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LINDENBERGIA LEHM. (OROBANCHACEAE): A NEW GENERIC RECORD IN JAVA AND BORNEO

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ABSTRACT
AL FARISHY, D. D., TIANARA, A. & MUSTAQIM, W. A. 2024. *Lindenbergia* Lehm. (Orobanchaceae): a new generic record in Java and Borneo. *Reinwardtia* 23(2): 105–111. — The genus *Lindenbergia* Lehm. is reported for the first time in Java, Indonesia, where *Lindenbergia philippensis* (Cham. & Schltdl.) Benth. was recently collected from the lowland area of Depok and Jakarta, northwest Java. The genus is also known to be collected in Borneo after literature examinations. Description, distribution map, identification key, note, and photographs of the species are given alongside a discussion of the occurrence status of the genus and species. A key to all six genera of Orobanchaceae in Java is also given accompanied by a list of all currently accepted species.

Key words: Genus, herbs, lowland, Malesia, taxonomy.

ABSTRAK
AL FARISHY, D. D., TIANARA, A. & MUSTAQIM, W. A. 2024. *Lindenbergia* Lehm. (Orobanchaceae): sebuah catatan baru marga di Jawa and Borneo. *Reinwardtia* 23(2): 105–111. — Marga *Lindenbergia* Lehm. dilaporkan untuk pertama kalinya di Jawa, Indonesia melalui upaya koleksi *Lindenbergia philippensis* (Cham. & Schltdl.) di wilayah dataran rendah Depok dan Jakarta, barat laut Jawa. Marga ini diketahui juga pernah dikoleksi di Borneo setelah melalui pengujian literatur. Pertelaan, peta distribusi, kunci identifikasi, catatan, dan foto jenis tersebut dibahas beserta dengan status kemunculan marga dan jenis. Kunci identifikasi untuk enam marga Orobanchaceae di Jawa juga dilampirkan beserta dengan seranai seluruh jenis yang diterima secara ilmiah.

Kata kunci: Dataran rendah, herba, Malesia, marga, taksonomi.

INTRODUCTION

Lindenbergia Lehm. is a non-mycoheterotrophic plant genus of the family Orobanchaceae. All species of this genus produce green leaves and are usually herbs, sometimes with woody stem bases, either annual or perennial. The total number of accepted species is 15 according to POWO (2021). The center of distribution for this genus is located in Southern Asia. In Malesia, this genus has been reported in the Philippines (Prijanto, 1969; Hjerston, 1995; Hong *et al*., 1998; Joyce *et al*. 2020) and also in Malaya (Craib, 1911). *Lindenbergia* is a subject to a number of molecular studies because it is the only chlorophyll-producing or autotrophic genus within the Orobanchaceae (Bennett & Mathews, 2006; Wickett *et al.*, 2011; Wicke *et al.,* 2013). The monophyly of this genus has been confirmed by a phylogenetic study by McNeal *et al*. (2013).

Several individuals belonging to the genus *Lindenbergia* were recently recorded in West Java. Our examination of type materials, protologue, and monographic works (Prijanto, 1969; Hjertson, 1995) has shown that our recently collected specimens are *Lindenbergia philippensis* (Cham. & Stldl.) Benth. Before this finding, this species was reported from mainland South and Southeast Asia to Peninsular Malaysia (Craib, 1911; Joyce *et al*., 2020) and the Philippines (Pelser *et al*., 2011-onwards). Literature examinations were also made to check the presence of this genus on Java,

ranging from Backer & Bakhuizen van den Brink (1965) to several new publications on the flora of Jakarta, Depok, and surroundings (Nisyawati & Mustaqim, 2017; Mustaqim *et al*., 2017; 2019). None of them reported the occurrence of *Lindenbergia* in Java. Therefore, we present the first record of the genus in Java.

MATERIALS AND METHODS

The observation was conducted since 2017 until we collected the fertile specimens in 2021 in one site at the edge of Universitas Indonesia Urban Forest. Our further observations yielded the discovery of other individuals and from two other locations in Depok, West Java, not too far from the first encountered specimens. Specimens were collected using standard methods following Rugayah *et al*. (2004) and Bridson & Forman (1992), while measurement of the morphological characters was done from fresh materials. Specimens were deposited at Herbarium Depokensis (UIDEP) Universitas Indonesia. Herbarium codes mentioned in this article refer to Thiers (updated continuously). For identification purpose, we examined type specimens from JSTOR Global Plants (plants.jstor.org) and other digital herbaria available online (ANDA (Nurainas *et al*., 2020), K, L, P). Morphological descriptions of the specimens also compared to Prijanto (1969) and Hjertson (1995).

RESULTS

Before this finding, six genera of Orobanchaceae were known for Java: *Aeginetia* L., *Alectra* Thunb. (sometimes as *Melasma* P.J. Bergius), *Buchnera* L., *Micrargeria* Benth., *Sopubia* Buch.-Ham., and *Striga* Lour. (Backer & Bakhuizen van den Brink, 1965; Pelser *et al*., 2011 -onwards). Description to the family is presented here from Wu & Raven (1998). To facilitate identification to the genus level, an updated key of the Orobanchaceae family in Java, including *Lindenbergia*, is presented here (modified from Hong *et al*., 1998).

TAXONOMIC TREATMENT

OROBANCHACEAE

Description after Wu & Raven (1998): Herbs annual, biennial, or perennial parasites, without chlorophyll. *Stems* unbranched or sometimes branched. *Leaves* scalelike, spirally or subimbricately arranged. Inflorescences racemose, spicate, or subcapitate, rarely 1-flowered; bract 1, usually similar to leaves; bractlets 2, adnate to base of calyx or pedicel. *Flowers* bisexual, subsessile or pedicelled. Calyx tubular, cupular, or campanulate, (rarely 3 or)4–6-lobed, 2–6-parted, 6-toothed, or spathelike, sometimes absent or of 3 free sepals. Corolla bilabiate, usually curved, sometimes tubular-campanulate or funnelform with 5 subequal lobes; upper lip entire, emarginate, or 2-lobed; lower lip 3-lobed. Stamens 4, didynamous, inserted at base of corolla tube; filaments slender; anthers 2 -celled, dehiscing longitudinally, sometimes 1 cell fertile and another sterile or reduced to spur. Pistil 2- or 3-carpellate; ovary superior; placentas 2–4 or 6(–10), parietal or sometimes axile at ovary base; ovules 2–4 or numerous, anatropous. Style long; stigma inflated, discoid, peltate, or 2–4-lobed. Capsule usually dehiscing loculicidally by 2 or 3 (or 4) valves. Seeds minute, testa pitted or reticulate.

List of Orobanchaceae in Java

AEGINETIA: *A. indica* L. ALECTRA: *A. avensis* (Benth.) Merr. syn. *Melasma avense* (Benth.) Hand.-Mazz. BUCHNERA: *B. tomentosa* Blume MICRARGERIA: *M. filiformis* (Schumach. & Thonn.) Hutch. & Dalziel. SOPUBIA: *S. trifida* Buch.-Ham. ex D.Don. STRIGA: *S. asiatica* (L.) Kuntze. syn. *Striga lutea* Lour. *S. angustifolia* (D.Don) C.J.Saldanha. syn. *Striga euphrasioides* (Vahl) Benth. & *S. multiflora* Benth.

LINDENBERGIA Lehm. in Link & Otto, Icon. Pl. Rar. (1828) 95. — Type: *L. urticifolia* Lehm.

Description after Hjerston (1995): *Annual to perennial herbs, subshrubs, to shrubs*. *Stem* erect or procumbent, without or often many-branched, most parts clad with long hairs, rarely nearly glabrous. *Leaves* simple, opposite, upper leaves often alternate, penninerved, margin serrate, dentate, crenate, or rarely subentire. *Flowers* yellow with reddish-brown marks often present, rarely purple, blue, or greenish (young?); solitary or in terminal racemes, less often axillary; subtended by leaf-like bracts, equaling or smaller in size; flowers ebracteolate, bracts rarely present and linear in shape. *Calyx* 5-lobed. *Corolla* 2-lipped; tube cylindrical, upper lip internal at first, apex retuse, bilobed or bidentate, lower lip 3-lobed with rounded apex. *Stamens* 4, didynamous, included; filaments slender, slightly adnate above the base of the corolla, basally pilose or glabrous; anthers opening by a longitudinal slit, all contain pollen. *Ovary* ovoid, glabrous or pilose; style slender, glabrous or pilose at the base, stigma nearly capitate, shortly bifid. *Capsule* longitudinally dehiscent. *Seeds* numerous, minute, ellipsoidal, surfaces usually smooth, rarely deeply reticulate.

Distribution. A genus of 12 species native in tropical and subtropical Africa and Asia. In Malesia previously known from Peninsular Malaysia and the Philippines (Hjerston, 1995). Now also recorded from Java in the western part (Depok and South Jakarta).

Key to the genera of Orobanchaceae in Java (modified from Hong *et al*., 1998).

1a. Plant leafless ..... *Aeginetia*
1b. Plant produces green leaves 2
2a. Flower ebracteolate; corolla two-lipped ..... *Lindenbergia*
2b. Flower bracteolate; corolla subactinomorphic 3
3a. Calyx campanulate-ovoid or semiglobose 4
3b. Calyx narrowly tubular 6
4a. Leaves oblong to ovate-oblong ..... *Alectra*
4b. Leaves linear 5
5a. Fertile thecae 1, one theca aborted, thecae strongly unequal in size ..... *Sopubia*
5b. Fertile thecae 2, both well-developed, either equal or subequal in size ..... *Micrargeria*
6a. Corolla tube straight ..... *Buchnera*
6b. Corolla tube curved ..... *Striga*

Notes. Generic overviews of the flora's in Malesian subregions were made in recent years, which include the genera of the Orobanchaceae family, such as the first record of *Christisonia* in Borneo (van der Ent & Wong, 2015). Our finding improves the current knowledge of the family, especially for Java. Further explorations in adjacent islands, where *Lindenbergia* is still unknown, are encouraged, perhaps with a special emphasis on Sumatra. Planning future collection localities should include more urbanized or disturbed areas as *Striga* and *Lindenbergia* were found in disturbed areas (see the habitat of *L. philippensis* below). Normally disturbed areas are often avoided during botanical explorations.

LINDENBERGIA PHILIPPENSIS (Cham. & Schltdl.) Benth., in DC. Prodr. 10: 377 (1846). Fig. 1 & 2.
Stemodia philippensis Cham., Linnaea 3: 5 (1828) – *Stemodia ruderalis* Blanco, Fl. Filip. ed. 1: 448 (837), *nom. illeg.* (non Retz., Obs. Bot. 5: 25 (1789)).

Erect herb, 40–100 cm tall; stem terete, woody at the base, green to reddish-green, covered with glandular multicellular uniseriate trichomes. *Leaves*: basal ones alternate or opposite, upwards opposite; petiole narrowly winged, 0.7–5.5 cm long; blades ovate, 14.5–17 × 6–8.2 cm, becoming smaller toward the apex of the stem, then ovate to elliptic-ovate, 1.5–3.5 × 0.7–2.5 cm, base attenuate, margin dentate, apex acute to minutely acute to pointedly acute; hairy on both surfaces, abaxial sides with longer hairs than the adaxial. *Inflorescence* erect, compact racemes, some borne from the upper leaf axils, 4–10 cm long. *Bracts* subsessile, ovate to lanceolate, 0.6–1.1 × 0.2–0.6 cm, base obtuse, margin denticulate, apex acute, pubescent. *Pedicels ca*. 1 mm long. *Calyx* campanulate, zygomorphic, 5–6 mm long, 5-lobed down to halfway with narrowly acute at the apex, patently hairy on both sides. *Corolla* connate, bilabiate, abruptly curved toward the apex, upper lip minutely 2-lobed, 1.4–1.5 cm long, slightly curved toward the apex, lower lip 3-lobed, 1.6–1.8 cm long, abruptly curved toward the apex, bright yellow with numerous dark red spots, inside with whitish hairs, outside hairs sparser rather than inside. *Stamens* 4, slightly didynamous, 8–10 mm long, filament shortly bifurcate near the apex. *Ovary* 1–2 mm long, style cylindrical, 8–9 mm long, hairy at the base. *Fruit* capsule, ovoid, 4–5 mm long, locules 2. *Seeds* ellipsoid, 1–2 mm long. (Figs. 1 & 2).

Specimens examined. INDONESIA. Java, West Java, Depok, Universitas Indonesia, RIK building and vicinities (6°22'13"S 106°49'48"E), 22 April 2021, *Al Farishy DEEUI 1* (UIDEP); *ibid*. *Al Farishy DEEUI 2* (UIDEP); *ibid*. *Al Farishy DEEUI 3* (UIDEP); Depok, Universitas Indonesia, fly over near Gerbatama (in front of UI Wood), 1 May 2021, *Al Farishy DEEUI4* (UIDEP).

Distribution. Adapted from Hjertson (1995) native of continental S to SE Asia. In Malesia: Peninsular Malaysia, Java, Borneo, and the Philippines. The distribution of this species in Java is confined to the western part of the island.

Habitat and Ecology (In Java). Lowland, near ditches, roadsides, abandoned places, and yards, around 80–100 m asl.

Phenology (In Java). Based on the known records, the plants develop flowers in April.

Notes. The species was first seen in Universitas Indonesia in 2017, however, it remained unidentified until 2021. During multi-year extensive botanical exploration in Depok and surrounding regions from 2014 to 2021, the authors did not find any individual of the species, cultivated or wild. Prijanto (1969), in his monographic works on the Asian species, did not give any information regarding the cultivation of this species, which is

Fig. 1. *Lindenbergia philippensis* (Cham. & Schltdl.) Benth. in its habitat in West Java, Indonesia. Photo by Dee Dee Al Farishy.

the same in Hjertson (1995). Holmes *et al*. (2023) also did not mention the species nor the synonym from the list of the naturalized plants in Malesia.

This is the only species of *Lindenbergia* in Malesia. Besides Java, further researches of materials showed that other specimens also have been collected in Borneo, *e.g. Alston 13430* [L.2805812] collected in 1954, and *Christensen* 1021 [K000223694] collected in 1993 from Sarawak, both long after the enumeration of the Bornean flora published by Merrill (1921). These specimens represent the Bornean record of the genus that must have been overlooked by Prijanto (1969) or Hjertson (1995) and recent floras (*e.g.* Pelser *et al*., 2011-onwards).

Java Island, especially western part, has plenty report on new records and alien species in a decade. There are several species in one family that has been recorded, like *ca.* 15 species on Asteraceae (Irsyam & Hariri, 2016; Irsyam & Irwanto, 2019; Irsyam *et al*., 2020a; Irsyam *et al*., 2020b; Santosa *et al*., 2020; Al Farishy & Salamah, 2021; Al Anshori *et al*., 2022). Moreover, the record has long list from many other families, like Araceae (Irsyam *et al*., 2023a; Irsyam *et al*., 2023b), Araliaceae (Irysam *et al*., 2022), Moraceae (Peniwidiyanti *et al*., 2021) and Solanaceae (Hariri & Irsyam, 2018). However, in this case, there is no cultivation or seed contamination record of *L. philippensis* from years before and the species has distribution range in same Malesian bioregion and nearby areas. As comparison, report on *Alstonia macrophylla* could be confirmed as naturalized species because the plant cultivation is quite common around Bogor and surrounding locations in West Java (Effendi & Mustaqim, 2021). Therefore, the status of *L. philippenis* remain unresolved until there is obvious evidence that the plants were intentionally or unintentionally brought to Java and Borneo.

This species was mentioned as a source of material to treat cuts and wounds (Quattrocchi, 2012). In Bontoc, Luzon, the Philippines, wild plants are gathered (Bodner & Gereau, 1988). In mainland Asia, the use of this species for medicinal purposes is more diverse. The plants were used for reduce ‘dampness’ in traditional Chinese me-dicine, treat vertebral osteomyelitis (Xia, 2014), treating and lessening pain of burns, uses as anti-inflammatory agents in Thailand (QSBG, 2011), or to treat wound infections (Chusri *et al.*, 2012). None of them mentioned that the material for medicine was collected from cultivated or wild plants.

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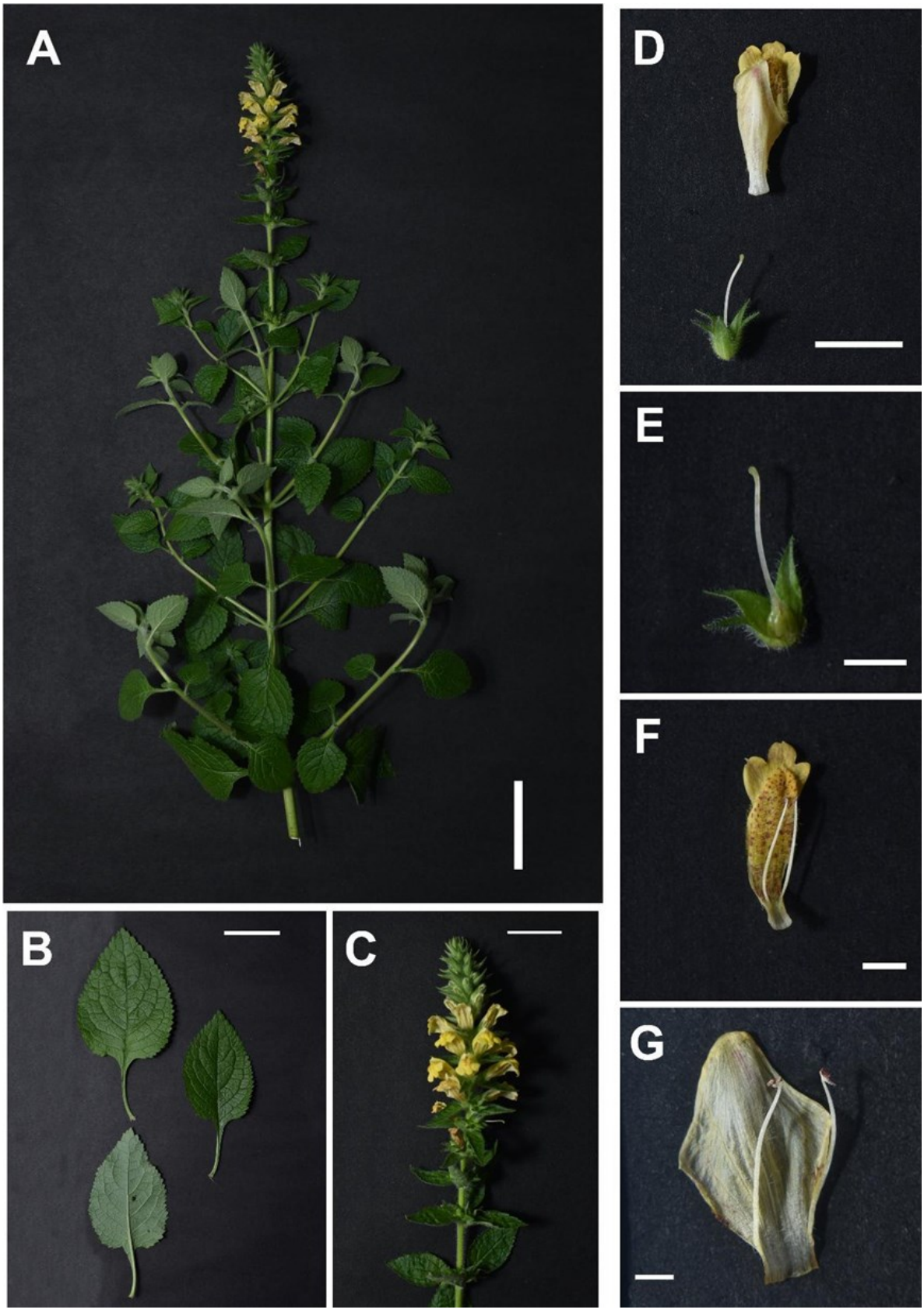

Fig. 2. Morphology of *Lindenbergia philippensis* (Cham. & Schltdl.) Benth. Collection number *DEEUI 1.* A. Individual with flowers. B. Leaves, top & middle adaxial, bottom abaxial. C. Inflorescence. D. Calyx, corolla, and style. E. Calyx and pistil. F–G. stamens attached to corolla. Scales: 5 cm for A & B; 2 cm for C, 1 cm for D, 4 mm for E & F, and 2 mm for G. Photos by Dee Dee Al Farishy.

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