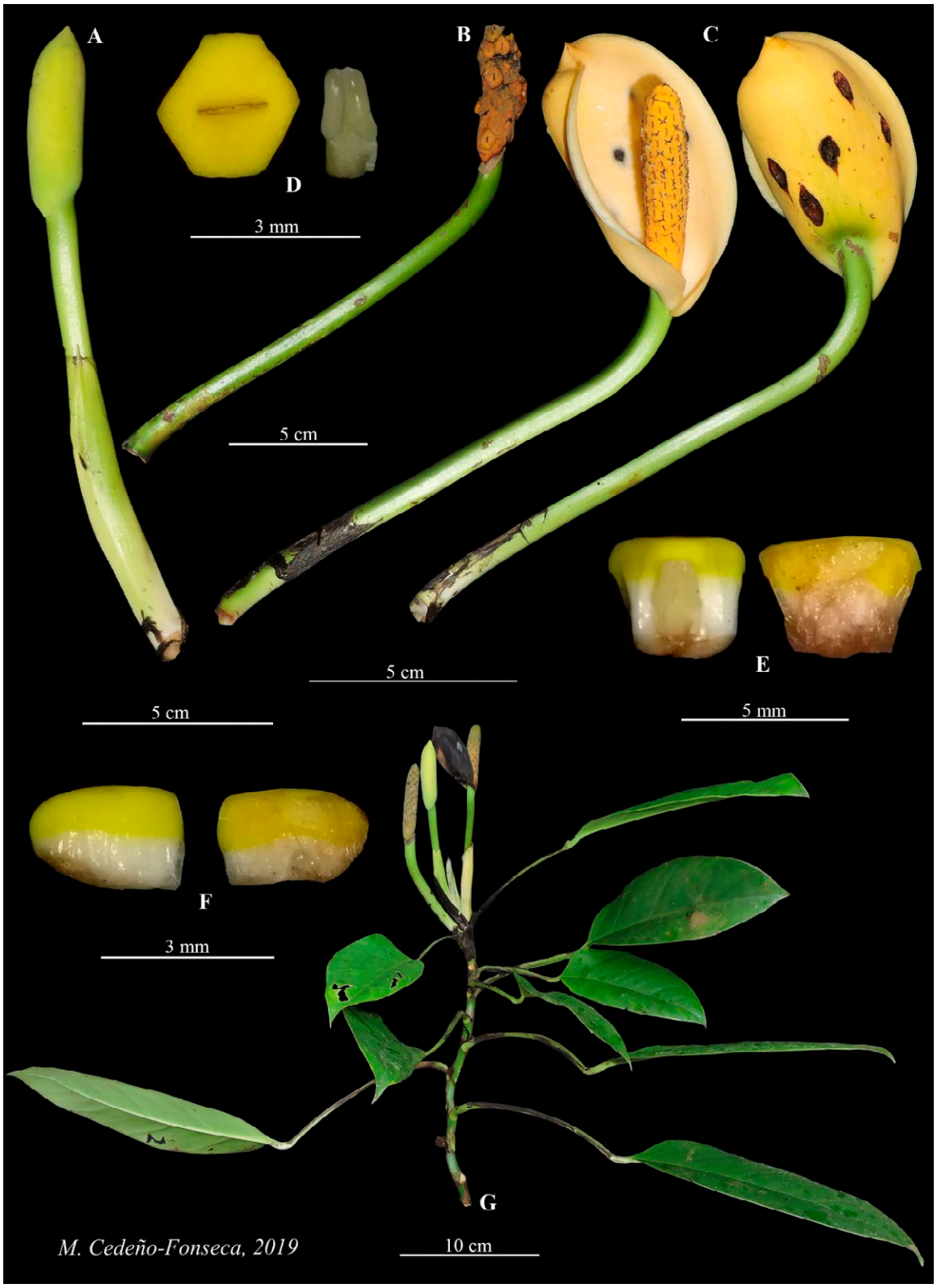

Figure 5. *Monstera obliqua* from Panamá, Cerro Azul. **A.** Developing inflorescence. **B.** Mature infructescence. **C.** Front and back views of open inflorescence. **D.** Stylar cap, top view (left), and individual stamen (right). **E.** Fertile flower in lateral view (left) and in longitudinal section (right). **F.** Sterile flower in lateral view (left) and in longitudinal section (right). **G.** Adult plant. Images by M. Cedeño-Fonseca.

leaf blades. This characteristic is present solely in one morphotype occurring throughout the Amazon basin and which may be a different species since (the type of *M. obliqua* is not of this morphotype). Madison (1977) speculated that the entire leaf morphotype from Panama (which also occurs in Costa Rica) was probably driven by a limited immigrant line from South America with a consequent decline in genetic variability.

Additional specimens studied:

COSTA RICA: Limón, Talamanca, Sixaola, San Miguel de Sixaola, Finca-albergue de ASACODE, 9°34'10''N 82°39'20''W, 35 m, 28 July 1994, (Fr.), *J. Sánchez et al. 340* (CR). Talamanca, Bratsi, Suretka, Bosques cercanos al sitio de exploración petrolera, 9°35'20''N 82°53'50''W, 200 m, 19 July 1995, (Fl., Fr.), *A. Cascante et al. 551* (CR). Talamanca, Cahuita, Between Bri Bri and Sixaola, NW of Paraíso, Disturbed forest, 9°39'0''N 82°40'0''W, 50 m, 5 July 1983, (Fr.), *K. Barringer et al. 3489* (CR, MO). Talamanca, Sixaola, Hills between headwaters of Quebrada Mata de Limón and upper branches of Quebrada Tigre, and lowland forest of Quebrada Tigre drainage, Finca Anai, (Sixaola region), 9°34'0''N 82°40'0''W, 28 m, 18 November 1984, (Fl., Fr.), *M. Grayum et al. 4458* (CR, MO). Talamanca, Sixaola, Headwaters of quebrada Mata de Limón, westernmost fork, Finca Anai, (Sixaola region), 9°34'0''N 82°39'0''W, 23 m, 17 November 1984, (Fr.), *M. Grayum et al. 4439* (CR, MO). Talamanca, Cahuita, Gandoca, El Llano entre Fila Manzanillo y Río Creek, Atrás de la playa, 9°37'0''N 82°41'0''W, 80 m, 27 March 1995, (Fr.), *G. Herrera & E. Sandoval 7600* (CR). Limón, Valle La Estrella, Fila Espavel, 9°39'37.853''N 83°1'11.19''W, 200 m, 3 July 2000, (Fr.), *L. Acosta 2117* (CR). Talamanca, Sixaola, Sendero Cerillo, 9°36'38.821''N 82°37'24.9''W, 1 m, 3 March 1999, (Fr.), *U. Chavarría 1920* (CR). Talamanca, Sixaola, San Miguel, senderos en la ruta a Manzanillo, 9°34'30''N 82°40'0''W, 30 m, 16 January 1997, (Fr.), *J. González 1582* (CR). Camino entre Fila Dimat y Río Uren, 22 October 1985, (Fr.), *L. Gómez 23765* (MO). 10 miles S of Punta Cahuita, 9°36'0''N 82°48'36''W, 70 m, 11 August 1977, (Infert.), *T.B Croat 43199A* (MO). Talamanca, Bribri, Proyecto ARA, 9°37'43''N 82°40'31''W, 4 m, 30 September 2018, (Fl., Fr.), *M. Cedeño et al. 1481* (USJ). Talamanca. Bribri. Proyecto ARA. 9°37'43''N 82°40'31''W, 4 m, 30 September 2018, (Fr.), *M. Cedeño et al. 1482* (USJ). **PANAMA: Bocas del Toro,** Above Chiriquí Grande on side road 10 mi from continental divide; on trail off pipeline trace, 8°55'N, 82°10'W, 300 m, 28 May 1988, *G. McPherson 12569* (MO). Hill just south of Chiriquí Grande; at end of pipeline access road 2 mi N of 2nd large bridge N (10 mi.) of cont. divide, 8°54'N, 82°10'W, 350–500 m, 10 Mar 1986, *Hammel et al. 14743* (MO). Vicinity of Chiriquí Lagoon, 8 Oct 1940, *Wedel 1091* (MO). Milla, 7.5, 26 July 1971, *T.B Croat & Porter 16277* (MO). **Chiriquí,** Chiriquí Grande-Fortuna, along Continental Divide from road branching N off main Fortuna-Chiriquí Grande Highway near Continental Divide, 1.1 mi from main highway, 8°44'N, 82°17'W, 1200 m, 11 Mar 1985, *T.B Croat & M. Grayum 60347* (MO). **Coclé:** Cerro Pilon near El Valle, 700-900 m, 700–900 m, 10 June 1967, Duke *12155* (MO). Between Cerro Pilon and El Valle, 700–900 m, 15 Aug 1967, *Duke 13993* (MO). El Valle, 1000 m, 24 Dec 1972, *Gentry 6893* (MO). El Valle; end of road leading to Turstico Hotel, 11 May 1977, *Folsom 3111* (MO). Trail between the Río Blanco and the Continental Divide N of El Cope and El Potroso sawmill, 400–1700 ft, 14 Dec 1980, *Sytsma et al. 2580* (MO). Vicinity of El Valle, 600–1000 m, 8 Dec 1938, *Allen 1227* (MO). Mountains beyond La Pintada, 400–600 m, 16 Feb 1935, *Hunter & Allen 544* (MO). Cerro Pilón, 2000–2700 ft, 28 Mar 1969, *Dwyer et al. 4565* (MO). Continental divide N of Penonome on road to Coclesito, 1600 ft, 25–26 July 1978, *Hammel 4039* (MO). Foot of Cerro Pilón, above El Valle de Antón. Rain forest, 2000 ft, 28 Mar 1969, *Porter et al, 4612* (MO). El Valle de Anton, La Mesa, 1000 m, 1 Apr 1973, *Helen et al. 3011* (MO). El Valle site, on the end of the trail from the end of the road to the site, 24 Apr 1968, *Kirkbride 1082* (MO). Continental divide, 4 mi past Llano Grande on road to Cascajal, NW of Penónome, 500 m, 9 Apr 1981, *Sytsma 3878* (MO). Road from Penonomé to Coclecito, 9 km N of Llano Grande, tributary on Río Caseaja, 11 Oct 1978, *D'Arcy & Hammel 12282* (MO). **Colón**: Santa Rita Ridge, Santa Rita (Arriba)-Cerro Azul, 09°20'21''N, 79°46'47''W, 200–260 m, 23 July 1990, *Grayum & Evans 9922* (MO). Santa Rita Ridge Road, 6.5 mi E of Boyd-Roosevelt Hwy, 09°21'15"N, 79°44'00"W, 370 m, 16 July 1994, *Croat & Zhu 76941* (GB, MO, SAR). 25-26 kms from Transisthmica Hwy on Santa Rita Ridge, 09°26'N, 079°37'W, 500 m, 21 Oct 1981, *Knapp et al. 1733* (MO). Santa Rita Ridge, E of Agua Clara rain gauge, 4 March 1973, *Kennedy 2753* (MO). Santa Rita Ridge. In forest on Tassell's property, 8 Nov 1974, *Mori & Kallunki 3026* (MO). Santa Rita lumber road, 8.7 km E of Transisthimian Highway, 15 June 1977, *Folsom 3690* (MO). Santa Rita Ridge Road, 7.8 km from the Boyd-Roosevelt Hwy., ca 25 km W of Colón., 23 Aug 1975, *Mori & Dressler 7907* (MO). Trail S of Río Guanche, on ridge to Cerro Pan de Azúcar, 200 m, 20 Sept 1974, *Mori & Kallunki 2031* (MO). 9 km W of Llano Grande just S of Cascajal, 800 ft, 11 Oct 1978, *Hammel & D'Arcy 5099* (MO). **Darién:** Vicinity Cerro Pirre, along trail from base camp to Rancho Frio on slopes of Cerro Pirre, 07°58'N,

77°43'W, 200–450 m, 27 July 1994, *Croat & Zhu 77130* (MO). Parque Nacional Darién, subiendo por la trocha limitrofe desde Casa Vieja hacia Cerro Sapo, 07°58'N, 78°23'W, 500–800 m, 25 May 1991, *Herrera et al. 1000* (MO). Parque Nacional Darién, Serranía de Cerro Sapo, por la trocha limitrofe del PND entre Casa Vieja y Cerro Sapo, 07°58'N, 78°23'W, 20–400 m, 24 Nov 1990, *Herrera & Polanco 742* (MO). Parque Nacional del Darién. Slopes of Cerro Mali; head waters of S branch of Río Pucuro; ca. 22 km E of Pucuro., 08°04'30"N, 77°14'00"W, 1300–1400 m, 21 Oct 1987, *Cuadros et al. 3912* (MO). Parque Nacional del Darién. Ridge between Río Topalisa & Río Pucuro ca. 13 km E of Pucuro; Quebrada Pobre to Mi Casita, 8°03'N, 77°20'W, 450–600 m, 14 Oct 1987, *Nevers et al. 8316* (MO). Parque Nacional del Darién Ridge between N & S Branches of Río Pucuro; in forest N of old village of Tacarcuna; ca. 18 km E of Pucuro, 8°05'N, 77°16'W, 600–800 m, 24 Oct 1987, *Hammel et al. 16486* (MO). Cerro Tacarcuna Expedition. South slope of Cerro Tacarcuna above Río Pucuro base camp, 700–1000 m, 25 January 1975, *Gentry & Mori 13899* (MO, PMA). Cerro Tacarcuna Expedition. Trail from Pico Mali to old Tacarcuna village on Río Tacarcuna, premontane wet forest, 700 m, 7 Feb 1975, *Gentry & Mori 14181* (MO). Cativo Swamp, Río Chucunaque, ca. 1/2 hr below Morti, 18–31 May 1967, *Duke 11749* (MO). 10 km NE of Jaqué, headwaters of Río Pavarandó, 1400 ft, 30 Jan 1981, *Sytsma & D'Arcy 3352* (MO). 10 km NE of Jaqué, ridge between Río Tabuelita and Río Pavarandó., 1400–1600 ft, 1 Feb 1981, *D'Arcy &. Sytsma 14551* (MO). Near Jacque at Enseñada del Guayabo, Apr 1980, *Garwood 1024* (MO). Cerro Mali: Cerro Tacarcuna Expedition. Trail from Tacarcuna village on Río Tacarcuna to Cerro Mali, 800–1300 m, 16 Jan 1975, *Gentry & Mori 13601* (MO). Parque Nacional Darién: S of Garachine near Pacific coast above Casa Vieja along boundary trail, W flank of Serranía Sapo, 7°58'N, 78°23'W, 150–300 m, 22 May 1991, *Hensold 1083* (MO, PMA). Punta Guayabo Grande: N of Punta Guayabo Grande, trail to ridge top, 200–600 ft, 21 Apr 1980, *Antonio & Hahn 4346* (MO, PMA). **Panamá,** Along trail to Cerro Brewster from Río Pacora Valley, 9°20'N, 79°15'W. Forested slopes c. 650 m, 9°20'N, 79°15'W, 650 m, 21 Nov 1985, *G. McPherson 7558* (MO). 1 mi N Cerro Azul, 2300 ft, 27 May 1966, *Tyson & Blum 4088* (FSU, MO); El Llano-Carti Road, 10 km from Interamerican Hwy., 5 Oct 1974, *Mori & Kallunki 2326* (MO). Campo Tres, 3 mi NE of Altos de Pacora, 500–800 m, 10 Mar 1973, *Liesner 578* (MO). Cerro Azul, 23 June 1972, *T.B Croat 17304* (MO). El Llano-Cartí Road, 09°16'N, 078°58'W, 1000 ft, 6 Sep 1980, *Sytsma 996* (MO). El Llano-Carti road, 12 km N of Pan. Am. Hwy at El Llano, 400 m, 11 Mar 1974, *Nee 10450* (MO). Cerro Azul, 24 Mar 1969, *Porter et al. 4070* (MO). *Porter et al. 4098* (MO). 2–3 mi S of Goofy Lake, road to Cerro Jefe, 2000–2200 ft, 10 Dec 1966, *Lewis et al. 264* (MO). Near foot of Loma Larga, east of Cerro Azul (Goofy Lake), 5 Apr 1973, *Dressler 4319* (MO, PMA). vicinity of Finca Neptuno, 3.5 km NE of Lago Cerro Azul on road to Cerro Jefe., 600–800 m, 11 May 1974, *Nee 11524* (MO). El Llano-Carti Road, 9.6 km from Inter-American Highway, 350 m, 26 May 1975, *Mori & Kallunki 6402* (MO). **Comarca Guna Yala,** Nusagandí, 30 May 1993, *Marrianne 25* (MO). Trail from mouth of Río Irgandí to a tributary of Río Cartí Senni. Two hours through second growth, one hour through forest. 9°25'N, 78°51'W., 9°25'N, 78°51'W, 20 Dec. 1985, *Nevers & Herrera 6580* (MO). Cangandi, 9°24'N, 79°24'W. 9°24'N, 79°24'W, 30 m, 10 Feb 1986, *Nevers & Herrera 7041* (MO). Cangandi, hills around village. Assoc: Cespedizia macrophylla, 9°24'N, 79°24'W., 9°24'N, 79°24'W, 50 m, 13 Dec. 1985, *Nevers et al. 6487* (MO, PMA). El Llano-Cartí Road, 19.1 km from Interamerican Hwy; elev. 350 m. 9°19'N, 78°55'W, 9°19'N, 78°55'W, 350 m, 4 Mar 1985, *Nevers et al. 4951* (MO). Campamanto Nusgandi, en ELC a 19.1 km de la vía Panamaericana, Sendero Wedar Igar, 9°11'N, 78°15'W, 200–350 m, 31 Oct 1992, *Herrera et al. 1265* (MO, PMA). Nusagandí; El Llano-Cartí Road, 9 mi N of main highway; Nergan Igar (Nergan Trail), 09°20'N, 79°00'W, 350 m, 2 July 1994, *Croat & Zhu 76563* (CM, MO). Trail east of Cangandi-Mandinga airport road, 2–5 mi S of Mandinga airport. 27 Oct 1967, Duke *14813* (MO). Cerro Habú, trail from Río Sidro, primary wet forest, 09°23'N, 078°49'W, 800–1400 ft, 18 Dec 1980, *Sytsma et al. 2635* (MO). On trail to inland village of Armila, 3 to 8 km SW of Puerto Obaldía, 21 June 1975, *Mori et al. 6798* (MO). Puerto Obaldía and trail to Colombian Frontier, 0–500 m, 28 Apr 1980, *D'Arcy 13624* (MO). 3-4 hours up Río Mulatupu, 17 Aug 1967, *Kirkbride 229* (MO). El Llano-Cartí road, 10.5 mi from Interamerican Hwy., 09°18'N, 079°58'W, 550 m, 14 Mar 1985, *Croat 60487* (MO). Nusagandi: Sendero Wedar, 9°18'N, 78°58'W, 300–400 m, 19 July 1986, *McDonagh et al. 174* (BM). **Veraguas,** Slopes of Cerro Tute, along trail from between first and second creeks N of height above Alto de Piedra; forest,08°30'N, 81°07'W, 600–750 m, 21 March 1987, *McPherson 10730* (MO). Trail on ridge to summit of Cerro Tuté, Cordillera de Tute. 1 km past Escuela Agricola Altos de Piedra, just W of Santa Fe, upper montane and elfin forest, 08°36'N, 081°06'W, 1250–1410 m, 15 December 1981, *Knapp & Sytsma 2532* (MO). Vicinity of Escuela Agricola Alto Piedra near Santa Fe, 0.3 mi beyond the fork in the road near the agricultural school toward Atlantic coast, along trail to top of Cerro Tute, 1050–1150 m, 29 November

1979, *Croat 48887* (MO, PMA). Carribbean slope above Río Primero Brazo 5 mi NW of Santa Fe, 700–1200 m, 18–19 Mar 1973, *Liesner 801* (MO). Along trail to summit of Cerro Tute, ca. 3 km above Escuela Agricultura Alto Piedra near Santa Fé, 2600–2800 ft, 4 Jan 1981, *Sytsma & Antonio 2987* (MO). Vicinity of Escuela Agricultura Alto Piedra, near Santa Fé along trail to top of Cerro Tute, 2800 ft, 3 Apr 1980, *Antonio 3978* (MO). Along road from Santa Fé to Río Calovebora 0.6 mile beyond Escuela Agricola Alto Piedra, 735 m, 4 Apr 1976, *Croat & Folsom 34133* (MO). 0.6 mi beyond Escuela Agricola Alto Piedra, 730 m, 4 Apr 1976, *Croat & Folsom 34000* (MO). Caribbean slope above Río Primero Brazo 5 mi NW of Santa Fé, 700–1200 m, 18–19 Mar 1973, *Croat 23146* (MO). Road beyond Escuela Agricola Alto Piedra, above Santa Fé, Atlantic watershed., 800–1000 m, 1 Jan 1975, *James et al. 4566* (DUKE); 1 km past Agricultural School, forested slope to the rear. Road from Santa Fe, 1000–1200 m, 5 Feb 1977, *Folsom & Collins 1610* (MO).

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A synopsis of the native Combretaceae in the Malay Peninsula

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Abstract. A synopsis of the native species of Combretaceae in the Malay Peninsula (Peninsular Thailand, Peninsular Malaysia and Singapore) is presented. A total of 29 species in four genera (*Combretum*, *Getonia*, *Lumnitzera* and *Terminalia*) are recognised. Keys to genera and species are included with synonymy and typification. In total 63 lectotypifications, three second-step lectotypifications and 11 neotypifications are proposed in the paper.

Keywords: *Calycopteris*, *Combretum*, *Getonia*, *Lumnitzera*, *Quisqualis*, *Terminalia.*

INTRODUCTION

The Combretaceae include about 500 species of predominantly trees and scandent shrubs found across most of the equatorial belt (Stace 2007). The family is well defined and its circumscription and higher-level classification is uncontentious. It is numerically dominated by two large genera *Combretum* and *Terminalia* which together make up about 97% of the extant species (Stace 2010). Combretaceae species are found in tropical rain forests, dry forests, savanna woodlands, savannas, littoral and mangrove vegetation. They are less common in montane forests.

In South-East Asia the family is a member of the native flora and its species are encountered in the lowlands. For the Malay Peninsula, the taxonomy of the family was covered by Ridley (1922) and Exell (1954). Since then there have been revisions of *Combretum* and *Terminalia* in Thailand (Nanakorn 1985, 1986), and of the arborescent taxa in Peninsular Malaysia (Kochummen 1972).

Recent activity in Combretaceae systematics has largely concerned generic circumscription and the general trend has been for the subsumation of small genera into the big two (*Combretum* and *Terminalia*). This can be epitomised by a comparison between the system proposed by Exell and Stace (1966) that recognised 20 genera and a recent summary (Byng 2014) where this number had dropped to 10. These changes are less evident in South-East

Asia where the only major change is the inclusion of *Quisqualis* in *Combretum* (Maurin et al. 2020).

The purpose of this study is to provide a taxonomic overview of the family as represented in the native flora of the Malay Peninsula including keys to genera and species, a nomenclatural synopsis and details of typification. The Malay Peninsula is taken here to include Peninsular Thailand, Peninsular Malaysia and Singapore. The research was conducted with reference to the collections in herbarium of the Royal Botanic Gardens Kew (K), some specimens on loan from SING, visits to BM and access to various internet databases (e.g. JSTOR Global Plants) and virtual herbaria (e.g. Berlin, Geneva, Paris).

KEY TO GENERA OF COMBRETACEAE IN THE MALAY PENINSULA

1. Mangrove trees with reddish twigs, fleshy leaves with a gland on the abaxial surface just below the apical notch; flowers and fruits bearing a pair of bracteoles adnate to the hypanthium ..... *Lumnitzera*

   Trees and scandent shrubs of seashores and inland forests, not true mangroves, twigs green or brown, not notably reddish, leaves chartaceous to coriaceous, not fleshy, lacking an apical gland; flowers and fruits without adnate bracteoles 2

2. Scandent shubs (except *C. quadrangulare*); flowers petalous ..... *Combretum*

   Erect trees and treelets; flowers apetalous 3

3. Sepals accrescent in fruit ..... *Getonia*

   Sepals not persisting in fruit ..... *Terminalia*

1. *Combretum* Loefl., Iter Hispan. 308. 1758, ***nom. cons.***

Type: *Combretum fruticosum* (Loefl.) Stuntz

(≡) *Aetia* Adans., Fam. Pl. 2: 84, 513. 1763, *nom. illegit. superfl.*

(=) *Grislea* L., Sp. Pl. 1: 348. 1753, *nom. rejic.*
Type: *Grislea secunda* L.

(=) *Quisqualis* L., Sp. Pl. (ed. 2) 1: 556. 1762. – *Udani* Adans., Fam. Pl. 2: (22). 1763, nom. illegit., superfl.. – *Combretum* sect. *Quisqualis* (L.) Stace, Fl. Neotrop. Monogr. 107: 159. 2010.
Type: *Quisqualis indica* L.

(=) *Kleinia* Crantz, Inst. Rei Herb. 2: 488. 1766, nom. illegit., non *Kleinia* Mill. (1754), nec *Kleinia* Jacq. (1760).
Type: *Kleinia quadricolor* Crantz.

(=) *Cacoucia* Aubl., Hist. Pl. Guiane 1: 450, pl. 179. 1775. – *Hambergera* Scop., Introd. (1777) 106. 1777, *nom. illegit. superfl.* – *Schousboea* Willd., Sp. Pl. 2: 578. 1799, *nom. illegit. superfl.* – *Combretum* subgenus *Cacoucia* (Aubl.) Exell & Stace, Bol. Soc. Brot., Sér. 2, 40: 10. 1966.
Type: *Cacoucia coccinea* Aubl.

(=) *Cristaria* Sonn., Voy. Ind. Orient. 2: 247. 1782, nom. rejic. – *Poivrea* Comm. ex DC., Prodr. 3: 17. 1828, *nom. illegit. superfl.* – *Combretum* sect. *Poivrea* G. Don, Gen. Hist. 2: 665. 1832.
Type: *Cristaria coccinea* Sonn.

(=) *Sphalanthus* Jack, Malayan Misc. 2(7): 55. 1822. – *Quisqualis* sect. *Sphalanthus* (Jack) Exell, J. Bot. 69: 121. 1931.
Type: *Sphalanthus confertus* Jack.

(=) *Gonocarpus* Ham., Prodr. Pl. Ind. Occid. 39. 1825, *nom. illegit.*, non *Gonocarpus* Thunb. (1783).
Type: *Gonocarpus jacquinii* Ham., *nom. illegit. superfl.*

(=) *Forsgardia* Vell., Fl. Flumin. 4: 152, t. 13. 1829.
Type: *Forsgardia laevis* Vell.

(=) *Chrysostachys* Pohl, Pl. Bras. Icon. Descr. 2: 66, t. 143. 1830.
Type: *Chrysostachys ovatifolia* Pohl.

(=) *Sheadendron* G.Bertol., Mem. Reale Accad. Sci. Ist. Bologna 2: 574. 1850.
Type: *Sheadendron butyrosum* G.Bertol.

(=) *Calopyxis* Tul., Ann. Sci. Nat., Bot., sér. 4, 6: 86. 1856. – *Combretum* sect. *Calopyxis* (Tul.) Jongkind, Bull. Mus. Natl. Hist. Nat., B, Adansonia Sér. 4, 17(3-4): 193. 1995.
Type: *Calopyxis sphaeroides* Tul. (lectotype selected by Stace (2010: 60).

(=) *Embryogonia* Blume, Mus. Bot. 2: 122. 1856.
Type: *Embryogonia acuminata* (Roxb.) Blume (lectotype selected by Stace (2010: 60).

(=) *Bureava* Baill., Adansonia 1: 71. 1860. 71, *nom. rejic.*
Type: *Bureava crotonoides* Baill.

(=) *Thiloa* Eichler, Flora 49: 149. 1866. – *Combretum* sect. *Thiloa* (Eichler) Stace, Fl. Ecuador 81: 13. 2007.

Type: *Thiloa glaucocarpa* (Mart.) Eichler (lectotype selected by Stace, Fl. Ecuador 81: 11. 2007).

(=) *Campylogyne* Welw. ex Hemsl., Hooker's Icon. Pl. 26: t. 2550. 1889. – *Quisqualis* sect. *Campylogyne* (Welw. ex Hemsl.) Exell, J. Bot. 69: 120. 1931.
Type: *Campylogyne exannulata* (O.Hoffm.) Hemsl.

(=) *Campylochiton* Welw. ex Hiern, Cat. Afr. Pl. 2: 353. 1901.
Type: *Campylochiton platypterus* (Welw.) Hiern.

(=) *Meiostemon* Exell & Stace, Bol. Soc. Brot., sér. 2, 40: 18. 1966.
Type: *Meiostemon tetrandrus* (Exell) Exell & Stace

Notes

The lectotypifications of *Calopyxis* and *Thiloa* were first proposed by Exell (1931) but the choices were clearly mechanical, so the later designations by Stace (2007, 2010) are accepted here.

Key to *Combretum* taxa

1. Floral bracts persisting to anthesis and beyond; upper hypanthium tubular; petals becoming pink or red 2

   Floral bracts generally dropping before anthesis; upper hypanthium salveriform to infundibuliform; petals white or green 5

2. Upper hypanthium 5-8 cm long..... 1.5 *C. indicum*

   Upper hypanthium 1-2 cm long..... 3

3. Sepals recurved at anthesis, with filiform tips 1-2 mm long 1.4 *C. densiflorum*

   Sepals not recurved at anthesis, filiform tips to 1 mm long. 4

4. Leaves with tertiary venation visible adaxially; floral bracts to 2 mm long with 1 central longitudinal nerve .... 1.6 *C. langkawiense*

   Leaves with tertiary venation obscure adaxially; floral bracts 1 cm long or more with at least 5 longitudinal nerves..... 1.2 *C. caudatum*

5. Indumentum including glandular hairs but not scales; flowers 5-merous; fruits with 5 wings or 5 longitudinal ridges (except *C. nigrescens* which has 4-merous flowers and 4-winged fruits) 6

   Indumentum including scales but not glandular hairs; flowers 4-merous; fruits with 4 wings or 4 longitudinal ridges 8

6. Flowers 5-merous; fruits with 5 wings or 5 longitudinal ridges 7

   Flowers 4-merous; fruits with 4 wings or 4 longitudinal ridges ..... 1.8 *C. nigrescens*

7. Leaves opposite with hairy domatia in axils of lateral nerves below; fruits with 5 wings ..... 1.12 *C. roxburghii*

   Leaves often ternate without domatia; fruits with 5 longitudinal ridges..... 1.15 *C. trifoliatum*

8. Trees, young twigs sharply 4-angled. 1.11 *C. quadrangulare*

   Climbers or scandent shrubs, young twigs more or less terete 9

9. Lower lamina with a dense covering of predominantly whitish scales, tertiary venation obscure 10

   Lower lamina with scales absent or with sparse covering of predominantly reddish scales, tertiary venation visible... 11

10. Inflorescences subcapitate .... 1.10a *C. punctatum var. punctatum*

    Inflorescences elongate .... 1.10b *C. punctatum var. squamosum*

11. Petals inconspicuous, to 1.5 mm long; fruits with 4 longitudinal blunt-topped ridges ..... 1.1 *C. acuminatum*

    Petals conspicuous at anthesis, more than 1.5 mm long; fruits with 4 distinct wings or if with longitudinal ridges then ridges sharp-edged (*C. tetralophum*) 12

12. Sepals 1.5 mm or longer and petals exceeding length of sepals; fruit with 4 longitudinal sharp-edged ridges .... 1.14 *C. tetralophum*

    Sepals to 1 mm long, or if longer then petals shorter than sepals; fruits with 4 papery wings..... 13

13. Inflorescences capitate (also detectable as knobbly ends to infructescences 3-4 mm long) ..... 1.13 *C. sundaicum*

    Inflorescences elongate 14

14. Flowers and inflorescence rhachis densely pale erect hairy; fruits sparsely hairy, scales absent..... 1.7 *C. latifolium*

    Flowers and inflorescence rhachis densely scaly; fruits glabrous but with scales present..... 15

15. Twigs drying reddish brown; leaves with red-brown scales conspicuous on lower lamina; flowers generally more than 4 mm long; fruits generally more than 3 cm across..... ..... 1.3 *C. chinense*

    Twigs drying whitish; leaves without conspicuous red-brown scales on lower lamina; flowers generally less than 4 mm long; fruits to 2.5 cm across..... 1.9 *C. porterianum*

1.1 *Combretum acuminatum* Roxb., Fl. Ind. 2: 228. 1832

Type: [unpublished illustration] Icones Roxburghianae 2225 (K, lectotype selected by du Puy and Telford (1993: 245).

(≡) *Embryogonia acuminata* (Roxb.) Blume, Mus. Bot. 2: 123. 1856.

(=) *Combretum costatum* Roxb., Fl. Ind. 2: 227. 1832.
Type: [unpublished illustration] Icones Roxburghianae 2478 (2476 on drawing) (lectotype CAL, selected by Gangopadhyay and Chakrabarty (1997: 299).

(=) *Combretum neurophyllum* Miq., Fl. Ned. Ind. 1(1): 608. 1856.
Type: Java, Tjitjiringin, *J. Hasskarl s.n.* (L barcode L0844403, lectotype designated here).

(=) *Combretum sarcopterum* Thwaites, Enum. Pl. Zeyl. 415. 1864.
Type: Sri Lanka, Reigam Corle, *Thwaites CP 3715* (CAL, lectotype selected by Gangopadhyay and Chakrabarty (1997: 299).

(=) *Combretum stenopetalum* Van Heurck & Müll.Arg., Observ. Bot. Descript. Pl. Nov. Herb. Van Heurckiani 2: 225. 1871.
Type: W. Griffith (syntypes BR, G).

(=) *Combretum vanheurckii* Müll.Arg., Observ. Bot. Descript. Pl. Nov. Herb. Van Heurckiani 2: 227. 1871.
Type: *W. Griffith 725* (G barcode G00177909, lectotype selected by Gangopadhyay and Chakrabarty (1997: 299); isolectotype BR).

(=) *Terminalia borneensis* Ridl., Bull. Misc. Inform. Kew 1938: 283. 1938, *nom. illegit.*, non *T. borneensis* Slooten (1919).
Type: Borneo, Bangarmassing, *J. Motley 380* (K barcode K000786585, lectotype designated here).

Notes

Nanakorn (1986: 196) referred to a specimen in G-DC from the distribution of the East India Company Herbarium under number 4014D as type of *Combretum acuminatum* Roxb. Some error crept in here – Nanakorn's proposed type is a specimen of *Anogeissus acuminata* (Roxb. ex DC.) Wall. ex Guillem. & Perr. rather than *Combretum*, and is certainly not original material for Roxburgh's name in *Combretum*. Therefore, the later typification by du Puy and Telford to a Roxburgh drawing is accepted here.

1.2 *Combretum caudatum* (Craib) O.Maurin & Boatw., Phytotaxa 451: 232. 2020

Bas.: *Quisqualis caudata* Craib, Bull. Misc. Inform. Kew 1930: 164. 1930.
Type: Thailand, Ranawng, Kao Pawta, Chongdong, 21 January 1929, *A.F.G. Kerr 16797* (K barcode K000786136, lectotype selected by Maurin et al. (2020: 232); isolectotypes ABD, BK barcode BK257801, BM barcode BM000947035).

Notes

Maurin et al. (2010) included this species in their analysis that showed it to be sister to the other '*Quisqualis*' species sampled and to be part of a subclade of *Combretum* subgenus *Cacoucia*.

1.3 *Combretum chinense* Roxb. ex G.Don, Trans. Linn. Soc. 15: 417, 432-433. 1827

Type: Calcutta Botanical Garden, *W. Roxburgh s.n.* (G barcode G00177910, lectotype selected by Nanakorn (1986: 174).

(=) *Combretum chinense* Roxb., Fl. Ind. 2: 230. 1832, as 'chinensis', *nom. illegit.*, non *C. chinense* Roxb. ex G.Don (1827).
Type: India, Calcutta Botanical Garden, *W. Roxburgh s.n.* (G barcode G00177910, lectotype selected by Nanakorn (1986: 174).

(=) *Combretum chinense* Roxb. var. *pubescens* King, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 66: 339. 1897.
Type: Peninsular Malaysia, Perak, Sungai Ryah, October 1880, *Dr King's Collector 889* (K barcode K001129737, lectotype designated here).

(=) *Combretum annulatum* Craib, Bull. Misc. Inform. Kew 1929: 113. 1929.
Type: Thailand, Chumpawn, Ta Ngaw, 17 January 1917, *A.F.G. Kerr 11488* (K barcode K000786590, lectotype selected by Gangopadhyay and Chakrabarty 1997: 314; isolectotypes ABD, BK barcode BK257787, BM barcode BM000947049, TCD barcode TCD0015621).

(=) *Combretum annulatum* Craub var. *orbiculare* Craib, Fl. Siam. Enum. 1(4): 614. 1931.
Type: Thailand, Puket, Ranawng, Kampuam, 29 January 1929, *A.F.G. Kerr 16881* (K (2 sheets) barcodes K000786589, K001129727, lectotype designated here; isolectotypes ABD, BM barcode BM000947050).

Notes

There has been considerable confusion about the name *Combretum chinense*. It was first published by William Roxburgh in his *Hortus Bengalensis* (Roxburgh 1814) but was a nomen nudum in the absence of any description or reference to a published description. As with many Roxburgh names, it was first validated by another author before it appeared with a description in one of the publications of Roxburgh's works after his death. George Don described *Combretum chinense* Roxb. in 1827 (Don 1827), before Roxburgh's own description was finally published in 1832 (Roxburgh 1832). Don referred to a Roxburgh specimen in the herbarium of A.B. Lambert. There is a relevant Roxburgh specimen now in G that appears to be annotated by Lambert. Exell (1954) argued that this was not Don's type as it did not match all the details in Don's description. He therefore treated *C. chinense* Roxb. ex G.Don as a confused name and referred the Malesian material to *Combretum yunnanese* Exell. Nanakorn (1985) disagreed, and effectively lectotypified both the Don and Roxburgh names to the G specimen. I find that the Malay Peninsula material is a reasonable match to the Roxburgh lectotype (image available online) and therefore employ *C. chinense* Roxb. ex G.Don for the specimens.

1.4 *Combretum densiflorum* (Wall. ex Planch.) I.M.Turner, Phytotaxa 451: 232. 2020

Bas.: *Quisqualis densiflora* Wall. ex Planch., Fl. Serres 6: 348. 1851.
Type: Peninsular Malaysia, Penang, *G. Porter s.n.* [EIC 4011] (K-W barcode K001117910, lectotype selected by Maurin et al., 2020: 232; isolectotypes BR barcode BR0000005639281, GZU barcode GZU000273166, K barcode K000786138, M barcode M0146742, P (×3) barcodes P01901448, P01901447, P01901446, PH barcode PH00023582

(=) *Sphalanthus confertus* Jack, Malayan Misc. 2(7): 55–56. 1822. – *Quisqualis conferta* (Jack) Exell, J. Bot. 69: 122. 1931.
Type: *W. Jack s.n.* (G barcode G00446750, lectotype selected by Exell (1931: 122).

Notes

The oldest name for this species is *Sphalanthus confertus* Jack, but *Combretum confertum* (Benth.) M.A.Lawson, the accepted name of an African species, blocks the transfer of Jack's name to *Combretum*.

1.5 *Combretum indicum* (L.) DeFilipps, Useful Pl. Dominica 277. 1998

Bas. *Quisqualis indica* L., Sp. Pl., ed. 2. 1: 556. 1762.
Type: [published illustration] "Quis qualis" in Rumphius, Herb. Amboin. 5: t. 38. 1747 (lectotype selected by Merrill (1917: 390).

(=) *Kleinia quadricolor* Crantz, Inst. Rei Herb. 2: 488. 1766.
Type: [published illustration] "Quis qualis" in Rumphius, Herb. Amboin. 5: t. 38. 1747 (lectotype selected by Maurin et al. (2020: 233).

(=) *Quisqualis glabra* Burm.f., Fl. Ind.: 104, t. 28, f. 2. 1768.
Type: Java, 1758, *Anon. s.n.* (G-PREL barcode G00805923, lectotype selected by Maurin et al. (2020: 233).

(=) *Quisqualis pubescens* Burm.f., Fl. Ind.: 104. 1768.
Type: [published illustration] "Quis qualis" in Rumphius, Herb. Amboin. 5: t. 38. 1747 (lectotype selected by Merrill (1917: 390).

(=) *Quisqualis ebracteata* P.Beauv., Fl. Oware 1: 56, 57, t. 35. 1806.
Type: Oware or Bénin, *Palisot de Beauvois s.n.* (G barcode G00446747 [2 sheets], lectotype selected by Maurin et al. (2020: 233).

(=) *Quisqualis obovata* Schumach. & Thonn., Beskr. Guin. Pl. 218-219. 1827.
Type: Guinea, *P. Thonning 315* (C barcode C10004457, lectotype selected by Hepper (1976: 40).

(=) *Quisqualis indica* Lour., Fl. Cochinchin. 274. 1790, *nom. illegit.*, non *Q. indica* L. (1762).
– *Quisqualis loureiroi* G.Don, Gen. Hist. 2: 667. 1832, as 'Loureiri'.
Type: *J. de Loureiro s.n.* (BM barcode BM000947033, lectotype selected at the first step by Exell 1931: 124, and at the second step by Maurin et al. (2020: 233).

(=) *Quisqualis villosa* Roxb., Fl. Ind. 2: 426. 1832. – *Quisqualis indica* var. *villosa* (Roxb.) Kurz, Forest Fl. Burma 1: 467. 1877.
Type: India, *W. Roxburgh s.n.* (BR barcode BR000000583537, lectotype selected by Maurin et al. (2020: 233).

(=) *Quisqualis sinensis* Lindl., Edwards's Bot. Reg. 30: t. 15. 1844.
Type: [published illustration] 'Quisqualis sinensis' in Lindley, Edwards's Bot. Reg. 30: t. 15. 1844 (lectotype selected by Maurin et al. (2020: 233).

(=) *Quisqualis spinosa* Blanco, Fl. Filip., ed. 2: 254, 1845.
Type: Philippines, Palawan, Taytay, 9 May 1913, *Merrill: Species Blanconae No. 582* (US barcode US00623716, neotype selected by Maurin et al. (2020: 233); isoneotypes BM, K).

(=) *Quisqualis longiflora* C.Presl, Epimel. Bot. 216. 1851.
Type: Martaban Helfer (not traced).

(=) *Quisqualis grandiflora* Miq., J. Bot. Neerl. 1: 119. 1861.
Type: China austr., *R. Krone 146* (U barcode U.1217341, lectotype selected by Maurin et al. (2020: 233).

(=) *Quisqualis indica* var. *oxypetala* Kurz, Forest Fl. Burma 1: 467. 1877.
Type: Burma, Ava, Kakhyen Hills (not traced).

1.6 *Combretum langkawiense* O.Maurin & Christenh., Phytotaxa 451: 233. 2020

Replaced synonym: *Quisqualis densiflora* var. *parvifolia* Ridl., Fl. Malay Penins. 1: 711. 1922.
Type: Peninsular Malaysia, Langkawi, Dayang Bunting, November 1916, *H.C. Robinson 6198* (K barcode K000786137, lectotype selected by Maurin et al. (2020: 233); isolectotype BM barcode BM000947036 (fragment ex K).

(≡) *Quisqualis parvifolia* (Ridl.) Exell, J. Bot. 69: 123. 1931.

1.7 *Combretum latifolium* Blume, Bijdr. (13): 641. 1826

Type: *C.L. Blume s.n.* (NY barcode NY00245959, lectotype designated at the first step by Gangopadhyay and Chakrabarty (1997: 311), and at the second step here).
(≡) *Embryogonia latifolia* (Blume) Blume, Mus. Bot. 2: 122. 1856.

(=) *Combretum extensum* Roxb. ex G.Don, Trans. Linn. Soc. 15: 422. 1827.
Type: India orientalis, *W. Roxburgh s.n.* (G barcode G00446751, lectotype designated here).

(=) *Combretum extensum* Roxb., Fl. Ind. 2: 229. 1832, nom. illegit., non *C. extensum* Roxb. ex G.Don (1827).
Type: [unpublished illustration] Icones Roxburghianae No. 1830 (K, lectotype designated here).

(=) *Combretum macrophyllum* Roxb., Fl. Ind. 2: 231. 1832.
Type: not traced.

(=) *Combretum rotundifolium* Roxb., Fl. Ind. 2: 226-227. 1832, *nom. illegit*., non. *C. rotundifolium* Rich. (1792). – *Combretum cyclophyllum* Steud., Nomencl. Bot., ed. 2, 1: 400. 1840.
Type: *W. Roxburgh s.n.* (BM barcode BM01382528, lectotype designated here).

(=) *Combretum wightianum* Wall. ex Wight & Arn., Prodr. Fl. Ind. Orient. 316. 1834.
Type: EIC 4007 (CAL, lectotype selected by Gangopadhyay and Chakrabarty (1997: 299).

(=) *Combretum formosum* Griff., Not. Pl. Asiat. 4: 682. 1854, *nom. illegit*., non *C. formosum* G.Don (1827).
Type: Burma, Mergue, in sylvis Kulweng, Dec 1834 (not traced).

(=) *Combretum horsfieldii* Miq., Fl. Ned. Ind. 1(1): 609. 1856.
Type: Java, *Horsfield s.n.* (holotype K barcode K0011297290).

(=) *Combretum latifolium* var. *ellipticum* Miq., Fl. Ned. Ind. 1(1): 609. 1856, as 'elliptica'.
Type: Java, *Horsfield s.n.* (holotype K barcode K001129730).

(=) *Combretum leucanthum* Van Heurck & Müll.Arg., Observ. Bot. Descript. Pl. Nov. Herb. Van Heurckiani 2: 240. 1871.
Type: Ceylon, *Thwaites C.P. 1601* (syntypes BR, G).

(=) *Combretum platyphyllum* Van Heurck & Müll.Arg., Observ. Bot. Descript. Pl. Nov. Herb. Van Heurckiani 2: 242. 1871.
Type: EIC 3995 (lectotype G, selected by Gangopadhyay and Chakrabarty (1997: 299).

Notes

In the protologue for *Combretum latifolium* Blume gave the locality '*in sylvis montosis Salak*'. I have failed to locate any Blume specimens that mention Mt Salak, so follow Gangopadhyay and Chakrabarty (1997: 311)

who selected unlocalised Blume material in NY as the type. As there are actually two specimens present in NY, a second-stage lectotypification is made here. Gangopadhyay and Chakrabarty (1997: 311) designated a Horsfield specimen in CAL as lectotype for *C. horsfieldii*, but the set of Horsfield specimens seen by Miquel when working on *Flora van Nederlandsch Indië* are in Kew and the single specimen present is therefore the holotype of Miquel's name.

1.8 *Combretum nigrescens* King, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 66: 340. 1897

Type: Peninsular Malaysia, Perak, October 1882, *Dr King's Collector 3469* (K barcode K000786600, lectotype designated here; isolectotype BM).

(=) *Combretum kunstleri* King, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 66: 340. 1897. – *Combretum nigrescens* var. *kunstleri* (King) Ridl., Fl. Malay. Penins. 1: 710. 1922.
Type: Peninsular Malaysia, Perak, Larut, October 1884, *Dr King's Collector 6664* (K barcode K000786597, lectotype designated here; isolectotype BM).

(=) *Combretum scortechinii* King, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 66: 341. 1897.
Type: Peninsular Malaysia, Perak, Goping, April 1885, *Fr. B. Scortechini 1942* (K barcode K000786602, lectotype designated here).

(=) *Combretum glandulosum* Slooten, Bijdr. Combret. Flacourt. Ned.-Ind. 39. 1919, *nom. illegit*., non *C. glandulosum* F.Hoffm. (1889). – *Combretum adenophorum* Slooten, Bull. Jard. Bot. Buitenzorg, sér. 3, 6: 56. 1924.
Type: Sumatra, 1880 *H. Forbes 3100* (L barcode L.2500736, lectotype designated here; isolectotypes BM barcode BM000947044, L barcode L.2500737).

(=) *Combretum elmeri* Merr., Univ. Calif. Publ. Bot. 15: 214. 1929.
Type: Borneo, British North Borneo [Sabah], Elphinstone Province, Tawao [Tawau], October 1922-March 1923, *A.D.E. Elmer 21440* (UC barcode UC290634, lectotype designated here; isolectotypes A barcode A00068596, BISH barcode BISH1001094, BM(2 sheets), BR barcode BR0000005629534, C barcode C10009529, CAS barcode CAS0033025, F barcode F0054644F, GH barcode GH00068595, HBG barcode HBG514719, K barcode K000786582, L barcode L0009752, M barcode M0146601, MO barcode MO-176152, MSC barcode MSC0091506, NY barcode NY00245957, PH barcode PH00006505, S sheet no. S09-25745, SINGx2 barcode SING0055423, U barcode U0226823, US(2 sheets) barcodes US00810961 US00810960, Z barcode Z-000002869).

(=) *Combretum elmeri* Merr. var. *glabrescens* Merr., Univ. Calif. Publ. Bot. 15: 215. 1929.
Type: Borneo, British North Borneo [Sabah], Elphinstone Province, Tawao [Tawau], October 1922-March 1923, *A.D.E. Elmer 21561* (UC barcode UC290635, lectotype designated here; isolectotypes A barcode A00068598, BISH barcode BISH1001095, BR barcode BR0000005629206, C barcode C10009531, CAS barcode CAS0032976, GH barcode GH00068597, HBG barcode HBG514718, K barcode K000786581, L barcode L0009753, M barcode M0146600, MICH barcode MICH1192150, MIN barcode MIN1002830, NY barcode NY00245958, S sheet no. S09-25747, SING barcode SING0055422, U barcode U0226815, US barcode US00117555. Z barcode Z-000002870).

(=) *Combretum kunstleri* var. *rectinerve* Craib, Fl. Siam. Enum. 1: 617. 1931.
Type: Thailand, Pattani, Bukit, *A.F.G. Kerr 7126* (K barcode K000786588, lectotype designated here; isolectotypes ABD, BK barcode BK257790, BM barcode BM000947045).

1.9 *Combretum porterianum* (C.B.Clarke) Wall. ex Craib., Fl. Siam. Enum. 1(4): 618. 1931

Bas.: *Combretum chinense* var. *porterianum* C.B.Clarke in J.D.Hooker, Fl. Brit. India 2: 457. 1878.

(≡) *Combretum wallichii* DC. var. *porterianum* (C.B.Clarke) M.Gangop. & Chakrab., J. Econ. Taxon. Bot. 17: 681. 1993.
Type: EIC 4000 (CAL, lectotype selected by Gangopadhyay and Chakrabarty 1997: 324; isolectotypes K barcode K000786603, K-W barcode K001117875, M M0146610).

1.10 *Combretum punctatum* Blume, Bijdr. 640. 1826

Type: Java, G. Parang, *C.L. Blume s.n*. (L barcode L0844301, lectotype designated here).

Notes

In the protologue, Blume referred to '*in montosis Parang, et ad pedem montium Salak, Tjerimai etc*'. Gangopadhyay and Chakrabarty (1997) designated a Blume

specimen in NY as the lectotype, but it is not annotated with any of the locations mentioned by Blume. There are specimens with these localities stated in L. Therefore, a lectotype is here designated from one of the specimens in L to supersede the designation of Gangopadhyay and Chakrabarty.

1.10a *Combretum punctatum* var. ***punctatum***

1.10b *Combretum punctatum* var. ***squamosum*** (Roxb. ex G.Don) M.Gangop. & Chakrab., J. Econ. Taxon. Bot. 17: 680. 1993

Bas.: *Combretum squamosum* Roxb. ex G.Don, Trans. Linn. Soc. 15: 419, 438. 1827.
Type: Roxburgh in herb. Linn. Soc. (not traced).

(≡) *Poivrea squamosa* (Roxb. ex G.Don) Walp., Repert. Bot. Syst. 2: 64. 1843.

(≡) *Combretum punctatum* subsp. *squamosum* (Roxb. ex G.Don) Exell, Fl. Males. ser. 1 4: 539. 1954.

(=) *Combretum squamosum* Roxb., Fl. Ind. 2: 231. 1832, *nom. illegit.*, non *C. squamosum* Roxb. ex G.Don.

(=) *Combretum distillatorium* Blanco, Fl. Filip. 295. 1837.
Type: Philippines, Luzon, Bulacan, Maon River, *Merrill: Species Blancoanae 847* [M. Ramos leg.] (US barcode US00623715, neotype designated here; isoneotype BM).

(=) *Combretum lepidotum* C.Presl, Abh. Königl. Böhm. Ges. Wiss., ser. 5, 3: 572. 1845
Type: ?Burma, *J.W. Helfer 116* (PR sheet no. 615825, lectotype designated here).

(=) *Combretum squamosum* var. *luzonicum* C.Presl, Abh. Königl. Böhm. Ges. Wiss., ser. 5, 6: 576. 1851.
Type: Philippines, *H. Cuming 1122* (syntype BM).

(=) *Combretum squamosum* var. *aureum* C.B. Clarke in Hooker, Fl. Brit. Ind. 2: 456. 1878.
Type: Burma, Prome Hills, 1827, *N. Wallich 252* [EIC 3988[A] p.p.] (K barcode K001117838l, lectotype designated at the first step by Gangopadhyay and Chakrabarty (1997: 314) and at the second step here).

(=) *Combretum foliatum* Craib, Bull. Misc. Inform. Kew 1930: 163. 1930.
Type: Thailand, Puket, Pang-nga, Nop Pring, 25 February 1929, *A.F.G. Kerr 17239* (K (2 sheets) barcodes K000786592, K000786593, lectotype designated here; isolectotypes BK barcode BK257797, BM barcode BM000947046).

(=) *Combretum squamosum* var. *dissitum* Craib, Flor. Siam. Enumerat. 1: 620. 1931.
Type: Thailand, Maharat, Lampang, Me Tia, 28 April 1923, *Winit 860* (K barcode K001129728, lectotype designated here).

Notes

I prefer to recognise the infraspecific taxa of *Combretum punctatum* at the rank of variety following Gangopadhyay and Chakrabarty (1997) and Chen and Turland (2007), rather than subspecies (Exell 1954).

1.11 *Combretum quadrangulare* Kurz, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 43(3): 188. 1874

Type: Burma, Tenasserim, *Helfer s.n.* [Kew distrib. no. 2181] (lectotype CAL, selected by Gangopadhyay and Chakrabarty (1997: 317).

(=) *Combretum quadrangulare* var. *lanceolatum* Gagnep., Fl. Gen. 2: 746. 1920.
Type: Cambodia, Prèy-kdey, Kg Speu, 25 April 1909, *Magnen et al. s.n.* [Châtillon leg.] (P barcode P05046162, lectotype designated here).

1.12 *Combretum roxburghii* Spreng., Syst. Veg. 2: 231. 1825

Replaced synonym: *Combretum decandrum* Roxb., Pl. Coromandel 1: 43, t. 59. 1796, *nom. illegit.*, non *C. decandrum* Jacq. (1760).
Type: *W. Roxburgh s.n.* [EIC 4009[A]] (K-W barcode K001117895, lectotype designated here).

(≡) *Poivrea roxburghii* (Spreng.) DC., Prodr. 3: 18. 1828.

(≡) *Pentaptera roxburghii* (Spreng.) Tul., Ann. Sci. Nat., Sér. 4 6: 84. 1856.

(=) *Combretum klossii* Ridl., J. Fed. Malay States Mus. 10: 90. 1920.
Type: Thailand, Koh Pipidon [Ko Phi Phi Don], *C.B. Kloss 6556* (K barcode K000786591, lectotype designated here; isolectotype SING barcode SING0055423).

Notes

Roxburgh's name was an illegitimate later homonym when it was published. Gangopadhyay and Chakrabarty (1997) took up *Combretum album* Pers. as the correct name. This appears in parentheses after *C. decandrum* in Persoon's *Synopsis plantarum* (Persoon 1805). The nature of Persoon's parenthetical names is controversial. In the Preface (p. ix), Persoon wrote 'E contrario in parenthesi nomen quasi secundarium passim addidi, quo idea plantae forte distinctior concipi possit.' It is difficult to equate Persoon's 'quasi-secondary' names with replacement or alternative names as currently employed, so *Combretum album* Pers. is not considered validly published. *Combretum roxburghii* is therefore the earliest replacement name for *C. decandrum* Roxb.

1.13 *Combretum sundaicum* Miq., Fl. Ned. Ind., Eerste Bijv. 327. 1861

Type: Sumatra, prov. Lampong, Tiga-nennin, *HB 4330* (U barcode U0001193, lectotype designated here).

(=) *Combretum oliviforme* A.C.Chao, Acta Phytotax. Sin. 7: 244. 1958, 'olivaeforme'.
Type: China, Hainan, Bak Sa, 23 July 1936, *S.K. Lau 27571* (holotype IBSC barcode IBSC0004026; isotypes A barcode A00244267, IBK barcode IBK00127780, NAS barcode NAS00047141, PE barcode PE00994471.

(=) *Combretum oliviforme* A.C.Chao var. *yaxianense* Y.R.Ling, Acta Phytotax. Sin. 19: 388. 1981.
Type: China, Hainan, [Ya Xian], 11 August 1933, *C. Wang 33616* (holotype IBSC barcode IBSC0004027; isotype A barcode A00068593).

1.14 *Combretum tetralophum* C.B.Clarke in Hooker, Fl. Brit. India 2: 454. 1878

Type: Peninsular Malaysia, Malacca, 1845, *W. Griffith s.n.* (K barcode K000786605, lectotype selected by Lecompte (1969: 49).

(≡) *Combretum tetragonocarpum* var. *tetralophum* (C.B.Clarke) M.Gangop. & Chakrab., J. Econ. Taxon. Bot. 17: 697. 1993.

(=) *Combretum wrayi* King, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 66: 339. 1897.
Type: Peninsular Malaysia, Perak, Matang, July 1888, *L. Wray 2504* (K barcode K000786607, lectotype designated here; isolectotype BM barcode BM000947040).

1.15 *Combretum trifoliatum* Vent., Choix Pl. t. 58. 1808

Type: Java, *La Haye s.n.* (G barcode G00177911, lectotype selected by Lecompte (1969: 40).

(≡) *Cacoucia trifoliata* (Vent.) DC., Prodr. 3: 22. 1828.

(=) *Combretum lucidum* Blume, Bijdr. Fl. Ned. Ind. 641. 1826. – *Cacoucia lucida* (Blume) Hassk., Flora 27: 607. 1844. – *Embryogonia lucida* (Blume) Blume, Mus. Bot. Lugd.-Bat. 2: 122. 1856.
Type: Java, Pamanoekang, *C.L. Blume 1543* (L barcode L0844262, lectotype designated here).

(=) *Terminalia lancifolia* Griff., Not. Pl. Asiat. 4: 685. 1854.
Type: Moulmein ad marginem sylvarum (not traced).

2. *Getonia* Roxb., Pl. Coromandel 1: 61, t. 87. 1798.

Type: *Getonia floribunda* Roxb.

(≡) *Calycopteris* Poir., Encycl., Suppl. 2: 41. 1811, *nom. illegit. superfl.*

Notes

Chen and Turland (2007: 315) explained why *Calycopteris* Lam. was not validly published and hence *Getonia* is the correct name for the genus.

2.1 *Getonia floribunda* Roxb., Pl. Coromandel 1: 61, t. 87. 1798

Type: [published illustration] Roxburgh, Pl. Coromandel 1: t. 87. 1798 (lectotype designated here).

(≡) *Calycopteris floribunda* (Roxb.) Lam. ex Poir., Encycl. Suppl. 2: 41. 1811.

(=) *Getonia nitida* Roth, Nov. Pl. Sp. 217. 1821. – *Getonia nutans* Roxb. ex DC., Prodr. 3: 15. 1828, *nom. illegit. superfl.* – *Calycopteris nutans* Kurz, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 46(2): 59. 1877, *nom. illegit. superfl.*
Type: *B. Heyne s.n.* [EIC 4013A] (K-W barcode K001117915, neotype designated here, excluding material on sheet annotated 'c' in pencil).

(=) *Getonia nutans* var. *brachystachya* DC., Prodr. 3: 15. 1828.
Type: ex herb. Thibaud (holotype G-DC IDC800 475/24).

(=) *Getonia nutans* Roxb., Fl. Ind. 2: 428. 1832, *nom. illegit.*, non *G. nutans* Roxb. ex DC. (1828)
Type: *W. Roxburgh s.n.* [EIC 4012[A]] (K-W barcode K001117911, lectotype designated here excluding material labelled 'B' in pencil on the sheet).

(=) *Calycopteris nutans* Kurz var. *roxburghii* Kurz, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 46(2): 59. 1877.
Type: not traced.

(=) *Calycopteris nutans* Kurz var. *glabriuscula* Kurz, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 46(2): 59. 1877.
Type: not traced.

Notes

Gangopadhyay and Chakrabarty (1997: 296) referred to both the published plate (t. 87) and the unpublished drawing as the type of *Getonia floribunda*. As both elements are original material, the typification is not effective. A new lectotypification to the published plate is therefore made here. There are some Roxburgh specimens extant, but as this name was published early in Roxburgh's career, it is difficult to be certain that collections were made before the publication date as Roxburgh very rarely provided dates (or much other information) on his specimens.

3. *Lumnitzera* Willd., Neue Schriften Ges. Naturf. Freunde Berlin 4: 186–187. 1803

Type: *Lumnitzera racemosa* Willd.

(=) *Pyrrhanthus* Jack, Malayan Misc. 2(7): 57. 1822.
Type: *Pyrrhanthus littoreus* Jack

(=) *Problastes* Reinw., Syll. Pl. Nov. 2: 10. 1825 ['1828'].
Type: *Problastes cuneifolia* Reinw.

(=) *Pokornya* Montrouz., Mem. Acad. Lyon 10: 201. 1860.
Type: *Pokornya ettingshausenii* Montrouz.

Key to *Lumnitzera* species

1. Inflorescences terminal, flowers pedicellate, petals red; stamens at least ×2 as long as erect petals..... 3.1 *L. littorea*

   Inflorescences axillary; flowers more or less sessile, petals white, stamens scarcely exceeding length of erect petals..... .....3.2. *L. racemosa*

3.1 *Lumnitzera littorea* (Jack) Voigt, Hort. Suburb. Calcutt. 39. 1845

Bas.: *Pyrrhanthus littoreus* Jack, Malayan Misc. 2(7): 57. 1822.
Type: Sumatra, *W. Jack s.n.* (E barcode E00273921, lectotype designated here).

(≡) *Lumnitzera coccinea* Wight & Arn., Prodr. Fl. Ind. Orient. 316. 1834, *nom. illegit. superfl.*

(≡) *Bruguiera littorea* (Jack) Steud., Nomencl. Bot., ed. 2, 1: 231. 1840.

(=) *Laguncularia coccinea* Gaudich., Voy. Uranie, Bot. (2): 68. 1826.
Type: Marianas, *C. Gaudichaud-Beaupré s.n.* (P barcode P01901322, lectotype designated here).

(=) *Laguncularia purpurea* Gaudich., Voy. Uranie, Bot. (12): 481. 1830. – *Lumnitzera purpurea* (Gaudich.) C.Presl, Repert. Bot. Syst. 1: 155. 1833.
Type: Marianas, *C. Gaudichaud-Beaupré s.n.* (P barcode P01901322, lectotype designated here).

(=) *Lumnitzera pedicellata* C.Presl, Reliq. Haenk. 2: 23. 1830. – *Laguncularia haenkei* Endl., Ann. Wiener Mus. Naturgesch. 1: 180. 1836, *nom. illegit. superfl.* – *Laguncularia pedicellata* (C.Presl) Steud., Nomencl. Bot., ed. 2, 2: 5. 1840.
Type: Marianas, *T.P.X. Haenke s.n.* (PRC barcode PRC450418 lectotype designated here; isolectotypes HAL barcode HAL118786, LE barcode LE00016815, PR sheet nos. 25245a, 25245b).

(=) *Petaloma coccineum* Blanco, Fl. Filip. 345. 1837, as 'coccinea'.
Type: Philippines, Luzon, Tayabas Province, Mt Kinatakian, 6 April 1913, *Merrill: Species Blancoanae No. 521* [L. Escritor leg.] (US barcode US 00623717, neotype designated here; isoneotypes BM, K barcode K001129749).

(=) *Lumnitzera pentandra* Griff., Not. Pl. Asiat. 4: 684. 1854. Icon. Pl. As. T. 644A 1854
Type: Mergue, Inter Rhizophora, Madamacca, Sept 1834, Griffith (not traced).

Notes

Gangopadhyay and Chakrabarty (1997: 326) selected a specimen from K-W under number 4018A (K001117945) as lectotype of *Pyrrhanthus littoreus* Jack. However, this specimen was collected by Wallich from

Pulau Dinding in 1822. It seems very unlikely Jack saw the specimen, but the typification would stand as a neotypification. However, there is a Jack specimen clearly labelled in E. This is here designated as lectotype to supersede the earlier designation.

Laguncularia coccinea Gaudich. was first validated in part 2 of the *Voyage … l'Uranie* rather than part 11 as generally cited: "une combrétacée du genre *Laguncularia* (*L. coccinea*), planche 104, et qui est le kada-kandel de Rheed. Mal. 6, planche 37, à fleurs rouge-ponceau très-vif, désigné ici sous le nom de guia-guia." The Rheede element actually refers to the white-flowered *Lumnitzera racemosa*, but Gaudichaud-Beaupré's mention of "very bright poppy-red flowers" seems sufficient to distinguish the species as this is a highly distinctive character. There also seems to have been confusion over the chosen epithet with *L. purpurea* being used in part 12, though apparently referring to the same taxon. These two names are lectotypified to the same specimen from Guam here.

3.2 *Lumnitzera racemosa* Willd., Neue Schriften Ges. Naturf. Freunde Berlin 4: 187. 1803

Type: India, *J.G. Klein s.n.* (B-W barcode B-W08141-010, lectotype selected by Wickens (1973: 93); isolectotype DNA (fragment).

(=) *Funckia karakandel* Dennst., Schlüssel Hortus Malab. 32. 1818.
Type: [published illustration] Rheede, Hort. Malab. 6: t. 37. 1685 (lectotype selected by Gangopadhyay and Chakrabarty (1997: 326).

(=) *Problastes cuneifolia* Reinw., Syll. Pl. Nov. 2: 10. 1828.
Type: [published illustration] Rheede, Hort. Malab. 6: t. 37. 1685 (lectotype selected by Gangopadhyay and Chakrabarty (1997: 329).

(=) *Bruguiera madagascariensis* DC., Prodr. 3: 28. 1828.
Type: [published illustration] Rheede, Hort. Malab. 6: t. 37. 1685 (lectotype selected by Gangopadhyay and Chakrabarty (1997: 326).

(=) *Petaloma alternifolium* Roxb., Fl. Ind. 2: 373. 1832, as 'alternifolia'.
Type: [published illustration] Rheede, Hort. Malab. 6: t. 37. 1685 (lectotype selected by Gangopadhyay and Chakrabarty (1997: 329).

(=) *Petaloma album* Blanco, Fl. Filip. 344. 1837, as alba.
Type: Philippines, Luzon, Province of Rizal, Maricaban, March 1914, *Merrill: Species Blancoanae No. 303* (US barcode US00623718, neotype designated here; isoneotypes BM, K barcode K001129748).

(=) *Pokornya ettingshausenii* Montrouz., Mem. Acad. Lyon 10: 201. 1860, 'Ettingshanseni'.
Type: Ile d'Art, Montrouzier (not traced).

(=) *Lumnitzera edulis* Blume ex Laness., Pl. Util. Col. Franç.: 256. 1886.
Type: New Caledonia, Marais de Gatope, 1861-1867, *E. Vieillard 2571* (K barcode K001129747, lectotype designated here).

(=) *Lumnitzera racemosa* var. *pubescens* Koord. & Valet., Meded. Lands Planten. 61: 33, 34. 1903
Type: Java, Ins. Karimon, Koorders (not traced).

4.1 *Terminalia* L., Syst. Nat. (ed. 12) 2: 665, 674. 1767, *nom. cons.*

Type: *Terminalia catappa* L.

(=) *Buceras* P.Browne, Civ. Nat. Hist. Jamaica 221. 1756, *nom. rejic.*
Type: *Bucida buceras* L.

(=) *Bucida* L., Syst. Nat. (ed. 10) 2: 1025, 1368. 1759, *nom. cons.* (against *Buceras* P.Browne) and *nom. rejic.* (against *Terminalia* L.).
Type: *Bucida buceras* L.

(=) *Adamaram* Adans., Fam. Pl. 2: 445. 1763, *nom. rejic.*
Type: *Terminalia catappa* L. (neotype selected by Exell (1931: 125).

(=) *Myrobalanifera* Houtt., Nat. Hist. 2(2): 485, t. 10, f. 2. 1774.
Type: *Myrobalanifera citrina* Houtt.

(=) *Pamea* Aubl., Hist. Pl. Guiane 946, t. 359. 1775, *nom. rejic.* (against *Buchenavia* Eichler).
Type: *Pamea guianensis* Aubl.

(=) *Tanibouca* Aubl., Hist. Pl. Guiane 448. 1775.
Type: *Tanibouca guianensis* Aubl.

(=) *Kniphofia* Scop., Intr. Hist. Nat.: 327. 1777, *nom. rejic.* (against *Kniphofia* Moench).
Type: *Terminalia catappa* L. (neotype designated here).

(=) *Chuncoa* Pav. in Juss., Gen. Pl. 76. 1789. – *Gimbernatia* Ruiz & Pav., Fl. Peruv. Prodr. 138, t. 36. 1794, *nom. illegit. superfl.*
Type: *Chuncoa amazonia* J.F. Gmel.

(=) *Badamia* Gaertn., Fruct. Sem. Pl. 2: 90. 1790.
Type: *Badamia commersonii* Gaertn.

(=) *Myrobalanus* Gaertn., Fruct. Sem. Pl. 2: 90. 1790. – *Terminalia* section *Myrobalanus* (Gaertn.) DC., Prodr. 3: 12. 1828.
Type: *Myrobalanus bellirica* Gaertn. (lectotype selected by Pfeiffer (1874: 394).

(=) *Catappa* Gaertn., Fruct. Sem. Pl. 2: 206. 1791. – *Terminalia* sect. *Catappa* (Gaertn.) DC., Prodr. 3: 10. 1828.
Type: *Catappa benzoin* Gaertn.

(=) *Hudsonia* A. Rob. ex Lunan, Hort. Jamaic. 2: 310. 1814, *nom. illegit*., non *Hudsonia* L. (1767).
Type: *Hudsonia arborea* A.Rob. ex Lunan.

(=) *Fatraea* Juss., Dict. Sc. Nat. 16: 206. 1820.
Type: *Fatraea buxifolia* Juss.

(=) *Ramatuela* Kunth, Nov. Gen. Sp. 7: 253, t. 656. 1825. – *Terminalia* sect. *Ramatuela* (Kunth) Alwan & Stace, Ann. Missouri Bot. Gard. 76(4): 1126. 1989, 'Ramatuella'.
Type: *Ramatuela argentea* Kunth

(=) *Conocarpus* sect. *Anogeissus* DC., Prodr. 3: 16. 1828. – *Anogeissus* (DC.) Wall. ex Guill. & al., Flor. Seneg. Tent. 1: 279. 1832.
Type: *Conocarpus acuminatus* Roxb. ex DC.

(=) *Pentaptera* Roxb. ex DC., Prodr. 3: 14. 1828.
Type: *Pentaptera arjuna* Roxb. ex DC. (lectotype designated here).

(=) *Vicentia* Allemão, Pl. Novas Brasil cum tab. 1844.
Type: *Vicentia acuminata* Allemão

(=) *Chicharronia* A.Rich., Hist. Phys. Cuba, Pl. Vasc. 529, t. 43. 1845. – *Terminalia* sect. *Chicharronia* (A.Rich.) Alwan & Stace, Fl. Neotrop. Monogr. 107: 187. 2010.
Type: *Chicharronia intermedia* A.Rich.

(=) *Buchenavia* Eichler, Flora 49(11): 164. 1866, *nom. cons.*
Type: *Bucida capitata* Vahl (lectotype selected by Stace (2007: 41).

(=) *Pteleopsis* Engl., Abh. Königl. Akad. Wiss. Berlin 1894: 25. 1894.
Type: *Pteleopsis variifolia* Engl.

(=) *Finetia* Gagnep., Notul. Syst. (Paris) 3: 278. 1916.
Type: *Finetia rivularis* Gagnep.

(=) *Terminaliopsis* Danguy in Lecomte et al., Madag. Bois Analamaz. 110. 1922; Bull. Mus. Natl. Hist. Nat. 29(1): 108. 1923.
Type: *Terminaliopsis tetrandrus* Danguy

Key to *Terminalia* species

1. Leaves spirally arranged, clustered at swollen ends of twigs 2

   Leaves generally opposite to subopposite, not clustered at twig ends, twig ends not notably swollen 8

2. Leaves generally exceeding 10 cm wide; petiole to 12 mm long ..... 4.3 *T. catappa*

   Leaves rarely exceeding 10 cm wide; petiole more than 12 mm long 3

3. Leaves with apex obtuse to acuminate 4

   Leaves with apex rounded to emarginate 7

4. Leaves with venation distinctly raised above in dry leaves; fruits without wings, densely velvety pubescent ..... 4.1 *T. bellirica*

   Leaves with venation more or less flush to sunken above in dry leaves; fruits winged or if not winged then glabrous to tomentose, but not densely velvety pubescent 5

5. Petioles not exceeding 2.5 cm long; fruits fleshy without wings ..... 4.6 *T. foetidissima*

   Petioles generally more than 2.5 cm long; fruits dry with 2 wings 6

6. Leaves glaucous below; fruits densely hairy with wings about as wide as long ..... 4.7 *T. glaucifolia*

   Leaves not glaucous below; fruits sparsely hairy with wings distinctly wider than long ..... 4.2 *T. calamansanai*

7. Leaves glaucous below; petioles 3 cm long or more; fruits winged ..... 4.10 *T. subspathulata*

   Leaves not glaucous below; petioles to 2.5 cm long; fruits not winged ..... 4.9 *T. phellocarpa*

8. Inflorescences axillary spikes; fruits generally with 2 wings ..... 4.8 *T. mucronata*

   Inflorescences panicles, fruits with 0 or 3 wings 9

9. Leaves with pair of glands on lamina margin near base rather than on petiole; fruits with three wings ....4.11 *T. triptera*

   Leaves with pair of glands generally visible on petiole rather than lamina; fruits without wings 10

10. Leaves to 6 cm wide, glabrous; fruits ellipsoid to fusiform apex beaked, endocarp with 5-angled sides..... 4.5 *T. citrina*

    Leaves generally more than 6 cm wide, hairy below; fruits globose to ovoid, apex rounded, not beaked, endocarp more or less round in cross section, not 5-angled..... .....4.4 *T. chebula*

4.1 *Terminalia bellirica* (Gaertn.) Roxb., Pl. Coromandel 2: 54, t. 198. 1805, as 'bellerica'

Bas.: *Myrobalanus bellirica* Gaertn., Fruct. Sem. Pl. 2: 90, t. 97, f. 2. 1790.
Type: [published illustration] Gaertner, Fruct. Sem. Pl. 2: t. 97, f. 2. 1790 (lectotype selected by Wickens (1990: 7).

(≡) *Terminalia myrobalana* B.Heyne ex Roth, Nov. Pl. Sp. 378. 1821, *nom. illegit. superfl.*

(=) *Myrobalanus taria* Buch.-Ham., Trans Linn. Soc. London 17: 159. 1835 ['1837']. – *Terminalia taria* Buch.-Ham., Trans Linn. Soc. London 17: 159. 1835 ['1837'].
Type: India, Mysore, *F. Buchanan-Hamilton s.n.* (BM, lectotype designated here).

(=) *Myrobalanus tania* Buch.-Ham. ex Kostel., Allg. Med.-Pharm. Fl. 4: 1497. 1835.
Type: [published illustration] 'Tani', Rheede, Hort. Malab. 4: t. 10. 1683 (lectotype designated here).

(=) *Terminalia punctata* Roth, Nov. Pl. Sp.: 381. 1821.
Type: *J.P. Rottler s.n.* (K barcode K000786123, neotype designated here).

(=) *Terminalia attenuata* Edgew., Trans. Linn. Soc. London 20: 46. 1846.
Type: India, Himalaya, altit. 4000 ped., near Jugutgurh, *M.P. Edgeworth 6* (K barcode K000786121, lectotype designated here).

(=) *Terminalia gella* Dalzell, Hooker's J. Bot. Kew Gard. Misc. 3: 227. 1851, as Gella.
Type: Crescit rar in Concano australiore (not traced).

(=) *Terminalia laurinoides* Teijsm. & Binnend. in Miquel, Fl. Ned. Ind. 1: 600. 1856. – *Terminalia bellirica* var. *laurinoides* (Teijsm. & Binnend.) C.B.Clarke in Hooker, Fl. Brit. India 2: 445. 1878. – *Myrobalanus laurinoides* (Teijsm. & Binnend.) Kuntze, Revis. Gen. Pl. 1: 237. 1891.
Type: Java, *J.E. Teijsmann s.n.* (L barcode L0843169, lectotype designated here).

4.2 *Terminalia calamansanai* (Blanco) Rolfe, J. Linn. Soc., Bot. 21: 310. 1884

Bas.: *Gimbernatia calamansanai* Blanco, Fl. Filip., ed. 2 266. 1845.
Type: Philippines, Mindanao, Butuan Subprovince, October 1913, *D.P. Miranda For. Bur. 20781* [Merrill: Species Blancoanae No. 605 p.p. (fruiting material only)] (US barcode US00623709, neotype designated here excluding flowering material mounted on the same sheet).

(=) *Pentaptera pyrifolia* C.Presl, Epimel. Bot. 215. 1851. – *Terminalia pyrifolia* (C.Presl) Kurz, Prelim. Rep. For. Veg. Pegu App. A: lix. 1875.
Type: Moulmein, *J.W. Helfer* (not traced).

(=) *Terminalia papilio* Hance, J. Bot. 15: 333. 1877.
Type: Vietnam, Ins. Phu Kok, *L. Pierre s.n.* [Herb. Hance 19745] (BM, lectotype designated here).

(=) *Terminalia bialata* var. *cuneifolia* C.B.Clarke in Hook.f., Fl. Brit. India 2: 449. 1878.
Type: Burma, Ava, 22 October [1826], *N. Wallich 315* [EIC 3972, p.p.] (K-W barcode K001117791, lectotype designated here).

(=) *Terminalia blancoi* Merr., Philipp. J. Sci., C 4: 645. 1909.
Type: Philippines, Luzon, Province of Rizal, February 1904, *Decades of Philippine Forest Flora No. 2* [*Ahern's Collector leg.*] (NY barcode NY00245999, lectotype designated here; isolectotype US barcode US00117589).

(=) *Terminalia calamansanai* var. *platypteris* Merr., Philipp. J. Sci., C 4: 646. 1909.
Type: Philippines, Luzon, Province of Zambales, Mar 1904, *W.M. Maule For. Bur. 371* (NY barcode NY00246001, lectotype designated here; isolectotype US barcode US00117606).

(=) *Terminalia calamansanai* var. *acuminata* Merr., Philipp. J. Sci., C 4: 646. 1909.
Type: Philippines, Luzon, Prov. Principe, Baler, August-October 1903, *E.D. Merrill 1067* (NY barcode

NY00246000, lectotype designated here; isolectotype US barcode US00117607).

(=) *Terminalia oryzetorum* Craib, Bull. Misc. Inform. Kew 1928: 69. 1928.
Type: Thailand, Mûang Pichit, 25 March 1922, *A.F.G. Kerr 5671* (K barcode K000786200, lectotype designated here; isolectotypes ABD, BM barcode BM000947099, NY barcode NY00245995, P barcode P02286610).

(=) *Terminalia latialata* C.T.White, J. Arnold Arbor. 10: 249. 1929.
Type: Papua New Guinea, Lower Vailala River, 15 March 1926, *L.J. Brass 1147* (A barcode A00068656, lectotype designated here; isolectotypes BM barcode BM000947096, BRI, K).

4.3 *Terminalia catappa* L., Mant. Pl. 1: 128. 1767

Type: *Anon. s.n.* (lectotype LINN 1221.1, selected by Byrnes 1977: 38).

(≡) *Juglans catappa* (L.) Lour., Fl. Cochinch. 2: 703. 1790.

(≡) *Myrobalanus catappa* (L.) Kuntze, Revis. Gen. Pl. 1: 237. 1891.

(≡) *Buceras catappa* (L.) Hitchc., Rep. (Annual) Missouri Bot. Gard. 4: 85. 1893.

(=) *Phytolacca javanica* Osbeck, Dagb. Ostind. Resa 276. 1757.
Type: Java, Pulau Panaitan, west of Tg. Parat, 3 October 1951, *J. van Borssum Waalkes 818* (K (2 sheets) barcode K001129735, K001129736, neotype designated here; isoneotype L L0843090).

(=) *Terminalia moluccana* Lam., Encycl. 1: 349. 1783.
Type: [published illustration] Rumph., Herb. Amboin. 1: t. 68. 1741 (lectotype selected by Merrill (1917: 390).

(=) *Terminalia subcordata* Humb. & Bonpl. ex Willd., Sp. Pl., ed. 4, 4(2): 968. 1806. – *Terminalia catappa* var. *subcordata* (Humb. & Bonpl. ex Willd.) DC., Prodr. 3: 11. 1828.
Type: Cuba, Havana, *F.W.H.A. Humboldt & A. Bonpland 1329* (B-W barcode B-W18940000, lectotype designated here; isolectotype P-Bonpl. barcode P00679491).

(=) *Terminalia intermedia* Bertero ex Spreng., Syst. Veg. 2: 359. 1825.
Type: Guadeloupe, 1816-1818, *C.G. Bertero s.n.* (TO).

(=) *Terminalia latifolia* Blanco, Fl. Filip. 376. 1837, nom. illegit., non *T. latifolia* Sw. (1788).
Type: Philippines, Luzon, Pangasinan Prov., Umingan, May 1914, *Merrill: Species Blancoanae No. 197* (US barcode US00689474, neotype designated here).

(=) *Terminalia paraensis* Mart., Flora 24 Beibl. 2: 24. 1841.
Type: Brazil, Pará, in sylvis Prov. Paraensis, *C.F.P. Martius s.n.* (M sheet no. M-0146722, lectotype designated here; possible isolectotype M sheet no. M-0146723).

(=) *Terminalia catappa* var. *chlorocarpa* Hassk., Tijdschr. Natuurl. Gesch. Physiol. 10: 145. 1843.
Type: non designatus.

(=) *Terminalia catappa* var. *macrocarpa* Hassk., Tijdschr. Natuurl. Gesch. Physiol. 10: 145. 1843.
Type: [published illustration] Rumph., Herb. Amboin. 1: t. 68. 1741 (lectotype designated here).

(=) *Terminalia catappa* var. *rhodocarpa* Hassk., Tijdschr. Natuurl. Gesch. Physiol. 10: 145. 1843.
Type: non designatus.

(=) *Terminalia rubrigemmis* Tul., Ann. Sci. Nat., Bot. sér. 4, 6: 102. 1856.
Type: Madagascar (not traced).

(=) *Terminalia catappa* var. *pubescens* Kurz, For. Fl. Brit. Burma 1: 454. 1877.
Type: Andamans, *W.S. Kurz* (not traced).

(=) *Terminalia burmanica* King ex Prain, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 73(5): 204. 1904.
Type: Burma, Sajein, August 1891, *Abdul Huk s.n.* (lectotype CAL accession no. 163973-4, selected by Gangopadhyay and Chakrabarty (1997: 343).

Notes

Phytolacca javanica Osbeck is the oldest name available for this well-known seashore species but its transfer to *Terminalia* is blocked by *T. javanica* Miq. Osbeck encountered the species on Nieu Eyland (New Island), now called Pulau Peucang, just off the South-West tip of Java. In the absence of any original material, a specimen collected from Pulau Panaitan quite nearby in the Sunda Straits, is here designated as neotype for Osbeck's name.

A name often cited in synonymy of *T. catappa* is *Badamia commersonii* Gaertn. However, the original figure and description, which refer to the fruit and seed alone, do not match *T. catappa*. The fruit is reported as oblong ellipsoidal with a slight obtuse beak and an

endocarp with six pronounced longitudinal ridges. It is based on a Commerson collection from Madagascar. The Tubingen herbarium has some material labelled *Badamia commersonii* from Gaertner's herbarium which consists of fruits of *T. catappa* that certainly differ from the original description and figure. I am inclined to follow Tulasne (1856: 92) who considered that *Badamia commersoni* was a species similar to *Terminalia exsculpta*.

Gangopadhyay and Chakrabarty (1997: 343) designated two plates from Rheede's *Hortus Malabaricus* as lectotype of *Badamia commersonii* Gaert., but as Gaertner did not cite Rheede, this cannot represent original material. In order to encourage further work on clarifying the true identity of the Gaertner species, below I designate the Gaertner figure as lectotype of *Badamia commersonii*.

Poiret published *Myrobalanus terminalia*, apparently entirely based on a figure in Lamarck's *Tableau Encyclopédique*. This figure is clearly a reworking of Gaertner's *Badamia* illustration, but as neither Poiret nor Lamarck referred to Gaertner or his name, Poiret's name has to be considered as nomenclaturally independent.

(=) *Badamia commersonii* Gaertn., Fruct. 2: 90, t. 97 f. 1(a-g). 1790, as 'Commersoni'.
Type: [published illustration] "Badamia Comersoni", Gaertner, Fruct. 2: t. 97 f. 1(a-g). 1790 (lectotype designated here).

(≡) *Terminalia badamia* DC., Prodr. 3: 12. 1828, *nom. illegit. superfl.*

(=) *Myrobalanus terminalia* Poir. in Lamarck, Encycl., Suppl. 3: 707. 1814, as Mirobolanus.
Type: [published illustration] Lamarck, Tabl. Encycl. 2, 5(1): Pl. 849 f. 2. 1799 (lectotype designated here).

4.4 *Terminalia chebula* Retz., Observ. Bot. 5: 31. 1788

Type: *J.G. Koenig s.n.* (lectotype LD acc. no. 1638155, selected by Fischer (1932: 57).

(≡) *Myrobalanus chebula* (Retz.) Gaertn., Fruct. Sem. Pl. 2: 91. 1790.

(≡) *Buceras chebula* (Retz.) A.Lyons, Pl. Nam.: 71. 1900.

(=) *Myrobalanifera citrina* Houtt., Handl. Pl.-Kruidk. 2: 486, t. 10 f. 2. 1774.
Type: [published illustration] Houttuyn., Handl. Pl.-Kruidk. 2: t. 10, f. 2. 1774 (lectotype selected by Turner (2014: 11).

(=) *Terminalia reticulata* B.Heyne ex Roth, Nov. Pl. Sp.: 381. 1821.
Type: India, Cannanore, February 1852, *R. Wight s.n.* [Peninsula Indiae Orientalis No. 1012] (K barcode K001129738, neotype designated here).

(=) *Terminalia aruta* Buch.-Ham. ex G.Don, Gen. Hist. 2: 659. 1832.
Type: Buchanan-Hamilton in herb. Lambert (not traced).

(=) *Terminalia gangetica* Roxb., Fl. Ind. 2: 437. 1832. – *Myrobalanus gangetica* (Roxb.) Kostel., Allg. Med.-Pharm. Fl. 4: 1497. 1835.
Type: not traced.

(=) *Terminalia tomentella* Kurz, J. As. Soc. Bengal 42: 80. 1873. – *Terminalia chebula* var. *tomentella* (Kurz) C.B.Clarke in Hooker, Fl. Brit. Ind. 2: 446. 1878. – *Myrobalanus tomentella* (Kurz) Kuntze, Revis. Gen. Pl. 1: 237. 1891.
Type: Burma, Kurz (not traced).

(=) *Terminalia glandulipetiolata* De Wild., Pl. Bequaert. 4(3): 344. 1928.
Type: Congo Belge, Eala, 29 December 1920, *A.A.P.J.G. Corbisier-Baland 1630* (BR barcode BR00000887320, lectotype designated here; isolectotypes BR barcode BR00000887353, BR00000887386, S acc. no. S09-25894).

4.5 *Terminalia citrina* (Gaertn.) Roxb. in Fleming, Asiat. Res. 11: 183. 1810

Bas.: *Myrobalanus citrina* Gaertn., Fruct. Sem. Pl. 2: 91, t. 97, f. 2n-s. 1790.
Type Cons.: Bangladesh, Mymensingh District, Gabtulli, 8 July 1872, *C.B. Clarke 17257* (K K000608176).

(≡) *Terminalia chebula* Retz. var. *citrina* (Gaertn.) Gagnep., Fl. Gen. Indo-Chine 2: 753. 1920.
(=) *Bucida comintana* Blanco, Fl. Filip. 856. 1837. – *Terminalia comintana* (Blanco) Merr., Philipp. J. Sci., C 4: 300. 1909.
Type: Philippines, Luzon, Batangas Prov., Mt Macolot, 5 Feb 1915, *E.D. Merrill: Species Blancoanae 780* [*M. Ramos leg.*] (US barcode US00623713, neotype designated here; isoneotype BM).

(=) *Embryogonia arborea* Teijsm. & Binnend., J. Bot. Neerl. 1: 365. 1861. – *Combretum arboreum* (Teijsm. & Binnend.) Miq., Ann. Mus. Bot. 4: 115. 1868. – *Terminalia teysmannii* Koord. & Valeton, Meded. Lands Plan-

tentuin 61: 20. 1902, *nom. illegit. superfl.* – *Terminalia arborea* (Teijsm. & Binnend.) Koord., Exkursionsfl. Java 2: 671. 1912.
Type: Java (not traced).

(=) *Terminalia citrina* var. *malayana* Kurz, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 45: 130. 1876.
Type: India, Ins. Nicobar, *Expedition Novara 75* [*leg. A. Jelinek 132*] (W sheet no. W 0080071, lectotype designated here).

(=) *Terminalia manii* King, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 66: 329. 1897.
Type: Nicobars, *Dr King's Collector 485* (CAL, lectotype selected by Gangopadhyay and Chakrabarty (1997: 348); isolectotypes BM, K barcode K001129734).

(=) *Terminalia multiflora* Merr., Govt. Lab. Publ. Philipp. 27: 34. 1904.
Type: Philippines, Luzon, Province of Rizal, Bosoboso, July 1903, *E.D. Merrill 2796* (K barcode K000786176, lectotype designated here; isolectotypes NY barcode NY00246011, US barcode US00117611).

(=) *Terminalia curtisii* Ridl., Bull. Misc. Inform. 1931: 449. 1931.
Type: Peninsular Malaysia, Penang, Waterfall, June 1896, *C. Curtis 3207* (K barcode K000786161, lectotype designated here; isolectotypes K barcode K000786160, SING barcode SING0055417).

4.6 *Terminalia foetidissima* Griff., Not. Pl. Asiat. 4: 685. 1854

Type: Burma, Mergui, March 1835, *W. Griffith s.n.* (syntype CAL).

(≡) *Myrobalanus foetidissima* (Griff.) Kuntze, Revis. Gen. Pl. 1: 237. 1891.

(=) *Terminalia sumatrana* Miq., Fl. Ned. Ind., Eerste Bijv. 326. 1861.
Type: Sumatra, Palembang, Toeboean, Ogan oeloe, *H.B. 3814* [J.E. Teijsmann leg.] (U barcode U0001196, lectotype designated here; isolectotype L barcode L.2493804).

(=) *Terminalia oocarpa* Merr., Publ. Bur. Sci. Gov. Lab. 17: 32. 1904, as *ovocarpa*.
Type: Philippines, Luzon, Province of Bataan, Lamao River, November 1903, *P.T. Barnes For. Bur. 67* (K barcode K000786170, lectotype designated here).

(=) *Terminalia ellipsoidea* Merr.
Type: Philippines, Mindoro, Pinamalayan, May 1903, *E.D. Merrill 2148* (K barcode K000786172, lectotype designated here; isolectotype US barcode US00117598).

(=) *Terminalia borneensis* Sloot., Bijdr. Combret. Flacourt. Ned.-Ind. 14. 1919.
Type: Borneo, *O. Beccari P.B. 2593* (K barcode K000786182, lectotype designated here; isolectotype FI-B).

4.7 *Terminalia glaucifolia* Craib, Bull. Misc. Inform. Kew 1928(2): 68. 1928

Type: Thailand, Doi Sootep, 20 August 1910, *A.F.G. Kerr 1328* (BK, lectotype selected by Nanakorn 1985, p. 81; isolectotypes ABD, BM, K barcode K000786198, P).

4.8 *Terminalia mucronata* Craib & Hutch., Bull. Misc. Inform. Kew 1909(9): 358. 1909

Type: Thailand, Chiengmai, Doi Sootep, 11 April 1909, *A.F.G. Kerr 593* (K (4 sheets) barcodes K000786194, K000786194, K000786195, K000786196, lectotype designated here; isolectotypes BM barcode BM000947102, L barcode L0009802, P barcode P02286601, TCD barcode TCD0016741).

(=) *Terminalia corticosa* Pierre ex Craib & Hutch., Bull. Misc. Inform. Kew 1909(9): 358. 1909.
Type: Vietnam, Baria, montibus Dinh, March 1862, *L. Pierre 203* (P barcode P02286603, lectotype designated here).

(=) *Terminalia thorelii* Gagnep., Not. Syst. 3: 287. 1916.
Type: Cambodia, Ubon, January anno. 1866-1868, *C. Thorel 2824* (P barcode P02286602, lectotype designated here).

(=) *Parinari euadenia* Kosterm., Bot. Tidsskr. 67: 321. 1973.
Type: Thailand, Chiengmai, Doi Sutep, 15 October 1958, *T. Sørensen et al. 5687* (holotype C C10017914).

Notes

The name *Terminalia corticosa* first appeared in Lanessan (1886: 315). The descriptive content of the account is slight – a size range of the tree and colour of the wood. This has been considered insufficient to validate the name (Gagnepain 1916: 215, Lecompte 1969:

88). Craib and Hutchinson described *Terminalia mucronata* in 1909. As well as a fairly detailed description, they included a diagnosis comparing *Terminalia mucronata* and *T. corticosa*. This effectively validated *T. corticosa* because the description of *T. mucronata* was sufficient to validate that name. It is not clear on what Craib and Hutchinson based their concept of *T. corticosa* as I have not found any flowering specimens in K or BM that they are likely to have seen. Possibly they visited Paris or had material on loan. In order to maintain continuity, I designate the specimen chosen by Lecompte (1969) as lectotype of *T. corticosa* Pierre ex Craib & Hutch. As Lecompte did not cite Craib and Hutchinson's publication, I here establish *T. mucronata* Craib & Hutch. as having priority over *T. corticosa* Pierre ex Craib & Hutch.

For *Terminalia thorelii*, the collection number 2823 was cited in the protologue. I have not traced this number and presume it was an error for 2824.

4.9 *Terminalia phellocarpa* King, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 66: 330. 1897

Type: Singapore, Bukit Mandai, 1892, *H.N. Ridley 3835* (K barcode K000786153, lectotype designated here).

4.10 *Terminalia subspathulata* King, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 66: 332. 1897

Type: Peninsular Malaysia, Perak, Kinta, Gopeng, July 1883, *Dr King's Collector 4529* (K barcode K000786156, lectotype designated here; isolectotypes BM, SING (×2) barcodes SING0055425, SING0055427).

4.11 *Terminalia triptera* Stapf, Bull. Misc. Inform. Kew 1895: 103. 1895

Type: Peninsular Malaysia, Langkawi, September 1890, *C. Curtis 1684* (lectotype K barcode K000786162, lectotype designated here; isolectotype SING barcode SING0055430).

(=) *Terminalia nigrovenulosa* Pierre ex Gagnep., Not. Syst. 3: 285. 1914.
Type: Vietnam, ad pedes montis Mu Xoai, October 1866, *L. Pierre 5011* (P barcode P02286589, lectotype selected by Lecompte (1969: 92).

(=) *Terminalia nigrovenulosa* Pierre ex Gagnep. var. *gracilior* Gagnep., Fl. Gen. Indo-Chine 2: 756. 1920
Type: Vietnam, Delta du Mè-Không, 1875-1877, *J.H.A.J. Harmand s.n.* (P barcode P04716917, lectotype designated here; isolectotypes K barcode K001129732, P barcodes P04716912, P04717014).

(=) *Terminalia obliqua* Craib, Bull. Misc. Inform. Kew 1912: 153. 1912.
Type: Thailand, Sriracha, Nawng Kaw, 19 September 1911, *A.F.G. Kerr 2073* (K barcode K000786152, lectotype designated here; isolectotypes BM barcode BM000947100, E barcode E00284575, K barcocde K001129733, TCD barcode TCD0016766).

(=) *Terminalia tripteroides* Craib, Bull. Misc. Inform. Kew 1912: 152. 1912.
Type: Thailand, Meh Ping, Muang Hawt, 6 September 1911, *A.F.G. Kerr 2010A* (K barcode K000786151, lectotype designated here; isolectotypes BM, E barcode E00284577, K no barcode, L barcode L0009816, TCD barcode TCD0016755).

(=) *Terminalia hainanensis* Exell, Sunyatsenia 2: 1. 1934.
Type: China, Hainan, [Gnai Yuen,] 5 Jul 1933, *F.C. How 70938* (BM barcode BM000947030, lectotype designated here; isolectotypes A barcodes A00068634, A00068635, B barcode B 10 0272120, IBK barcode IBK00190688, K barcode K000786127, NAS barcode NAS00047726, NY barcode NY00245994, P barcode P02286590, PE barcode PE00994592, US barcode US00117594).

Notes

An entry for *Terminalia inguovenulosa* Pierre is found in Lanessan (1886: 315), but as the only description presented is a vague size of the tree, the name is not validly published. Gagnepain (1916) indicated that Lanessan's name was a nomen nudum and that it was an error for *Terminalia nigrovenulosa*. Gagnepain effectively validated *T. nigrovenulosa* by providing a diagnosis comparing it with *Terminalia oliveri* Brandis. *Terminalia triptera* Stapf has priority over *T. nigrovenulosa* Pierre ex Gagnep. and is here accepted as the correct name for the species.

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Lectotypification of *Vigna wightii* (Leguminosae: Papilionoideae)

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Abstract. George Bentham's *Vigna wightii*, endemic to the Southern Western Ghats, is here lectotypified by using R.H.Beddome's collection from the Anamallai mountains, India.

Keywords: *Leguminosae: Papilionoideae, Vigna*, nomenclature.

INTRODUCTION

The genus *Vigna* Savi (Leguminosae: Papilionoideae) is represented with c.104 species (Delgado-Salinas et al. 2011) and shows complex taxonomy due to its relationship with *Phaseolus* (Marechal et al. 1978; Delgado-Salinas et al. 1993). These authors systematically recognized seven sub-genera in the genus *Vigna* s.l. namely, *Ceratotropis, Haydonia, Lasiospron, Macrorhynchus, Plectotropis, Sigmoidotropis* and *Vigna*. The sub-genus *Ceratotropis* (Piper) Verdcourt, which is popularly known as Asiatic *Vigna* has its centre of diversity in Asia (Tomooka et al. 2002) with ca. 29 species distributed in India (Dixit et al. 2011; Aitawade et al. 2012; Latha et al. 2014; Gaikwad et al. 2014; Gaikwad et al 2015; Balan et al. 2017).

During the studies on Leguminosae: Papilionoideae of Kerala State, we found that *Vigna wightii* Benth. ex Bedd., needs to be typified, which is discussed below. The lectotypes are selected based on Art.9.3 and 9.12 of the Shenzen Code (Turland et al. 2018). Herbarium acronyms follow Thiers (2016).

The name *Vigna wightii* Benth. was first validly published by Beddome in Trans. Linn. Soc. London 25(2): 215. 1865 and not in Icon. Pl. Ind. Orient. 69. t. 296. 1874 as cited by Noltie (p. 513. 2005). Baker (1876) also overlooked Beddome's treatment of this taxon. However, Baker (1876) curiously referred Beddome's Ic. Pl. Ind. Or. t. 296. 1874 and cited *Carnatic: Courtallum, Wight, Thomson*. (Krishnaraj and Mohanan 2014). While revising the

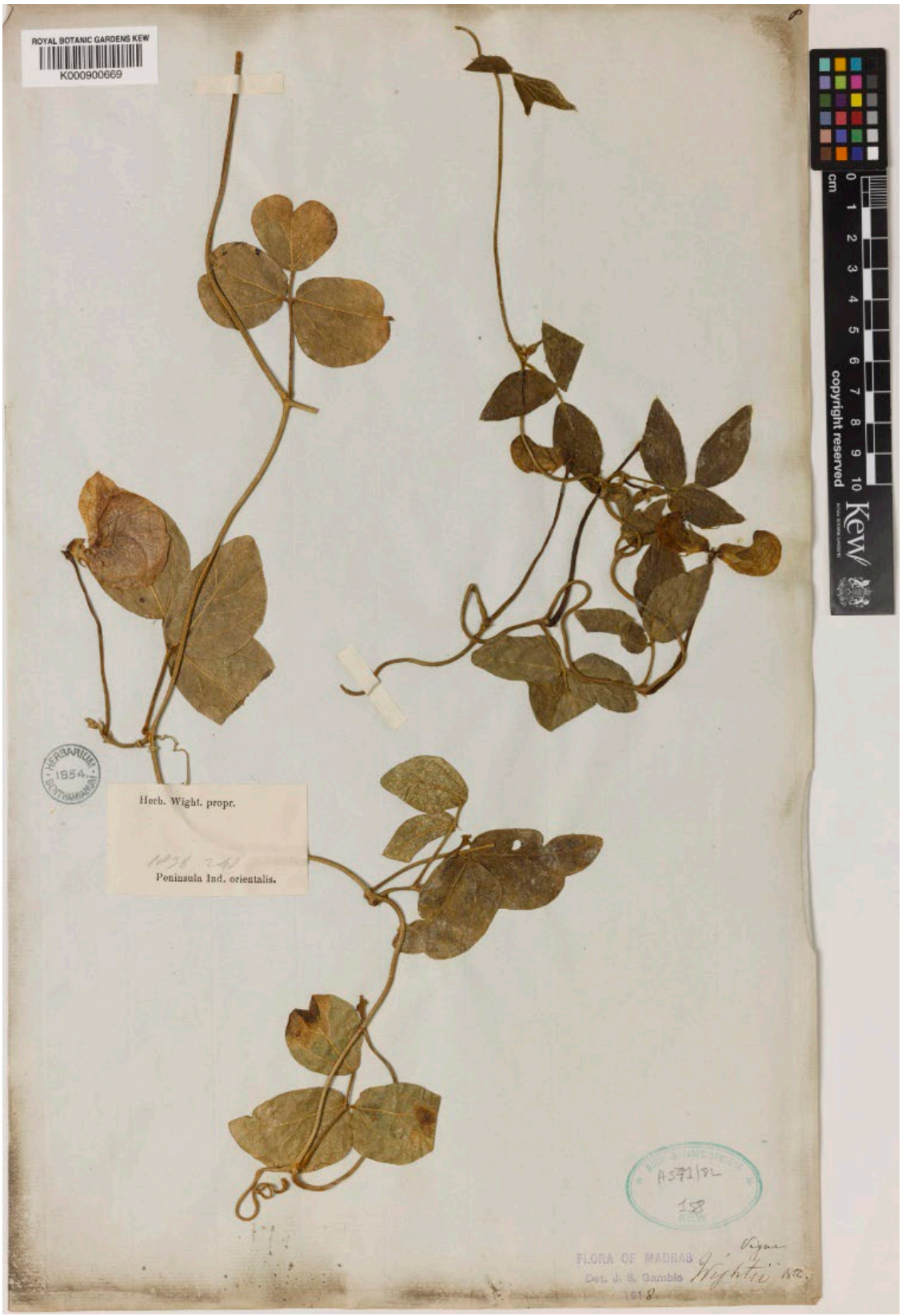

Figure 1. Herb. Wight Prop. 1836, coll. no. 244 (K000900669!.@ Board of Trustees of the Royal Botanic Gardens, Kew).

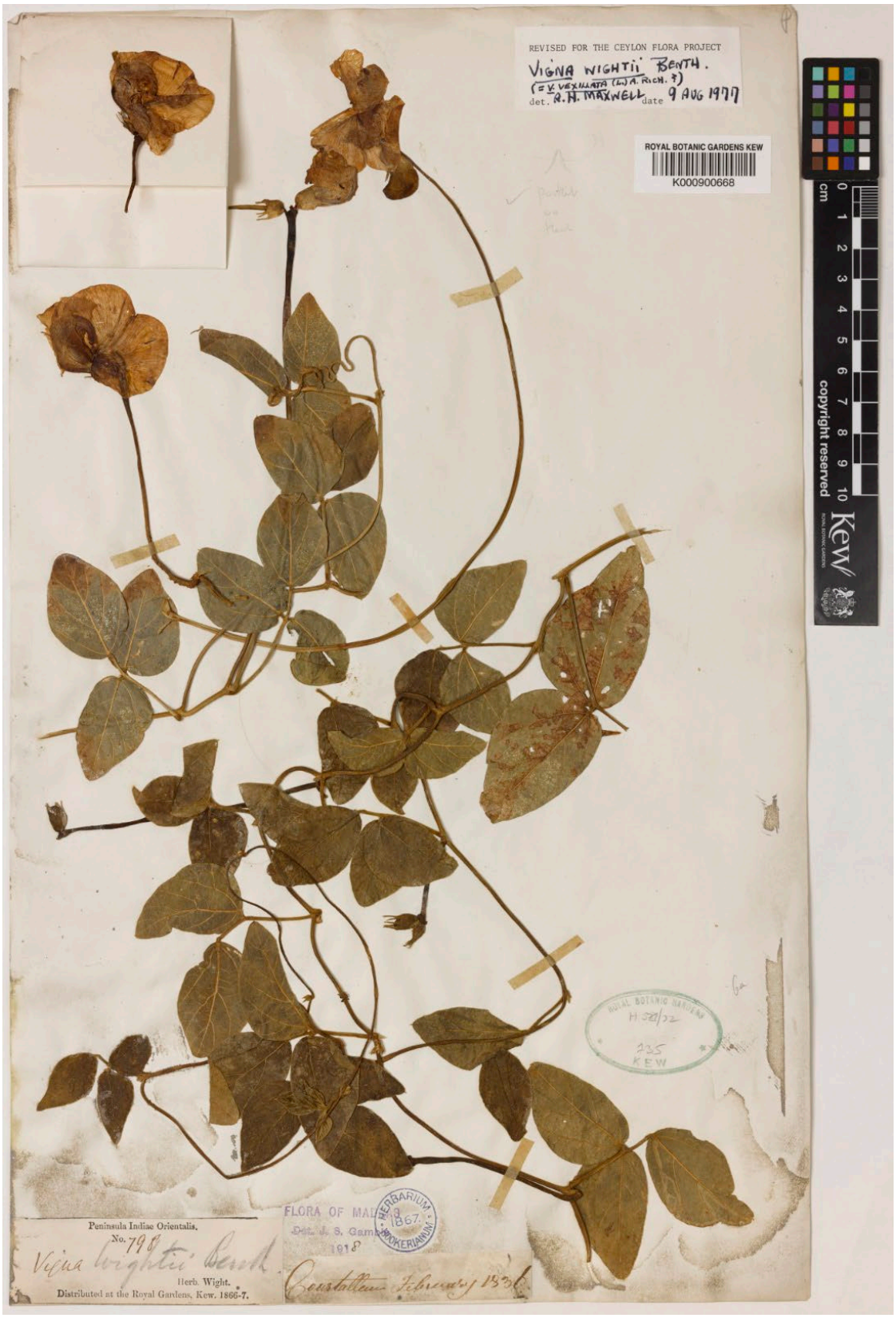

Figure 2. Herb. Wight, no.798 (K000900668! !.@ Board of Trustees of the Royal Botanic Gardens, Kew).

Figure 3. Lectotype of *Vigna wightii* Benth. ex Bedd. (BM001217768! @ British Museum, Natural History).

tribe Phaseoleae in India, Babu et al. (1985) erroneously typified *Vigna wightii* Benth. ex Bedd. based on Wight 1836, deposited at the Kew Herbarium (K), which they again cited as the type of *Phaseolus wightianus* Graham ex Wight & Arn.

While transferring *Phaseolus wightii* Wight & Arn. to *Vigna,* Babu et al. (1985) proposed the name *Vigna hainiana* (as *nom. nov.*) due to the presence of preoccupied epithet '*wightii*' under *Vigna* (as *V. wightii* Benth. ex Bedd.). It should also be noted that *P. wightianus* Graham ex Wight & Arn. is a *nom. nud.* and hence it is not a 'name' or validly published name and has not any type. Hence, the replaced synonym of *V. hainiana* should be *Phaseolus wightii* (Wight 1834) or correctly *P. wightianus* Graham ex Wight & Arn. Babu et al. (1985) ascribed the name *Vigna wightii* Benth. to Baker and cited as *Vigna wightii* Benth ex Baker, which is also wrong.

Most probably, the specific epithet '*wightii*' was coined by Bentham after examining the materials collected by Wight from Peninsular India. This is clearly evident through the collections of Wight in possession of Bentham, sealed as Herbarium Benthamianum (Herb. Wight Prop. 1836, coll. no. 244(K000900669!. Figure 1.). The ambiguity around this specimen is solved in consultation with Kew herbarium staff and is found that even though collection no. 244 from Wight was received in 1854, before publication of the name *Vigna wightii* Benth. ex Bedd., most probably, the specimen was not studied by Beddome. In the protologue, Beddome described the fruit characteristics as "*legumine tereti, juniori strigoso, adulto glabro*". This means that Beddome studied both young and mature specimens with fruits prior to its publication but none of the collections by Wight in possession of Bentham bears fruits. Another relevant specimen available at Kew Herbarium was collected from Courtallum by Wight during his expeditions in 1836, which is not eligible as type because of its late reception at Kew and bearing a seal as Herbarium Hookerianum. (Herb. Wight, no.798 (K000900668! Figure 2.). This sheet is also devoid of fruits.

Beddome described *Vigna wightii* during his enumeration of Anamallai plants in southern India and did not cite any specimens in the protologue. However a thorough search of Beddomes collections at BM and K culminated in one gathering. At BM, this collection was labelled as Courtallum and Wyanad, *Beddome 2243* [BM001217768!] with the handwriting of Beddome and hence it is eligible as a type. (Figure 3.).This specimen bears flowers and fruits and fully agrees with the protologue including collection locality. Hence we designate this specimen as the lectotype of *Vigna wightii* Benth. ex Bedd.

Nomenclature

Vigna wightii Benth. ex Bedd. Trans. Linn. Soc. London 25(2): 215. 1865

Type: Courtallum and Wayanad, *s.d.*, *Beddome 2243* (BM001217768!, lectotype here designated). Figure 3.

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Rediscovery of a lost type: solving the mysterious identity of *Amorphophallus longispathaceus* Engl. & Gehrm. (Araceae)

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Abstract. The taxonomic identity of the incompletely described *Amorphophallus longispathaceus* Engl. & Gehrm. has been a mystery for almost 109 years. Types were assumed destroyed during WWII, other than a sterile isotype at K, the recent discovery of a fertile isotype at NY, here designated the lectotype, has enabled the identity of this species to be clarified. *Amorphophallus longispathaceus* is conspecific with and takes priority over the more recent *A. dactylifer* Hett.

Keywords: Araceae, *Amorphophallus*, typification, Luzon, Mt. Apo, nomenclature.

INTRODUCTION

There are currently 17 species of *Amorphophallus* recognized for the Philippines (Pelser et al. 2011 onwards). Among these, three species whose holotypes were destroyed during WWII, remain poorly known *viz.*, *Amorphophallus luzoniensis* Merr., *A. merrillii* K.Krause, and *A. longispathaceus* Engl. & Gehrm. *Amorphophallus luzoniensis* was described using a specimen from Abulug river, Cagayan province (Merrill 1915). Duplicates of its destroyed holotype, *Curran 19560*, are still being searched for, and up to this writing, the identity of this species remains uncertain. A similar situation exists for *Amorphophallus merrillii* which was collected from Cavili island, Palawan province (Krause 1912), and its identity is presently being studied by the first author. *Amorphophallus longispathaceus* was described using a specimen from Todaya, Mt. Apo in Mindanao (Engler 1911). The protologue of this species was insufficient for confident identification with any known *Amorphophallus* species in the Philippines. Its holotype (*R.S. Williams 2684* [wrongly quoted by Engler as 2654, the correct number mentioned by Merrill 1923 in: Enum. Philipp. Flow. Plants I: 179]) in PNH was destroyed during WWII. In Hetterscheid et al. (2020) an isotype is mentioned, which is

preserved in K. However, this is just a leaf fragment and proved insufficient for the authors to associate with any of the known or unidentified species in the Philippines. The protologue by Engl. & Gehrm. in Engl., Araceae-Lasioideae. Das Pflanzenr. IV. 23C, 1911: 91, does not unequivocally identify any Philippine species known to date. Therefore, Hetterscheid et al. 2020 decided to not consider this name in their paper. But fortunately, an isotype of *Amorphophallus longispathaceus* was discovered recently by the first author in NY, solving the mystery behind its almost forgotten name and identity.

We here designate the NY sheet of *R.S. Williams 2684* with the inflorescence as the lectotype of the name *A. longispathaceus* following article 9.3 and 9.12 of the Shenzhen Code (Turland et al. 2017). The rediscovered isotype contains a full inflorescence and closely matches the more recent *Amorphophallus dactylifer* Hett. which we now place in the synonymy of the older name. Meanwhile, the second sheet at NY with the same number but with a leaf fragment is not included in the lectotype choice (here designated as paratype) because it is a separate gathering of another plant, since in this species (and most others of the genus) leaf and inflorescence do not appear simultaneously on the same plant. We do acknowledge though that it is indeed an original material, and taxonomically it is quite certain that it is the leaf of the same species. An updated description of *Amorphophallus longispathaceus* is provided using the protologue of *A. dactylifer* (Hetterscheid 1994) including a supplementary description by Magtoto et al. 2013, and observations from live specimens.

TAXONOMIC TREATMENT

Amorphophallus longispathaceus Engl. & Gehrm. in Engl. Araceae-Lasioideae. Pflanzenr. IV. 23C, 1911: 91

Type: Todaya, Mt. Apo, Mindanao, Philippines, 05 April 1905. *R.S. Williams 2684* [holotype; PNH (lost); iso, K! (leaf fragment), NY!; lectotype here designated: *R.S. Williams 2684*, New York Botanical Garden Herbarium sheet NY03774120 (Figures 1 & 2), NY!; paratypes, *R.S. Williams 2684*, NYBG sheet NY03774118 (Figure 3)].

(=) *Amorphophallus dactylifer* Hett. in Blumea 39(1/2), 1994: 252, **syn. nov.**
Type: Luzon, San Mariano, Isabela, Sierra Madre Mts., Bo. Disulap, undergrowth in Nabulay Forest, Philippines, 18 May 1961. *H.G. Gutierrez PNH 78180* (holotype, L).

Description

Tuber depressed globose, 3–9 cm long × 7–16 cm wide. *Leaf* solitary, lamina diameter ca. 180 cm; *petiole* background color greyish green (light to dark reddish when young), ca. 140 cm long × 2–6 cm wide, smooth; petiole markings elongate-elliptic with whitish or green spots, the latter with a whitish margin, those at the base of the petiole strongly raised, crust-like, upper part of petiole with obscure, dark reddish brown, narrowly elliptic to near linear spots; *rachis* winged distally from the basal branching, basal part naked with a few petiolulate leaflets; *leaflets* elliptic or elliptic-lanceolate, 16–18 cm long × 5–6 cm wide, long acuminate (acumen up to 3 cm long). *Inflorescence* solitary, long peduncled; *peduncle* almost the same coloration and marking with petiole, 60–130 cm long × 1–3.5 cm wide; *spathe* campanulate, 30–38 cm long × 12–20 cm wide, elongate triangular, acute, base strongly convolute, limb arching over; outside of spathe brown with white spots, smooth, entire, membranaceous; inside of base dark purple with pale upper part, densely clothed with short and long, simple or branched, fleshy or flaky, purple to reddish or brown finger-like warts, especially near the base of the spadix. *Spadix* sessile, at most twice as long as the spathe, 42–60 cm long × 2–3 cm wide; *female zone* cylindric, 4–8.5 cm long × 2–4 cm wide, flowers slightly distant; *male zone* elongate obconic or cylindric, 4.5–6.5 cm long × 1.5–3 cm wide at the top, flowers congested; *appendix* elongate conic, top obtuse, acute or subacute, 31–46 cm long × 2–3 cm wide at the base, gradually tapering to the tip, smooth, dark brownish, red or purple. *Ovaries* subglobose or depressed globose, 2–2.5 mm long × 2–3 mm wide, unilocular; *style* reddish or brown, 2–5 mm long × 0.8–1 mm wide; *stigma* large, brown or dark red, 1–1.5 mm long × ca. 2 mm wide, oval in cross section, shallowly or deeply 2- or 3-lobed, lobes rounded or conic, appearing claw-like, surface with numerous large conic fleshy projections. *Male flowers* consisting of 2–3(–5) stamens; *stamens* reddish, 1–1.5 mm long; *filaments* 0.1–0.5 mm long, connate; *anthers* ca. 1 × 1.5–2.5 mm, truncate, pores apical, elongate. *Pollen* psilate.

Distribution

Philippines: Luzon, Sierra Madre Mountains, San Mariano, Bo. Disulap, ca. 152 m (Hetterscheid 1994), Municipality of Palanan, Isabela Province (J.M. Agcaoili pers. obs.); Mt. Makiling, Los Banos, Laguna Province; San Narciso, Zambales Province; Visayas**,** Samar; Mindanao Todaya, Mt. Apo; Mt. Kabatuan, Surigao Province (Hetterscheid 1994).

Figure 1. Lectotype of *Amorphophallus longispathaceus* Engl. & Gehrm. (NY03774120). (Image courtesy of the C.V. Starr Virtual Herbarium of the New York Botanical Garden http://sweetgum.nybg.org/science/vh/). E-loan No.: 25991.

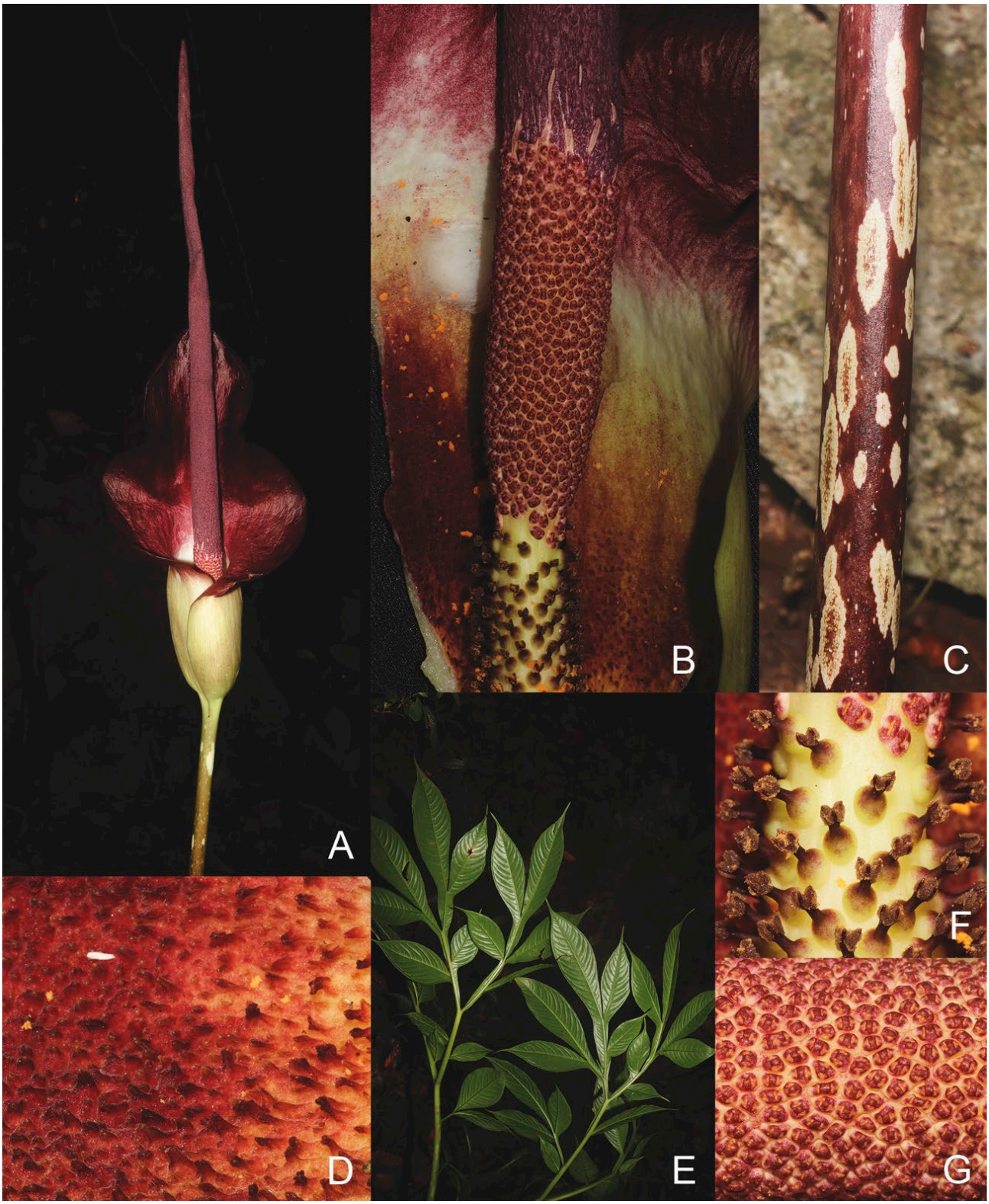

Figure 2. "*Amorphophallus dactylifer* Hett." i.e. *A. longispathaceus* Engl. & Gehrm. from Palanan, Isabela, Luzon Island, Philippines. A. Inflorescence; B. Details of the male and female zones; C. Peduncle detail; D. Inside detail of the spathe base; E. Leaves; F. Detail of stigmas, styles and ovaries; G. Detail of the stamens. (Photos by J.M. Agcaoili).

Figure 3. Paratype of *Amorphophallus longispathaceus* Engl. & Gehrm. (NY03774118). (Image courtesy of the C.V. Starr Virtual Herbarium of the New York Botanical Garden http://sweetgum.nybg.org/science/vh/). E-loan No.: 25991.

Phenology

Flowering: June–July; Fruiting: late July–August.

Notes

The lectotype of *Amorphophallus longispathaceus* is clearly identifiable as *A. dactylifer* with the peduncle much longer than spathe, style longer than 2 mm, spathe almost as broad as long, and the spadix at most twice as long as the spathe.

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We thank Amy Weiss, Collections Manager, William and Lynda Steere Herbarium, New York Botanical Garden, New York, USA for her invaluable help in scanning, and allowing the authors to use the image of *A. longispathaceus*. The Mabuwaya Foundation, Inc. is thanked for their technical and logistical support during the Palanan fieldwork. Special thanks to Mr. John Michael Agcaoili for allowing the authors to use his *A. longispathaceus* photos; to Mr. Adriane Tobias for his kind assistance, and to the Philippine Taxonomic Initiative, Inc. (phtaxa.org) for bringing together the expertise of the researchers involved in this study. Anonymous reviewers are also thanked for their valuable comments and suggestions that improved this manuscript.

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The importance of rediscovering rare and endemic plants: Two species of *Pleroma* D.Don (Melastomataceae), an update of conservation status, and improved descriptions

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Abstract. The remaining portion of Atlantic Forest in the state of Rio de Janeiro constitutes a strategic challenge in the conservation of the biome, by concentrating high richness and endemism of species that are distributed in distinct vegetative fragments covering the mountainous regions. In the state, the genus *Pleroma* presents a high diversity, currently 45 species, of which 14 are endemic and several of these have knowledge gaps. This paper aims to document rediscoveries in the Três Picos State Park of two species of *Pleroma* that had not been collected for 69 and 100 years respectively. These discoveries resulted from the actions of the National Center for Plant Conservation, a division of the Rio de Janeiro Botanical Garden. Updated descriptions, geographic information and distribution maps, and cited collections for these two species of *Pleroma* are presented here together with an assessment of their current conservation status. Based on IUCN criteria, we recommend a classification of Critically Endangered (CR) and Endangered (EN) for *Pleroma virgatum* and *P. elegans*, respectively.

Keywords: *Campo de altitude*, Linnean shortfall, Melastomateae, Serra dos Órgãos, taxonomic inflation, Wallacean shortfall.

INTRODUCTION

Pleroma D.Don is a neotropical genus of Melastomataceae with 157 species, which are mainly distributed in eastern Brazil, occurring primarily in the Atlantic Forest and Cerrado biomes and rarely in the Caatinga (Guimarães et al. 2019). *Pleroma* is now considered a distinct genus from *Tibouchina* Aubl. based on the molecular phylogenetic analysis of Michelangeli et al.

(2013) and new combinations of the taxa were made by Guimarães et al. (2019). *Pleroma* is distinguished from the other genera of Melastomateae Neotropical by presenting stamens with well-developed pedoconnectives and purple or pink anthers and, if pedoconnectives have trichomes, they are glandular, and the calyx lobes are deciduous in fruits (Guimarães et al. 2019).

In Rio de Janeiro state, Brazil, *Pleroma* is represented so far by 45 species, and of these, 14 species are endemic to the state (P.J.F. Guimarães and D.N. Silva in prep.). Two species that are rare and endemic in the state of Rio de Janeiro, *Pleroma thereminianum* (DC.) Triana and *P. cleistoflorum* (Ule) P.J.F.Guim., Oliveira da Silva & Michelang., were studied regarding geographic distribution patterns in order to recommend conservation strategies (Pinheiro 2013). Of the other species endemic to the state, two are known only by the type collection: *Pleroma schwackei* (Cogn.) P.J.F.Guim. & Michelang. collected in 1887 in the municipality of Nova Friburgo, at Alto Macahé (Cogniaux 1891), a locality currently known as Macaé de Cima; and *P. discolor* (Brade) P.J.F.Guim. & Michelang. collected in 1935 in the municipality of Santa Maria Madalena, at Serra da Forquilha (Brade 1938). Additionally, two other species remain without any new record in nature for over 46 years: *Pleroma cristatum* (Brade) P.J.F.Guim. & Michelang. was last found in 1938 in Santa Maria Madalena (Brade 1938) and *P. pallidum* (Cogn.) P.J.F.Guim. & Michelang. recorded in the city of Rio de Janeiro at Pedra da Gávea in 1973 (Cogniaux 1885; Rosa et al. 2018).

The Global Strategy for Plant Conservation (GSPC) seeks to slow the pace of plant extinction around the world. The first of its five objectives starts with the best understanding of plant diversity through the publication of online floras and listings of species threatened with extinction (Sharrock et al. 2014). In 2010, Brazil published the Catalog of Plants and Fungi of Brazil (Forzza et al. 2010) and launched the first online version of the List of Species of the Brazilian Flora (Reflora 2010), meeting Target 1 (BFG 2018). Target 2 was reached in 2013 with the publication of the Red Book of the Brazilian Flora by the Rio de Janeiro Botanical Garden, consolidating an important framework for the study of Brazilian biodiversity conservation (Martinelli and Moraes 2013). To date, extinction risk assessment has been completed for 17 Brazilian species of *Pleroma* (Martinelli and Moraes 2013; Martinelli et al. 2018). However, two knowledge gaps have became obstacles to the assessment of conservation status, namely the Wallacean and Linnean shortfalls (Kozlowski 2008; Hortal et al. 2015). The Linnean shortfall is associated with systematics and refers to our extremely limited knowledge of overall biodiversity (Brown and Lomolino 1998; Brito 2010). The Wallacean shortfall is a question of biogeography and refers to our inadequate knowledge of the distribution of a particular taxon. Surely, the best way to circumvent both Wallacean and Linnean shortfalls is to invest in biodiversity inventories and herbaria curation (Balmford and Gaston 1999).

The efforts to evaluate the extinction risk of endemic species in the state of Rio de Janeiro by the National Center for Plant Conservation/Rio de Janeiro Botanical Garden enabled the rediscovery of two species endemic to the state of Rio de Janeiro, as well as additional data for understanding their conservation status: *Pleroma elegans* Gardner (Figure 1), unknown in nature since 1915, and *P. virgatum* Gardner (Figures 3 and 4C), last collected in 1941. Both species did not include a detailed locality description, including only a reference to the extensively collected locality of Serra dos Órgãos. The previous known records of these species hinder conservation status assessments, giving insufficient data of geographical distribution and population size. This paper aims to document the rediscoveries of these two taxa in the Três Picos State Park occurring, respectively, after 69 and 100 years since they were last collected in the region. Here, we present their current conservation status, and the morphological description and taxonomy of the taxa are revisited.

MATERIAL AND METHODS

Rediscovery location

Serra do Mar runs through the state of Rio de Janeiro, Brazil, almost continuously from end to end, in a SW-NE direction, and its most imposing section is that which runs through the municipalities of Petrópolis, Teresópolis and Nova Friburgo, the mountain massif named Serra dos Órgãos (MMA 2008). It is in this portion of the Serra do Mar that the highest elevations and the largest relief gradients occur (Mallet-Rodrigues et al. 2007). The highest peak is the Pico Maior de Friburgo at 2,366 m in the Três Picos State Park (PETP) (Faria 2005). The PETP was established in 2002, with an area of 65,000 hectares and is located in the north-central region of Rio de Janeiro state, covering the municipalities of Teresópolis, Nova Friburgo, Cachoeira de Macacu, and Silva Jardim. The PETP is part of the mosaic of the *Mata Atlântica Central Fluminense* which aims to integrate 29 conservation units, including the Serra dos Órgãos National Park (PARNASO) (INEA 2013).

In the area of the PETP, there are different physiognomies of the Atlantic Forest biome, with Cloud Forest

[*Floresta Ombrófila Densa Montana*, according to Veloso et al. (1991), and also called *Floresta Pluvial Atlântica Montana* by Rizzini (1997)] being the one that predominates. In addition there is the Submontane Rain Forest (*Floresta Ombrófila Densa Submontana*) and the *campos de altitude* which is the site of occurrence of the rediscovered species.

The *campos de altitude* s.l. occur at the highest points of the main mountain ranges of the Atlantic Forest biome, such as Serra do Mar, Serra da Mantiqueira, and Serra Geral (Martinelli 1996; Safford 1999; Caiafa and Silva 2005). The peculiar and adverse environmental conditions present at *campos de altitude* where these grasslands are found, such as oscillation between high and low temperatures, wind intensity, frequent presence of fog, in addition to shallow and nutrient-poor soils, contribute to the large number of endemic species that have been described from this ecosystem (Mocochinski 2006).

Data compilation, morphology, and conservation status assessments

This study was conducted through analysis of field observations and collections deposited at BM, BR, C, F, G, K, LE, M, MO, NY, P, R, RB, and US herbaria. Acronyms are according to Thiers (2020). Radford et al. (1976) was consulted for morphological terminology. The map was developed using ArcGIS software (https://www.arcgis.com/index.html).

The conservation status of the rediscovered species was performed according to the model adopted for the evaluation of the Brazilian flora that follows the system of categories and criteria of the IUCN (IUCN 2012; MMA 2014; also see Moraes and Kutschenko 2012). We followed the generation of spatial indexes [Extent of Occurrence (EOO) and Area of Occupancy (AOO)] in the CNCFlora system, using minimum convex polygon, WGS84 datum and UTM projection. Where the EOO was calculated using the area of the minimum convex polygon, and AOO using a grid of 4 km^2 cells (IUCN 2017; also see Moraes and Kutschenko 2012).

RESULTS AND DISCUSSION

The species rediscovered here are clearly rare due to their restricted distribution and abundance (Flather and Sierg 2007). Both were recorded only in the central region of the state, in the massif of Serra dos Órgãos (Figures 2A and 4A), by a few collections. The taxonomic factor may influence the characterization of species as rare (Sano et al. 2014), because the species is a category that reflects the expert's perception of the group and the concept of species applied by this (Rapini 2000). On the other hand, rarity is the result of the analysis of measurable attributes, such as frequency, abundance, or distribution, applied to individuals or populations (Sano et al. 2014). However, the taxonomic limits of *Pleroma elegans* and *P. virgatum* are expanded because the heterotypic synonyms attributed to these species are accepted (Guimarães et al. 2019). This further reinforces the importance of these rediscoveries.

Pleroma elegans and *P. virgatum* were rediscovered during field expeditions carried out in areas of difficult access in *campos de altitude* of the PETP; seven different mountains were visited within this conservation unit. *Pleroma elegans* was found at 2000 m elevation, near the ridge of the mountain known as "Mulher de Pedra" (Figure 2), located exactly on the border of the municipalities of Cachoeiras de Macacu and Teresópolis, following 100 years without any collection records. *Pleroma virgatum* was rediscovered in the mountain known as "Branca de Neve", located in the municipality of Teresópolis between 1750 and 1950 m elevation (Figure 4), after 69 years without any records. Both species showed low population densities in their areas of occurrence.

1. Rediscovery of Pleroma elegans after 100 years and redescription

Pleroma elegans Gardner, London J. Bot. 2: 350. 1843

Type: Brazil, Rio de Janeiro, Organ Mountains, May 1837, *G. Gardner 405* [K barcode K000329022!, lectotype designated by Guimarães et al. (2019); isolectotype BM barcode BM000953939!]. See heterotypic synonyms in Guimarães et al. (2019).

(≡)*Lasiandra elegans* (Gardner) Naudin in Ann. Sci. Nat., Bot., sér. 3, 13: 159. 1850.

(≡) *Tibouchina elegans* (Gardner) Cogn., Fl. Bras. 14: 323. 1885.

Description

Shrubs ca. 1.30 m tall; branches rotund-quadrangular, terete or quadrangular, indument strigose, trichomes ca. 0.8 mm long, smooth multicellular trichome; older cauline internodes glabrescent. *Leaves* with petiole 5–8 mm long; blades 3.2–5.2 × 1.4–2.2 cm, lanceolate-ovate, oblong-lanceolate or lanceolate, base acute or obtuse, apex acute, margin strigose, trichomes 0.8–1 mm long, entire; adaxial surface plane, glabrous, abaxial surface sparsely short strigose, smooth multicellular tri-

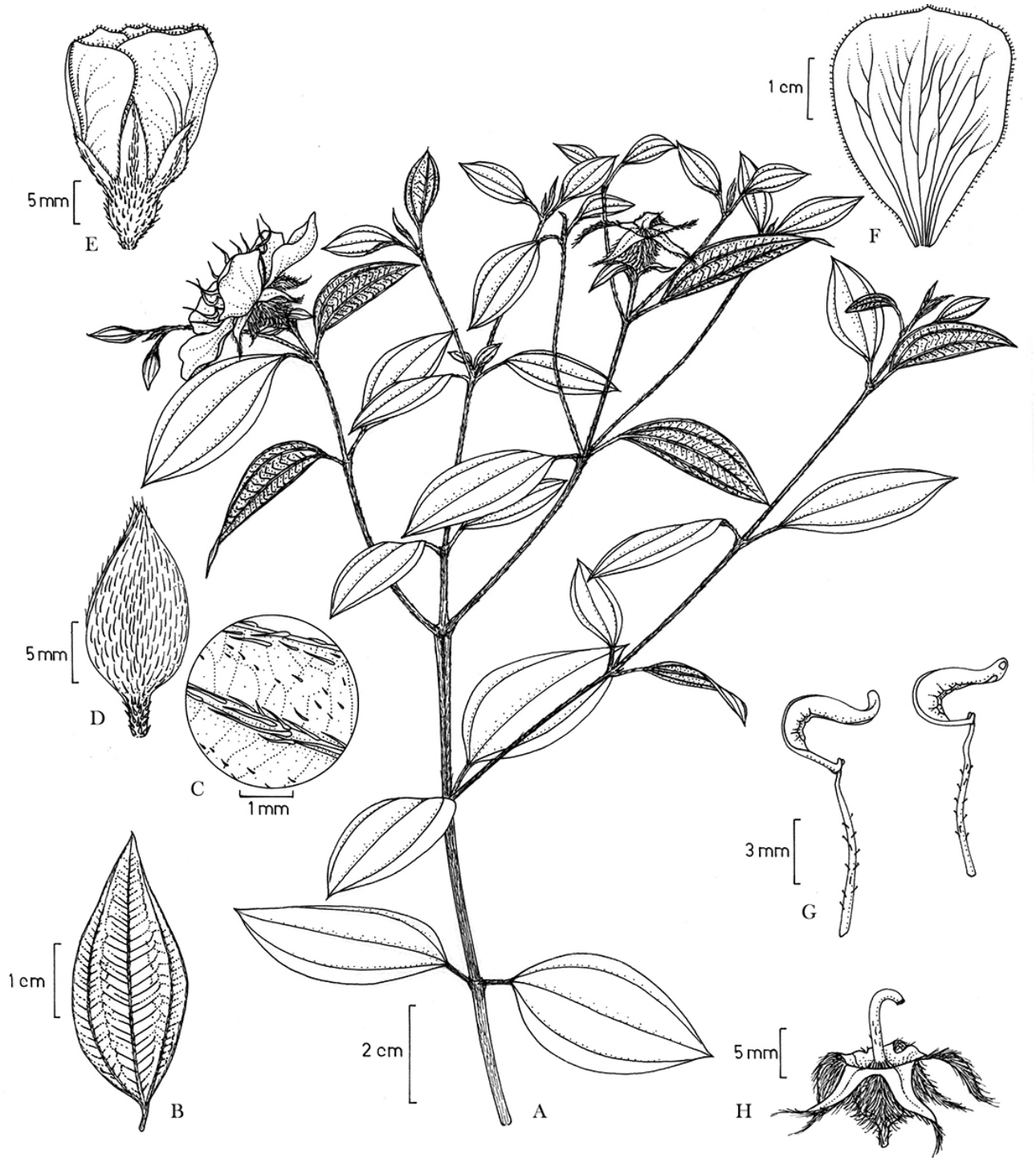

Figure 1. *Pleroma elegans* Gardner. (a) Branch with leaves and flower. (b) Adaxial surface of leaf. (c) Detail of trichomes on the abaxial surface of leaf. (d) Adaxial surface of bracteole. (e) Flower in pre-anthesis. (f) Adaxial surface of petal. (g) Antesepalous (left) and antepetalous (right) stamens. (h) Details of the inner surface of sepals, style, and stigma. From *G. Gardner 405* (K).

chomes 0.25–1 mm long; primary veins densely strigose; 3-nerved, basal. *Inflorescences* reduced to a single flower or dichasium, terminal; bracteoles 2, 2.8–1.6 × 5–9 mm, concave, ovate, apex acute, outer surface sericeous, margin ciliate; pedicels 1–1.5 mm. *Flowers* 5-merous; hypanthium 5.5–6 × 4.8 mm, campanulate, indument hirsute-

scabrous, smooth multicellular trichome. Calyx with tube inconspicuous; lobes 9–10 × 2.8–3.2 mm, lanceolate, apex acute, strigose-sericeous in the middle, margin ciliate. Petals ca. 4 × 3.5 cm, magenta, apex rounded or apiculate, margin glandular-ciliate. Stamens 10, slightly dimorphic in size, filaments with glandular trichomes 0.25–0.5 mm long, pedoconnectives with ventral bicalcarate appendage; antepetalous stamens: filament ca. 6 mm long, thecae ca. 5 mm long, pedoconnective ca. 0.5 mm long, appendage ca. 0.75 mm long; antesepalous stamens: filament ca. 6.5 mm long, thecae ca. 5 mm long, pedoconnective ca. 1.2 mm long, appendage ca. 0.6 mm long. Ovary with apical portion densely covered with sericeous hairs; style ca. 6.5 mm long, glabrous. *Fruit* a capsule 9–10 × 8–9 mm; seeds ca. 1 mm long, cochleate. See Figure 1.

New record

BRAZIL: Rio de Janeiro, Teresópolis, Proteção Integral, Parque Estadual dos Três Picos, Seio da Mulher de Pedra próximo ao cume, 22°21'44"S, 42°35'26"W, 1822–2040 m, 17 January 2015 (fl., fr.), *C. Baez et al. 213* (RB barcode RB00932145!).

Additional specimens examined

BRAZIL: Rio de Janeiro, without municipality, "Centralstock" [Serra dos Órgãos], November 1915 (fl., fr.), *P. von Luetzelburg 6476* (M, NY barcode NY00685829!); ibid, Serra dos Órgãos, February 1890 (fl., fr.), *J.T. Moura s.n.* (RB barcode RB00541587!); ibid, Serra dos Órgãos, December 1888 (fl., fr.), *J.T. Moura 358* (BR barcode BR0000005225163!); ibid, Cachambú, près das Petropólis dans le bois vierge, 22 January 1887 (fl., fr.), *A.F.M. Glaziou 15981* (BR!, C!, K!, P barcodes P05228293! and P05228294!, R!); ibid, Serra d'Estrella, 27 January 1875 (fl.), *A.F.M. Glaziou 7611* (BR barcode BR0000005224838!, C barcode C10015060!, P barcodes P00121400! and P00121401!); ibid, in montibus Serra d'Estrella, Braziliae australis prope Bell Monte, 1844 (fl.), *H.A. Weddell 757* (B [probably destroyed] F negative barcode F0BN026117!, BR barcode BR0000005224500! [fragment], F barcode V0063574F! [fragment], G-DC barcode G00318950!, P barcodes P00121402! and P00121403!).

Taxonomic notes

The diagnostic features of this species are the adaxial leaf surface glabrous and the abaxial surface sparsely short strigose, trichomes 0.25–1 mm long, with 3 acrodromous basal nerves. *Pleroma elegans* is more similar to *Pleroma dubium* (Cham.) P.J.F.Guim. & Michelang. and *P. floribundum* (Cogn.) P.J.F.Guim. & Michelang., due to their floral characteristics, of which they can be separated mainly by the leaf indumentum. In the last two, the adaxial leaf surface has trichomes that vary from strigose to scabrous and arranged in rows parallel to the veins. *Pleroma dubium* has been collected from the state of São Paulo to Rio Grande do Sul, on *campos de altitude*, growing between crevices, river banks and cloud forests, at elevations of 800–1500 m (Guimarães and Oliveira 2009). *Pleroma floribundum* has been recorded only for the state of Rio de Janeiro, in rocky outcrops at approximately 1100 m.

Some of the collections attributed to *Lasiandra imperatoris* Wawra collected in Bahia, Brazil were identified wrongly by Cogniaux (1885) as *T. elegans* (Gardner) Cogn. (= *P. elegans* Gardner), although there are no morphological and geographic similarities between them, see *J.B. Blanchet 3078A* (G-DC barcode G00318961).

Habitat, distribution, and phenology

Pleroma elegans is a medium-sized heliophilous terrestrial shrub, growing in *campos de altitude*. This species was collected, until now, only in the state of Rio de Janeiro, at higher elevations in the massif of Serra dos Órgãos in the municipalities of Teresópolis and Petrópolis, between 1800–2000 m (Figure 2). Specimens with flowers and fruits were recorded from November to January.

This species was last collected in 1915 in Serra dos Órgãos (*Luetzelburg 6476*), probably in the Retiro (Pedra do Retiro, Petrópolis, Rio de Janeiro, Brazil), and recollected 100 years later in the municipality of Teresópolis in the Três Picos State Park during the Flora of Altitude Grasslands Project.

Conservation status

This species should be considered Endangered (EN) according to the criteria B1ab(i,ii,iii) + 2ab(i,ii,iii). Its AOO is equal to 16 km² and EOO is 41.08 km². The historical collections made by naturalists in the 19th century indicate that *Pleroma elegans* occurs in Serra dos Órgãos and in the Serra da Estrela, localities currently impacted by the irregular anthropic occupation of slopes in the mountainous region of the state of Rio de Janeiro (Guerra *et al.* 2007); there are also records of invasion of exotic species in the area (Mautone *et al.* 1990). Forest fires are also one of the main threats to known populations of this species (INEA 2013). Before rediscovery, this species was evaluated as DD (Deficient Data).

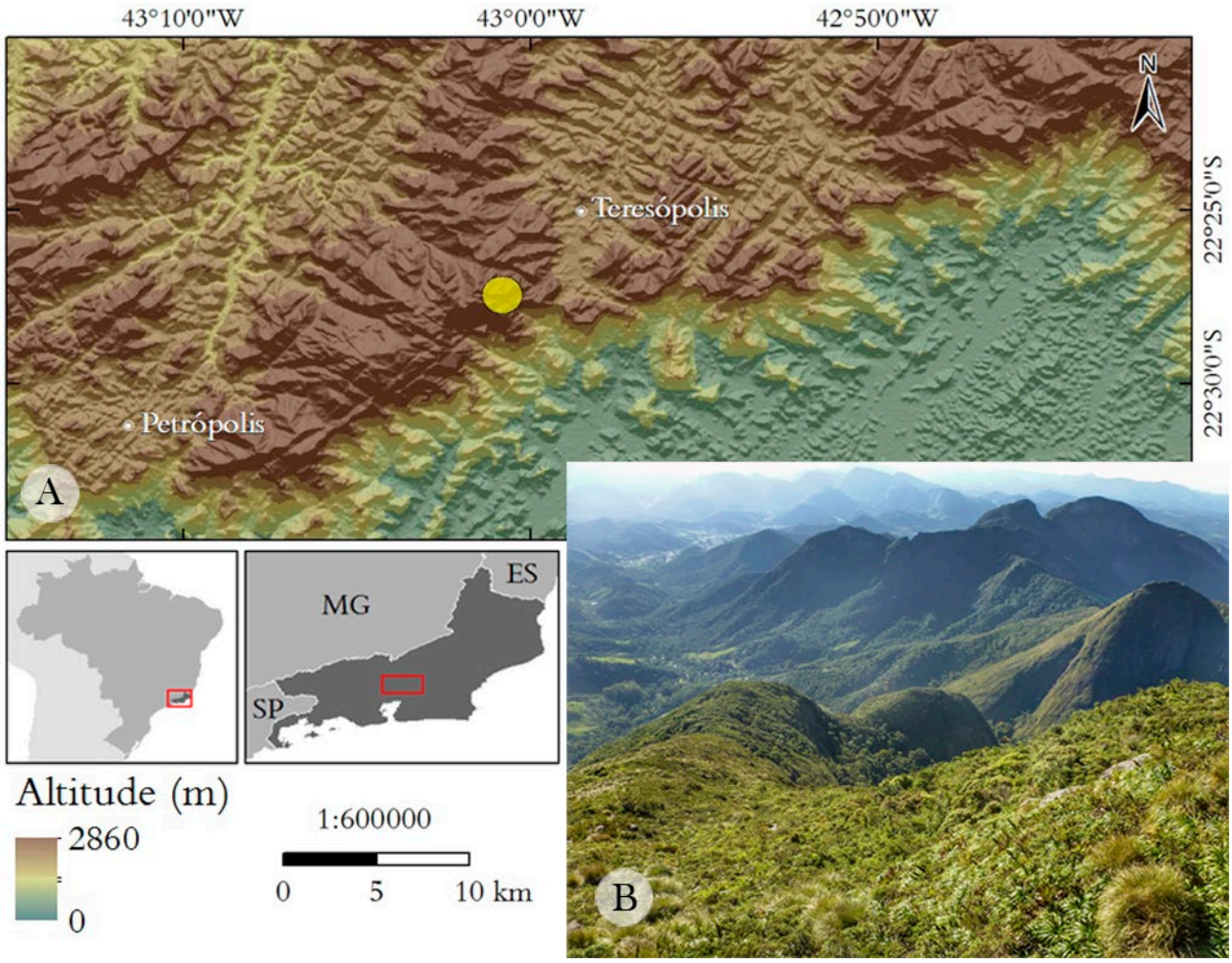

Figure 2. Distribution map and habitat of *Pleroma elegans* Gardner. (a) Geographic distribution of the species (yellow dot). (b) Location near the top of the "Seio da Mulher de Pedra", Teresópolis, Rio de Janeiro state, Brazil. Photo: C. Baez (B).

2. Rediscovery of Pleroma virgatum after 69 years and re-description

Pleroma virgatum Gardner, London J. Bot. 2: 350. 1843.

Type: BRAZIL. Rio de Janeiro: Organ mountain, elev. 4500 ft., May 1837, *G. Gardner 403* [BM barcode BM000020625!, lectotype designated by Guimarães et al. (2019); isolectotypes K barcode K000329058!, NY barcode NY00245682!]. See heterotypic synonyms in Guimarães et al. (2019).

(≡) *Lasiandra virgata* (Gardner) Naudin, Ann. Sci. Nat., Bot., sér. 3, 13: 159. 1850.

(≡) *Tibouchina virgata* (Gardner) Cogn., Fl. Bras. 14: 365. 1885.

Description

Shrubs ca. 60 cm tall; branches rotund-quadrangular, canaliculate, indument sparsely scabrous, trichomes 0.4–1.5 mm long, short barbellate, older branches becoming terete with bark peeling off. *Leaves* with the petiole 0.8–2.3 cm long; blades 6.2–9.5 × 2.7–6.4 cm, lanceolate-ovate or ovate, rarely oblong-lanceolate, base obtuse or sub-cordate, apex obtuse, rarely acute, margin ciliate, trichomes 0.7–1.2 mm long, entire, rarely weakly crenulate; adaxial surface flat or slightly bullate, indument strigose, trichomes (0.4–)1.75–3.5 mm long, base forked, adaxial surface with indument short strigose to sericeous or almost glabrous, interspersed with trichomes barbellate 0.3–0.6mm long; primary veins strigose or strigose-sericeous, trichomes barbellate (0.5–)1–3 mm long; 7–11-nerved, acrodromous suprabasal.

Inflorescences thyrsoid, terminal, 7–17.5 cm long; bracteoles 2, 6–8.5 × 4.5–6 mm, white, concave, oblong, apex obtuse, outer surface strigose-sericeous, margin ciliate; pedicels 0.6–1.5 mm. *Flowers* 5-merous; hypanthium 4–5 × 3.5 mm, campanulate, indument strigose-sericeous, trichomes dendritic. Calyx with reduced tube to ca. 0.6 mm long; lobes 2–3 × 1.2–1.8 mm, oblong, apex obtuse, covered with trichomes as those of the hypanthium, margin ciliate. Petals ca. 1.4 × 0.7 cm, purple, margin ciliate. Stamens 10, slightly dimorphic in size, glabrous, connectives with ventral bituberculate appendage; antepetalous stamens: filament ca. 7.5 mm long, thecae 5–6 mm long, pedoconnective ca. 0.4 mm long, appendages ca. 0.5 mm long; antesepalous stamens: filament ca. 9.5 mm long, thecae ca. 7 mm long, pedoconnective 2–2.8 mm long, appendages ca. 0.75 mm long. Ovary with apical portion densely covered with sericeous hairs; style 7–8.5 mm long, glabrous. *Fruit* a capsule 5.5–7 × 5–6 mm; seeds ca. 0.6 mm long, cochleate. See Figures 3 and 4C.

New records

BRAZIL: Rio de Janeiro, Nova Friburgo, Parque Estadual dos Três Picos, Sítio República dos Três Picos (Paulo & Rose), na trilha para a Cabeça do Dragão, 22°19'14"S, 42°43'24"W, 1976 m, 6 April 2016 (fl.), *J.F.A. Baumgratz et al. 1485* (RB barcode RB01118483!); ibid, 22°19'14"S, 42°43'25"W, 1980 m, 6 April 2016 (fl.), *J.F.A. Baumgratz et al. 1486* (RB barcode RB01118484!); ibid, 22°19'15"S, 42°43'25"W, 1990 m, 6 April 2016 (fl.), *J.F.A. Baumgratz et al. 1487* (RB barcode RB01118485!). Teresópolis, Proteção Integral, Parque Estadual dos Três Picos. Trilha para o cume da Branca de Neve já na área de campos de altitude, 22°21'15"S, 42°45'38"W, 1780–2040 m, 3 February 2015 (fl.), *C. Baez et al. 225* (RB barcode RB00932157!).

Additional specimens examined

BRAZIL: Rio de Janeiro, Alto Macahé [Nova Friburgo], 21 April 1888 (fl., fr.), *A.F.M. Glaziou 16794 part*. (BR barcode BR0000005226665!, C barcode C10015092!, G [on 3 sheets], K barcode K000329011!, LE, P barcode P00708718!); ibid, 8 April 1888 (fl.), *A.F.M. Glaziou 16794 part*. (BR barcodes BR0000005226337! and BR0000005226641!, K barcode K000329010, MO barcode MO100754164!, P barcodes P00708714!, P00708715!, and P00708716!, R barcode R000009288!). Petrópolis, 14 March 1888 (fl.), *A.F.M. Glaziou 16795* (B [probably destroyed] F negative barcode F0BN016726!, BR barcodes BR0000005225378! and BR0000005226030!, C barcodes C10015093! and C10015094!, G [on 2 sheets], K barcode K000329012!, P barcode P00708727!). Petrópolis (Sapucaia), Distrito de Serra Capim, Serra das Flores, 1 May 1946 (fl., fr.), *R. Burle Marx & H.L. Mello Barreto 15461* (RB barcode RB00231755!). Without municipality, ibid, Frade, Serra dos Orgãos, 4 April 1870 (fl., fr.), *A.F.M. Glaziou 3974* (BR barcode BR0000005226023!, C barcode C10015091!, K barcode K000329011!, P barcodes P00708719! and P00708720!, R barcode R000009289!); ibid, Serra dos Órgãos ou Friburgo?, *s.d.* (fl.), *s.c.* (RB barcode RB00231530!).

Taxonomic notes

The diagnostic features of this species are the lightly bullate adaxial leaf surface, with strigose indumentum, trichomes (0.4–)1.75–3.5 mm long, abaxial surface short strigose to sericeous or subglabrous, with barbellate trichomes 0.3–0.6 mm long. *Pleroma virgatum* resembles *P. pallidum* in floral characteristics, but in the latter the adaxial leaf surface is flat, not bullate and the adaxial surface has smooth trichomes, not barbellate, that are sparsely distributed. *Pleroma pallidum* was collected in the city of Rio de Janeiro, Brazil, in the Tijuca forest in rock outcrops of Pedra da Gávea.

Cogniaux (1885, 1891) described two other species, *Tibouchina nervulosa* Cogn. and *T. aspericaulis* Cogn., respectively, close to *Pleroma virgatum*. However, in this study we are following the synonymies suggested by Guimarães et al. (2019).

Habitat, distribution, and phenology

Pleroma virgatum is a small, heliophilous, terrestrial shrub occupying the *campos de altitude* s.l. and along the Montane Rain Forest (*Floresta Ombrófila Densa Alto-Montana*), where it is occasional. This species was recorded only in the state of Rio de Janeiro in the Serra dos Órgãos massif (Figure 4). Specimens with flowers and fruits were recorded from March to July.

This species was described in the late 19th century; it was collected again in 1946 in the municipality of Petrópolis in Serra do Capim in Pedra das Flores, but it had not been collected since that time. Through the efforts of the CNCFlora, *Pleroma virgatum* was recollected in 2015 in the Três Picos State Park.

Conservation status

This species should be considered Critically Endangered (CR) according to the criteria B2ab (ii,iii). Its AOO is equal to 8 km^2 and EOO is 73.16 km^2. *Pleroma virgatum* is constantly threatened due to forest fires that spread easily when they reach low vegetation in the *campos de altitude* of the state of Rio de Janeiro (Aximoff and Rodrigues 2011). In addition, the growing number of tourists and hikers visiting the region may also neg-

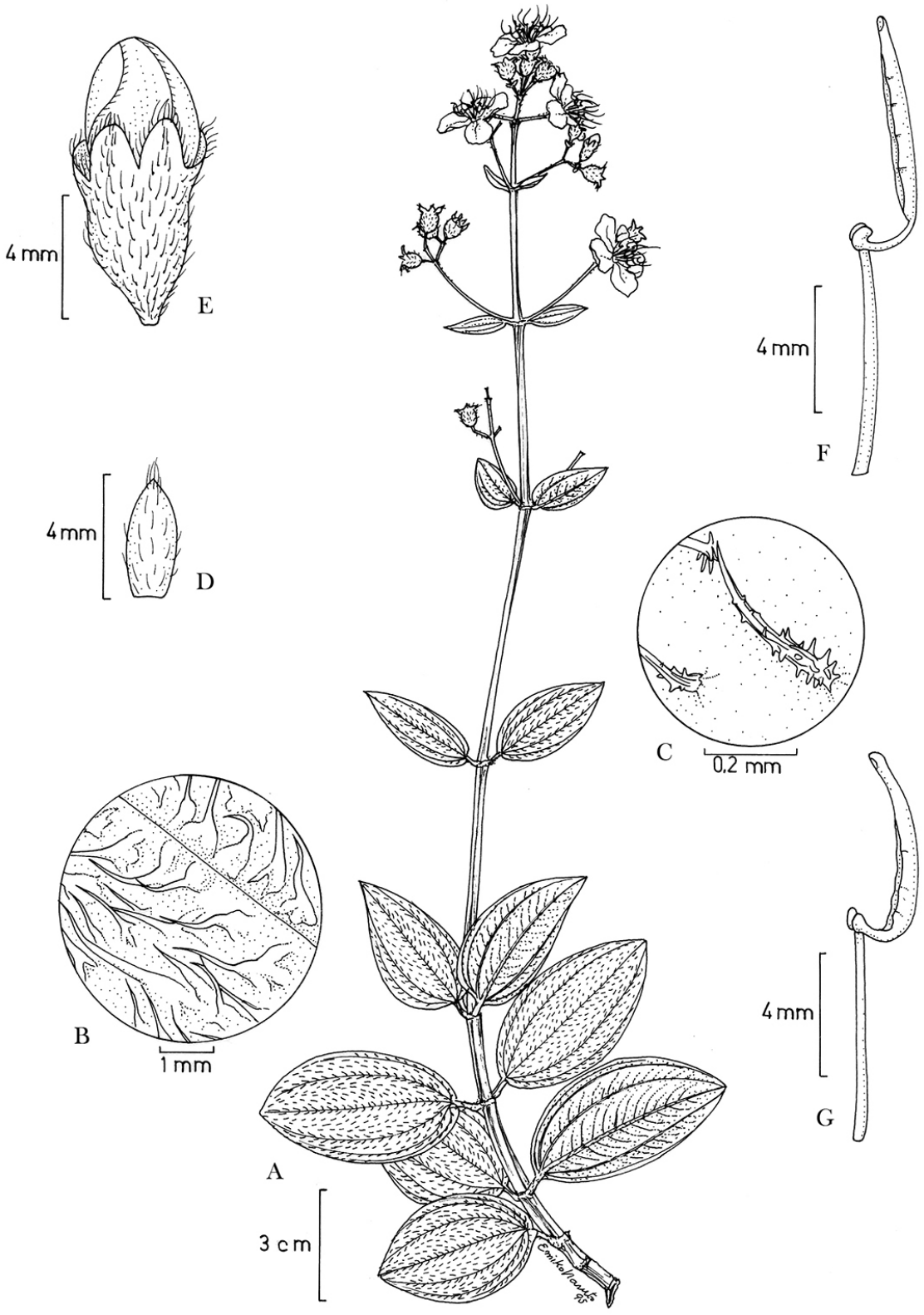

Figure 3. *Pleroma virgatum* Gardner. (a) Branch with leaves, flowers, and immature fruits. (b–c) Detail of trichomes on leaves. (b) Adaxial surface. (c) Abaxial surface. (d) Adaxial surface bracteole. (e) Floral bud. (f–g) Stamens. (f) Antesepalous. (g) Antepetalous. From *G. Gardner 403* (BM).

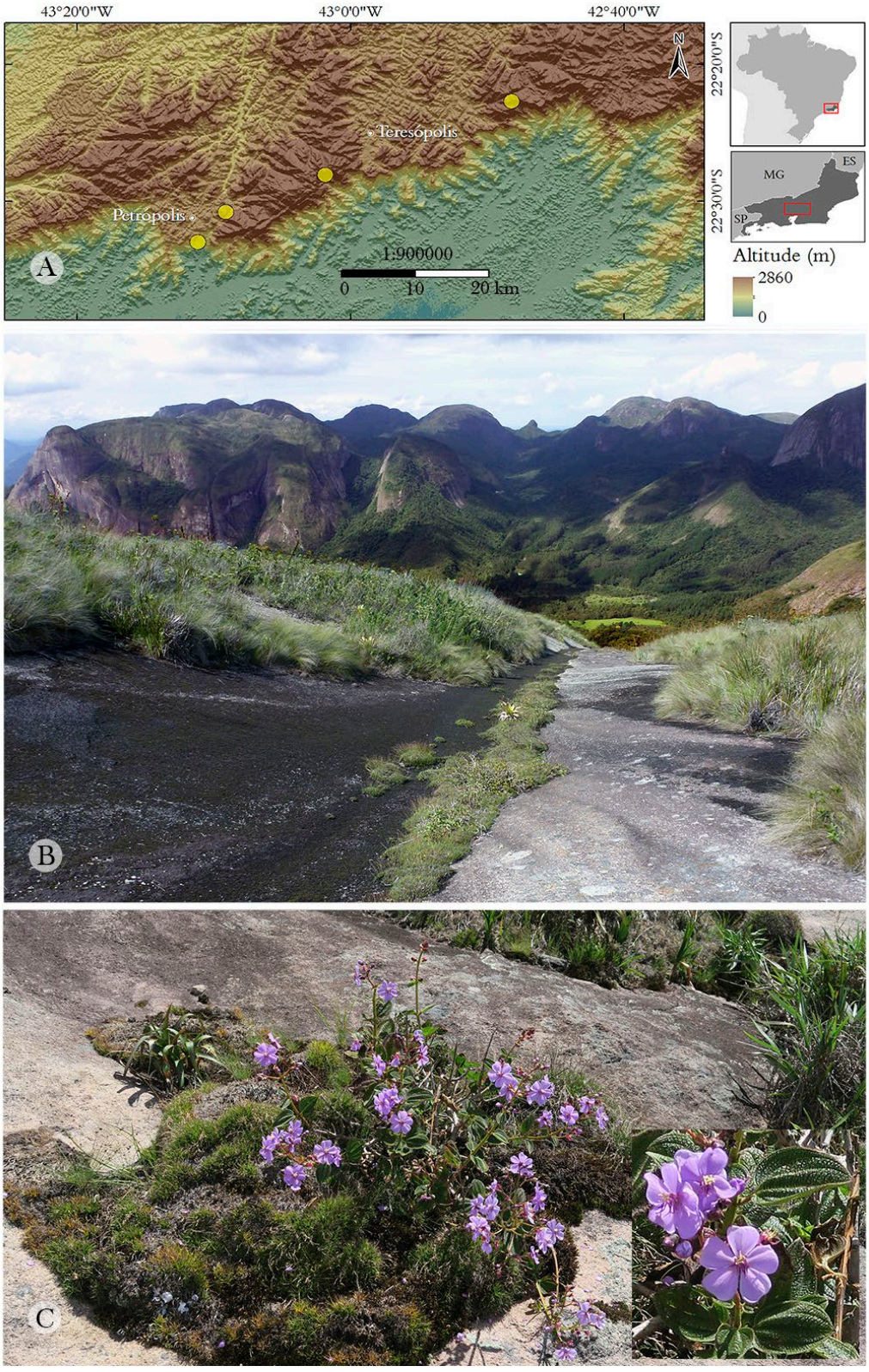

Figure 4. Distribution map and habitat of *Pleroma virgatum* Gardner. (a) Geographic distribution of the species (yellow dots). (b) Location near the top of the "Branca de Neve", Teresópolis, Rio de Janeiro state, Brazil. (c) Specimens images on the trail to "Cabeça do Dragão", Nova Friburgo, Rio de Janeiro state, Brazil. Photos: C. Baez (B) and J.F.A. Baumgratz (C).

atively impact the native vegetation of these environments. Before rediscovery, this species was evaluated as DD (Deficient Data).

CONCLUSION

Studies on the taxonomy, systematics, and conservation of endemic species are imperative to overcome the various knowledge gaps and comply with the international agreements of the Global Strategy for Plant Conservation. The collection of poorly known species is a challenging but necessary task, especially for megadiverse countries such as Brazil (Teixeira et al. 2014). Recently, sampling efforts in under-collected areas of the Brazilian Atlantic Forest have revealed taxonomic novelties in different genera of Melastomataceae (Goldenberg et al. 2016; Bochorny et al. 2017; Bacci et al. 2018; Justino et al. 2018). Therefore, the collection of specimens of rare species is essential to refine morphological circumscriptions of taxa, gain knowledge about their geographic distribution, and to provide recommended conservation assessments. Thus, we believe that our data provide fundamental information for conservation management decisions as poorly known species are rediscovered.

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How much of morphological variability in pollen from genus *Rubus* L. might be explained by climate variability

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Abstract. The aim of this study was to assess the influence of 19 climatic factors during flowering periods and taxonomic proximity on the morphological features of the pollen from the genus *Rubus* L., which comprises numerous species, often with small ranges of natural occurrence.. It was hypothesized that the pollen morphology would be driven more by the effects of taxonomic proximity than by climatic variables, due to the conservatism of the pollen features, connected with a shared evolutionary history. The analyses revealed that climatic variability can explain an additional 2.5% to 14.0% of pollen morphology. The majority of the modelled pollen features were not correlated with the bioclimatic factors studied, except for the P/E ratio, which was positively correlated, and E, which was negatively correlated with PC3. However, most of the variability was explained by random effects connected with the taxonomic affiliation of the studied species to the genus *Rubus* L., which is very difficult in taxonomic terms. The study, therefore, showed how much additional interspecific variability in pollen morphology might be explained by the climatic variability of the species distributions.

Keywords: intraspecific variability, interspecific variability, bioclimatic variables, mixed-effects models, variance partitioning, palynology, *Rubus*.

INTRODUCTION

Environmental factors which affect plant growth can be classified as abiotic factors and biotic factors. The abiotic factors that affect plant characteristics include topography, soil, and climatic factors (light, temperature, moisture etc.). They are the non-living components of the environment. They also affect plant adaptation (Eyduran et al. 2015; Unlukara 2019; Marsic et al. 2019).

Pollen production and pollen morphology may be strongly constrained by environmental factors, including climate (Charlesworth et al. 1987; Murcia 1990; Delph et al. 1997; Walther et al. 2002; Rao et al. 2019). Nevertheless, knowledge of their impact on the morphological features of pollen is scarce (Ejsmond et al. 2011, 2015). The most important climatic factors affecting the

growth and development of pollen are air temperature and humidity (Delph et al. 1997; Harder and Aizen 2010; Zinn et al. 2010; Ejsmond et al. 2011, 2015; Hinojosa et al. 2018). Furthermore, pollen grains are sensitive to abiotic stresses such as high temperature (Paupière 2014). Pollen reaction to heat stress during the flowering period was also observed by Prasad et al. (2011) and Omidi et al. (2014).

Several studies have confirmed that plants have to choose between the quantity and size of pollen grains produced (Mione and Anderson 1992; Vonhof and Harder 1995; Cruden 2000; Sarkissian and Harder 2001; Ashman et al. 2004; Yang and Guo 2004; Knight et al. 2005). However, empirical support of this compromise does not explain which ecological or functional factors determine the optimal combination of pollen size and quantity produced by a plant growing under given conditions (Ashman et al. 2004; Ejsmond et al. 2011, 2015). Therefore, there is a need for a new trend in palyno-climatic research, the results of which may be helpful in solving the abovementioned research problems. Ejsmond et al. (2011) proved that pollen production is closely connected to environmental temperature through the optimization of the number and size of the pollen grains produced. In the opinion of these authors, temperature does not significantly affect pollen shape. According to Ejsmond et al. (2015), pollen size increases with temperature. Indeed, it is likely that the intensity of the pollen competition on stigma increases the optimal temperature of the flowering period, which in turn is expected to promote large pollen grains.

The genus *Rubus* L. is species rich and includes from 750 to more than 1000 species distributed worldwide (Weber 1995); The genus includes 108 species in Poland (Kosiński et al. 2018). Genus *Rubus* is highly complex and is one of the most taxonomically challenging genera of flowering plants (Robertson 1974; Ling-Ti 1983; Richards et al. 1996) and circumscription of the species is complicated by hybridization, polyploidy, agamospermy, and the lack of a universal species concept (Gustafsson 1943; Weber 1996; Zieliński 2004; Zieliński et al. 2004). The very large and growing number of *Rubus* species are resulted from the small and local geographic distribution of their natural occurrence. A recent species concept for European *Rubus* agamosperms, only allows as species those biotypes whose distribution exceeds an area of 50 km in diameter (Weber 1996).

In this study, for the first time, 11 morphological features of the pollen from 57 *Rubus* species were tested for their correlation with 19 climatic factors during flowering periods. The aim was to assess the influence of bioclimatic variables and taxonomic proximity on the morphological features of the pollen in the genus *Rubus*, which comprises numerous species, often with small ranges of natural occurrence. It was hypothesized that the pollen morphology would be driven more by of taxonomic proximity than by climatic variables, due to the conservatism of the pollen features, connected with a shared evolutionary history.

STUDIED TAXA

The study was conducted on 57 *Rubus* species, representing four out of five subgenera, all three sections and 22 series found in Poland, including six endemic species (*R. capitulatus* Utsch, *R. chaerophylloides* Sprib., *R. ostroviensis* Sprib., *R. posnaniensis* Sprib., *R. seebergensis* Pfuhl ex Sprib. and *R. spribillei* Sprib.) (Table 1). The taxonomic classification of the studied taxa followed Zieliński (2004). The verification of the taxa was made by Prof. Jerzy Zieliński (from the Institute of Dendrology, the Polish Academy of Sciences in Kórnik), an outstanding taxonomist and specialist of the genus *Rubus*.

Pollen sampling and preparation

Several randomly-selected inflorescences (flowers) were collected from 57 natural bramble localities in Poland (Table 1). The plant material was stored in the herbarium of the Department of Forest Botany, Poznan University of Life Sciences (PZNF).

Acetolysis was carried out on the pollen grains according to the method used by Erdtman (1952, 1960). The grains were mixed with the acetolysis solution, which consisted of nine parts acetic anhydrite and one part concentrated sulphuric acid. The mixture was then heated to boiling point and kept in a water bath for 2-3 min. The samples were centrifuged in the acetolysis mixture, washed with acetic acid and centrifuged again. The pollen grain samples were then mixed with 96% alcohol and centrifuged 4 times, with the processed grains subsequently divided into two groups. One half of the processed sample was immersed in an alcohol-based solution of glycerin for LM, while the other was placed in 96% ethyl alcohol in preparation for scanning electron microscopy (SEM). The SEM observations were made using a Zeiss Evo 40 and the LM measurements of the acetolysed pollen grains were taken using a Biolar 2308 microscope at a magnification of 640x. The pollen grains were immersed in glycerin jelly and measured using an ocular eyepiece with a scale. The measurement results were converted into micrometers by multiplying each measurement by two. Each sample consisted of 30 mature, randomly selected, properly developed pollen grains. In total, 1710 pollen grains were measured. This

Table 1. List of localities of the *Rubus* species studied.

No	Species	Localities	Geographical coordinates	Collector, herbarium
1	*R. acanthodes*	Poland, Dolnośląskie, Nowe Łąki near Pielgrzymka	51°07'06,1"N, 15°46'37,5"E	Boratyńska, Dolatowska, Tomlik, Zieliński; KOR
2	*R. allegheniensis*	Poland, Zachodniopomorskie, Łukęcin near Świnoujście	54°02'34,9"N, 14°52'23,8"E	Boratyńska, Dolatowska, Zieliński; KOR
3	*R. angustipaniculatus*	Poland, Mazowieckie, Zakrzew near Radom	50°26'27,3"N, 21°00'02,4"E	Maliński, Zieliński; POZNF
4	*R. apricus*	Poland, Wielkopolskie, Bachorzew near Jarocin	51°59'39,9"N, 17°33'49,9"E	Maliński, Zieliński; POZNF
5	*R. bavaricus*	Poland, Wielkopolskie, Robczysko near Leszno	51°48'41,4"N, 16°45'38,6"E	Danielewicz, Maliński; POZNF
6	*R. bifrons*	Poland, Podkarpackie, Łukowe near Sanok	49°25'20,1"N, 22°14'14,1"E	Oklejewicz; KOR
7	*R. caesius*	Poland, Lubuskie, Osiecznica near Krosno Odrzańskie	52°04'45,0"N, 15°03'11,0"E	Maliński, Zieliński; POZNF
8	*R. camptostachys*	Poland, Wielkopolskie, Raków near Kępno	51°11'16,8"N, 18°05'54,1"E	Zieliński; KOR
9	*R. canadensis*	Poland, Dolnośląskie, Bialskie Mts. near Stronie Śląskie	50°14'59,9"N, 16°57'45,7"E	Kosiński; KOR
10	*R. capitulatus*	Poland, Wielkopolskie, Psienie-Ostrów near Pleszew	51°57'48,2"N, 17°45'51,5"E	Danielewicz, Maliński; POZNF
11	*R. chaerophylloides*	Poland, Wielkopolskie, Laskowo near Chodzież	53°01'19,2"N, 17°05'45,4"E	Maliński, Zieliński; POZNF
12	*R. chlorothyrsos*	Poland, Pomorskie, Bargędzino near Łeba	54°43'53,4"N, 17°43'19,3"E	Boratyńska, Dolatowska, Zieliński; KOR
13	*R. circipanicus*	Poland, Zachodniopomorskie, Jarosławiec near Ustka	54°32'21,3"N, 16°32'31,6"E	Zieliński; KOR
14	*R. clusii*	Poland, Małopolskie, Dobronków near Tarnów	49°59'28,2"N, 21°20'37,5"E	Maliński, Zieliński; POZNF
15	*R. constrictus*	Poland, Małopolskie, Lipinki near Gorlice	49°40'20,4"N, 21°17'31,6"E	Oklejewicz; KOR
16	*R. corylifolius*	Poland, Lubuskie, Różanówka near Bytom Odrzański	51°46'05,4"N, 15°52'29,5"E	Maliński, Zieliński; POZNF
17	*R. czarnunensis*	Poland, Pomorskie, Drzewicz, Bory Tucholskie National Park	53°51'07,3"N, 17°34'08,4"E	Tomlik, KOR
18	*R. divaricatus*	Poland, Lubuskie, Bielawy near Bytom Odrzański	51°46'21,3"N, 15°55'09,6"E	Maliński, Zieliński; POZNF
19	*R. dollnensis*	Poland, Dolnośląskie, Młynowiec near Stronie Śląskie	50°16'36,1"N, 16°54'04,8"E	Kosiński, Tomaszewski, Zieliński; KOR
20	*R. fabrimontanus*	Poland, Lubuskie, Tarnów Jezierny Nowa Sól	51°51'45,1"N, 15°59'07,7"E	Maliński, Zieliński; POZNF
21	*R. fasciculatus*	Poland, Podkarpackie, Gruszowa near Przemyśl	49°40'57,4"N, 22°40'47,2"E	Maliński, Zieliński; POZNF
22	*R. glivicensis*	Poland, Małopolskie, Maga near Tarnów	50°00'09,8"N, 21°20'24,7"E	Maliński, Zieliński; POZNF
23	*R. gothicus*	Poland, Wielkopolskie, Pakówka near Bojanowo	51°40'20,7"N, 16°46'07,9"E	Maliński, Zieliński; POZNF
24	*R. grabowskii*	Poland, Lubuskie, Tarnów Jezierny Nowa Sól	51°51'45,1"N, 15°59'07,7"E	Maliński, Zieliński; POZNF
25	*R. gracilis*	Poland, Podkarpackie, Pod Lasem, near Rzeszów	49°53'42,5"N, 21°35'52,1"E	Maliński, Zieliński; POZNF
26	*R. henrici-egonis*	Poland, Opolskie, Barnice near Głubczyce	50°03'02,5"N, 17°47'38,5"E	Kosiński, Tomaszewski, Zieliński; KOR
27	*R. hercynicus*	Poland, Dolnośląskie, Stare Bogaczowice near Wałbrzych	50°50'53,7"N, 16°11'37,4"E	Boratyński, Zieliński; KOR
28	*R. hevellicus*	Poland, Wielkopolskie, Tarce near Jarocin	52°00'02,4"N, 17°35'26,1"E	Maliński, Zieliński; POZNF
29	*R. idaeus*	Poland, Kujawsko-Pomorskie, Brodnica near Bydgoszcz	53°15'29,2"N, 19°23'57,9"E	Tomlik; KOR
30	*R. koehleri*	Poland, Dolnośląskie, Mirsk near Świeradów-Zdrój	50°58'19,9"N, 15°23'08,9"E	Boratyński; KOR
31	*R. lamprocaulos*	Poland, Dolnośląskie, Serby near Głogów	51°41'04,1"N, 16°06'42,9"E	Maliński, Zieliński; POZNF
32	*R. macrophyllus*	Poland, Dolnosląskie, Przywsie near Rawicz	51°34'37,1"N, 16°52'36,1"E	Maliński, Zieliński; POZNF
33	*R. marssonianus*	Poland, Pomorskie, near Kartuzy	54°20'03,2"N, 18°11'50,5"E	Boratyński; KOR
34	*R. micans*	Poland, Opolskie, Wieszczyna near Prudnik	50°19'18,2"N, 17°34'48,4"E	Kosiński, Tomaszewski, Zieliński; KOR
35	*R. mollis*	Poland, Dolnosląskie, Lądek-Zdrój, Trzykrzyska Mt.	50°20'54,6"N, 16°52'39,9"E	Kosiński, Tomaszewski, Zieliński; KOR
36	*R. montanus*	Poland, Dolnośląskie, Kowary near Kostrzyca	50°47'37,5"N, 15°50'01,8"E	Zieliński; KOR
37	*R. nessensis*	Poland, Dolnośląskie, Karczmisko near Kłodzko	50°17'56,7"N, 16°49'32,8"E	Kosiński; KOR

(Continued)

No	Species	Localities	Geographical coordinates	Collector, herbarium
38	*R. odoratus*	Poland, Lubelskie, Niedrzwica Duża near Lublin	51°06'51,3"N, 22°23'16,2"E	illegible name; KOR
39	*R. opacus*	Poland, Wielkopolskie, Starkowo near Leszno	51°58'37,7"N, 16°18'35,7"E	Zieliński; KOR
40	*R. orthostachys*	Poland, Wielkopolskie, Ostatni Grosz near Krotoszyn	50°39'54,4"N, 17°21'18,9"E	Maliński, Zieliński; POZNF
41	*R. ostroviensis*	Poland, Wielkopolskie, Wielkopolski National Park near Poznań	52°16'26,5"N, 16°46'50,1"E	Zieliński, Maliński; POZNF
42	*R. parthenocissus*	Poland, Podkarpackie, Koniusza near Przemyśl	49°40'57,4"N, 22°40'47,2"E	Maliński, Zieliński; POZNF
43	*R. pedemontanus*	Poland, Dolnośląskie, Nowy Kościół near Złotoryja	51°04'20,1"N, 15°52'05,3"E	Boratyński, Zieliński; KOR
44	*R. perrobustus*	Poland, Podkarpackie, Dudyńce near Sanok	49°39'04,9"N, 22°04'31,9"E	Oklejewicz; KOR
45	*R. pfuhlianus*	Poland, Wielkopolskie, Mieczewo near Kórnik	52°14'20,8"N, 17°00'27,8"E	Zieliński; KOR
46	*R. plicatus*	Poland, Lubuskie, Różanówka near Bytom Odrzański	51°46'05,4"N, 15°52'29,5"E	Maliński, Zieliński; POZNF
47	*R. posnaniensis*	Poland, Opolskie, Szybowice near Prudnik	50°21'09,5"N, 17°29'11,9"E	Kosiński, Tomaszewski, Zieliński; KOR
48	*R. pyramidalis*	Poalnd, Wielkopolskie, Chruszczyny near Ostrów Wielkopolski	51°38'41,4"N, 17°35'42,6"E	Maliński, Zieliński; POZNF
49	*R. radula*	Poland, Podkarpackie, Hermanowa near Rzeszów	49°56'07,4"N, 22°00'40,4"E	Maliński, Zieliński; POZNF
50	*R. schleicheri*	Poland, Wielkopolskie, Kościan	52°05'10,7"N, 16°38'41,9"E	Maliński, Zieliński; POZNF
51	*R. scisus*	Poland, Śląskie, Rudniki near Częstochowa	50°52'33,6"N, 19°14'28,5"E	Zieliński; KOR
52	*R. seebergensis*	Poland, Wielkopolskie, Wielkopolski National Park near Poznań	52°16'26,5"N, 16°46'50,1"E	Danielewicz; POZNF
53	*R. siemianicensis*	Poland, Wielkopolskie, Psienie-Ostrów near Pleszew	51°57'48,2"N, 17°45'51,5"E	Danielewicz, Maliński; POZNF
54	*R. sprengelii*	Poland, Wielkopolskie, Borownica near Zduny	51°38'20,8"N, 17°24'23,3"E	Maliński, Zieliński; POZNF
55	*R. spribillei*	Poland, Wielkopolskie, Gądki near Kórnik	52°18'45,4"N, 17°02'47,8"E	Zieliński; POZNF
56	*R. wimmerianus*	Poland, Podkarpackie, Gniewczyna Łańcucka near Przeworsk	50°06'19,5"N, 22°29'43,7"E	Oklejewicz, Zatorski; POZNF
57	*R. xanthocarpus*	Poland, Świętokrzyskie, Miedzianka near Kielce	50°50'22,5"N, 20°22'03,3"E	Maciejczak, Bróż, Zieliński; KOR

KOR - Herbarium of the Institute of Dendrology, Polish Academy of Sciences, Kórnik, Poland; PZNF - Herbarium of the Department of Forest Botany, Poznań University of Life Science.

study uses the results of biometric pollen measurements made for earlier, already published (Lechowicz et al. 2020) studies on morphology and variability pollen of Polish and European *Rubus* species.

Features analyzed

The pollen grains were analyzed for 11 quantitative characters: length of the polar axis (P) and equatorial diameter (E), length of the ectoaperture (Le), thickness of the exine along the polar axis and equatorial diameter (Exp and Exe), distance between apices of two ectocolpi (d) and P/E, Le/P, Exp/P, Exe/E, d/E (apocolpium index P.A.I) ratios.

The descriptive palynological terminology followed Punt et al. (2007) and Halbritter et al. (2018).

Climatic data

In the analysis, 19 bioclimatic variables were used (Table 2), developed for species distribution models BIOCLIM (Booth 2018; Booth et al. 2014)SDM is one of the most active areas of global ecology. Three books published in 2009, 2011 and 2017 have reviewed SDM, and the closely related areas of ecological niche modelling and habitat suitability modelling. All three books provide excellent introductions to these topics, but give very little information on the role that BIOCLIM played in laying the foundation for these research areas. Understanding the history of BIOCLIM is vital because it was the first package to implement the basic SDM process in an easy-to-use integrated system. It provided what are still the most commonly used set of 19 bioclimatic variables and contributed to the development of the interpolation routines used to prepare the most commonly used source of bioclimatic data (WorldClim. These variables were obtained from the WorldClim 1.4 database (Hijmans et al. 2005) using *raster::getData()* function in 2.5' resolution (~5 km in the study area). Due to intercorrelations between the variables, Principal Component Analysis (PCA) was used to use the main gradients of the bioclimatic variables in the reduced space (Fig. 1 a-c). Prior to PCA, the variables were scaled and centered to avoid artifacts connected with differences in ranges and units. PCA was performed using *vegan::rda()* function. Analysis of the inertia shared by particular principal components (screeplot, Fig. 1 d) revealed that the PC1-PC3 axes explained more variance than the null model of random variance distribution (broken stick model). Thus, all of them were used in further analyses. PC1 described the transition between the wetter and colder parts of the study area (a positive correlation with mean annual temperature) and the warmer and drier parts (a negative correlation with precipitation in both cold and warm periods). Therefore, PC1 was seen as representing aridity and temperature gradient. PC2 increased as the temperature of the driest and coldest month rose, as well as the precipitation in the coldest quarter, but decreased with the increasing temperature range, isothermality, precipitation in the wettest month and precipitation seasonality. Thus, PC2 was considered to represent aridity and climate variability. PC3 described seasonal variation in the climate, showing a positive correlation with temperature isothermality and a negative correlation with seasonality. Therefore, PC3 represented continentality – the seasonal variation gradient from a maritime to a continental climate (high PC3 values indicated a low seasonality of temperature). These three axes of PCA explained 53.96%, 22.24% and 15.97% of the variability, respectively. A lack of variance inflation in the models was also ensured by calculating the variance inflation factors.

Table 2. Overview of bioclimatic variables used in this study.

Abbreviation	Variable	Unit
bio1	Annual Mean Temperature	°C
bio2	Mean Diurnal Range (Mean of monthly (max temp - min temp)	°C
bio3	Isothermality (BIO2/BIO7) (* 100)	°C
bio4	Temperature Seasonality (standard deviation *100)	°C
bio5	Max Temperature of Warmest Month	°C
bio6	Min Temperature of Coldest Month	°C
bio7	Temperature Annual Range (BIO5-BIO6)	°C
bio8	Mean Temperature of Wettest Quarter	°C
bio9	Mean Temperature of Driest Quarter	°C
bio10	Mean Temperature of Warmest Quarter	°C
bio11	Mean Temperature of Coldest Quarter	°C
bio12	Annual Precipitation	mm
bio13	Precipitation of Wettest Month	mm
bio14	Precipitation of Driest Month	mm
bio15	Precipitation Seasonality (Coefficient of Variation: mean/SD*100)	%
bio16	Precipitation of Wettest Quarter	mm
bio17	Precipitation of Driest Quarter	mm
bio18	Precipitation of Warmest Quarter	mm
bio19	Precipitation of Coldest Quarter	mm

Data analysis

To assess the studied relationships which acknowledged intraspecific variability and species-specific

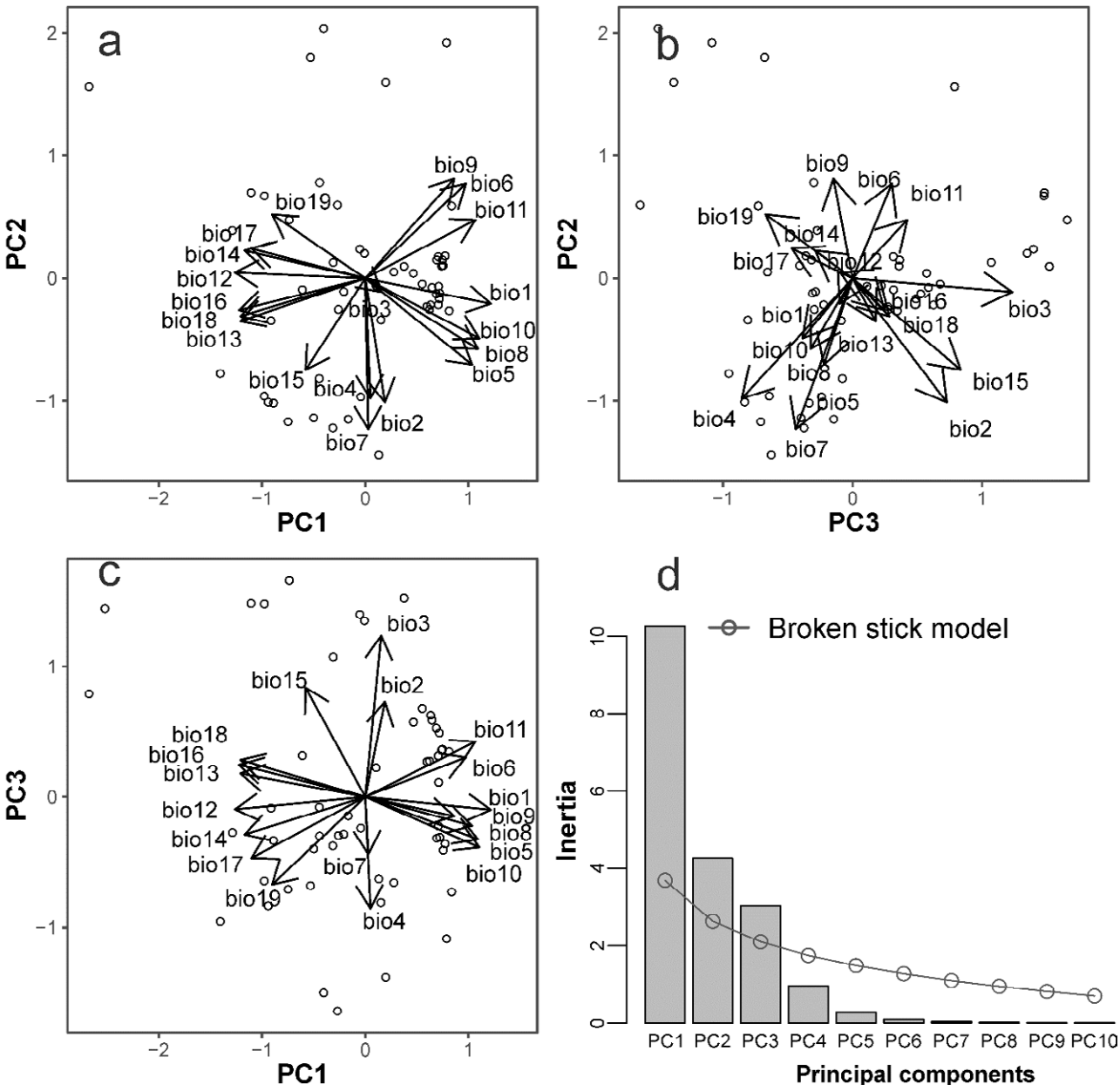

Figure 1. Result of principal components analysis for 19 bioclimatic variables (see: Table 2).

effects, we used linear mixed-effects models (LMM) would be used. For data aggregated at species level, full models were used (eq. 1)

$$Y = \beta_0 + \Sigma^{n}_{i=1}\,\beta_i X_i + u_{p:q:r:s} + u_{q:r:s} + u_{r:s} + u_s + \varepsilon_{p,q,r,s,j} \quad (1)$$

$u_{p:q:r:s} \sim N(0,\sigma^2)$

$u_{q:r:s} \sim N(0,\sigma^2)$

$u_{r:s} \sim N(0,\sigma^2)$

$u_s \sim N(0,\sigma^2)$

$\varepsilon_{p,q,r,s,j} \sim N(0,\sigma^2)$

where Y = dependent variable (pollen morphological feature), X = predictors (particular climate PCA axes and their interactions), $u_{p:q:r:s}$ = random effects connected with series (nested in subsection, section and subgenus), $u_{q:r:s}$ = random effects connected with subsection (nested in section and subgenus), $u_{r:s}$ = random effects connected with section (nested in subgenus), u_s = random effects connected with subgenus, and $\varepsilon_{p,q,r,s,j}$ = residual error of particular samples.

A mixed-effects models *lmerTest* package (Bates et al. 2015; Kuznetsova et al. 2017) was developed. Firstly,

a model compromising all three main bioclimatic components (PC1-PC3) was developed and then reduced according to Akaike Information Criterium corrected for small samples (AICc) using *MuMIn::dredge()* function (Bartoń 2017). From the list of candidate models the best fit was chosen, according to AICc and Akaike weights. In the case that the best fit was a null model (intercept-only), the second best model was used as the final model. Metrics (AICc and Akaike weights) were also provided for the null and full models in order to show the increase in information in the models. Information was provided on the amount of variance explained by the fixed effects using only the marginal coefficient of determination (R^2_m) and by both the random and fixed effects using the conditional coefficient of determination (R^2_c), calculated following Nakagawa and Schielzeth (2013), using the *MuMIn::r.squaredGLMM()* function (Bartoń 2017).

We assumed random effects connected with taxonomic nestedness as a proxy of interspecific variability, to compare with effect size of climatic variables. This made it possible to acknowledge phylogenetic non-independence in the data using random effects in the models. We ignored p-values as a measure of statistical significance since these can be biased by sample size or not connected with biologically meaningful effects (Wasserstein and Lazar 2016).

RESULTS

The two most important climatic factors – temperature and humidity – were analyzed based on 19 bioclimatic variables (Table 2). Analyses of the mixed-effects models revealed that in the case of the majority of the modeled pollen features, the null model had the lowest AIC, which means that these traits were not correlated with the bioclimatic variables studied (Table 3). However, it was found that the P/E ratio was positively correlated and E was negatively correlated with PC3 (Table 4). Nevertheless, the estimates indicated low effect sizes. In the case of these morphological features of the pollen, the climatic data explained 14.0% and 2.8% of the variability, respectively. In contrast, the taxonomic affiliation, included in the models as a random effect, explained from 2.5% to 75.2% of the variability (Table 3).

Among the taxonomic random effects, the most important were these of the subgenus and series, while the least were those of the section (Table 4).

DISCUSSION

The results confirmed the hypothesis that pollen morphology is driven more by taxonomic proximity effects than by climatic variables, due to pollen feature conservatism associated with shared evolutionary history. The reproductive parts of plants (pollen grains and seeds) characters are more conservative and constant than their vegetative ones (Cruden 1977, 2009). Therefore, pollen grains of related taxa usually have similar morphology, as it is the case also with pollen grains of the majority of the genera of the Rosaceae family (e.g. *Crataegus, Malus, Rosa, Rubus,* and *Spiraea*). They have isopolar monads, are generally medium-sized (rarely

Table 3. Summary of mixed-effects models comparison for studied pollen morphological features.

Pollen feature	Full model AICc	Full model AW	Null model AICc	Null model AW	Final model AICc	Final model AW	Final model dependent variables	Final model R^2_c	Final model R^2_m
P	258.9	0.010	**251.2**	**0.450**	**251.2**	**0.450**	null	0.000	0.738
E	237.2	0.019	231.7	0.297	**231.4**	**0.348**	PC3	0.025	0.744
P/E	-122.7	0.000	-142.6	0.486	**-142.7**	**0.499**	PC3	0.140	0.327
Exe	22.8	0.000	**-11.0**	**0.933**	**-11.0**	**0.933**	null	0.000	0.133
Exp	21.1	0.000	**-3.0**	**0.908**	**-3.0**	**0.908**	null	0.000	0.025
Le	246.4	0.006	**237.4**	**0.527**	**237.4**	**0.527**	null	0.000	0.752
d	166.6	0.001	**154.4**	**0.667**	**154.4**	**0.667**	null	0.000	0.255
Le/P	-244.6	0.000	**-280.6**	**0.992**	**-280.6**	**0.992**	null	0.000	0.459
Exp/P	-313.5	0.000	**-354.2**	**0.996**	**-354.2**	**0.996**	null	0.000	0.395
Exe/E	-295.7	0.000	**-334.4**	**0.995**	**-334.4**	**0.995**	null	0.000	0.415
d/E	-181.7	0.000	**-214.1**	**0.985**	**-214.1**	**0.985**	null	0.000	0.539

AICc – Akaike Information Criterion corrected for small samples; AW – Akaike weights; Full model refer to model with three variables – PC1, PC2 and PC3, null model – to model with intercept and random effects only and final model – to best fit model (parameters – Table 4).

Table 4. Parameters of mixed-effects models of studied pollen morphological features.

Pollen feature	SD $u_{p:q:r:s}$	SD $u_{q:r:s}$	SD $u_{r:s}$	SD u_s	SD $\varepsilon_{p,q,r,s,,j,}$	Term	Estimate	SE	df	t	p
P	1.20042	0.80436	0.00112	2.14196	1.55210	Intercept	23.6510	1.2610	3.0920	18.7600	0.0003
E	0.89480	0.18510	0.57330	3.01650	1.66410	Intercept	20.1160	1.1449	3.2811	17.5700	0.0002
						PC3	-0.5264	0.2677	49.4355	-1.9670	0.0549
P/E	<0.00001	0.00073	<0.00001	<0.00001	0.00262	Intercept	1.1792	0.0150	5.3231	78.7140	<0.0001
						PC3	0.0306	0.0092	53.8903	3.3290	0.0016
Exe	0.06843	<0.00001	<0.00001	0.00006	0.17757	Intercept	1.7828	0.0281	19.1669	63.5500	<0.0001
Exp	<0.00001	<0.00001	<0.00001	<0.00001	0.20037	Intercept	1.8058	0.0266	51.2241	67.7900	<0.0001
Le	1.02893	0.62121	<0.00001	2.09733	1.39485	Intercept	19.1220	1.2080	3.3490	15.8200	0.0003
d	0.18280	<0.00001	<0.00001	<0.00001	0.53320	Intercept	4.4877	0.1348	19.4111	33.3000	<0.0001
Le/P	0.00348	<0.00001	<0.00001	0.01428	0.01616	Intercept	0.8126	0.0104	2.7305	77.9400	0.0000
Exp/P	0.00463	<0.00001	<0.00001	0.00412	0.00773	Intercept	0.0736	0.0036	0.9695	20.6100	0.0337
Exe/E	0.00003	<0.00001	<0.00001	0.00003	0.00008	Intercept	0.0858	0.0044	0.9280	19.4300	0.0400
d/E	0.00004	<0.00001	<0.00001	0.00094	0.00084	Intercept	0.2250	0.0193	2.2835	11.6700	0.0044

SD – standard deviations of random effects: $u_{p:q:r:s}$ – random effects connected with series (nested in subsection, section and subgenus); $u_{q:r:s}$ – random effects connected with subsection (nested in section and subgenus); $u_{r:s}$ – random effects connected with section (nested in subgenus); u_s – random effects connected with subgenus; $\varepsilon_{p,q,r,s,,j,}$ – residual error of particular samples.

small-sized), with tricolporate or tricolpate pollen grains and mostly striate exine ornamentation (Nazeri 2008; Polyakova and Gataulina 2008; Wrońska-Pilarek and Jagodziński 2011; Wrońska-Pilarek et al. 2013, 2019; Lechowicz et al. 2020). Moreover, intra-generic studies indicated that pollen grains were so similar that usually it was possible to distinguish only a few sections or series and from a few to several individual species, and most often there were groups of taxa with similar pollen characteristics. In this research, among the random effects describing the phylogenetic relatedness of the species studied, the most important ranks were those of subgenus and series, while the least were those of section (Table 4). In contrast, the latest palynological study on *Rubus* (Lechowicz et al. 2020) revealed a low agreement between pollen morphological differentiation and taxonomic division. Pollen traits were most useful at the species level. In the case of the subgenus and series, it was observed that species belonging to these taxa did not generally form separate groups. Other genera of the Rosaceae family (e.g. *Spiraea, Rosa,* and *Crataegus*) showed a greater correlation between pollen morphology and infrageneric taxonomic classification (Wrońska-Pilarek and Jagodziński 2011; Wrońska-Pilarek et al. 2013, 2019). In *Rubus* this may be the result of apomixes, that is the replacement of the normal sexual reproduction by asexual reproduction, without fertilization, which could reduce natural variability (Weber 1996; Zieliński 2004).

In older papers, Bell (1959) and Aizen and Raffaele (1998) indicated differences in pollen size due to fluctuations in the temperature occurring under the influence of different climatic conditions. According to Déri's (2011) modern studies on *Cydonia oblonga*, the pollen size and shape of this species were dependent on different climatic factors, such as temperature and humidity. Ejsmond et al. (2011), based on theoretical findings, showed a general trend for plants in environments with higher temperatures and potential evapotranspiration (PET) to produce less numerous and larger pollen grains (pollen with larger values of P and E) and to exhibit a slight change in grain shape, which may be more difficult to detect. Dainese and Sitzia (2013) as well as Maiti and Rodriguez (2015) and Azzazy (2016) also confirmed this opinion. Ejsmond et al. (2011) claimed that temperature does not significantly affect pollen shape. The research presented here did not fully confirm these results. Our study shows that pollen shape (P/E ratio) was positively correlated and equatorial diameter (E) was negatively correlated with PC3 (Table 4). This means that the less seasonal variability of the climate (higher PC3 values), the shorter the equatorial diameter of the pollen (E) and the larger the value of the P/E ratio , that is, the larger the share of elongated pollen grains.

Lawrence and Campbell (1999) sampled 57 *Rubus* taxa including 20 species of subgenus *Rubus*, one to seven species from other 11 subgenera. Their genetic analyzes indicated that species from this genus were generally consistent with biogeography and ploidy, but traditionally important morphological characters, such as stem armature and leaf type, appeared to have a limited phylogenetic value in *Rubus*. This confirms

the results of our earlier palynological studies (Lechowicz et al. 2020), which also showed that the morphological features of the pollen had considerable but limited impact on the taxonomy of genus *Rubus*. Lawrence and Campbell (1999) proved that ITS sequences were most informative among subgenera, and variability was low between closely related *Rubus* species. They distinguished three large clades in the genus *Rubus*. The first one contained all the sampled species of nine of the 12 studied subgenera, including subgenera *Cylactis*, *Anoplobatus* and *Idaeobatus* analyzed in this paper. The second clade included extreme Southern Hemisphere species of subgenera *Comaropsis* and *Lampobatus*, and the third consisted of subgenus *Rubus* (from which came 54 of the 57 examined species) and *R. alpinus* of subgenus *Lampobatus*. Such research results seem to confirm the hypothesis presented in this study that in *Rubus* pollen, the "impulse" caused by taxonomic and genetic factors is stronger than the influence of climatic factors. The cited authors showed the compatibility of the studied species with biogeography, which would indicate the great importance of the ranges of natural occurrence of the individual blackberry species for their diagnosis. The cited studies also indicate that the impact of geographical factors associated with climate factors on pollen morphology could perhaps be greater than demonstrated in this paper. It cannot be excluded that the results obtained in this study were influenced by the fact that the pollen grains (pollen samples) were collected from one natural site of a given blackberry species.

In contrast to palyno-climatic studies, research on the relationships between leaf traits and climatic data have been conducted more often. Wright et al. (2017) analyzed leaf data for 7670 plant species, along with climatic data from 682 sites worldwide. The authors provided a fully quantitative explanation for the latitudinal gradient in leaf size, with implications for plant ecology and physiology, vegetation modelling, and paleobotany. Large-leaved species predominate in wet, hot, sunny environments; small-leaved species typify hot, sunny environments only in arid conditions; small leaves are also found in high latitudes and at high elevations. By modelling the balance of leaf energy inputs and outputs, they showed that daytime and nighttime leaf-to-air temperature differences were key to geographic gradients in leaf size. Midolo et al. (2019) performed a global meta-analysis of leaf traits in 109 plant species located in four continents and demonstrated that there were common cross-species patterns of intraspecific leaf trait variation across elevational gradients worldwide. Irrespective of whether such variation is genetically determined via local adaptation or attributed to phenotypic plasticity, the leaf trait patterns quantified here suggest that plant species are adapted to living in a range of temperature conditions. The comprehensive studies cited above showed clear relationships between the morphological characteristics of leaves (e.g. leaf size) and climatic factors. It is therefore probable that in the case of a much larger pollen grain sample of different species from different geographical locations, the relationships between the pollen features and climatic factors would be much more pronounced.

CONCLUSIONS

The study revealed than climatic variability can explain an additional 2.5% to 14.0% of pollen morphology. However, most of the variability was explained by random effects connected with the taxonomic affiliation of the studied species to the genus *Rubus* L., which is very difficult in taxonomic terms.

Although the study analysed data concerning the interactions between the study site climate and the taxonomic affinity of the species on the pollen morphology, the results are biased due to the lack of species-specific replications. For this reason, phylogenic differences in the pollen morphology may have been masked by site specific effects. Despite this, as previously no attempts had been made to differentiate these two effects in the case of apomictic genus comprised of species often with small geographic ranges, it is assumed that these results might be a preliminary finding in the further exploration of such relationships. Further studies are required in order to determine whether knowing the biometric features of the pollen grains can significantly improve predictions of the impact of climate change on plant populations and to reconstruct past environmental conditions.

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Macro- and micro-morphologies and conservation status of *Hymenorchis javanica* (Orchidaceae: Aeridinae): the only representative of the genus in Malaysia

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Abstract. Analysis of morphological characters and conservation status were carried out for *Hymenorchis javanica* from Peninsular Malaysia. Morphology was studied in detail and accompanied by a botanical drawing prior to the correct identification. From most closely related *Hymenorchis phitamii* found in Vietnam, it differs in the lip ovate-oblong with apex acute and margins entire, and the leaves margins prominently serrulate. Based on the current IUCN criteria, we proposed *H. javanica* as an endangered species under the threatened category. Judging from the current small population sizes and degraded habitats, *H. javanica* in Malaysia is threatened by extinction in the wild.

Keywords: endangered species, climate change, *Hymenorchis*, Orchidaceae, taxonomy.

INTRODUCTION

Hymenorchis Schltr. is an orchid genus under subfamily Epidendroideae, tribe Vandeae and subtribe Aeridinae (Comber 1990). The genus comprises of small monopodial epiphytes that own short stems bearing leathery leaves with minutely serrulate margins (Rice 2018). The plant culminates axillary inflorescence with white to yellow flowers, free petals and sepals with serrulate margins, immobile and small green lip lamina, relatively large spur, and two pollinia (Comber 1990; Rice 2018). In Malaysia, *Hymenorchis javanica* (Teijsm. & Binn.) Schltr. is the only representative of the genus. *Hymenorchis javanica* was previously claimed endemic to West Java at from 900–1000 m elev. (Comber 1990) and was many years then discovered in Mount Ulu Kali, Genting Highlands, Pahang, Malaysia (Ng et al. 2012; Govaerts et al. 2020). In Malaysia, this rare species is confined to a single population on a few trees on the roadside in Genting Highlands, which are now lessening in the location where it was spotted previously (Ng et al. 2012). Until now, no other plants

nor localities were recorded in Malaysia, indicating rarity and vulnerability to local extinction with the current rate of forest conversion and environmental changes in the area. Genting Highlands is a resort development comprising hotels, casinos, shopping malls, and a theme park in Pahang that built on the peak of Mount Ulu Kali at 1,758 m elev. (Chua and Saw 2001; Genting Malaysia Berhad 2010). The summit area is located within the Bukit Tinggi Forest Reserve to the east and Batang Kali Forest Reserve to the west. Since 1967, rapid construction of roads and hotel complexes have had a detrimental impact on its physical environment and vegetation (Stone 1981; Chua and Saw 2001; Go et al. 2015a). Habitat destructions together with local climate change might have caused the orchid species to be eradicated locally or extinct (Go et al. 2015b). Collective findings from the previous floristic accounts and specimens deposited in the local herbaria and Singapore Botanic Gardens listed a total of 134 taxa and 51 genera of orchids in the Genting Highlands, including 33 endemic species to Peninsular Malaysia (Ng et al. 2012). The compilation includes a past collection by H.N. Ridley in Mount Mengkuang Lebah (Ridley 1914), William S. Null (Null 1972), B.C. Stone (Stone 1981), G. Seidenfaden and J.J. Wood (Seidenfaden and Wood 1992), R. Kiew (Kiew 1998), and a reassessment by FRIM in 1997 as a comparison to Stone's investigation (Chua and Saw 2001).

Hitherto no proper documentation on the occurrence of *H. javanica* in Malaysia nor the taxonomic description and illustration. Morphologically, *H. javanica* is highly identical to the *Hymenorchis phitamii* Aver. found in Vietnam. Both species are also occurring in montane forest (Averyanov et al. 2012; Ng et al. 2012). Vietnamese flora shows a strong similarity to tropical flora of Peninsular Malaysia at both family and generic levels (Zhu and Roos 2004). Therefore, the same orchid species may occur in both regions. Also, our specimens had not been thoroughly examined due to lack of floral structures and the small existing population as it is now at the current single locality. We thought it would be worth looking at the general morphology in detail to authenticate our earlier identification. Profiling on floral-surface micromorphology was conducted in order to enhance knowledge on the diversity and organographic distribution of the floral microstructures with inference to the taxonomic evaluation and physioecological demands. To the best of our knowledge that based on the plants growing in the Genting Highlands, *H. javanica* exhibits ephemeral, small and fragile flowers, and rarely flowering in the wild, as of *Corybas*, hence, a taxonomic study of the floral parts is noteworthy (Besi et al. 2019a).

MATERIALS AND METHODS

Specimen with complete floral structures was processed as herbarium specimens following Bridson and Forman (2000). The Copenhagen-preserved flower specimen was dissected, measured, described, and photos were taken for each of the significant part to assist the botanical drawing (Besi et al. 2020a). Plant descriptions and botanical drawings were based on the dissection of the spirit-preserved and fresh flower specimens. Classical taxonomy with reference to the type specimen, protologue, and botanical literatures of Smith (1903), Schlechter (1914) and Comber (1990) was employed in the identification process. Digitised images of herbarium collections, botanical drawing and records deposited in National Herbarium of the Netherlands (NHN) accessed through Browse Dutch Natural History Collections: BioPortal (Naturalis) (http://bioportal.naturalis.nl/) and Swiss Orchid Foundation (https://orchid.unibas.ch/index.php/en/) were studied in detail for both identification and evaluation of the species' distribution status. The accepted name was validated via KEW World Checklist of Selected Plant Families (WCSP) (Govaerts et al. 2020).

Floral-surface micromorphology examination was conducted using scanning electron microscope (SEM) in Anatomy Lab and Scanning Electroscope Room in the Faculty of Agriculture, UPM, Malaysia. The sample processing was made according to Spence (2001). The flower parts were cut into a number of 1 cm slices, put into separate vials, and fixed in formalin acetic acid. Then, the samples were post-fixed in 1% (v/v) osmium tetroxide for overnight. After that, a series of ethanol was used in dehydration step; 50%, 75%, 90%, 95%, and 100% (v/v). The samples were dehydrated in each ethanol solution for 30 minutes and twice in the absolute one. The samples were then transferred into specimen baskets prior to critical point drying using liquid CO_2 critical dryer for about 70 minutes. Dried samples were mounted onto the stub by means of double-sided carbon adhesive tabs and gold coated them in sputter coater. Finally, the samples were viewed under JEOL-JSM 5610 LV Scanning Electron Microscope. The floral-surface microstructures of dorsal sepal, lateral sepal, petals, lip, column, and pollinia were observed at various magnifications. The microstructures parameters observed were epicuticular waxes, epicuticular ornamentation, stomata, trichomes distribution and type, and pustular glands. Enumeration of trichomes requires four steps following Theobald et al. (1979). Parameter measurements were done using a ruler under a clear magnification and the values obtained were multiplied with the magnification scales. Epicuticu-

lar ornamentation was described following Piwowarczyk (2015), Ghimire et al. (2018), and Kong and Hong (2018). Meanwhile, the description of epicuticular waxes was based on Wilkinson (1979). Enumeration of the micromorphological features was done following the outline in Ghazalli et al. (2019).

The current conservation status was validated through the IUCN Red List of Threatened Species database (http://www.iucnredlist.org). Assessment of the proposed conservation status was opined for *H. javanica* following a guideline in IUCN Red List Categories and Criteria version 14 (August 2019) (IUCN Standards and Petitions Committee 2019). The current information gathered were used in the assessment based on the geographical range in the form of the current Area of Occupancy (AOO) and Extent of Occurrence (EOO). The range of distributions was assessed using Geospatial Conservation Assessment Tool (GeoCAT) (http://geocat.kew.org/). This tool was for rapid geospatial analysis of the species in a simple yet reliable way. It supports the Red Listing process to help identify, evaluate against IUCN criteria, and conserve threatened species. The range of distribution from historical and current localities within Malaysia and Java was plotted in Google Earth maps. Extinction risk was determined based on Criterion B (IUCN Standards and Petitions Committee 2019).

TAXONOMY

Hymenorchis javanica (Teijsm. & Binn.) Schltr., Repert. Spec. Nov. Regni Veg. Beih. 1: 995 (1913) (Figure 1 and Figure 2)

Basionym: *Oeceoclades javanica* Teijsm. & Binn., Natuurk. Tijdschr. Ned. -Indië 24: 326 (1862);

(≡) *Saccolabium javanicum* (Teijsm. & Binn.) J.J. Sm., Icon. Bogor.: t. 122 B (1903).

Description

Plants epiphytic, monopodial, small. *Roots* terete, thick, holding substrate. *Stem* short, ca. 1 cm long, having 4-6 distichous leaves, covered by finely spiky leaf sheaths. Internodes prominent, swollen, short. *Leaves* ca. 1.8 cm × 0.8 cm, ovate-oblong, apex acute, slightly conduplicate, dark green abaxially, paler green adaxially, thick, fleshy, margins finely serrulate distally, arranged at one plane. *Inflorescence* ca. 1-1.5 cm long, 4-8 flowered, flowers close to each other, arising from leaf axil in between sheaths. *Pedicel-with-ovary* ca. 6 mm long, arising from a single point at the posterior of leaves. *Floral bracts* ca. 2 mm long, triangular, acute, margin fimbriate, greenish. *Flowers* ca. 1 cm × 0.6 cm, large in proportion compared to the whole plant, flower including pedicel ca. 1 cm, flower longer than broad, ca. 2 cm across, bell shape, odourless, resupinate. Sepals and petals free, thin, translucent white in colour, ovate to oblong with sharp tips, margins finely serrulate distally, prominent median outer keel. *Dorsal sepal* ca. 6 mm × 3 mm, ovate to oblong, apex widely acute. *Lateral sepals* ca. 6 mm × 3 mm, oblong, apex obtuse. *Petals* ca. 7 mm × 4 mm, ovate to elliptic, apex obtuse. *Lip* ca. 4 mm × 2.6 mm, fleshy, whitish with dark green patch at lamina, ovate-oblong, almost oval, apex acute, margin entire, keeled basally, basal clawed and bent down, lamina small. *Column* ca. 4 mm long, stout, lacking foot, broad stigma, whitish. *Anther-cap* obovate. *Spur* ca. 4.8 mm × 1.7 mm, oblong, laterally flattened, pointing backwards parallel to ovary, whitish. *Pollinia* two. *Infructescences* 5-6 seedpods. *Seedpods* ca. 2 cm long, oblong, ridged on outer surface, green in colour.

Etymology

Hymenorchis is derived from Greek words, *hymen* (membrane) and *orchis* (orchid), descriptive of the delicate texture of the flowers (Schultes and Peace 1963). Latin *javanica* refers to Java, the type locality of this species.

Distribution

Genus *Hymenorchis* consists of fourteen species in the world (Govaerts et al. 2020). The centre of distribution of this species is in the Island of New Guinea and Philippines, except one outlying species, was far located in Java, *H. javanica* (Comber 1990; Schuiteman and de Vogel 2009). The species was an extremely endemic species to Java. It was found as trunk epiphyte in an open area near Mount Halimun, West of Bogor (Comber 1990). Then, this species was newly discovered for Malaysia region in Genting Highlands, an integrated hill resort development set amidst the cool mountain air and a majestic 100 million-year-old rainforest (Ng et al. 2012).

Specimen examined

MALAYSIA: Pahang, Genting Highlands, Mount Ulu Kali, ca. 1700 m elev., roadside, 14.5.2006, *Edward Entalai Besi, Ng Yong Jin, Farah Alia Nordin, Rusea Go. NYJ148* (UPM!),

Notes on habitat and current population in Malaysia

The plants were discovered on a tree growing at the roadside in the summit area of Genting Highlands. The

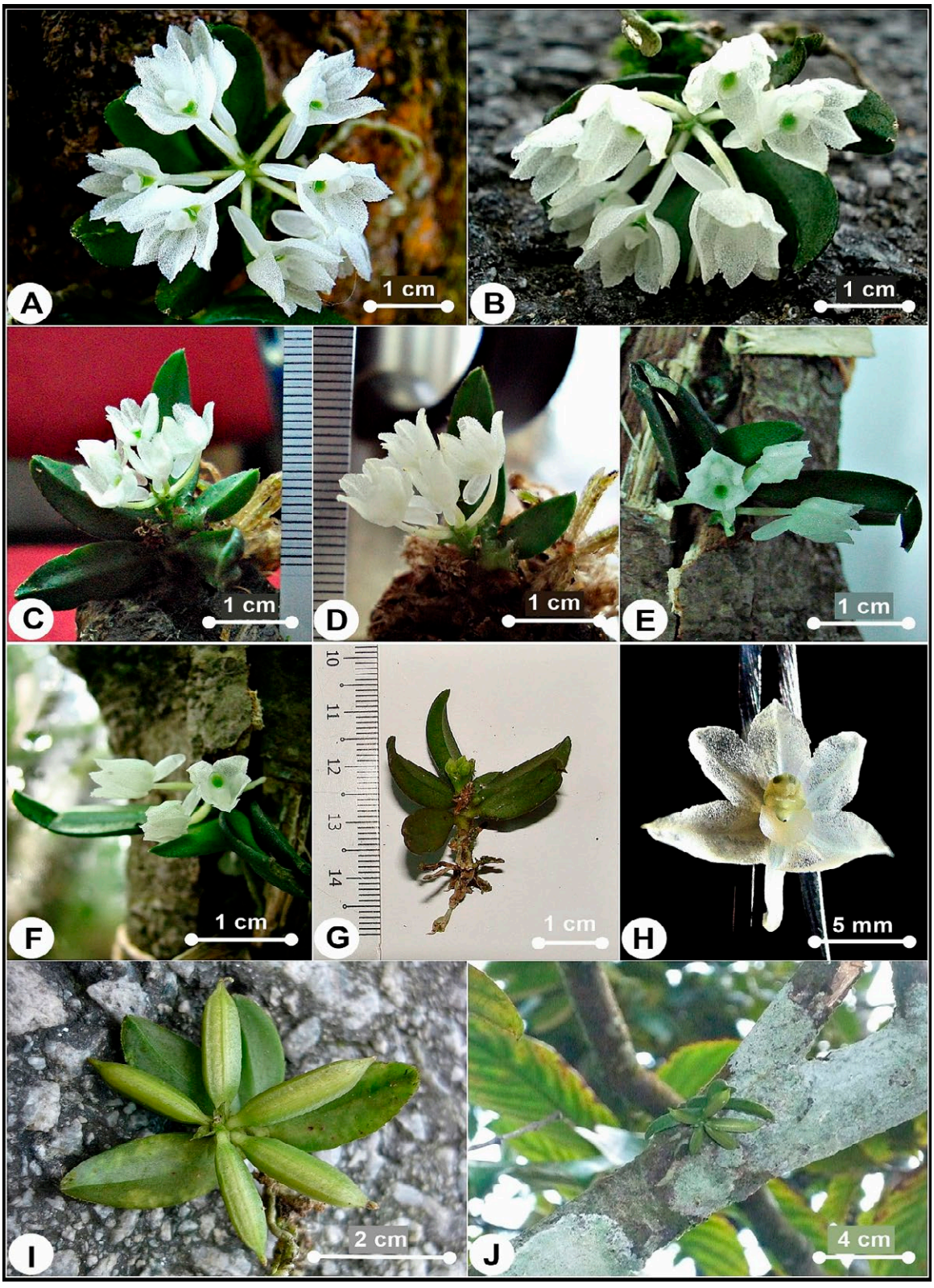

Figure 1. *Hymenorchis javanica* found in Genting Highlands. (**A**) Plant and flowers in the wild. (**B**) Plant and flowers, front view of the flowers. (**C**) Plant and flowers, lateral view. (**D**) Plant and flowers, back view. (**E**) Plant and flowers, top view. (**F**) Plant and flowers in *ex-situ*. (**G**) Plant with flowers in bud stage. (**H**) Flower (opened). (**I**) Plant with seedpods. (**J**) Plant on a tree at the roadside of Genting Highlands.

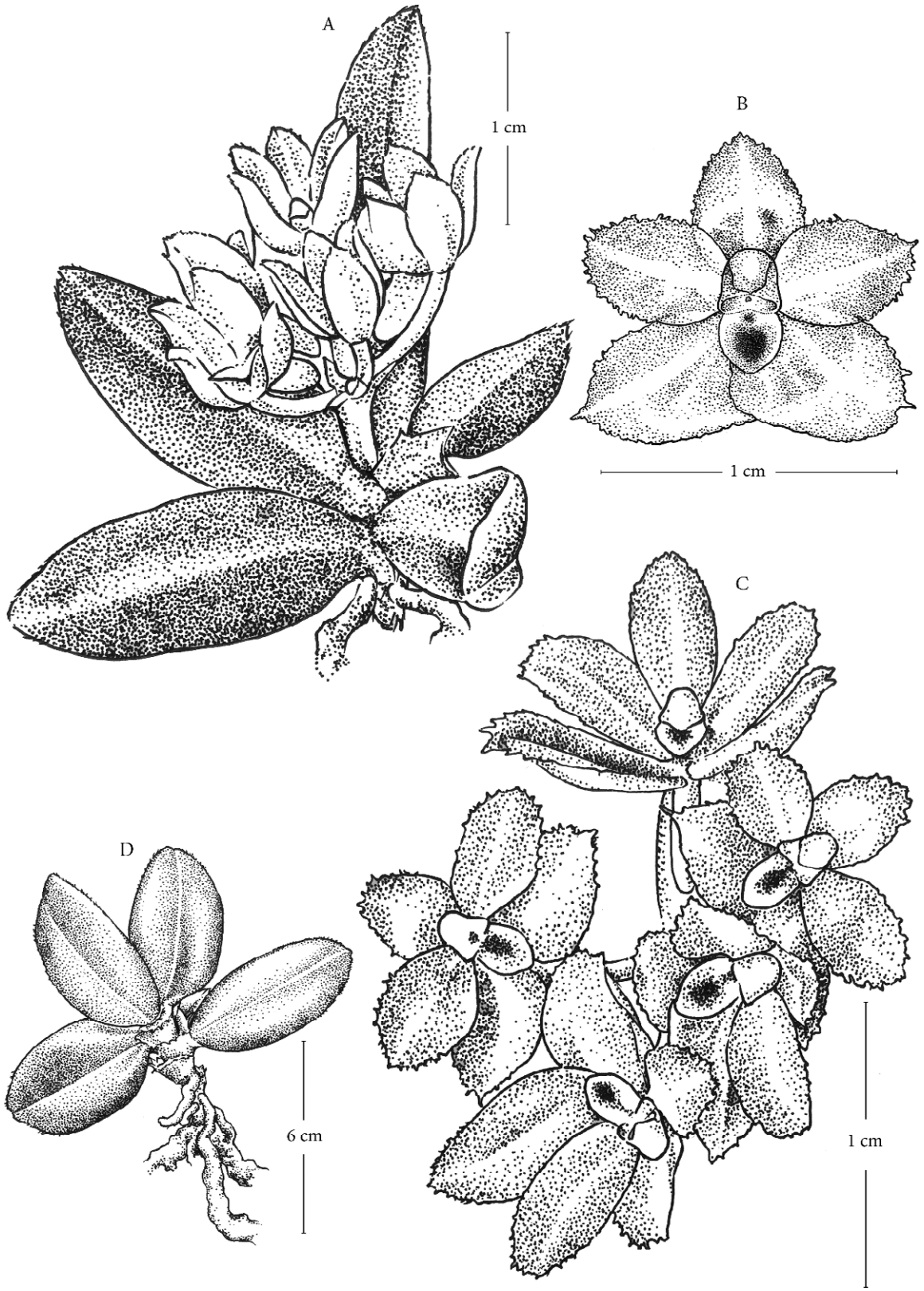

Figure 2. *Hymenorchis javanica*: (**A**) Plant with flowers. (**B**) Flower's front view showing serrulate margins of the tepals. (**C**) Flowers' top view showing ovate-oblong lip. (**D**) Plant. Drawn by Khalid Hashim.

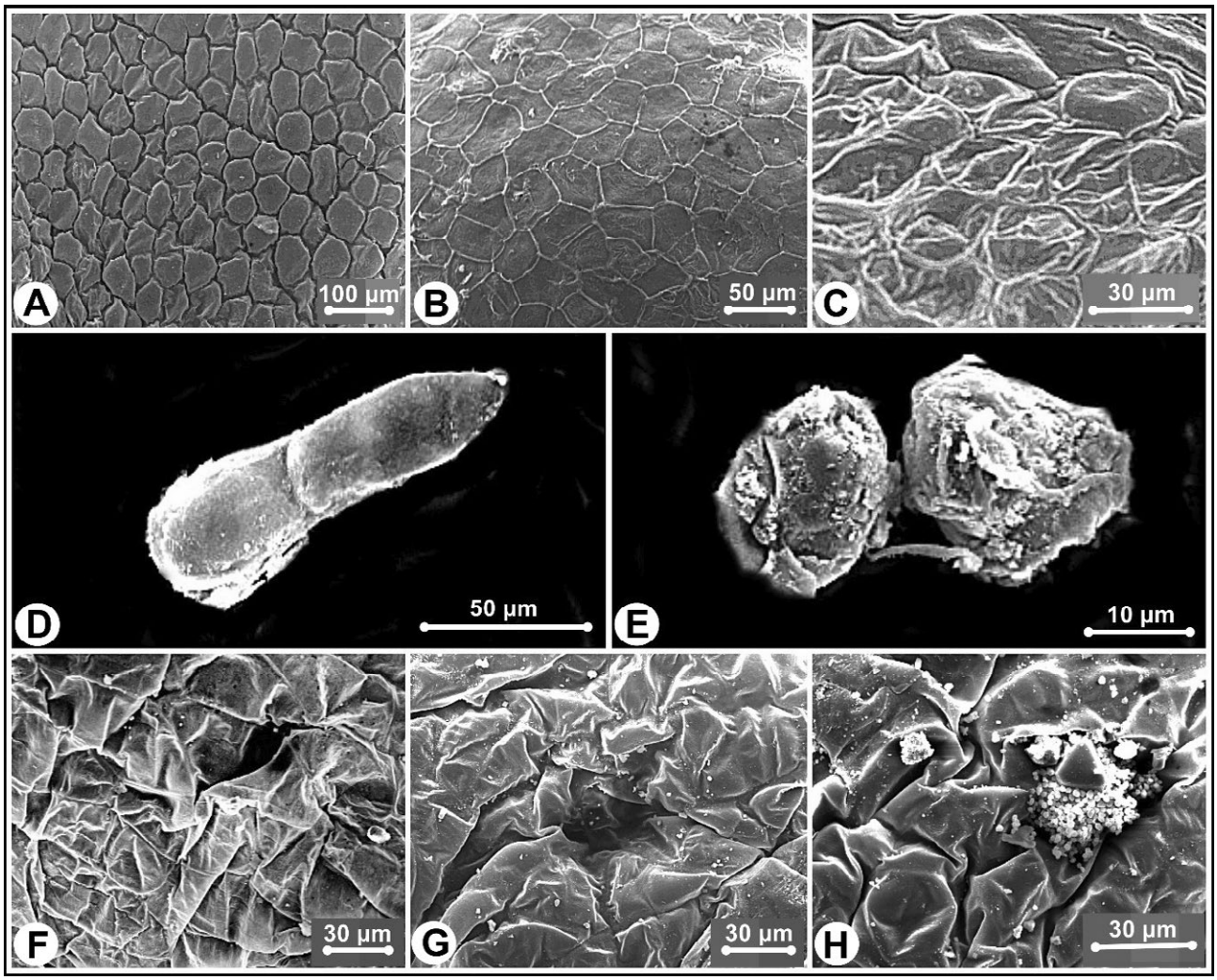

Figure 3. SEM observations of epicuticular ornamentation, trichomes, nectarostomata and waxes on surface of floral parts of *H. javanica*: (**A**) Type I epicuticular ornamentation on petals and sepals. (**B**) Type II epicuticular ornamentation on petals and sepals. (**C**) Type IV epicuticular ornamentation on pollinia. (**D**) Non-glandular, simple, multicellular trichomes occurring sparsely on the dorsal sepal and spur. (**E**) Warty-granulated waxes. (**F**) Type III epicuticular ornamentation on dorsal sepals. (**G**) Nectarostomata on spur. (**H**) Nectarostomata with globular waxes on spur.

summit area is considered as an upper montane forest (Whitmore and Burnham 1969). A montane forest developed for hotel and shopping complexes. There is a certain forest area of the summit area considered as a mossy elfin forest which is the sub-type of upper montane forest. The elfin forest is characterised by its stunted and twisted trees with its canopy of 5–7 m or less, dense and flattened crown, coriaceous leaves, and is indicated by species such as *Dacrydium comosum* Corner and *Leptospermum polygalifolium* Salisb. (Stone, 1981). There was merely one population of *H. javanica* about 10–20 individuals found in the area.

Species references

Oeceoclades javanica Teijsm. & Binn. (Teysmann and Binnendijk 1863); *Saccolabium javanicum* (Teijsm. & Binn.) J.J.Sm. (Smith, 1903); *Hymenorchis phitamii* Aver. (Averyanov et al. 2012).

Additional specimens examined

MALAYSIA: Pahang, Bentong, Genting Highlands, Mount Ulu Kali, 16.12.2009, *M. Firdaus MFK071* (UPM!); Indonesia: Java, Poentjoek (Puncak), 15.7.1908, *Smith L1512749* (NHN-photo!).

Species enumeration under SEM examination

Description (Figure 3): **Waxes** scattered, warty-granulated, and globular occurring on spur. **Epicuticular ornamentation** Type I: laevigate outer and polygonal periclinal wall; furrowed, straight and rounded anticlinal wall, on dorsal sepal, petals, lateral sepals, column and lip; Type II: laevigate and polyhedral outer periclinal wall; furrowed, straight and rounded anticlinal wall, on petals and sepals; Type III: laevigate-with-seams outer periclinal wall; furrowed, straight and rounded anticlinal wall, on spur; Type IV: foveate outer periclinal wall; fibrillary and undulate anticlinal wall, on pollinia. **Stomata type and distribution** nectarostomata on spur. **Trichomes distribution** present on dorsal sepal and spur. **Trichomes type** non-glandular, multicellular, short (ca. 100 μm), 2-tiers cells. **Pustular glands** sparsely present on the floral parts. **Papillae** absent.

Conservation status assessment

Based on the current IUCN Red List of Threatened Species, *H. javanica* has not yet been evaluated against the criteria. On the assessment of their proposed conservation status, *H. javanica* is here assessed as Endangered, EN B(2) (b)(iii), with the estimated AOO is 12 km^2 and EOO is 36,932.713 km^2. The AOO is less than 500 km^2 and continuing decline in extent and quality of habitat (IUCN Standards and Petitions Committee 2019). Although the estimated EOO goes above the thresholds needed for a threatened category, however, the current collection localities in Malaysia and Java are within narrow AOO value (Figure 4). Our observation over the years including the visits by other colleagues without recollecting specimens show the current population on the few trees along the roadside of Genting Highlands are thinning of about 10 matured individuals if compared to when it was first found in scattered patches on several trees. The development in Genting Highlands has significantly affected the cloud forest in the summit area. Out of nine plots established by Stone, at least four had been replaced with buildings after 25 years (Chua and Saw 2001). Through the observation of change in species composition, there have been severe environmental changes in the summit area of Genting Highlands. This suggests that the fragmentation of forests may have damagingly impacted certain plant species (Chua and Saw 2001). Hence, a drastic conservation and preservation effort should be done to conserve this rare species from extinction and preserve its current habitat.

DISCUSSION

As reported above, now that there is a new *Hymenorchis* species discovered in southern Vietnam, *H. phitamii*, a congener that resembles *H. javanica*. It is deemed important to relook at the morphological description of *H. javanica* found in Malaysia to delineate these two cryptic species. The new record of *H. javanica* in Malaysia was mentioned in Ng et al. (2012), but it was not accompanied by a taxonomic description nor sufficient information on its occurrence and conservation status. Vietnamese plant looks closely similar with *H. javanica* on its vegetative characteristics and whitish flower that strikingly contrast with the small lip patched dark green on the lamina. Vegetatively, almost all species of *Hymenorchis* can be easily recognised by the finely serrulate leaf margin and fimbriate margin of leaf sheaths. These miniature plants with stem and leaves commonly not exceeding 1-2 cm long produce few relatively large white flowers arranged into a compact head-like inflorescence. The lip shape and accessory features in orchids, including the colour pattern, are useful in orchid classification and identification since the lip shows a wide variety of morphological diversity (Pridgeon et al. 1999). The *H. phitamii* differs from *H. javanica* in emarginate, long erose-dentate, almost orbicular lip, and hardly serrulate or even nearly entire straight margin of tepals and old leaves (Averyanov et al. 2012). Our botanical drawing illustrates the serrulated tepals and leaves, and ovate-oblong and entire lip.

Taxonomic and physioecological aspects of the floral-surface micromorphology

The microstructures occurring on the floral parts of *H. javanica* provide no taxonomic significance due to the absence of diagnostic microcharacters, such as glandular trichomes, papillae, and rare type stomata. Only single type of trichomes occurring on the floral parts, the mutual short and multicellular non-glandular trichomes. The same goes for the epicuticular ornamentation that is lacking variation in morphology. Only the common ones with laevigate or foveate and polyhedral or polygonal periclinal walls were observed on the floral parts. These trichomes and epicuticular ornamentation types can be found in most of the floral parts of orchid species, including *Corybas* (Besi et al. 2019a), *Crepidium* (Besi et al. 2020b), *Paphiopedilum* (unpublished account), and *Vanda* (unpublished account). Clearly, the floral micromorphological characters are inconspicuous without a definite boundary to discriminate. Nevertheless, the microcharacters still offer significant notes on

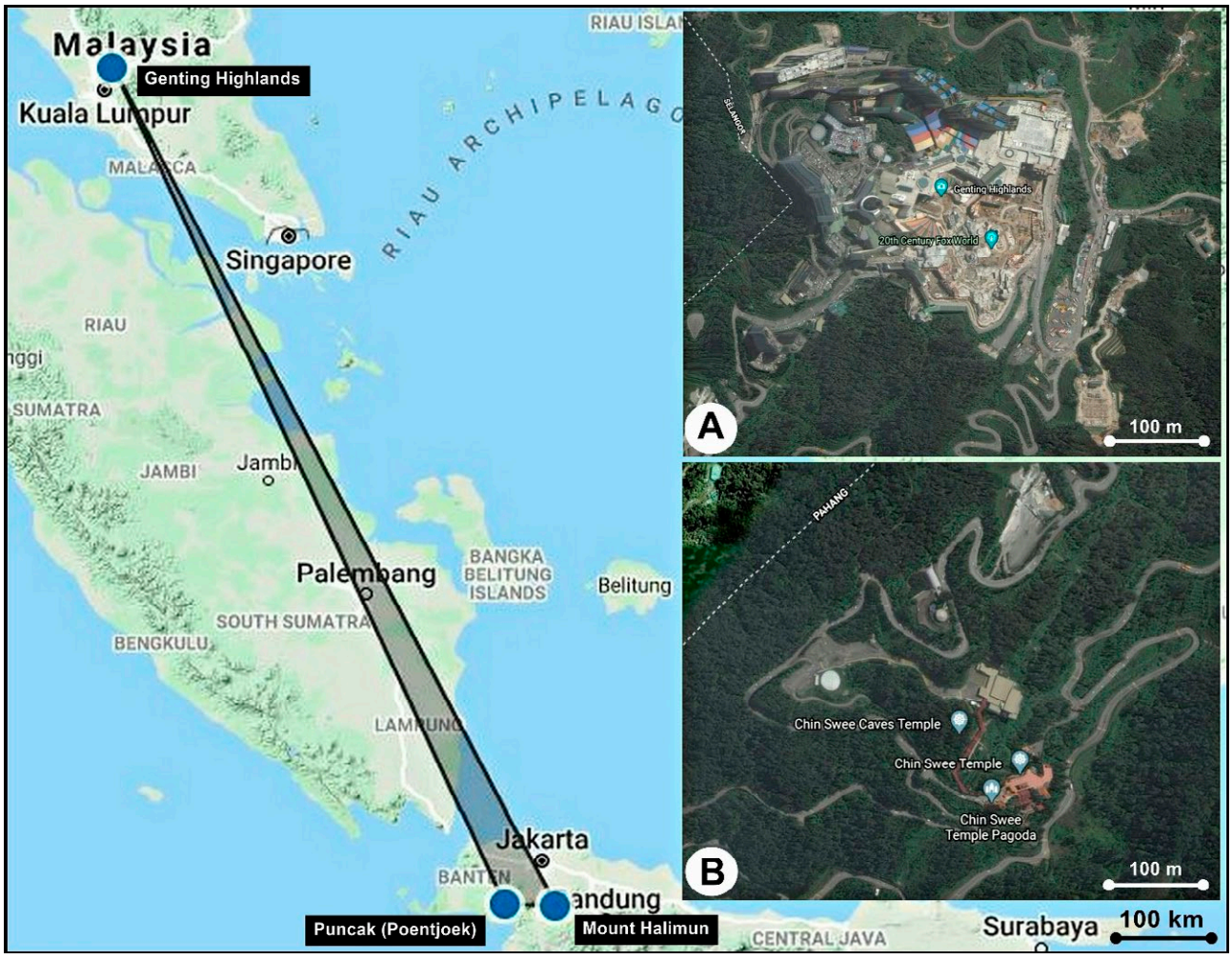

Figure 4. Extent of occurrence for *H. javanica* plotted with GeoCat: (**A**) Hotel and shopping complexes in Genting Highlands. (**B**) Road expansion in Genting Highlands.

the physioecological demands. Here, we deduce that the flowers offer rewards or nectar to the pollinators. This supported by the micrograph of the spur showing the presence of nectarostomata with waxy substance accumulated in it. Yet, absence of glandular trichomes, papillae and stomata on the floral parts, and lacking of waxes deposition on the sepals, petals and lip may suggest otherwise.

The flowers are not scented. Hence, the pollinator may be first attracted to the flower by the colour deceit alone, the bright white coloured tepals with a dark green patch on the ca. 2 mm-wide lip lamina. The green patch glistening the lip draws the pollinator towards the opening of the spur. Then, the canaliculated claw at the base of the lip directs them straight to the spur. Though based an observation on some *Bulbophyllum* species, the median groove of the lip was often filled with liquid substance that visiting flies were seen to probe on (Ong and Tan 2012). However, the presence of liquid nor waxy substances on the lip of *H. javanica* was not presented in the micrograph, but a further observation on the pollinator visit in the field and cytochemistry may offer better inference. Also, lacking trichomes and waxes may suggest that flowers prone to desiccation and herbivorous insects (Davies and Turner 2004).

Threats to H. javanica and a proposal for conservation in Malaysia

Two major threats faced by all the montane plant species in tropical countries are local climatic changes and the conversion of forested areas for other use. Temperature rise and humidity drop are the two key param-

Figure 5. Habitat of *H. javanica* in Genting Highlands showing current on-going hotel complexes development and road expansion, and the host trees along the roadside.

eters that significantly impact the survival of many mountain peak endemic species in Peninsular Malaysia (Ng et al. 2012). The current habitat is now part of a road expansion for hotel development in the Genting Highlands (Ng et al. 2012) (Figure 5). This species should be monitored regularly or transferred to an *ex-situ* conservatory when necessary. Our *ex-situ* conservation trials in terraria placed in an air-conditioned room and controlled environment growth chamber were unsuccessful. Presumably, it might be probably due to the plants' sensitiveness and slow adaptation to sudden changes in irradiance, nutrients, and atmospheric-nitrogen deposition (Zhang et al. 2018). Also, the plants are lacking pseudobulbous organs that can store nutrients and water during dry periods (Yang et al. 2016; Besi et al. 2019b). Though epiphytic orchids have greater capacity to conserve water and avoid the damaging effects of drought based on their root functioning (Li et al. 2018).

Future studies should investigate the mechanisms that determine slow growth and flower induction of miniature orchids under both natural and *ex-situ* conditions. A good understanding of orchid physiology is essential for orchid conservation and utilisation. Besides small habits, species of the genus, including species described here, have a certain significance for horticulture as tiny miniature ornamental plants (Averyanov et al. 2012). The flowers are large in proportion to the rest of the plant which seems like to have a bell-shape. This makes it worthwhile to introduce it into cultivation. A plant conservatory can be built in the summit area in Genting Highlands to accommodate the *ex-situ* conservation. It is much more suitable to put the orchids from montane cloud forest habitat in a highland conservatory with fitting cold and moist conditions. This is a very practical way because no cost needed to equip a cooling system for cloud forest orchids. However, this does not mean that our highly treasured orchids can be simply taken out of its natural habitat. Only vulnerable orchid populations that a have large probability of losing their chance of survival should be planted in the conservatory.

CONCLUSION

Our taxonomic treatment confirms the identification of *H. javanica* found in Malaysia. Also, our study underlines the role of the floral-surface micromorphological structures as protection and a potential site of nectar or food reward exudation. Though it offers no taxonomic significance due to the absence of diagnostic characters. Current local climate change has also impacted major mountain regions in Peninsular Malaysia, with evidence of thinning and declining of moss-carpeted forest floor seen in the Genting Highlands. More observations and evaluations will be required to confirm this. The most important limitation lies in our current study is the small existing population. The diminishing population of *H. javanica* in Malaysia restricts accessibility for further research on physioecology and micropropagation. The current habitat is not ideal for thorough observation to be made. We are therefore hoping to encounter more populations of this endangered plant prior to its conservation.

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A key to the grasses (Poaceae) of Egypt

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Abstract. A key for identifying 284 native and naturalized Egyptian grass species belonging to 103 genera in 22 tribes and 7 subfamilies is presented. The key is principally based on floral characters of the inflorescence and spikelet. A list and classification of all known species of Egyptian grasses is provided.

Keywords: classification, Gramineae, grasses, Egypt, identification key.

INTRODUCTION

The Poaceae (Gramineae) is a large cosmopolitan family with 768 genera and 11,506 species (Soreng et al. 2017). The family includes cereal grasses, bamboos, and species occurring in natural grasslands, cultivated lawns, and pastures. The family has been divided into subfamilies ranging from two (Tzvelev 1989) to six (Clayton and Renvoize 1986), and more recently the family has been divided into 12 subfamilies (Takhtajan 2009; Reveal 2012; Soreng et al. 2017, 2019; Stevens 2017).

In Egypt the grasses are the largest family of flowering plants with 284 species belonging to 103 genera and 22 tribes (Ibrahim et al. 2016). The most comprehensive account of the family in Egypt was done by Täckholm et al. (1941). Other treatments of the grasses of Egypt include Täckholm (1974), Cope and Hosni (1991), Cope (2005), Boulos (2009), and Ibrahim et al. (2016).

The identification of grasses is usually based on the structure of the inflorescence and floral characteristics. However, in some cases it is necessary to identify grasses by its vegetative character if the flowers are not available. In such cases the vegetative characters can be used until a flowering specimen is obtained (Hosni and Ibrahim 2004; Ibrahim et al. 2016).

Phylogenetic studies using results from DNA sequences have changed the classification of the grasses and this paper follows the current use of a name as proposed in these papers. With the publication of the grasses of Egypt using a vegetative key (Ibrahim et al. 2016), the need for an updated floral key is apparent. Earlier traditional treatments of the grasses of Egypt,

i.e., Cope and Hosni (1991) and Cope (2005) are outdated and it is often difficult to determine the current use name. Our paper presents a new key for the identification of grasses native and adventive in Egypt and is written for use by both trained botanists and interested amateurs. Therefore, we have included an introduction defining many terms used in the key. The key is designed to facilitate the identification and is simplified as much as possible using characters based on the inflorescence and spikelet. Our key refers only to Egyptian specimens and, in addition, we include a updated classification of all grasses found in Egypt.

The accepted names follow the Catalogue of New World Grasses (Soreng et al. 2015, 2017) using terminology found in Kellogg (2015), Clayton et al. (2016), Ibrahim et al. (2016, 2018), and Herrera Arrieta and Peterson (2018). Because the inflorescence of grasses takes a variety of shapes, it is convenient to group them into categories based on their morphology. Accordingly, the identification key is divided into two parts, a key of major groups based mainly on inflorescence characters followed by keys to the species within each group. Brief descriptions, synonyms, and illustrations of the species was provided in Ibrahim et al. (2016). The classification of each species in Table 1 follows Soreng et al. (2017, 2019).

GENERAL MORPHOLOGY

Grasses are annual, biennial or perennial herbs and the root systems are fibrous, rhizomatous or stoloniferous. Flowering stems (culms) are usually unbranched, composed of several internodes and are mostly hollow, rarely solid throughout, and the solid nodes can sometimes be hairy. Leaves are borne solitary at the node and can be crowded at the base of the culm. Each leaf consists of a sheath, ligule and lamina. Leaf blades may be hairy or glabrous. The base of the leaf sheath is attached to the nodes and clasping the stems firmly with overlapping free or connate margins, sometimes with two small falcate or erect outgrowths at the mouth (auricles). At the junction of a sheath and blade is a ligule that can be membranous or hairy (often a line of hairs) but occasionally a ligule can be absent. Leaf sheaths are mostly linear, flat, and sometimes folded or rolled in various ways.

Flowers (Fig. 1) are usually hermaphrodite, sometimes unisexual (male and female), anemophilous (sometimes autogamous, apomictic or entomophilous) small and inconspicuous. The perianth is usually represented by two or three, minute but up to six, inconspicuous hyaline scales (lodicules) which correspond to the inner perianth whorl of other monocots. Stamens are hypogenous, 1–6 in number but usually 3 with delicate filaments and two anthers that dehisce through terminal pores or longitudinal slits. The ovary is unilocular with a single ovule. There are usually two or three (rarely 1) styles, generally with plumose stigmas. In grasses the fruit or caryopsis is single-seeded with an adherent pericarp, although there are numerous species with free pericarps and these would technically be termed akenes.

The floral parts are placed between two bracts, the lower (lemma) and upper (palea). These two structures are collectively referred to as a floret. The floret is usually subtended by two glumes. Lemmas vary in size and texture like the glumes and differ in the number of veins (usually with an odd number of veins), their overall shape, and the nature of their attachment to the rachilla. Lemmas are often awned or mucronate near the apex, or the awn is borne somewhere along the dorsal back. Awns can be straight, keeled or twisted. The paleas are usually membranous, tightly enclosing the pistil and stamens. Paleas (sometimes reduced) usually have two major veins and are therefore 2-keeled. The lemma, palea, and reproductive structures are called florets. The characteristic floral structure in grasses (spikelets) consist of one to many florets distichously inserted on either side of a slender, jointed rachilla (Fig. 1). Spikelets vary in size from minute (1 mm or less) to relatively large (1 or 2 cm). Each spikelet is usually subtended by two lower empty scales or glumes. Glumes are variously veined and sometimes bear one or more awns. The base of a spikelet or floret is sometimes enlarged and hardened into a small knob or stalk (often sharp) called a callus. Glumes may be shorter than the adjoining lemma or longer and sometimes can be long enough to enclose the entire spikelet, or one or both glumes may be reduced or absent. Spikelets may be dorsiventrally compressed, laterally compressed, or terete.

Table 1. The following list is a synopsis of the classification of the genera into subfamilies and tribes for the grasses of Egypt.

I. Subfamily: ARISTIDOIDEAE Caro

1. TRIBE: ARISTIDEAE C.E.Hubb.
Aristida adscensionis L.
Aristida funiculata Trin. & Rupr.
Aristida mutabilis Trin. & Rupr.
Stipagrostis acutiflora (Trin. & Rupr.) De Winter
Stipagrostis ciliata (Desf.) De Winter
Stipagrostis drarii (Täckh.) De Winter
Stipagrostis hirtigluma (Steud. ex Trin. & Rupr.) De Winter

Stipagrostis lanata (Forssk.) De Winter
Stipagrostis multinerva H. Scholz
Stipagrostis obtusa (Delile) Nees
Stipagrostis paradisea (Edgew.) De Winter
Stipagrostis plumosa (L.) Munro ex T. Anderson
Stipagrostis raddiana (Savi) De Winter
Stipagrostis scoparia (Trin. & Rupr.) De Winter
Stipagrostis shawii (H.Scholz) H.Scholz
Stipagrostis uniplumis (Licht.) De Winter
Stipagrostis vulnerans (Trin. & Rupr.) De Winter

II. Subfamily ARUNDINOIDEAE Kunth ex Beilschm.

2. TRIBE: ARUNDINEAE Dumort.
Arundo donax L.
3. TRIBE: MOLINIEAE Jirásek
Phragmites australis (Cav.) Trin. ex Steud.
Phragmites karka (Retz.) Steud. [syn *Phragmites mauritianus* Kunth]

III. Subfamily CHLORIDOIDEAE Kunth ex Beilschm.

4. TRIBE: CENTROPODIEAE P.M. Peterson, N.P. Barker & H.P. Linder
Centropodia forskalii (Vahl) Cope
Centropodia fragilis (Guinet & Sauvage) Cope

5. TRIBE: CYNODONTEAE Dumort.
Aeluropus lagopoides (L.) Trin. ex Thwaites
Aeluropus littoralis (Gouan) Parl.
Chloris flagellifera (Nees) P.M. Peterson [syn. *Ochthochloa compressa* (Forssk.) Hilu]
Chloris gayana Kunth
Chloris prieurii Kunth [syn *Enteropogon prieurii* (Kunth) Clayton]
Chloris pycnothrix Trin.
Chloris virgata Sw.
Coelachyrum brevifolium Hochst. & Nees
Cynodon dactylon (L.) Pers.
Cynodon transvaalensis Burtt Davy
Dactyloctenium aegyptium (L.) Willd.
Dactyloctenium aristatum Link
Dactyloctenium scindicum Boiss.
Desmostachya bipinnata (L.) Stapf
Dinebra retroflexa (Vahl) Panz.
Dinebra panicea (Retz.) P.M.Peterson & N.Snow [syn. *Leptochloa panicea* (Retz.) Ohwi]
Diplachne fusca (L.) P.Beauv. [syn. *Leptochloa fusca* (L.) Kunth]
Eleusine africana Kenn.- O'Byrne
Eleusine coracana (L.) Gaertn.
Eleusine floccifolia (Forssk.) Spreng.
Eleusine indica (L.) Gaetn.
Halopyrum mucronatum (L.) Stapf
Leptothrium senegalense (Kunth) Clayton
Melanocenchris abyssinica (R.Br. ex Fresen.) Hochst.
Schoenefeldia gracilis Kunth
Tetrapogon cenchriformis (A.Rich.) Clayton
Tetrapogon villosus Desf.
Tragus berteronianus Schult.
Tragus racemosus (L.) All.
Trichoneura mollis (Kunth) E.Ekman

6. TRIBE ERAGROSTIDEAE Stapf
Enneapogon desvauxii P.Beauv.
Enneapogon lophotrichus Chiov. ex H.Scholz & P.Koinig
Enneapogon persicus Boiss.
Enneapogon scaber Lehm.
Eragrostis aegyptiaca (Willd.) Delile
Eragrostis aspera (Jacq.) Nees
Eragrostis barrelieri Daveau
Eragrostis cilianensis (All.) Vign. ex Janch.
Eragrostis ciliaris (L.) R. Br.
Eragrostis japonica (Thunb.) Trin.
Eragrostis lepida (A.Rich.) Hochst. ex Steud.
Eragrostis minor Host
Eragrostis pilosa (L.) P.Beauv.
Eragrostis sarmentosa (Thunb.) Trin.
Eragrostis tef (Zucc.) Trotter
Eragrostis tenuifolia (A.Rich.) Hochst. ex Steud.
Eragrostis tremula Hochst. ex Steud.
Schmidtia pappophoroides Steud.

7. TRIBE TRIRAPHIDEAE P.M. Peterson
Triraphis pumilio R.Br.

8.TRIBE ZOYSIEAE Benth.
Sporobolus alopecuroides (Piller & Mitterp.) P.M.Peterson [syn. *Crypsis alopecuroides* (Piller & Mitterp.) Schrad.]
Sporobolus aculeatus (L.) P.M.Peterson [syn. *Crypsis aculeata* (L.) Aiton]
Sporobolus ioclados (Nees ex Trin.) Nees
Sporobolus natalensis (Steud.) T. Durand & Schinz
Sporobolus niliacus (Bornm.) P.M.Peterson [syn. *Crypsis vaginiflora* (Forssk.) Opiz]
Sporobolus spicatus (Vahl) Kunth
Sporobolus pungens (Schreb.) Kunth
Sporobolus schoenoides (L.) P.M.Peterson [syn. *Crypsis schoenoides* (L.) Lam.]
Sporobolus wrightii Munro ex Scribn.

IV. Subfamily DANTHONIOIDEAE H.P. Linder & N.P. Barker

9. TRIBE: DANTHONIEAE Zotov.
Cortaderia selloana (Schult. & Schult. f.) Asch. & Graebn.
Schismus arabicus Nees
Schismus barbatus (L.) Thell.

V. Subfamily: ORYZOIDEAE Kunth ex Beilschm.

10. TRIBE: EHRHARTEAE Nevski
Ehrharta calycina Sm.

11. TRIBE: ORYZEAE Dumort.
Leersia hexandra Sw.
Oryza sativa L.

VI. Subfamily PANICOIDEAE Link

12. TRIBE: ANDROPOGONEAE Dumort.
Andropogon distachyos L.
Chrysopogon plumulosus Hochst.
Chrysopogon zizanioides (L.) Roberty
Coix lacryma-jobi L.
Cymbopogon citratus (DC.) Stapf
Cymbopogon flexuosus (Nees ex Steud.) Watson
Cymbopogon jwarancusa (Jones) Schult.
Cymbopogon martinii (Roxb.) Watson
Cymbopogon nardus (L.) Rendle
Cymbopogon schoenanthus (L.) Spreng. subsp. *schoenanthus*
Cymbopogon schoenanthus subsp. *proximus*
Dichanthium annulatum (Forssk.) Stapf
Dichanthium foveolatum (Delile) Roberty
Elionurus royleanus Nees ex A. Rich
Hemarthria altissima (Poir.) Stapf & C.E.Hubb.
Hyparrhenia hirta (L.) Stapf
Imperata cylindrica (L.) Raeusch.
Lasiurus scindicus Henrard
Miscanthus sinensis Andersson
Pogonatherum paniceum (Lam.) Hack.
Saccharum officinarum L.
Saccharum spontaneum L.
Sorghum arundinaceum (Desv.) Stapf
Sorghum bicolor (L.) Moench
Sorghum x drummondii (Nees ex Steud.) Millsp. & Chase
Sorghum halepense (L.) Pers.
Sorghum virgatum (Hack.) Stapf
Themeda triandra Forssk.
Themeda villosa (Poir.) A.Camus
Vossia cuspidata (Roxb.) Griff.
Zea mays L. subsp. *mays*
Zea mays subsp. *mexicana* (Schrad.) Iltis

13. TRIBE: PANICEAE R.Br.
Cenchrus americanus (L.) Morrone [syn. *Pennisetum glaucum* (L.) R.Br.]
Cenchrus biflorus Roxb.
Cenchrus ciliaris L. [syn. *Pennisetum ciliare* (L.) Link]
Cenchrus clandestinus (Hochst. ex Chiov.) Morrone (syn. *Pennisetum cladestinum* Hochst. ex Chiov.)
Cenchrus echinatus L.
Cenchrus longisetus M.C.Johnst. (syn. *Pennisetum villosum* R. Br. ex Fresen.)
Cenchrus orientalis (Rich.) Morrone (syn. *Pennisetum orientale* Rich.)
Cenchrus pennisetiformis Hochst. & Steud.
Cenchrus ramosissimus Poir. (syn. *Pennisetum ramosissimus* Poir.)
Cenchrus setaceus (Forssk.) Morrone [syn. *Pennisetum setaceum* (Forssk.) Chiov.]
Cenchrus setiger Vahl
Cenchrus sieberianus (Schltdl.) Verloove [syn. *Pennisetum sieberianum* (Schltdl.) Verloove]
Cenchrus violaceus (Lam.) Morrone
Digitaria ciliaris (Retz.) Koeler
Digitaria nodosa Parl.
Digitaria sanguinalis (L.) Scop.
Digitaria velutina (Forssk.) P.Beauv.
Digitaria violascens Link
Echinochloa colona (L.) Link
Echinochloa crusgalli (L.) P.Beauv.
Echinochloa pyramidalis (Lam.) Hitchc. & Chase
Echinochloa stagnina (Retz.) P.Beauv.
Megathyrsus maximus (Jacq.) B.K.Simon & S.W.L.Jacobs (syn. *Panicum maximum* Jacq.)
Melinis minutiflora P.Beauv.
Melinis repens (Willd.) Zizka
Moorochloa eruciformis (Sm.) Veldkamp [syn. *Brachiaria eruciformis* (Sm.) Griseb.]
Panicum antidotale Retz.
Panicum coloratum L.
Panicum hygrochris Steud.
Panicum miliaceum L.
Panicum repens L.
Panicum turgidum Forssk.
Setaria geminata [syn. *Paspalidium geminatum* (Forssk.) Stapf]
Setaria italica (L.) P.Beauv.
Setaria megaphylla (Steud.) T.Durand & Schinz
Setaria obtusifolia (Delile) Morrone [syn. *Paspalidium obtusifolium* (Delile) D.Simpson]

Setaria pumila (Poir.) Roem. & Schult.
Setaria verticillata (L.) P.Beauv.
Setaria viridis (L.) P. Beauv.
Stenotaphrum secundatum (Walter) Kuntze
Tricholaena teneriffae (L.f.) Link
Urochloa deflexa (Schumach.) H.Scholz [syn. *Brachiaria deflexa* (Schumach.) C.E.Hubb. ex Robyns.]
Urochloa leersioides (Hochst.) H.Scholz & Valdés [syn. *Brachiaria leersioides* (Hochst.) Stapf]
Urochloa mutica (Forssk.) T.Q.Nguyen [syn. *Brachiaria mutica* (Forssk.) Stapf]
Urochloa panicoides P. Beauv.
Urochloa ramose (L.) T.Q.Nguyen [syn. *Brachiaria ramosa* (L.) Stapf]
Urochloa reptans (L.) Stapf [syn. *Brachiaria reptans* (L.) C.A. Gardner]

14. TRIBE: PASPALEAE J.Presl
Paspalum dilatatum Poiret
Paspalum distichum L.
Paspalum racemosum Lam.

15. TRIBE: TRISTACHYIDEAE Sánchez-Ken & L.G. Clark
Danthoniopsis barbata (Nees) C.E.Hubb.

VII. Subfamily: POOIDEAE Benth.

16. TRIBE*:* BRACHYPODIEAE Harz
Brachypodium distachyon (L.) P.Beauv.

17. TRIBE: BROMEAE Dumort.
Bromus aegyptiacus Tausch
Bromus alopecuros Poir.
Bromus catharticus Vahl
Bromus danthoniae Trin. ex C.A.Mey.
Bromus diandrus Roth var. *diandrus*
Bromus diandrus var. *rigidus* (Roth) Sales
Bromus fasciculatus C.Presl
Bromus hordeaceus L.
Bromus inermis Leyss.
Bromus japonicus Thunb.
Bromus lanceolatus Roth
Bromus lepidus Holmb.
Bromus madritensis L.
Bromus pectinatus Thunb.
Bromus pulchellus Fig. & De Not.
Bromus pumilio (Trin.) P.M. Sm. [syn *Boissiera squarrosa* (Banks & Sol.) Nevski]
Bromus rubens L.
Bromus scoparius L.
Bromus sterilis L.
Bromus tectorum L. subsp. *tectorum*
Bromus tectorum subsp. *lucidus* Sales

18. TRIBE: LYGEEAE J.Presl
Lygeum spartum Loefl. ex L.

19. TRIBE: MELICEAE Rchb.
Melica persica Kunth

20. TRIBE: POEAE R.Br.
Agrostis stolonifera L.
Alopecurus myosuroides Huds.
Ammochloa palaestina Boiss.
Avena barbata Pott ex Link subsp. *barbata*
Avena barbata subsp. *wiestii* (Steud.) Mansf.
Avena fatua L.
Avena longiglumis Durieu
Avena sativa L.
Avena sterilis L.subsp. *sterilis*
Avena sterilis subsp. *ludoviciana* (Durieu) J.M.Gillet & Magne
Briza maxima L.
Briza minor L.
Calamagrostis arenaria (L.) Roth [syn. *Ammophila arenaria* (L.) Link
Catapodium rigidum (L.) C.E.Hubb..
Corynephorus divaricatus (Pourr.) Breistr.
Cutandia dichotoma (Forssk.) Batt. & Trab.
Cutandia maritima (L.) Barbey
Cutandia memphitica (Spreng.) Benth.
Cynosurus echinatus L.
Dactylis glomerata L.
Desmazeria philistaea subsp. *rohlfsiana* (Coss.) H.Scholz
Festuca brevis (Boiss. & Kotschy) Asch., Schweinf. & Muschl. (syn. *Vulpia brevis* Boiss. & Kotschy)
Festuca fasciculata Forssk. [syn. *Vulpia fasciculata* (Forssk.) Samp.]
Festuca bromoides L. [syn. *Vulpia bromoides* (L.) Gray]
Festuca myuros L. [syn. *Vulpia myuros* (L.) C.C.Gmel.]
Festuca pectinella Delile [syn. *Vulpia pectinella* (Delile) Boiss.]
Gastridium phleoides (Nees & Meyen) C.E.Hubb.
Holcus annuus Salzm.
Lagurus ovatus L.
Lamarckia aurea (L.) Moench
Lolium arundinaceum (Schreb.) Darbysh. (syn *Festuca arundinacea* Schreb.)
Lolium multiflorum Lam.
Lolium perenne L.
Lolium rigidum Gaudin
Lolium temulentum L.

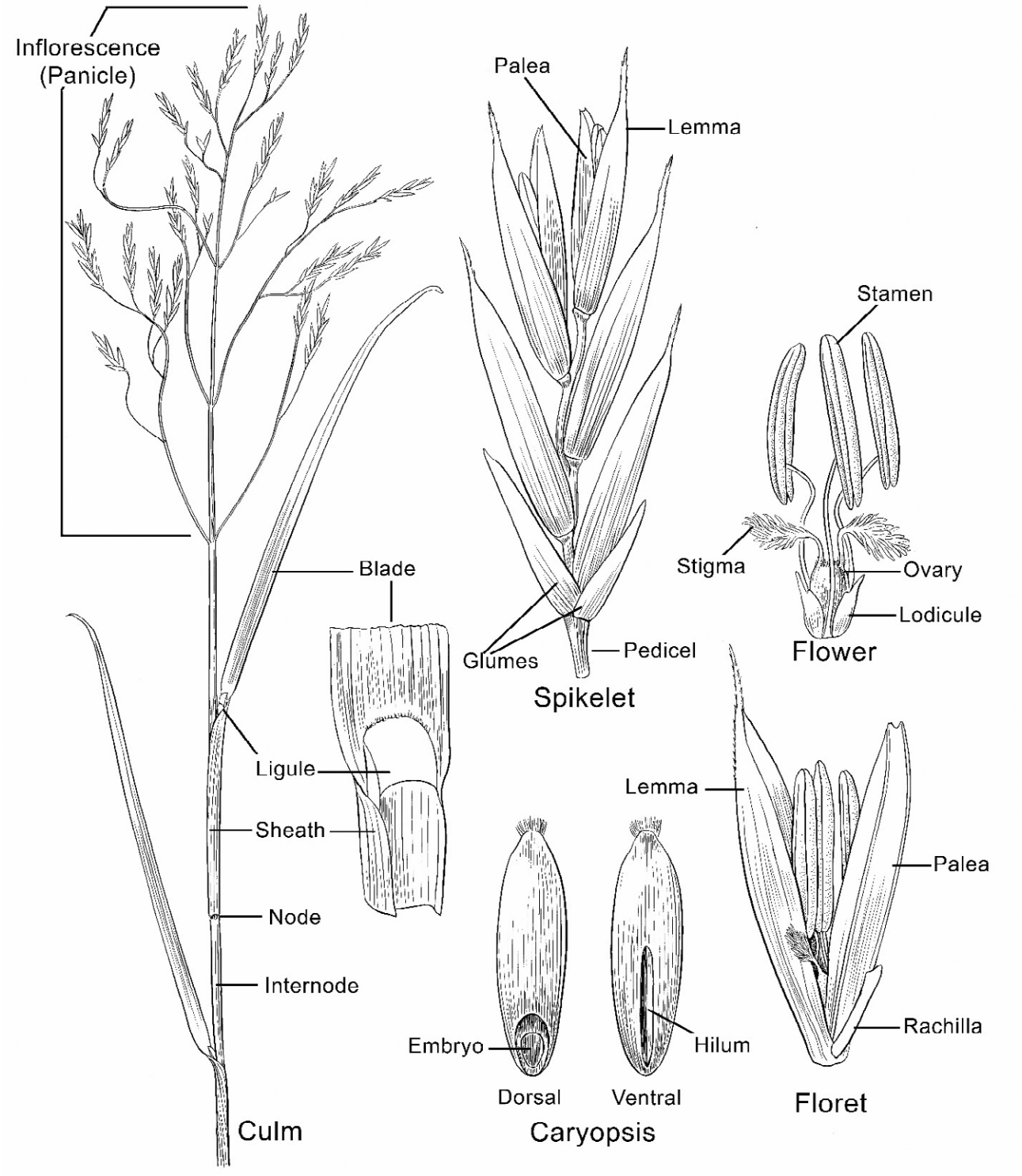

Figure 1. General morphology of a grass, illustrating the culm, blade, panicle, spikelet, floret, flower, and caryopsis.

Parapholis filiformis (Roth) C.E.Hubb.
Parapholis incurva (L.) C.E.Hubb.
Parapholis marginata Runem.
Phalaris aquatica L.
Phalaris arundinacea L.
Phalaris canariensis L.

Figure 2. Inflorescence types used to determine groups in the key. A Open panicle (*Avena sativa*) B Headlike panicle (*Bromus rubens*) C Dichotomously branched panicle (*Cutandia dichotoma*) D Digitately arranged spikes (*Dactyloctenium aegyptium*) E Spikes along central axis (*Dinebra retroflexa*) F Simple spike (*Lolium rigidum*) G Panicles subtended by spatheole (*Lygeum spartum*) H Plumose panicle (*Saccharum spontaneum*) I Spiciform panicle (*Trisetaria linearis*).

Phalaris coerulescens Desf.
Phalaris minor Retz.
Phalaris paradoxa L.
Phleum pratense L.
Phleum subulatum (Savi) Asch. & Graebn.
Poa annua L
Poa diaphora Trin. [syn. *Eremopoa altaica* (Trin.) Roshev.]
Poa infirma Kunth
Poa persica Trin. [syn. *Eremopoa persica* (Trin.) Roshev.]
Poa sinaica Steudel
Polypogon maritimus Willd.
Polypogon monspeliensis (L.) Desf.
Polypogon viridis (Gouan) Breistr.
Rostraria cristata (L.) Tzvelev
Rostraria hispida (Savi) M.Dogan
Rostraria obtusiflora (Boiss.) Holub subsp. *obtusiflora*
Rostraria pumila (Desf.) Tzvelev
Rostraria rohlfsii (Asch.) Holub
Sphenopus divaricatus (Gouan) Rchb.
Triplachne nitens (Guss.) Link
Trisetaria glumacea (Boiss.) Maire
Trisetaria koelerioides (Bornm. & Hack.) Melderis
Trisetaria linearis Forssk.
Trisetaria macrochaeta (Boiss.) Maire

21. TRIBE: STIPEAE Dumort.
Oloptum miliaceum (L.) Röser & H.R.Hamasha [syn. *Oryzopsis miliacea* (L.) Asch. & Schweinf.]
Piptatherum holciforme (M.Bieb.) Roem. & Schult. [syn. *Oryzopsis holciformis* (M.Bieb.) Hack.]
Stipa arabica Trin & Rupr.
Stipa lagascae Roem. & Schult.
Stipellula capensis (Thunb.) Röser & H.R.Hamasha (syn. *Stipa capensis* Thunb.)
Stipellula parviflora (Desf.) Röser & H.R.Hamasha (syn. *Stipa parviflora* Desf.)

22. TRIBE: TRITICEAE Dumort.
Aegilops bicornis (Forssk.) Jaub. & Spach
Aegilops geniculata Roth
Aegilops kotschyi Boiss.
Aegilops longissima Schweinf. & Muschl.
Aegilops peregrina (Hack.) Eig
Aegilops ventricosa Tausch
Agropyron cristatum (L.) Gaertn.
Crithopsis delileana (Schult.) Roshev.
Elymus elongatus (Host) Runem.
Elymus farctus (Viv.) Runemark ex Melderis
Elymus repens (L.) Gould
Eremopyrum bonaepartis (Spreng.) Nevski
Eremopyrum distans (K.Koch) Nevski
Hordeum marinum Huds. subsp. *marinum*
Hordeum marinum subsp. *gussoneanum*
Hordeum murinum L. subsp. *leporinum* (Link) Arcang.
Hordeum murinum L. subsp. *glaucum* (Steud.) Tzvelev
Hordeum spontaneum K. Koch
Hordeum vulgare L.
Taeniatherum caput-medusae (L.) Nevski
Triticum aestivum L.
Triticum dicoccum (Schrank) Schubl.
Triticum durum Desf.
Triticum pyramidale (Delile ex Schult.) Percival
Triticum turgidum L.

The inflorescence (synflorescence) is usually compound, composed of simple or complex aggregation of primary inflorescences (spikelets) often produced on a central axis (rachis) which may be terminal, rarely axillary, or compound and rebranched (Fig. 2). Spikelets may be arranged in spikes, racemes or panicles (open or contracted). In spikes, the spikelets are attached directly (sessile) to the unbranched main axis without pedicels. Racemes are unbranched inflorescences with each spikelet borne on a single pedicel directly on a branch axis. Multiple racemes can be arranged digitally or scattered along the rachis. Open or contracted panicles are inflorescences in which the main axis has several lateral, whorled or individual indeterminate branches with each branch terminating in a pedicellate spikelet. Spiciform panicles is where contraction has proceeded to the point where individual branches are closely appressed or adherent to the central axis. Inflorescences can sometimes be subtended by a bladeless sheath known as spatheole.

IDENTIFICATION KEY

The identification key is composed of two parts: a key to major groups and a key to each group.

Key to major groups

1a. Inflorescence ovoid, cylindrical or a headlike panicle ..... **group 1**

1b. Inflorescence open and not ovoid or a headlike panicle .. 2

2a. Inflorescence branches or spikes digitate or subdigitately inserted, terminal..... **group 2**

2b. Inflorescence branches branched and rebranched (paniculate) and not digitately or subdigitately inserted 3

3a. Inflorescence with racemes or spikelike panicles terminal; spikelets with an involucre of numerous bristles or hairs at the base ..... **group 3**

3b. Inflorescence with racemes appressed along a central axis or a panicle; spikelets without an involucre of numerous bristles or hairs at base 4

4a. Spikes or racemes appressed along central axes .... **group 4**

4b. Spikes or racemes not appressed along central axes 5

5a. Spikelets 3–9-awned or lemma awns 3-branched; inflorescence a contracted or open panicle ..... **group 5**

5b. Spikelets 1-awned or unawned; inflorescence a raceme or panicle 6

6a. Spikelets prickly; inflorescence a simple raceme or spikelike panicle ..... **group 6**

6b. Spikelets not prickly; inflorescence a raceme or panicle .. 7

7a. Inflorescence tri- or dichotomously branched ..... **group 7**

7b. Inflorescence not tri- or dichotomously branched 8

8a. Inflorescence subtended by spatheoles..... **group 8**

8b. Inflorescence not subtended by spatheoles..... 9

9a. Inflorescence plumose, large 20–60 cm long, open; culms 4–8 m tall ..... **group 9**

9b. Inflorescence not plumose, generally ≤ 20 (–60 cm) long, if longer, never plumose, open or contracted; culms ≤ 2 m tall 10

10a. Inflorescence a simple spike, raceme or spikelike panicle ... . **group 10**

10b. Inflorescence an open or contracted panicle..... 11

11a. Panicles spiciform, narrow usually < 1 cm wide . **group 11**

11b. Panicles open usually 0.5–30 cm wide..... 12

12a. Panicles contracted, 0.5–3 (–4) cm wide ..... **group 12**

12b. Panicles open, not contracted, usually (2–) 4–30 cm wide. 13

13a. Spikelets awned ..... **group 13**

13b. Spikelets unawned..... **group 14**

Group 1: Inflorescence ovoid, cylindrical or a headlike panicle

1a. Heads woolly with plumose hairs or bristles 2

1b. Heads not wooly 3

2a. Spikelets not subtended by bristles, 1-flowered with a single perfect floret; glumes (5.5–) 7–10 mm long, awned, the awns 1.5–3 mm long..... *Lagurus ovatus*

2b. Spikelets subtended by an involucre of bristles, 2-flowered, the lower floret sterile; glumes 0.3–5.2 mm long, unawned .....*Cenchrus longisetus*

3a. Spikelets subtended by an involucre of bristles, bristles plumose, 4–7 cm long .....*Cenchrus longisetus*

3b. Spikelets not subtended by an involucre of bristles 4

4a. Panicle bilateral, pyramidal; cultivated .... *Triticum pyramidale*

4b. Panicle not pyramidal; native..... 5

5a. Stoloniferous perennials; with stringlike culms, richly branched at the nodes .....*Aeluropus lagopoides*

5b. Plants not stoloniferous; culms erect..... 6

6a. Glumes shiny with attenuate apices; lemmas shiny, surface villous, hairy below, hairs 4–8 mm long, apex setaceous or attenuate .....*Cortaderia selloana*

6b. Glumes and lemmas green and not shiny, with acute and/or mucronate apices..... 7

7a. Panicles subtended by an inflated sheath,or spatheole; spikelets 1-flowered 8

7b. Panicles not subtended by an inflated leaf sheath or spatheole; spikelets 2-many-flowered..... 10

8a. Panicles ellipsoid; lower glume with glabrous margins ....*Sporobolus schoenoides*

8b. Panicles ovoid or ellipsoid, lower glumes with hairy margins..... 9

9a. Panicles 0.5–1 cm long; uppermost leaf continuous with its sheath; paleas 0–1-veined .....*Sporobolus aculeatus*

9b. Panicles 0.3–1.5 cm long; uppermost leaf clearly demarcated from its sheath; paleas 2-veined ..*Sporobolus niliacus*

10a. Lemmas unawned..... 11

10b. Lemmas awned..... 12

11a. Spikelets 4–14-flowered; panicles exserted ....*Ammochloa palaestina*

11b. Spikelets 3-flowered with only one fertile floret; panicles partially included in the sheath .....*Phalaris minor*

12a. Glumes dissimilar; lemmas mucronate or short-awned, the awns ≤ 1.5 mm long ..... *Dactylis glomerata*

12b. Glumes similar; lemmas all awned, awns ≥ 2 mm long . 13

13a. Most florets perfect; sheaths pubescent to pilose 14

13b. Florets both sterile and perfect; sheaths glabrous 15

14a. Spikelets 15–30 mm long; lemmas 10–15 mm long, awns 7–23 mm long ..... *Bromus rubens*

14b. Spikelets 4–5 mm long; lemmas 3–4. 5 mm long, awns 3–5 mm long ..... *Rostraria hispida*

15a. Awns of sterile spikelets 15–20 mm long; spikelets 6–7 mm long; lemmas 3.4–4 mm long..... *Cynosurus coloratus*

15b. Awns of sterile spikelets 6–15 mm long; spikelets 8–14 mm long; lemmas 4–6.5 mm long..... *Cynosurus echinatus*

Group 2: Inflorescence branches or spikes digitate or sub-digitately inserted, terminal

1a. Racemes 1–2 (3) digitate 2

1b. Racemes usually 2 or more 8

2a. Lemmas awned 3

2b. Lemmas unawned 4

3a. Racemes subtended by reddish spatheole; rachis with white hairs; lemma awns 10–35 mm long, geniculate with twisted column ..... *Hyparrhenia hirta*

3b. Racemes not subtended by spatheole; rachis glabrous; lemma awns 7–10 mm long, straight..... ..... *Brachypodium distachyon*

4a. Culms spongy; racemes 10–30 cm long; rachis angular; glumes with long caudate apex ..... *Vossia cuspidata*

4b. Culms not spongy; racemes ≤ 15.5 cm long; rachis winged or flattened; glumes without a caudate apex..... 5

5a. Spikelets 4–7-flowered, 3.3–7.8 mm long..... 6

5b. Spikelets 1 or 2-flowered, when 2-flowered the lower floret sterile, 2–3.2 mm long..... 7

6a. Leaf blades with tufts of short white hairs scattered along the margins; upper glumes 1veined; grain rugulose .... *Eleusine floccifolia*

6b. Leaf blades without tufts of hairs scattered along the margins; upper glumes 2–3-veined; grains striate .... *Eleusine indica*

7a. Racemes 2–8 cm long; rachis narrowly winged; spikelets dorsally compressed..... *Paspalum distichum*

7b. Racemes 0.7–1.5 cm long; rachis flattened; spikelets laterally compressed ..... *Cynodon transvaalensis*

8a. Lemmas awned..... 9

8b. Lemmas unawned or short aristate 16

9a. Lemmas with geniculate awns and twisted columns..... 10

9b. Lemmas with straight or flexuous awns..... 12

10a. Upper glume awned, the awn 4–10 mm long; fertile spikelets 8–16 mm long ..... *Andropogon distachyos*

10b. Upper glume unawned; fertile spikelets 2–7 mm long... 11

11a. Racemes 3–7 cm long; lemma apex entire, awns 8–25 mm long, adventive ..... *Dichanthium annulatum*

11b. Racemes 10–30 cm long; lemmas apex bifid, awns 6–12 mm long, cultivated..... *Miscanthus sinensis*

12a. Lemmatal awns flexuous,10–30 (–40) mm long; glumes 1-awned, awns 0.5–1 mm long ..... *Schoenefeldia gracilis*

12b. Lemmatal awns straight, less than 10 mm long..... 13

13a. Lemmatal awns 0.5–5 mm long, as long as lemma .... *Chloris gayana*

13b. Lemmatal awns more than 5 mm long, more than twice as long as lemma 14

14a. Leaf blade with an obtuse apex; glume apex acute .... *Chloris pycnothrix*

14b. Leaf blade with an acute apex; glume apex acuminate... 15

15a. Lowest lemma without a crown of spreading hairs; spikelets 4–6-flowered..... *Chloris prieurii*

15b. Lowest lemma with a crown of long spreading hairs, the hairs 1.5–4 mm long; spikelets 3 flowered .. *Chloris virgata*

16a. Flowers unisexual, plants monoecious, female inflorescences subtended by leafy spatheoles, rachis enlarged into a woody cob..... 17

16b. Flowers perfect, plants hermaphroditic, inflorescences not subtended by spatheoles and rachis not enlarged into a cob 18

17a. Female inflorescences 2–5 (–10) cm thick with 8–24 rows of spikelet pairs forming a thick woody cob, all tightly enclosed by several leafy spatheoles .... *Zea mays* subsp. *mays*

17b. Female inflorescences less than 1 cm thick with 2 rows of spikelet pairs formang a hardened rachis, all enclosed by a single leafy spatheole..... *Zea mays* subsp. *mexicana*

18a. Racemes 1–2 mm broad..... 19

18b. Racemes 2–5 mm broad 23

19a. Glumes equal; racemes 3–5..... *Chloris flagellifera*

19b. Glumes unequal or absent; racemes 2–16..... 20

20a. Spikelets 1-flowered; racemes 2 or more closely placed or whorled with a flat rachis, unwinged; ligule a ciliate membrane ..... *Cynodon dactylon*

20b. Spikelets 2-flowered; racemes mostly in pairs or whorled or alternate, he rachis flat or triquetrous, winged; ligule membranous 21

21a. Glumes two, dissimilar..... *Digitaria ciliaris*

21b. Glume one, the lower absent or obscure 22

22a. Spikelets 2.5–3.3 mm long; fertile spikelets paired along a narrowly winged rachis..... *Digitaria sanguinalis*

22b. Spikelets 1.2–2 mm long; fertile spikelets ternate along a broadly winged rachis ..... *Digitaria violascens*

23a. Racemes terminated by the naked tips of the rachis, bristle like 24

23b. Racemes terminated by a spikelet..... 26

24a. Racemes 1.2–6.5 cm long, inflorescence open .... *Dactyloctenium aegyptium*

24b. Racemes 0.8–2 cm long, inflorescence compact 25

25a. Stoloniferous perennials; anthers 1.1–2 mm long .... *Dactyloctenium scindicum*

25b. Tufted annuals often rooting at the lower nodes; anthers 0.3–0.5 mm long..... *Dactyloctenium aristatum*

26a. Racemes in terminal pairs (rarely 3) with scattered one or two below; spikelets 8–20-flowered..... *Acrachne racemosa*

26b. Racemes not in terminal pairs, digitate or subdigitately arranged; spikelets 3–9-flowered 27

27a. Upper glume apex obtuse; lemma apex obtuse …… ... . *Coelachyrum brevifolium*

27b. Upper glume apex acute; lemma apex acute 28

28a. Racemes 9–15 mm wide; spikelets ovate; grains subglobose, brown, exposed between gaping lemmas and paleas at maturity, cultivated ..... *Eleusine coracana*

28b. Racemes 3–8 mm wide; spikelets elliptic; grains ellipsoid, blackish, not exposed or concealed by the florets, native and/or weedy 29

29a. Leaf blades with tufts of short white hairs scattered along the margins; upper glumes 1veined; grain rugulose .... *Eleusine floccifolia*

29b. Leaf blades without tufts of hairs scattered along the margins; upper glumes 2–3-veined; grains striate or granular 30

30a. Lemmas 2.1–3.6 mm long; racemes 3–3.5 mm wide; grains 1–1.3 mm long, striate..... *Eleusine indica*

30b. Lemmas 3.7–5 mm long; racemes 4–8 mm wide; grains 1.2–1.6 mm long, granular ..... *Eleusine africana*

Group 3: Inflorescence with racemes or spikelike panicles terminal; spikelet with an involucre of numerous bristles or hairs at the base

1a. Inflorescence 1 or 2 digitate racemes; spikelets surrounded by hairs; lemmatal awns 2–4 mm long, straight .... *Tetrapogon villosus*

1b. Inflorescence a panicle; spikelets surrounded by free or connate bristles; lemmas unawned 2

2a. Plants robust 2–3 m tall 3

2b. Plants 90 cm or less tall 4

3a. Annuals; culms glabrous below the panicle; bristles shorter than the spikelets, persistent; cultivated..... ..... *Cenchrus americanus*

3b. Perennials; culms villous below the panicle; bristles much longer than the spikelets, deciduous; indigenous .... *Cenchrus orientalis*

4a. Bristles connate, deciduous with the spikelets, inner bristles longer than outer with one long bristle, flat 5

4b. Bristles free, not deciduous with the spikelet..... 9

5a. Bristles of the involucre retrorsely barbellate, tenaciously clinging to clothing, longest bristles scarcely emergent ... 6

5b. Bristles of the involucre antrorsely scaberulous not clinging; sometimes with one conspicuous longer bristle 7

6a. Inner bristles connate only at the bases to form a shallow disc, 2–4 mm long; inner bristle 2.9–7 mm long; ciliate .... *Cenchrus biflorus*

6b. Inner bristles fused for about half their length to form a cup, 5–10 mm long; longest bristle 2–5 mm long, pubescent spinose ..... *Cenchrus echinatus*

7a. Inner bristles rigid, flattened, 2–3 mm long, connate for ½–2/3 their length forming a cup, inner bristles with longest bristle scarcely emergent; 2–4 mm long..... ..... *Cenchrus setiger*

7b. Inner bristles flexuous, filiform above, 6–12 mm long, inner bristles with one conspicuously longer bristle 8–16 mm long; ciliate 8

8a. Inner bristles united only at the bases to form shallow disc 0.5–1.5 mm diam., occasionally connate for up to 0.5 mm above its rim..... *Cenchrus ciliaris*

8b. Inner bristles connate for 1–2.5 mm above the rim of the basal disc forming a cup ..... *Cenchrus pennisetiformis*

9a. Bristles persistent 10

9b. Bristles deciduous with the spikelets 14

10a. Inflorescences open panicles, bristles 2–2.5 cm long ..... *Setaria megaphylla*

10b. Inflorescences a spiciform panicles 11

11a. Bristles retrosely barbed clinging to clothes, 4–7 mm long ..... *Setaria verticillata*

11b. Bristles antrorsely barbed 12

12a. Upper glumes as long as the spikelets; each spikelet subtended by 1–3 bristles, 5–10 times as long as the spikelets. *Setaria viridis*

12b. Upper glumes shorter than the spikelets 13

13a. Lemmas strongly rugose; each spikelets subtended by 4–12 bristles, 3–8 mm long ..... *Setaria pumila*

13b. Lemmas rugulose or unwrinkled; each spikelet subtended by 1–3 bristles, 4–16 mm long ..... *Setaria italica*

14a. Inflorescences comprising only a few spikelets; comprising 2–4(–6) fertile spikelets; shorter than basal leaves; subtended by an inflated leaf-sheaths; enclosed; bristles shorter than the spikelets (cult.) .... *Cenchrus clandestinum*

14b. Inflorescences spike-like panicles, exserted 15

15a. Panicles ovoid to subspherical very dense;bristles plumose, 40–70 mm long; lemmas acute, 7–9-veined ..... *Cenchrus longisetus*

15b. Panicles elongate; lemmas 16

16a. Involucre sessile ..... *Cenchrus violaceum*

16b. Involucre stipitate (stalked 17

17a. Plants glaucous, pinkish; spikes purple or pink; involucral base stipitate, the stipe 1–3 mm long .... *Cenchrus setaceus*

17b. Plants not glaucous, not pinkish; involucral base stipitate, the stipe 0.5–1 mm long 18

18a. Panicles axes glabrous; involucral bristles 7–20 mm long .. *Cenchrus ramosissimus*

18b. Panicles axes pubescent; involucral bristles 6–9 mm long with a conspicuous longer bristle, 10–25 mm long ..... *Cenchrus sieberianus*

Group 4: Spikes or racemes appressed along central axes

1a. Spikelets headlike, several, small, nodding along an unbranched axes; glumes long villous and soft ..... *Melanocenchris abyssinica*

1b. Spikelets not headlike, erect or reflexed along the central axis but not nodding; glumes not long villous 2

2a. Glumes as long as or longer than the spikelets, persistent, similar, exceeding apex of florets; lower glume apex caudate ..... *Dinebra retroflexa*

2b. Glumes much shorter than the spikelets; lower glume apex not caudate 3

3a. Racemes 0.5–1 cm long; spikelets embedded in a corky rachis; leaf blade apex obtuse .... *Stenotaphrum secundatum*

3b. Racemes more than 1 cm long, not embedded in rachis; leaf blades apex acute 4

4a. Lemmas and/or glumes acuminate or awned 5

4b. Lemmas or glumes unawned 9

5a. Racemes 15–35 cm long; spikelets 8–15 mm long; lemma apex mucronate or with a short awn ≤ 1.5 mm long; fertile spikelets pedicelled, pedicels filiform, 0.5–1.5 mm long; glumes unequal ..... *Diplachne fusca*

5b. Racemes 2–10 cm long; spikelets 3–6 mm long; lemma apex awned; fertile spikelets sessile or with pedicels <0.5 mm long; glumes equal or subequel 6

6a. Lemmas apex mucronate or short awned, the awns 0.3–3 mm long 7

6b. Lemmas awned, the awn 20–50 mm long 8

7a. Racemes 2–7(–10); spikelets comprising 1 fertile floret; spikelets 3–4.5 mm long; lemmas rugulose, mucronate, the mucro 0.3–1 mm long ..... *Urochloa panicoides*

7b. Racemes 10–40; spikelets comprising 5–9 fertile florets; spikelets 6–8 mm long; lemmas sparingly hairy, mucronate or short awned up to 2 mm long ... *Trichoneura mollis*

8a. Caespitose annuals; racemes straight; spikelets pedicelled, 1–2 mm long; lemmas hispid, awns up to 50 mm long; upper glumes apex cuspidate ..... *Echinochloa crusgalli*

8b. Rhizomatous perennials; racemes flexuous; spikelets sessile to subsessile; lemmas pubescent, awns 20 mm long, upper glumes entire or awned, the awns 0–4 mm long ..... *Echinochloa stagnina*

9a. Rachis winged 10

9b. Rachis unwinged 15

10a. Racemes compact, appressed to the long slightly hollowed common axis; leaf blade apex obtuse ..... *Setaria obtusifolia*

10b. Racemes not compact, and not as above; leaf apex acute 11

11a. Spikelets 6–9 mm long; lemma margin and midvein pubescent; glume apex caudate ..... *Dinebra panicea*

11b. Spikelets 1.5–4 mm long; lemmas glabrous; glume apex acute to obtuse 12

12a. Spikelets 2.5–3.5 mm long; rachis broadly winged, the wing 0.5–2 mm wide; lemmas apex obtuse 13

12b. Spikelets 1.5–2.5 mm long; rachis narrowly winged, the wing < 0.5 mm wide; lemma apex acute 15

13a. Lower glumes absent or obscure..... *Paspalum racemosum*

13b. Both glumes present, dissimilar 14

14a. Racemes 5–20 cm long; spikelets 2.5–3.5 mm long; lemma surfaces rugulose, stramineous ..... *Urochloa mutica*

14b. Racemes 0.5–4 cm long; spikelets 1.5–2.5 mm long; lemma surface smooth, shiny, dark brown..... ..... *Setaria geminata*

15a. Glume one, the lower absent or obscure 16

15b. Glumes 2, the lower present 17

16a. Glumes apex obtuse; lemmas 3-veined ....*Paspalum dilatatum*

16b. Glumes apex acute; lemmas 7-veined ..... *Digitaria velutina*

17a. Inflorescences up to 60 cm long, racemes numerous 20–50 or more .....*Desmostachya bipinnata*

17b. Inflorescences <60 cm long, racemes few, up to 10..... 18

18a. Lemma and glume apices obtuse ... *Moorochloa eruciformis*

18b. Lemma and glume apices acute or cuspidate..... 19

19a. Spikelets with 8–25 florets..... 20

19b. Spikelets with 1fertile and 1 sterile floret 21

20a. Rachilla villous; callus bearded .... *Halopyrum mucronatum*

20b. Rachilla glabrous; callus not bearded .... *Catapodium rigidum*

21a. Lower glume apex obtuse; lemmas pilose or villous, bearing white hairs .....*Digitaria nodosa*

21b. Lower glume apex acute; lemmas not pilose or villous .. 22

22a. Spikelets packing adaxial, distant, irregular..... .....*Urochloa deflexa*

22b. Spikelets packing regular, 2- or 4–6-rowed 23

23a. Spikelets packing regular, 2-rowed 24

23b. Spikelets packing regular, 4–6-rowed 27

24a. Spikelets packing broadside to rachis; glume apex obtuse and erose, lemma apex apiculate ..... *Aeluropus littoralis*

24b. Spikelets not packing broadside to rachis; glume apex acute, not erose; lemmas apex acute, often mucronate 25

25a. Spikelets 1.5–2 mm long with hirsute pedicels; lower glumes 0.15–0.25 as long as the spikelets without veins, apex truncate ..... *Urochloa reptans*

25b. Spikelets 2–3.5 mm long with glabrous or scabrous pedicels; lower glumes 1/3–½ as long as the spikelets with 3–7 veins, apex acute or obtuse 26

26a. Lemmas dark brown; upper glumes not separated from lower glumes by an internode..... *Urochloa ramosa*

26b. Lemmas green; the upper glumes separated from the lower glumes by a distinct internode 0.2–0.5 mm long..... .....*Urochloa leersioides*

27a. Plants annual, caespitose; upper glumes pubescent, apex cuspidate .....*Echinochloa colona*

27b. Plants perennial with rhizomes; upper glumes glabrous or hispidulous, apex acute .....*Echinochloa pyramidalis*

Group 5: Spikelets 3–9-awned or lemma awns 3-branched; inflorescence a contracted or open panicle

1a. Lemmas 5–9-awned 2

1b. Lemmas awns 3, or awns 3-branched 7

2a. Panicles open or contracted; lemmas hairy below the middle, 5-awned, the awns 4–8 mm long..... .....*Schmidtia pappophoroides*

2b. Panicles compact or spiciform; lemmas not hairy; lemmas 5–9-awned 3

3a. Small villous grasses; panicles densely ovoid; lemmas with 5–9 scabrid awns ..... *Bromus pumilio*

3b. Tall, glabrous grasses, panicles spiciform, oblong-linear; lemma awns 9, feathery..... 4

4a. Lemmas awns scaberulous throughout ....*Enneapogon scaber*

4b. Lemmas awns ciliate below, scaberulous only towards tip.. 5

5a. Fertile lemmas with 3 dense patches of hairs on the backs, one along midrib and one along each margin; nodes glabrous ..... *Enneapogon lophotrichus*

5b. Lemmas with hairs on the back evenly distributed; nodes bearded..... 6

6a. Basal leaf sheaths persistent, forming a bulbous swelling near base; spikelets 2.8–5.5 mm long..... ..... *Enneapogon desvauxii*

7a. Basal leaf sheaths persistent, not forming a bulbous swelling near base; spikelets 5.5–12 mm long..... *Enneapogon persicus*

7a. Lemma awns glabrous to scabrous, column not twisted .. 8

7b. Lemma awns feathery, at least the principal or central awn with atwisted column 14

8a. Lemma 3-awned, central awn arising from sinus and the lateral awns arising dorsally or marginally, persistent, central awn not more than 10 mm long, lateral awns not more than 5 mm long 9

8b. Lemma with a single 3-branched awn, deciduous, central awn more than 10 mm long, lateral awns usually more than 5 mm long..... 15

9a. Central lemma awns geniculate with twisted column, apex of awn smooth..... 10

9b. Central lemma awn straight, apex of awn scabrous..... 13

10a. Central lemma awns inserted below the middle, scarcely exserted from the spikelet, the awns 2.5–3 mm long, lateral lemma awns 1–1.5 mm long..... *Trisetaria glumacea*

10b. Central lemma awns inserted near the middle or upper ¼, exserted from the spikelet, the awns 3–10 mm long, lateral lemma awns 1–5 mm long 11

11a. Lemmas glabrous, central awns 5–7 mm long; lateral awns 1.5–5 mm long 12

11b. Lemmas villous, central awns 3–4 mm long, lateral awns 1–1.5 mm long..... *Triplachne nitens*

12a. Panicles loosely contracted, 0.5–3.5 cm wide, oblong-ovate; central lemma awn 5–8 mm long, lateral awns 1.5 mm long ..... *Trisetaria macrochaeta*

12b. Panicles densely contracted, 0.5–1 cm wide, linear; central lemma awn 8–15 mm long, lateral awns 3–5 mm long ..... *Trisetaria linearis*

13a. Spikelets elliptic, 10–40 mm long; lemmas with minutely bifid apex, awns curved, spreading, 5–15 mm long, lateral lemma awns arising dorsally, shorter than the central ..... *Bromus danthoniae*

13b. Spikelets lanceolate, 4–6 mm long; lemmas central awns 1.5–3 mm long, lateral lemma awns arising from the margins 0.5–1 mm long 25

14a. Spikelets 5–11-flowered; glumes 1.5–3 mm long, shorter than the spikelet; lemmas pilose, margins ciliate, central awn inserted in the sinus, the awn 1.5–2.5 mm long, not geniculate or twisted ..... *Triraphis pumilio*

14b. Spikelets 2-flowered; glumes 4–5 mm long, longer than the spikelet; lemmas entirely glabrous, shiny, central awn inserted dorsally on upper ½, the awn 2.5–3 mm long, geniculate and twisted ..... *Trisetaria glumacea*

15a. All three awns glabrous, lateral awns as long as the central awn; glumes unequal..... 16

15b. Central and sometimes lateral awns plumose, lateral awns shorter than the central; glumes subequal..... 18

16a. Awns without a column, not articulating at the summit; ligule a ciliolate membrane..... *Aristida adscensionis*

16b. Awns with a column, articulating at the summit; ligule a fringe of hairs 17

17a. Spikelets 6–7 mm long; lemma awns 10–30 mm mm long ..... *Aristida mutabilis*

17b. Spikelets 20–30 mm long; lemma awns 35–45 mm long .... *Aristida funiculata*

18a. All three lemma awns plumose, lateral awns about as long as the central awn with or without a twisted column 19

18b. Only the central lemma awn plumose, lateral awns much shorter than the central awn with a twisted column 21

19a. Internodes densely woolly; panicles 5–10 cm long; central lemma awns 20–35 mm long, the column 3–5 mm long, twisted ..... *Stipagrostis lanata*

19b. Internodes glabrous; panicles 10–40 cm long; central lemmas awns 7–10 mm long, the column 0–1 mm long, straight or slightly twisted 20

20a. Lower glumes longer than the upper; panicles 20–40 cm long; awns not or scarcely exserted from spikelets..... ..... *Stipagrostis scoparia*

20b. Lower glumes shorter than the upper; panicles 10–20 cm long; awns exserted from the spikelets..... ..... *Stipagrostis vulnerans*

21a. Nodes bearded; lemmas articulating near the middle (across the body) ..... *Stipagrostis ciliata*

21b. Nodes not bearded; lemmas articulating near apex..... 22

22a. Central lemma awns plumose throughout 23

22b. Central lemma awns glabrous in the lower and/or upper portions..... 25

23a. Callus glabrous; column straight or slightly twisted .... *Stipagrostis raddiana*

23b. Callus bearded; column twisted..... 24

24a. Callus with 2 collars of hairs; column 7–13 mm long, hairy on the upper portion; central lemma awns 35–70 mm long, lateral lemma awns 10–25 mm long..... ..... *Stipagrostis hirtigluma*

24b. Callus with a single collar of hairs; column 5–10 mm long, glabrous; central lemma awns 20–35 mm long, lateral lemma awns 10–12 mm long .... *Stipagrostis uniplumis*

25a. Central lemma awns glabrous in the lower or upper portion.....26

25b. Central lemma awns glabrous in the lower and upper portion.....29

26a. Central lemma glabrescent toward tip.....27

26b. Central lemma awns glabrescent toward base 28

27a. Callus glabrous; column 1.5–2 mm long; central lemma awns 13–25 mm long, lateral lemma awns 7–17 mm long .....*Stipagrostis drarii*

27b. Callus bearded; column 11–14 mm long; central lemma awns 60–70 mm long, lateral lemma awns 17–25 mm long .....*Stipagrostis paradisea*

28a. Lower glume apex obtuse; lemmas 2–2.5 mm long, central lemma awns 20–30 mm long, ...*Stipagrostis obtusa*

28b. Lower glume apex acute; lemmas 3–4 mm long, central lemma awns 45–47 mm long .....*Stipagrostis shawii*

29a. Column straight or slightly twisted, 1 mm long, central lemma awns 13–18 mm long.....*Stipagrostia acutiflora*

29b. Column twisted, 3–9 mm long, central lemma awns 25–60 mm long 30

30a. Glumes 3-veined, lower glumes glabrous .....*Stipagrostis plumosa*

30b. Glumes 5–7-veined, lower glumes pilose.....*Stipagrostis multinerva*

Group 6: Spikelets prickly; inflorescence a simple raceme or panicle

1a. Lower glumes well developed, modified into a long flat recurved tail, upper glumes usually smaller, enfolding the lemmas, tuberculate .....*Leptothrium senegalense*

1b. Lower glumes very small or suppressed, upper glumes and lemmas about equal with raised veins bearing hooked bristles.....2

2a. Apical spikelets sterile; upper glumes 7-veined .....*Tragus racemosus*

2b. All spikelets fertile; upper glumes 5-veined .....*Tragus berteronianus*

Group 7: Inflorescence tri- or dichotomously branched

1a. Panicles trichotomously branched and rebranched; spikelets 2 mm long; pedicels terete, club-shaped, slender .....*Sphenopus divaricatus*

1b. Panicles dichotomously branched; spikelets 6–8 mm long; pedicels 3-angled.....2

2a. Spikelets 5–9 (–12)-flowered; glumes 3–5-veined .....*Cutandia maritima*

2b. Spikelets 2–4-flowered; glumes 1-veined.....3

3a. Panicles partially enclosed in the sheath below; panicle internodes longer in length than the spikelets; lemmas 7.5– 8.5 mm long, apex awned, the awns 10–11 mm long .....*Cutandia memphetica*

3b. Panicles exserted not enclosed in the sheath; panicle internodes shorter in length than the spikelets; lemmas 4.5–5.5 mm long, apex acute or bidentate .....*Cutandia dichotoma*

Group 8: Inflorescence subtended by spatheoles

1a. Inflorescence a single terminal spikelet, one-sided enclosed by spatheole; lemmas villous.....*Lygeum spartum*

1b. Inflorescence composed of many spikelets; lemmas not villous.....2

2a. Inflorescence composed of male and female racemes.....3

2b. Inflorescence composed of bisexual florets 5

3a. Female racemes sessile subtended by bony utricles; male racemes pedunculate projecting from the utricles .....*Coix lacryma-jobi*

3b. Female racemes subtended by 1 or more herbaceous spatheoles.....4

4a. Female inflorescences 2–5 cm broad; rachises thick woody, enclosed by several leafy spatheoles.....*Zea mays* subsp. *mays*

4b. Female inflorescences less than 1 cm broad; rachises tough not woody, enclosed by single spatheole .....*Zea mays* subsp.*mexicana*

5a. Rachis with white hairs.....*Hyparrhenia hirta*

5b. Rachis pubescent or glabrous but not with white haris....6

6a. Spatheoles colored red or brown 7

6b. Spatheoles green.....9

7a. Plants not aromatic; spikelets 6–14 mm long surrounded by hairs; callus bearded, the hairs red; lemma awns 20–70 mm long, straight, hispidulous ..... *Themeda triandra*

7b. Plants aromatic; spikelets 4–5.5 mm long; callus not bearded; lemma awns 7–18 mm long, geniculate with a twisted column.....8

8a. Lower glume of sessile spikelet veins distinct, winged; lemma awns 12–18 mm long..... *Cymbopogon martini*

8b. Lower glume of sessile spikelet veins absent or obscure and not winged; lemma awns 7–10 mm long..... *Cymbopogon jwarancusa*

9a. Rachis villous; spikelet pedicels villous; lemmas unawned. ..... *Cymbopogon citratus*

9b. Rachis ciliate; spikelet pedicels ciliate; lemmas awned ... 10

10a. Awns geniculate with a twisted column..... 11

10b. Awns straight..... 14

11a. Plants aromatic; racemes 2 12

11b. Plants not aromatic; racemes 1 13

12a. Lower glume of sessile spikelet elliptic lanceolate, usually 2- or 3-veined between the keels ..... *Cymbopogon nardus*

12b. Lower glume of sessile spikelet narrowly lanceolate, usually veinless between the keels ..... *Cymbopogon flexuosus*

13a. Lower glume of sessile spikelet pubescent with reddish hairs and not pitted, apex obtuse; lemma awns absent or to 10 mm long..... *Themeda villosa*

13b. Lower glumes of sessile spikelet glabrous, shining, pitted, apex acute; lemma awns 12–18 mm long..... *Dichanthium foveolatum*

14a. Racemes 2–3 cm long; spatheoles 2–3 cm long; lower glume of sessile spikelet glabrous ..... *Cymbopogon schoenanthus* subsp. *schoenanthus*

14b. Racemes 1–2 cm long; spatheoles 1–2 cm long; lower glume of sessile spikelet pubescent..... *Cymbopogon schoenanthus* subsp. *proximus*

Group 9: Inflorescence plumose, large 20–60 cm long, open; culms 4–8 m tall

1a. Culms solid; callus bearded with white silky hairs..... 2

1b. Culms not solid; callus not bearded..... 3

2a. Callus hairs white; panicles 25–40 cm long..... *Saccharum spontaneum*

2b. Callus hairs off-white; panicles up to 1 m long..... *Saccharum officinarum*

3a. Lemmas pilose, the hairs 4–9 mm long; rachilla glabrous; glumes longer than the florets..... *Arundo donax*

3b. Lemmas glabrous, rachilla hairy; glumes shorter than the florets..... 4

4a. Rachilla hairs 4–7 mm long; upper glumes 3–5(–6) mm long; leaf blades scabrid below..... *Phragmites karka*

4b. Rachilla hairs 8–15 mm long; upper glumes 6–9 mm long; leaf blades smooth below..... *Phragmites australis*

Group 10: Inflorescence a simple spike, raceme or spikelike panicle

1a. Inflorescence a fragile cylindrical bilateral raceme with spikelets sunken in hollow of axes, glumes placed side by side covering the hollow 2

1b. Inflorescence not as above and without any sunken spikelets along the axis..... 4

2a. Keel of glume wingless; culms and racemes strongly curved..... *Parapholis incurva*

2b. Keel of glume winged; culms and racemes usually straight 3

3a. Racemes bearing 5–10 spikelets; upper glume apices acute; lemma apices acute..... *Parapholis marginata*

3b. Racemes bearing 10–20 spikelets; upper glume apices acuminate; lemmas apices obtuse ..... *Parapholis filiformis*

4a. Spikes 1-sided..... 5

4b. Spikes 2- or more sided..... 6

5a. Raceme not subtended by inflated leaf sheath; spikelets pectinate, solitary..... *Festuca pectinella*

5b. Raceme subtended by an inflated leaf sheath; spikelets surrounding the rachis, not pectinately arranged..... *Tetrapogon cenchriformis*

6a. Spikelets white-silky villous..... *Lasiurus scindicus*

6b. Spikelets green..... 7

7a. Raceme subtended by an inflated leaf sheath..... *Elionurus royleanus*

7b. Racemes not subtended by an inflated leaf sheath 8

8a. Racemes partially enclosed in the sheath ..... *Dichanthium foveolatum*

8b. Racemes exserted, not enclosed in the sheath 9

9a. Inflorescence open, lax with remote spikelets..... 10

9b. Inflorescence dense, narrow with approximate spikelets. 16

10a. Lower glumes absent; spikelets rotated 90° edgewise from the culm axis and packed adaxially..... 11

10b. Lower glumes present; spikelets not rotated 90° edgewise from culm axis and packed laterally 14

11a. Glumes much longer than the spikelets; lemmas elliptic-ovate, rigid ..... *Lolium temulentum*

11b. Glumes shorter than the spikelets; lemmas oblong-lanceolate, not rigid 12

12a. Spikelets 11–22-flowered; lemmas awned, at least the upper ones ..... *Lolium multiflorum*

12b. Spikelets 3–10-flowered; lemmas unawned, rarely awned 13

13a. Perennials; spikelets 2–10-flowered; lemma, if awned, up to 8 mm long; glumes 1/3 to as long as the spikelets ..... *Lolium perenne*

13b. Annuals; spikelets 5–8-flowered; lemma, if awned, the awns 3–10 mm long; glumes as long or longer than the spikelets ..... *Lolium rigidum*

14a. Rachis fragile, disarticulating at the base of each internode, spikelets falling with attached rachis ..... *Elymus farctus*

14b. Rachis not disarticulating at maturity; florets falling separately, the glumes persistent 15

15a. Glumes unawned, apex obtuse or mucronate; lemmas unawned; rhizomes absent ..... *Elymus elongatus*

15b. Glumes mucronate or short-awned, apex acute; lemmas unawned or short-awned if awned, the awns up to 6 mm long; rhizomes present ..... *Elymus repens*

16a. Inflorescence short, rarely over 10 cm long; internodes clavate; spikelets in pairs at each node of thick rachis, pedicelled spikelet sterile and sessile spikelet fertile, deeply sunken in excavated rachis ..... *Hemarthria altissima*

16b. Inflorescence long, over 10 cm; internodes not clavate; one to many spikelets borne at a node, not as above and not sunken in an excavated rachis 17

17a. Glumes narrowly-linear throughout their length appearing awnlike 18

17b. Glumes lanceolate to ovate, wider near the base and not appearing awnlike throughout. 19

18a. Inflorescence rachis glabrous throughout; lemmas 8–12 mm long, scabrous ..... *Taeniatherum caput–medusae*

18b. Inflorescence rachis ciliate along the margins; lemmas 5–7 mm long, villous ..... *Crithopsis delileana*

19a. Spikelets in pairs or in groups of 3 at a node 20

19b. Spikelets solitary at each node 26

20a. Spikelets in pairs, comprising 1 sessile and 1 pedicelled spikelet without rhachilla extension; glumes dissimilar; central lemma awned from a sinus; flexuous; 8–22 mm long ..... *Pogonatherum paniceum*

20b. Spikelets in group of 3 at each node, lateral spikelets staminate or sterile, central spikelets 1-flowered with bristlelike rachilla extension; glumes similar; central lemma awned from apex, not within a sinus 21

21a. Inflorescence rachis tough, not disarticulating at maturity. ..... *Hordeum vulgare*

21b. Inflorescence rachis fragile, disarticulating at maturity 22

22a. Awns of fertile lemma stout, 4–15 cm long; 2 lateral florets sessile; glumes silky hairy ..... *Hordeum spontaneum*

22b. Awns of fertile lemma slender, not more than 3 cm long; 2 lateral florets pedicelled; glumes not silky hairy 23

23a. Margin of glumes eciliate; lemma awns 10–24 mm long 24

23b. Margin of glumes long ciliate; lemma awns 18– 50 mm long 25

24a. One glume of the lateral spikelets expanded below into a broad or narrow wing ..... *Hordeum marinum* subsp.*marinum*

24b. Both glumes of the lateral spikelets not expanded below into a broad or narrow wing ..... *Hordeum marinum* subsp. *gussoneanum*

25a. Leaf blades green; anthers of central spikelets 0.7–1.4 mm long; prolongation of rachilla of lateral spikelets 3–4 mm long, slender ..... *Hordeum murinum* subsp. *leporinum*

25b. Leaf blades glaucous; anthers of central spikelets 0.2–0.5 mm long; prolongation of rachilla of lateral spikelets 1–2 mm, stout ..... *Hordeum murinum* subsp. *glaucum*

26a. Glumes rounded over the midveins, lateral veins distinct 27

26b. Glumes keeled over the midveins, lateral veins not always distinct 32

27a. Spikes moniliform (resembling a string of beads), swollen at base; disarticulating at the base of the spikelet ..... *Aegilops ventricosa*

27b. Spikes not moniliform or swollen at base; disarticulating at the base of the internode 28

28a. Spikes 10–20 cm long; glumes unawned; only the terminal spikelets with 2 long stout awns ..... *Aegilops longissima*

28b. Spikes 1–8 cm long; glumes awned or unawned; terminal spikelet with awns no different than those below. 29

29a. Spikes 4–8 cm long; glume apex bidentate; principal lemma awns 30–60 mm long ..... *Aegilops bicornis*

29b. Spikes 0.5–5 cm long; glumes apex not bidentate; principal lemma awns ≤30 mm long 30

30a. Glumes with veins unequal in width, unequally spaces and sunk into the surface of the glume ..... *Aegilops geniculata*

30b. Glumes with veins equal in width, equally spaced, riblike and protruding from the surface of the glume 31

31a. Awns of lower glumes of equal width below and about equal in length; glumes of lowest fertile spikelet always with 3 awns ..... *Aegilops kotschyi*

31b. Awns of lower glumes of unequal width below and unequal in length; glumes of lowest fertile spikelet with 2 or 3 awns ..... *Aegilops peregrina*

32a. Lemma awns up to 15 cm long (cultivated wheat) 33

32b. Lemma awns 0–7 mm long (wild plants)..... 36

33a. Inflorescense rachis fragile, disarticulating at maturity; upper glumes apex emarginate; lemma awns 10–15 cm long ..... *Triticum dicoccum*

33b. Inflorescence rachis tough, not diararticulating at maturity; upper glumes apex with a unilateral teeth, truncate or 1-awned 34

34a. Glumes keeled above; winged on keeled; , rounded below; upper glumes apex with a unilateral teeth; truncate or 1-awned, awns 0–40 mm long; lemma awns 0–15 cm long *Triticum aestivum*

34b. Glumes keeled from the bases to the apex; upper glumes apex with unilateral teeth, truncate; lemma awns 8–15 cm long..... 35

35a. Spikelets with 2–3 fertile florets..... *Triticum durum*

35b. Spikelets with 3–5 fertile florets..... *Triticum turgidum*

36a. Perennials; racemes tough; anthers 3–5 mm long ..... *Agropyron cristatum*

36b. Annuals; racemes fragile; anthers < 1.5 mm long 37

37a. Palea at least as long as the body of the lemma; lemma awned, the awns 5–7 mm long; upper glumes awned, the awns 5–7 mm long..... *Eremopyrum distans*

37b. Palea shorter than the body of the lemma; lemma unawned or with a short awn, the awns up to 3 mm longupper glumes unawned..... *Eremopyrum bonaepartis*

Group 11: Panicles spiciform, narrow usually < 1 cm wide

1a. Panicles silky with the spikelets enveloped in long silky white hairs originating from the callus..... *Imperata cylindrica*

1b. Panicles not silky and callus not long hairy..... 2

2a. Base of glumes dilated forming a bulblike swelling ..... *Gastridium phleoides*

2b. Base of glumes not dilated..... 3

3a. Panicle branches consisting of clusters each with 3 sterile spikelets ± covering 2 smaller spikelets, one of which is fertile ..... *Lamarckia aurea*

3b. Panicle branches not as above..... 4

4a. Spikelets awned (lemma and/or glumes) 5

4b. Spikelets unawned..... 13

5a. Glumes awned 6

5b. Glumes unawned; lemmas awned or mucronate..... 9

6a. Lemmas awned..... 7

6b. Lemmas unawned 8

7a. Lower glume mucronate, the mucro 0.5–1 mm long; upper glume awns 1.5–6 mm long; fertile lemma apex entire; sterile lemma awn hooked..... *Holcus annuus*

7b. Lower glume awns 3–7 mm long; upper glume awns 4–7 mm long; lemma apex dentate, 4-fid; lemma awns not hooked..... *Polypogon monspeliensis*

8a. Lower and upper glumes awns 1–2 mm long ..... *Phleum pratense*

8b. Lower and upper glumes awns 3–7 mm long..... *Polypogon maritimus*

9a. Lemma apex entire, mucronate or awned, the awns up to 2 mm long..... *Trisetaria koeleroides*

9b. Lemmas usually awned, the awns 1–16 mm long..... 10

10a. Lemma awns 8–16 mm long, the geniculate awn arising dorsally near the base of the lemma..... *Alopecurus myosuroides*

10b. Lemma awns 1–5 mm long; the straight awn arising near or just below the apex of the lemma 11

11a. Glumes subequal, the lower minutely longer than the upper and often densely wooly ..... *Rostraria pumila*

11b. Glumes unequal, the lower shorter and narrower than the upper, the lower never densely wooly, usually glabrous or with a few scattered hairs 12

12a. Panicles oval in outline, bristly; lemma surface setose, the hairs 0.5 mm long; lemma awns 3–5 mm long ..... *Rostraria hispida*

12b. Panicles linear or oblong in outline, not bristly; lemma surface not setose; lemma awns 1–3 mm long..... 13

13a. Panicles branches pubescent; lower glumes pubescent; lemma awns subterminal, scabrous. ..... *Rostraria rohlfsii*

13b. Panicles branches glabrous; lower glumes glabrous or pubescent; lemma awns terminal, glabrous ..... *Rostraria cristata*

14a. Glume keel winged 15

14b. Glume keel not winged 20

15a. Glume with 2 teethlike projections just above the middle .. *Phalaris paradoxa*

15b. Glume without 2 teethlike projections just above the middle 16

16a. Wings broad, margins erose or denticulate. 17

16b. Wings narrow, margins entire 18

17a. Perennials; culms with a swollen base or pseudocorm; sterile spikelets surrounding the fertile spikelet; lemmas glabrous or with a few hairs near apex ..... *Phalaris coerulescens*

17b. Annuals; culms without a swollen base; sterile spikelets not surrounding the fertile spikelet; lemmas pubescent ..... *Phalaris minor*

18a. Inflorescence capitate, wider near base; caespitose annuals ..... *Phalaris canariensis*

18b. Inflorescence oblong, not wider near base; rhizomatous perennials 19

19a. Panicles interrupted below; rhizomes long and creeping; ligules 6–10 mm long ..... *Phalaris arundinacea*

19b. Panicles not interrupted below; rhizomes short and knotty; ligules 2–4 mm long ..... *Phalaris aquatica*

20a. Lemmas pilose with tubercle-based hairs, the hairs 4–5 mm long ..... *Melica persica*

20b. Lemmas not long pilose or with tubercle based. 21

21a. Glumes deciduous 22

21b. Glumes persistent 23

22a. Spikelets with 6–12 florets; palea keels pectinate-ciliate, the hairs nearly 1 mm long; ligule a ciliate membrane; lemma apex obtuse ..... *Eragrostis ciliaris*

22b. Spikelets with 1 floret; palea keels not pectinate-ciliate; ligule a line of hairs; lemma apex acute ..... *Sporobolus spicatus*

23a. Lemma surface pubescent with clavate hairs; lemma apex truncate ..... *Phleum subulatum*

23b. Lemma surface glabrous or pubescent but without clavate hairs; lemma apex acute or obtuse 24

24a. Culms 60–150 cm tall, erect and reedlike; spikelets 10–16 mm long; panicles 7–22 cm long .... *Calamagrostis arenaria*

24b. Culms 5–50 cm tall, decumbent, geniculate or mat-forming; spikelets 2–7 mm long; panicles 1–7.5 cm long 25

25a. Spikelets 1-flowered, 2–2.5 mm long; lemmas 1-veined, 2–2.5 mm long; glumes shorter than the florets ..... *Sporobolus alopecuroides*

25b. Spikelets 3–5-flowered, 3–77 mm long; lemmas 5-veined, about 4 mm long; glumes slightly longer than the florets .. *Rostraria obtusiflora*

Group 12: Panicles contracted, 0.5–3 (–4) cm wide

1a. Upper and/or lower glumes awned 2

1b. All glumes unawned 3

2a. Lower glume awned, the awns 3–5 mm long; upper glume awns 7–8 mm long; lemmas 6–7 mm long; spikelets 7–10 mm long ..... *Festuca brevis*

2b. Lower glume unawned; upper glume awns 4–6 mm long; lemmas 8–18 mm long; spikelets 12–16 mm long ..... *Festuca fasciculata*

3a. Principal lemmas awned 4

3b. Principal lemmas unawned 9

4a. Lemmas hairy between the veins with 2–8 transverse rows of hair tufts; lemma awns 3–5 mm long 5

4b. Lemmas not hairy between veins or with transverse rows of hair tufts; awns 5–15 mm long 6

5a. Culms 50–120 cm tall, robust; panicles 17–35 cm long; anthers 1.6–2.7 mm long ..... *Centropodia fragilis*

5b. Culms 10–50 cm tall, smaller; panicles 2–15 (–20) cm long; anthers 0.7–1.3 mm long ..... *Centropodia forskalii*

6a. Lemma apex bidentate ..... *Bromus fasciculatus*

6b. Lemmas apex entire 7

7a. Panicles curved or nodding ..... *Festuca myuros*

7b. Panicles straight, not curved or nodding 8

8a. Lemmas awns 5–12 mm long; callus rounded, about 0.2 mm long; glumes similar ..... *Festuca bromoides*

8b. Lemma awns 15–25 mm long; callus pointed, 0.5–0.8 mm long; glumes dissimilar ..... *Festuca fasciculata*

9a. Spikelets 1-flowered 10

9b. Spikelets 3–10-flowered 13

10a. Lemmas 1-veined; ligule a line of hairs; glumes as long or shorter than the floret 11

10.b. Lemmas 3 or 5-veined; ligule membranous; glumes longer than the floret 12

11a. Leaf blades stiff and pungent, conspicuously distichous; glumes ½ to as long as the floret; lower glume apex acute. ..... *Sporobolus pungens*

11b. Leaf blades not stiff, pungent or distichous; glumes <1/2 as long as the floret; lower glume apex obtuse..... ..... *Sporobolus natalensis*

12a. Glumes shiny and glabrous, scaberulous only along the keel; lemmas 1.5–2.3 mm long, apex obtuse; anthers 1–1.5 mm long..... *Agrostis stolonifera*

12b. Glumes scabrous throughout, roughened and not shiny; lemmas 1–1.5 mm long, apex truncate; anthers 0.5–0.8 mm long..... *Polypogon viridis*

13a. Lemmas 3-veined, 1.4–1.5 mm long, membranous, apex acute; glumes deciduous ..... *Eragrostis sarmentosa*

13b. Lemmas 5–7-veined, 2–7.5 mm long, coriaceous, apex obtuse or truncate; glumes persistent..... 14

14a. Spikelets with 3–10 fertile florets, if sterile florets present these located above the fertile ones; lemmas 2–2.5 mm long, apex obtuse; stamens 3; anthers about 0.3 mm long. ..... *Catapodium rigidum*

14b. Spikelets with a single upper fertile floret and two basal sterile florets; lemmas 3.5–7.5 mm long, apex truncate; stamens 6; anthers 3–4 mml long ..... *Ehrharta calycina*

Group 13: Spikelets awned; panicles open

1a. Lemma awns (8–)10–30 cm long, feathery 2

1b. Lemma awns much shorter, usually < 5 cm long, glabrous or scabrous..... 5

2a. Awns conspicuously twisted together with adjacent spikelet awns forming a tail; annuals ..... *Stipellula capensis*

2b. Awns not conspicuously twisted together with others and not forming a tail; perennials 3

3a. Awns plumose for their whole length, the hairs 0.5–1.3 mm long..... *Stipa arabica*

3b. Awns scabrid or pubescent, the hairs < 0.3 mm long..... 4

4a. Awns 20–25 cm long, pubescent ..... *Stipa lagascae*

4b. Awns 6–13 cm long, scabrous..... *Stipellula parviflora*

5a. Spikelets usually flushed with purple; awns of lemmas inserted from the base, the column with a clavate upper limb, brownish, with a ring of hairs at the junction .... *Corynophorus divaricatus*

5b. Spikelets green; awns of lemmas subapical or inserted near the middle, the column never clavate or with a ring of hairs at the junction..... 6

6a. Spikelets all solitary. 7

6b. Spikelets in pairs usually with a sessile and pedicellate or in triplets with two pedicellate and one sessile. 30

7a. Spikelets (10–) 15–60 mm long 8

7b. Spikelets 1.5–12 mm long 36

8a. Glumes longer than the spikelet; lemma awns geniculate with a strongly twisted column; ovaries pubescent all over 9

8b. Glumes much shorter than the spikelet; lemma awns usually straight and not geniculate; ovaries pubescent only near the apex 15

9a. Tips of lemmas bidentate with awned teeth, the teeth awns usually 1–1.5 cm long. 10

9b. Tips of lemmas bidentate with unawned teeth or with the awns of the teeth much shorter than 0.8 mm long 12

10a. Spikelets erect; callus elongated, 4.2–6 mm long; lower glumes 25–40 mm long..... *Avena longiglumis*

10b. Spikelets pendulous; callus obtuse, < 2 mm long; lower glumes 16–26 mm long..... 11

11a. Spikelets (1.8–) 2–3 cm long; lower lemma 1.6–2 cm long. ..... *Avena barbata* subsp. *barbata*

11b. Spikelets 1.4–1.8 cm long; lower lemma 1.2–1.4 cm long... ..... *Avena barbata* subsp. *wiestii*

12a. Floret callus glabrous; lemmas glabrous. ..... *Avena sativa*

12b. Floret callus hairy; lemmas hairy on the lower 1/3..... 13

13a. Lemmas dark brown; rachilla not disarticulating at maturity..... *Avena fatua*

13b. Lemmas green; rachilla disarticulating between the florets at maturity 14

14a. Glumes 30–50 mm long; lowest lemmas 25–40 mm long.... ..... *Avena sterilis* subsp. *sterilis*

14b. Glumes 25–30 mm long; lowest lemmas 20–25 mm long.... ..... *Avena sterilis* subsp. *ludoviciana*

15a. Spikelets 45–60 mm long; lemmas awns 45–60 mm long.... 16

15b. Spikelets less than 45 mm long; lemmas awns 4–40 mm long..... 17

16a. Panicles lax, spreading, broadly ovate, the branches longer than spikelets; base of lemmas in profile, contracted just above the callus; callus blunt with an oval scar .... *Bromus diandrus* var. *diandrus*

16b. Panicles contracted, stiffly erect, narrowly ovate, the branches usually shorter than the spikelets; base of lemmas in profile, continuous with callus; callus pointed with an elliptic scar .....*Bromus diandrus* var. *rigidus*

17a. Lower glumes 1-veined; upper glumes 3-veined; lemma awns not more than 20 mm long.....18

17b. Lower glumes 3–9-veined; upper glumes 5–13-veined; awns usually 15–40 mm long 21

18a. Panicles branches compound bearing (3–) 5–8 fertile spikelets..... *Bromus tectorum* var. *tectorum*

18b. Panicles branches simple bearing 1–3 fertile spikelets....19

19a. Panicles branches bearing 1–3 fertile spikelets; spikelet pedicels ≤ 1 cm long; lemmas 10–20 mm long.....20

19b. Panicles branches bearing a single fertile spikelet; spikelet pedicels usually > 3 cm long; lemmas 15–40 mm long..... ..... *Bromus sterilis*

20a. Plants perennial and rhizomatous; lemmas awnless, mucronate or short-awned, the awns up to 1.5 mm long .. .. *Bromus inermis*

20b. Plants annuals, caespitose; lemmas awned, the awns 12–20 mm long..... *Bromus madritensis*

21a. Lemma awns curved and reflexed-spreading.....22

21b. Lemma awns straight 23

22a. Lemmas coriaceous with inconspicuous veins; margins of lemma not involute but overlapping the back of the adjacent lemma; ligules 1–3 mm long.....*Bromus japonicus*

22b. Lemmas membranous with conspicuous veins; margins of lemma somewhat involute at maturity, not overlapping the back of the adjacent lemma but wrapped around the caryopsis; ligules 3–6 mm long ..... *Bromus pulchellus*

23a. Lemma awns briefly coiled at the base 24

23b. Lemmas awns not coiled at the base.....26

24a. Spikelets 10–15 mm long, 2–3 mm wide; lemmas 6–11 mm long..... *Bromus scoparius*

24b. Spikelets (12–) 25–50 mm long, 3–16 mm wide, lemmas 11–18 mm long.....25

25a. Leaf blades 3–5 mm wide; lemma awns awns 11–20 mm long; spikelets 3–7 mm wide..... *Bromus alopecuros*

25b. Leaf blades 1–2.5 mm wide; lemma awns 6–12 mm long; spikelets 6–16 mm wide ..... *Bromus lanceolatus*

26a. Lemmas strongly keeled; spikelets strongly laterally compressed..... *Bromus catharticus*

26b. Lemmas rounded on the back; spikelets terete to moderately laterally compressed 27

27a. Glumes with ciliolate margins; culms nodes swollen..... ..... *Bromus aegyptiacus*

27b. Glumes without ciliolate margins; culm nodes not swollen 28

28a. Lemmas 5.5–6.5 mm long; lemma awns 3–7 mm long, terete near base, straight; caryopsis longer than the palea, often visible beyond the tip of the lemma.. *Bromus lepidus*

28b. Lemmas 8–17 mm long; lemma awns 5–17 mm long, flattened near base, straight or slightly divergent; caryopsis shorter than the palea, concealed within the floret.....29

29a. Lemmas 5–7-veined, 2–4 mm wide, glabrous or pubescent, narrowly lanceolate in profile; lemma awn arising 2–3 mm below the tip; anthers 1 mm long; lower glumes usually 3-veined .....*Bromus pectinatus*

29b. Lemmas 7–9 (–11)-veined, 4.5–5.5 mm wide, hirsute, narrowly oblanceolate in profile; lemma awn arising 0.7–1.9 mm below the tip; anthers 2–2.5 mm long; lower glumes 3–7-veined..... *Bromus hordeaceus*

30a. Spikelets in triplets with two pedicellate and one sessile31

30b. Spikelets in pairs, fertile spikelets sessile and sterile spikelets pedicelled 32

31a. Panicles branches villous with white or dark brown hairs; fertile lemmas glabrous without transverse tufts of hairs; leaf blade apices not stiff and pungent, margins not white cartilaginous; upper glume of fertile lemma plumose ....*Chrysopogon plumulosus*

31b. Panicle branches scaberulous without white or dark brown hairs; fertile lemmas with transverse tufts of hairs, the hairs 4–5 mm long; leaf blade apices stiff and pungent with conspicuous white cartilaginous margins; upper glume of fertile lemma unawned .....*Danthoniopsis barbata*

32a. Column of the lemma awns pubescent, hairy on the spiral; paleas present 33

32b. Column of the lemma awns glabrous, not hairy on the spiral; paleas absent or minute.....34

33a. Apex of lower glume dentate, 3-fid; awns of upper lemma 10–16 mm long; plants perennial, rhizomatous ....*Sorghum halepense*

33b. Apex of lower glume entire; awns of upper lemma up to 10 mm long; plants annual or short-lived perennials, not rhizomatous..... *Sorghum bicolor*

34a. Lower glumes pubescent with white or yellow hairs..... ..... *Sorghum arundinaceum*

34b. Lower glumes glabrous....35

35a. Panicle branches tough; spikelet callus pilose.... *Sorghum x drummondii*

35b. Panicle branches fragile at node; spikelet callus not pilose. *Sorghum virgatum*

36a. Glumes and lemmas villous with white or purplish-red hairs....37

36b. Glumes and lemmas glabrous....37

37a. Spikelets 1.5–2 (–2.4) mm long; upper glumes not gibbous.... *Melinis minutiflora*

37b. Spikelets 5–12 mm long; upper glumes gibbous.... *Melinis repens*

32a. Lemmas 1.5–2 mm long, the awns 3–5 mm long; apex of lemma obtuse.... *Oloptum miliaceum*

32b. Lemmas 6–7.5 mm long, the awns 8–13 mm long, apex of lemma acute.... *Piptatherum holciforme*

Group 14: Spikelets unawned; panicles open

1a. Both glumes absent or obscure....2

1b. Both glumes or at least the upper present....3

2a. Spikelets 8–11 mm long, 2.5–3.5 mm wide, persistent; lemma apex mucronate or awned, the awns up to 160 (cult.).... *Oryza sativa*

2b. Spikelets 3.4–4.8 (–5.2) mm long, 1.2–1.4 (–1.7) mm wide, disarticulating entire; lemma apex entire, not mucronate or awned.... *Leersia hexandra*

3a. Primary panicles branches whorled, at least on the lower nodes....4

3b. Primary panicles branches not whorled at most nodes..10

4a. Lemmas pubescent, hairy below and along the veins....5

4b. Lemmas glabrous throughout....6

5a. Lemma apex apiculate; anthers 1.4–2.6 mm long.... *Poa diaphora*

5b. Lemma apex not apiculate; anthers 0.3–0.7 (–1) mm long.. *Poa persica*

6a. Glumes longer than the florets, persistent....7

6b. Glumes ≤ the florets, deciduous or persistent....8

7a. Roots aromatic; lower glumes surface spinose, glumes dissimilar; spikelets 3.5–5 mm long.... *Chrysopogon zizanioides*

7b. Roots not aromatic; lower glumes surface not spinose, glumes similar; spikelets 1.8–3 mm long.... *Agrostis stolonifera*

8a. Spikelets dorsally compressed with a 5-veined sterile lemma just below the fertile lemma; leaf blades usually 12–35 mm wide.... *Megathyrsus maximus*

8b. Spikelets laterally compressed without a sterile lemma below the fertile lemma, the fertile lemma 1-veined; leaf blades 1–10 mm wide....9

9a. Panicles 3–20 cm long; apex of lower glumes obtuse; anthers 0.7–1 mm long.... *Sporobolus ioclados*

9b. Panicles 20–60 cm long; apex of lower glumes acute; anther 1.1–1.3 mm long.... *Sporobolus wrightii*

10a. Spikelets pendulous; lemmas orbicular, gibbous, and auriculate near base....11

10b. Spikelets not pendulous; lemmas not orbicular. gibbous or auriculate near base....12

11a. Spikelets 3–5 mm long, 3–5 mm wide; apex of lemma not cuspidate.... *Briza minor*

11b. Spikelets 14–25 mm long, 8–15 mm wide; apex of lemma cuspidate.... *Briza maxima*

12a. Spikelets in pairs with a fertile sessile and sterile pedicelled.... *Sorghum bicolor*

12b. Spikelets not in pairs....13

13a. Lemmas with white capitate hairs near base, the hairs 0.2 mm long.... *Desmazeria philistaea*

13b. Lemmas without white capitate hairs....14

14a. Glumes and lemmas pilose with white tubercle-based hairs.... *Tricholaena teneriffae*

14b. Glumes and lemmas not pilose or, if hairy, the hairs not white and tubercle-based....15

15a. Lemma apex bifid and dentate....16

15b. Lemmas apex not bifid or dentate....19

16a. Spikelets 15–25 mm long; lemmas 10–13 mm long; ovary pubescent on the apex; rhizomatous perennials.... *Bromus inermis*

16b. Spikelets ≤ 7 mm long; lemmas 1.2–3.3 mm long; ovary glabrous throughout; caespitose annuals or perennials..17

17a. Spikelets 1.5–2.4 mm long, persistent; lower glumes without veins.... *Melinis minutiflora*

17b. Spikelets 4–7 mm long, deciduous with the pedicels; lower glumes 5–7-veined....18

18a. Lemmas 2–3.5 mm long, apical lobes narrowly triangular,

0.6–1.3 mm long; palea shorter than the lemma. .... *Schismus arabicus*

18b. Lemmas 1.5–2 mm long, apical lobes broadly triangular, 0.3–0.4 mm long; palea ≥ the lemma in length ....*Schismus barbatus*

19a. Spikelets all 1-flowered with no additional florets .... *Sporobolus wrightii*

19b. Spikelets with more than a single floret.....20

20a. Spikelets with one fertile floret and 1 or 2 sterile florets..... 21

20b. Spikelets with 3–10 fertile florets 28

21a. Spikelets laterally compressed, each spikelet with 2 basal sterile florets; fertile florets with 6 stamens ....*Ehrharta calycina*

21b. Spikelets dorsally compressed, each spikelet with 1 basal sterile floret; fertile florets with 3 stamens 22

22a. Upper fertile lemma faintly to strongly rugose..... .....*Megathyrsus maximus*

22b. Upper fertile lemma smooth 23

23a. Spikelets 3.5–5.5 mm long 24

23b. Spikelets 2–3.2 (–3.5) mm long 25

24a. Plants annual without woody culms or resembling bushes; leaf blade apices not pungent ..... *Panicum miliaceum*

24b. Plants perennial with woody culms resembling bushes; leaf blade apices pungent ..... *Panicum turgidum*

25a. Lower glumes ½–2/3 the length of the spikelet; lemmas apex acute .....*Panicum antidotale*

25b. Lower glumes up to ⅓ the length of the spikelet 26

26a. Plants with a knotty rootstock; lower glume membranous, 1–3 (–7)-veined.....*Panicum coloratum*

26b. Plants without a knotty rootstock but with slender rhizomes or stolons; lower glumes hyaline, usually unveined, rarely 3-veined.....27

27a. Plants erect with spreading rhizomes; leaf sheaths tough, wooly on the margins when young; leaf blade apices pungent; ligules 0.3–0.5 mm long..... *Panicum repens*

27b. Plants with stolons; leaf sheaths loose, papery, glabrous on the margins; leaf blade apices not pungent; ligules 0.8–2 mm long.....*Panicum hygrocharis*

28a. Lemmas 5-veined.....29

28b. Lemmas 3-veined.....32

29a. Spikelets 10–18 mm long; lemmas 6–9 mm long; culms 50–150 cm tall; leaf blades 4–10 mm wide .... *Lolium arundinaceum*

29b. Spikelets 2–10 mm long; lemmas 2–5 mm long; culms ≤ 65 cm tall; leaf blades 1–5 mm wide 30

30a. Plants perennial forming a bulbous base composed of old leaf sheaths; anthers 1.5–2.5 mm long; apex of ligule acute .....*Poa sinaica*

30b. Plants annual or short-lived perennials, not forming a bulbous base of old leaf sheaths; anthers ≤ 1.1 mm long; apex of ligule obtuse.....31

31a. Anthers 0.6–1 (–1.1) mm long; spikelets crowded or sparsely arranged on the branches.....*Poa infirma*

31b. Anthers 0.1–0.5 mm long; spikelets always crowded on the branches.....*Poa annua*

32a. Plants perennial, forming innovations at the basal nodes; caryopses narrowly triangular in cross section, strongly laterally flattened with a deep ventral groove .... *Eragrostis tenuifolia*

32b. Plants annual, usually tufted, without innovations at the basal nodes; caryopses not narrowly triangular in cross section or strongly laterally flattened, without a deep ventral groove.....33

33a. Palea keels prominently ciliate, the cilia 0.2–1 mm long 34

33b. Palea keels smooth or scabrous the scabridities < 0.2 mm long. 35

34a. Spikelets 2.2–3 mm long; lemmas and culms without glands; lemmas (0.8–) 1–1.2 mm long, oblong; anthers 2... .....*Eragrostis lepida*

34b. Spikelets 6–20 mm long; lemmas with crateriform glands on the keels, similar glands also often present below the nodes; lemmas 2–2.8 mm long, broadly ovate; anthers 3 ... .*Eragrostis cilianensis*

35a. Ligules membranous, neither ciliolate or ciliate..... .....*Eragrostis japonica*

35b. Ligules membranous and ciliolate to ciliate, the cilia often longer than the basal membrane 36

36a. Plants with glandular pits or bands somewhere, the locations various, including any or all of the following: below the cauline nodes, on the sheaths, blades, rachises, panicle branches or pedicels, or on the keels of the lemmas and paleas.....37

36b. Plants without glandular pits or bands 40

37a. Spikelets 1–1.4 mm wide; pedicels 1–10 mm long, lax appressed or divergent.....*Eragrostis pilosa*

37b. Spikelets 1.1–4 mm wide; pedicels 0.2–4 mm long, stiff, straight, usually divergent.....38

38a. Lemmas 2–2.8 mm long with 1–3 crateriform glands along the keels; spikelets 6–20 mm long, 2–4 mm wide, with 10–40 florets; disarticulation below the florets, the rachillas persistent; anthers yellow ..... *Eragrostis cilianensis*

38a. Lemmas 1.4–1.8 mm long, rarely with 1 or 2 crateriform glands along the keels; spikelets 4–7 (–11) mm long, 1.1–2.2 mm wide, with 7–12 (–20) florets; disarticulation below the lemmas , both the paleas and rachillas usually persistent; anthers reddish-brown 39

39a. Panicles with glandular regions below the nodes, the glandular tissue forming a ring or band, often shiny or yellowish; blade margins without crateriform glands; pedicels without glandular bands ..... *Eragrostis barrelieri*

39b. Panicles sometimes with glandular areas, but rarely rings of glandular spots or crateriform pits below the nodes, the glands usually dull greenish-gray to straminious; blade margins sometimes with crateriform glands; pedicels usually with glandular bands..... *Eragrostis minor*

40a. Lemmas 1.6–3 mm long; florets persistent and the grain retained within; caryopses 0.3–1.3 mm long obovoid, smooth, light brown to white; plants cultivated, occasionally escaping..... *Eragrostis tef*

40b. Lemmas 1.2–1.7 mm long; florets deciduous, the grains not retained within; caryopses 0.4–0.9 mm long, ovoid, orbicular to prism-shaped or isodiametric, smooth or striate, brownish; plants native or established introductions 41

41a. Spikelets 5–25 mm long, 10–60-flowered; anthers 2..... ..... *Eragrostis tremula*

41b. Spikelets 3–15 mm long, 4–20 flowered; anthers 3 42

42a. Lower glumes 1–1.5 mm long, about as long as the upper glume, 1-veined; panicle branches not whorled at the lower nodes; lemma apex truncate or obtuse; caryopses orbicular, isodiametric ..... *Eragrostis aspera*

42b. Lower glumes 0.5–0.7 mm long, ½ to 2/3 as long as the upper glume, unveined; panicle branches whorled at the lower nodes; lemma apex acute or obtuse caryopses ellipsoid 43

43a. Panicle branches partially included below in the subtending leaf; spikelets 5–15 cm long; caryopses 0.5–0.7 mm long..... *Eragrostis aegyptiaca*

43b. Panicle branches exserted and not included below in the subtending leaf; spikelets 3–6 mm long; caryopses 0.7–1 mm long..... *Eragrostis pilosa*

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Stellaria ruderalis M. Lepší, P. Lepší, Z. Kaplan et P. Koutecký, a new species record for the flora of Ukraine

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Abstract. *Stellaria ruderalis* is an annual (semi)ruderal species from the *S. media* group, which has been recently published by Lepší et al., therefore, its distribution range in Europe is insufficiently known. This paper is based on field exploration of 39 localities of *S. media* s.l. in the Lviv region, Western Ukraine. The first report of *S. ruderalis* in Ukraine comes from Dmytre village, where it grows at roadsides and arable field edges in a semiruderal habitat of the alliance *Aegopodion podagrariae*. As only a single population was found, *Stellaria ruderalis* is obviously still spreading in Western Ukraine, a fact which was reported already for northern Central Europe. This record represents the northeasternmost locality of the species so far known.

Keywords: new record, *Stellaria media* group, *Stellaria ruderalis*, Ukraine.

INTRODUCTION

The *Stellaria media* group comprises in Europe four species, *S. media* (L.) Vill., *S. pallida* (Dumort.) Crép., *S. neglecta* Weihe, and the recently published one, *S. ruderalis* M. Lepší, P. Lepší, Z. Kaplan et P. Koutecký (Chater and Heywood 1964; Sobey 1981; Lepší et al. 2019). Up to now, *S. media*, *S. pallida,* and *S. neglecta* were recognized for the flora of Ukraine (Klokov 1952; Mosyakin and Fedoronchuk 1999). These species are morphologically close and also overlap in their distribution range. Therefore, either *S. media* s. l., or more controversially, several microtaxa are reported in the literature (Whitehead and Sinha 1967; Colasante et al. 1999). However, a complex analysis of morphological features (i.e., structure of the inflorescence, length of petals, number of stamens, and shape of tubercules on the seed surface) together with karyological and molecular data allowed distinguishing four species within *S. media* group in Europe (Lepší et al. 2019).

The newly described *S. ruderalis* is suggested to be an allopolyploid originated from *S. pallida* and *S. neglecta* (Lepší et al. 2019), hence it combines

some morphological features of both species. *Stellaria ruderalis* differs from *S. media* s. str. by long (longer than wide) conical tubercles on the seed surface with no or few papillae on the upper part of their surface, a more condensed inflorescence at the juvenile stage. Such long tubercules are also present on the seeds of *S. neglecta*. However, *S. ruderalis* differs from *S. neglecta* by lower number of stamens (3–5(10) vs. 8–10) and shorter petals, which are not longer than sepals. *Stellaria pallida* distinctly differs from all other species by smaller seeds (up to 1 mm), a low number of stamens (1–3, rarely 4), a minute or absent petals, and generally smaller plants. Up to now, *Stellaria ruderalis* is known from the Czech Republic, Slovakia, Austria, Hungary, Slovenia, Croatia, Serbia, Italy (including Sardinia), and Greece. It grows in disturbed ruderal communities such as grasslands, edges of ruderal scrubs, forests and tree plantations, along roads, railways, and in disturbed river habitats (Lepší et al. 2019). For the Lviv region in Western Ukraine, only *S. media* (s.l.) is known (Zelenchuk 1991, Sytschak and Kagalo 2010). Therefore, we were interested if *Stellaria ruderalis* is also occurring in Western Ukraine.

MATERIALS AND METHODS

Vouchers of *Stellaria media* s.l. in the herbarium of the State Museum of Natural History of the National Academy of Sciences of Ukraine (LWS) were initially revised. Field work was conducted in May and June 2020 in Lviv and its surroundings. In total, 39 localities of *S. media* s.l. were explored, including 11 localities in Lviv and 28 localities in the adjacent towns and villages (Zymna Voda, Kholodnovidka, Konopnytsia, Dibrivky, Obroshyno, Stavchany, Schyrets, Horbachi, Dmytre, Popeliany, Kaguiv, Dorohovyzh, Rozvadiv, Medenychi, Hirske. Kolodruby, Piatnychiany, Pukenychi, Vilhivtsi, Zaritschia, Nova Skvariava, Griada, Kulykiv, Grusiatychi, Khodorkivtsi, Nestanychi, and Vidnyky). Plants were randomly sampled and identified using a ×20 magnifier. Photos of flowers and seeds were made with a Dino-Lite Pro AM-413ZT digital microscope.

RESULTS AND DISCUSSION

As expected, no herbarium vouchers of *S. ruderalis* were found in LWS. This can be easily explained with the fact that such a common species group like *Stellaria media* s.l. is usually neglected by botanists. Among all investigated localities, only one comprised *S. ruderalis*, where it was growing parapatrically with *S. media* s.str. The following herbarium voucher has been deposited in LWS and is available online via http://dc.smnh.org/. *Stellaria ruderalis*, Ukraine, Lviv region, Pustomyty district, Dmytre village, near the cemetery, 49.60507°N 23.87046°E, alt. 270 m a.s.l, leg. Andriy Novikov & Mariia Sup-Novikova 20.05.2020, det. Andriy Novikov 17.06.2020, confirm. Clemens Pachschwöll (LWS 118505). Plants of *S. ruderalis* were growing along both roadsides (Figure 1), at the edge of a arable field and among tree plantings together with *Aegopodium podagraria* L. (dominant), *Cirsium arvense* (L.) Scop., *Chaerophyllum aromaticum* L., *Dactylis glomerata* L., *Lamium album* L., *Taraxacum officinale* agg., *Urtica dioica* L., and *Veronica chamaedrys* L. This is a semiruderal and

Figure 1. Habitat of *Stellaria ruderalis* in Dmytre village (Pustomyty district, Lviv region, Ukraine).

Figure 2. Close-up view of *Stellaria ruderalis* flowers from Dmytre village.

Figure 3. Flower of *Stellaria ruderalis* from Dmytre village.

nutrient-rich habitat of the alliance *Aegopodion podagrariae* Tüxen 1967 (Solomakha 2008; Láníková et al. 2009), a vegetation type well known for Lviv (Kucheryvyi et al. 1991). Explored plants of *S. ruderalis* had dense inflorescences (Figure 2), 4–6(8) stamens, petals significantly shorter than sepals (Figure 3), seeds longer than 1 mm and conical tubercles on the seed surface (Figure 4), which allowed us to clearly distinguish it from *S. media* s.str. and other related taxa. Although we expected to find *S. ruderalis* easily, in all other explored localities only *S. media* s.str. was growing. In our opinion, it supports the fact that *S. ruderalis* is currently still spreading in northern Central Europe including Western Ukraine (Lepší et al. 2019).

This is the first report of *S. ruderalis* for Ukraine. The nearest locations of *S. ruderalis* were reported from Tatabánya city in Hungary (about 590 km away), Kuchyňa village in Slovakia (about 630 km away), as well as from Břeclav city (about 620 km away) and Vranovice village (about 630 km away) in the Czech Republic (Lepší et al. 2019). Hence, this is the northeasternmost locality of *S. ruderalis* in Europe so far known. Our finding gives a hope that *S. ruderalis* will be soon discovered in other parts of Ukraine as well as other countries of Eastern and Southeastern Europe.

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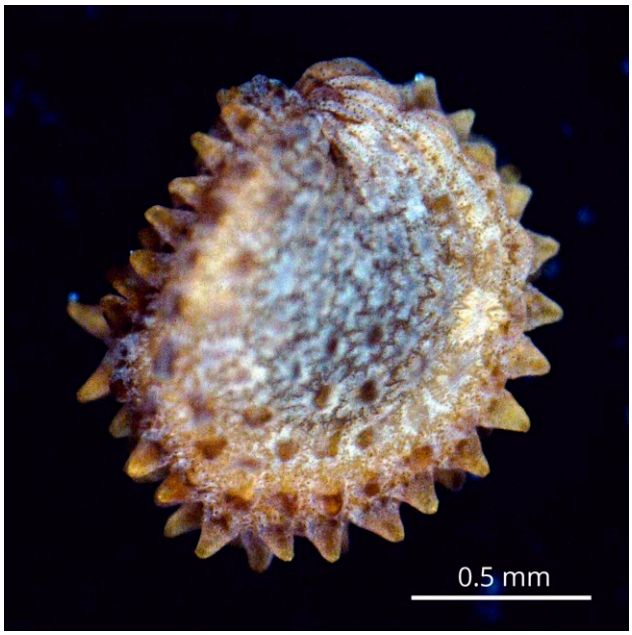

Figure 4. Seed of *Stellaria ruderalis* from Dmytre village.

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Index of New Taxa

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The new taxa, new combinations, new synonyms and the names described in volume 75 (2020) are listed below. The last number shows the page/s of publication and the asterisk means that the taxon is provided by an illustration or photo.

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Table of contents

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