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Millettia sirindhorniana and *M. tomentosa*, two new species of *Millettia* (Fabaceae: Millettieae) for Thailand

SAWAI MATTAPHA[1,*], SOMRAN SUDDEE[2], NAIYANA TETSANA[2],
THEERAWAT THANANTHAISONG[2] & ANUSARA KAEWMUAN[2]

ABSTRACT

Two new species of the genus *Millettia*, *M. sirindhorniana* and *M. tomentosa*, are herein described and illustrated. *Millettia sirindhorniana* shares morphological characteristics with *M. extensa* and *M. fruticosa* in being a woody climber with the same leaflet shape and inflorescence type. However, it differs from those species by the presence of stipels and basal callosities, and its shallowly crenate floral disk. *Millettia tomentosa* is similar to *M. extensa* and *M. suddeei*, but differs from the first species by having a brachyblast bearing ca 10 flowers, the standard with basal callosities, presence of a tubular floral disk and oblong to slightly obovate fruits; and it differs from the latter by the absence of stipels, the standard with swollen basal callosities, monadelphous stamens and the tubular floral disc. Descriptions, illustrations, colour plates, vernacular names, etymology, conservation status and key diagnostic characteristics are provided.

KEYWORDS: Khun Kon Waterfall, Leguminosae, Pala-U, Pha Son Kaeo, Suan Phueng.

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INTRODUCTION

Millettia Wight & Arn., belonging to subfamily Papilionoideae of family Fabaceae, was described by Wight and Arnott in 1834. The genus has long been known as a heterogenous taxon because of much taxonomic confusion with other genera within the tribe Millettieae (Doyle *et al.*, 1997, 2000; Hu, 2000; Kajita *et al.*, 2001; Hu *et al.*, 2000, 2002; Wojciechowski *et al.*, 2004; Schrire, 2005; Mattapha, 2017). To date, the most widely accepted generic concept follows Geesink's circumscription (1984), but it remains loosely defined because of shared similarities with other related genera within the tribe Millettieae in pseudoracemose or pseudopaniculate inflorescences, dehiscent or tardily dehiscent, strap-shaped fruits with or without perpendicular wings along their margins. Particularly, the winged fruit is largely recognised as a significant distinguishing character for segregating *Millettia* from allied genera; perpendicular winged fruits in *Millettia* vs parallel winged fruits in *Aganope* Miq., *Brachypterum* (Wight & Arn.) Benth. and *Derris* Lour.

Mattapha (2020) recently published the taxonomic account of *Millettia* for the Flora of Thailand, recognising 27 species. Prior to this treatment, three new species had been described from Thailand (Mattapha *et al.*, 2019). However, owing to the lack of unique morphological characters, species of *Millettia* are still difficult to distinguish from those in other genera within the tribe Millettieae based purely upon vegetative material.

Two new species are described herein, *Millettia sirindhorniana* Mattapha, Thanant., Kaewmuan & Suddee and *M. tomentosa* Mattapha & Tetsana. We attempted several times to revisit the areas where these species were previously collected in the hope of finding flowers in different seasons. Ultimately, additional flower specimens were obtained to examine for the first species in April 2021 (*Thananthaisong et al. 429*), and for the latter species in June 2019 (*Mattapha s.n.*) and July 2020 (*Tetsana et al. 1731*). After close examination of recent flower collections of each species, comparison with the type specimens of closely related species in herbaria and the previous

[1] Department of Biology, Faculty of Science, Udon Thani Rajabhat University, Udon Thani 41000, Thailand.

[2] Forest Herbarium, Department of National Parks, Wildlife and Plant Conservation, Chatuchak, Bangkok 10900, Thailand.

* Corresponding author: Indigoferasawai@gmail.com

reports of Adema (2000), Lôc & Vidal (2001), Wei & Pedley (2010) and Mattapha (2020), these taxa proved to be undescribed species.

Millettia sirindhorniana was discovered in Thailand's South-Western forests, close to the Thai-Burmese border. Interestingly, the new species was discovered from Kaeng Krachan National Park and from adjacent areas of three provinces including Phetchaburi, Prachuap Khiri Khan and Ratchaburi which are situated along the Tenasserim mountain range. There were several families and different taxa described over the last two decades from this area; of these, only four of the taxa belonged to Fabaceae (Table 1).

Table 1. List of Family and taxa described from the Tenasserim mountain range (1927–2022).

Family	Taxa	References
Apocynaceae	*Kamettia chandeei* D.J.Middleton	Middleton *et al.* (2005)
Balsaminaceae	*Impatiens suksathanii* Ruchis. & Triboun	Ruchisansakun *et al.* (2014)
Begoniaceae	*Begonia kanburiensis* Phutthai	Phutthai (2014)
	B. sirindhroniana Phutthai, Thanant., Srisom & Suddee	Phutthai *et al.* (2021)
Convolvulaceae	*Argyreia suddeeana* Traiperm & Staples	Traiperm & Staples (2014)
	Argyreia variabilis Traiperm & Staples	Staples & Traiperm (2008)
Cucurbitaceae	*Trichosanthes phonsenae* Duyfjes & Pruesapan	Duyfjes & Pruesapan (2004)
Ebenaceae	*Diospyros phengklaii* Duangjai, Sinbumroong & Suddee	Duangjai *et al.* (2018)
Fabaceae	*Derris reticulata* Craib	Craib (1927)
	Afgekia mahidoliae B.L.Burtt & Chermsir.	Burtt & Chermsirivathana (1971)
	Kanburia chlorantha (Mattapha & Sirich.) J.Compton, Mattapha, Sirich. & Schrire	Sirichamorn *et al.* (2016); Compton *et al.* (2019)
	Kanburia tenasserimensis (Mattapha & Sirich.) J.Compton, Mattapha, Sirich. & Schrire	Sirichamorn *et al.* (2016); Compton *et al.* (2019)
Lamiaceae	*Teucrium scabrum* Suddee & A.J.Paton	Suddee & Paton (2008)
Lauraceae	*Cryptocarya kaengkrachanensis* M.Z.Zhang, Yahara & Tagane	Zhang *et al.* (2020)
Orchidaceae	*Dendrobium obchantiae* Promm., Suddee & Kidyoo	Prommanut *et al.* (2018)
	Didymoplexis sirichaii Suddee	Suddee (2014)
	Gastrodia fimbriata Suddee	Suddee (2005)
	Nervilia hemratii S.W.Gale, Tetsana & Suddee	Gale *et al.* (2022)
Rosaceae	*Prunus kaengkrachanensis* Nagam., Tagane & Suddee	Nagamasu *et al.* (2015)
Thelypteridaceae	*Cyclosorus thailandicus* S.Linds.	Lindsay *et al.* (2008)

NEW SPECIES

1. Millettia sirindhorniana Mattapha, Thanant., Kaewmuan & Suddee, **sp. nov.**

This species resembles *Millettia fruticosa* (DC.) Benth. ex Baker in having subterminal inflorescences, but differs in having leaves without stipels (present in *M. fruticosa*), standard petal with basal callosities (vs without basal callosities in *M. fruticosa*), the base of the standard tapering into the claw (vs abruptly constricted into the claw in *M. fruticosa*), pseudo-monadelphous stamens (vs truly monadelphous in *M. fruticosa*), and the presence of floral disk (vs absent in *M. fruticosa*). It is also similar to *M. extensa* (Benth.) Benth. ex Baker but differs in having the terminal leaflet the same size as lateral ones or slightly larger (vs terminal leaflet much larger than lateral ones in *M. extensa*), absence of stipels (vs present in *M. extensa*), each brachyblasts having 3–5 flowers (vs 1–3 flowers in *M. extensa*), purple flowers, rarely white (vs pinkish to creamy white flowers in *M. extensa*) and presence of floral

disk (vs no floral disk in *M. extensa*). Type: Thailand, Ratchaburi Province, Suan Phueng District, the Natural Science Park Project, a Royal Initiative of Her Royal Highness Princess Maha Chakri Sirindhorn, mixed deciduous forest, 23 Apr. 2021, 172 m, 13°30′3″N, 99°15′33″E, *Thananthaisong, Kaewmuan, Kerdkaew, Krachangyut & Somyot 429* (holotype **BKF!**; isotypes **BK!**, **BKF!**). Figs. 1–2.

Large woody climber with straggling branches; young twigs pubescent with ferruginous hairs when young, glabrous when mature. *Leaves* imparipinnate, spiral; petioles 6–10 cm long, pubescent; stipules ovate to ovate-lanceolate, 2.5–3 × 3–5 mm, outside pubescent, inside glabrous, persistent; rachis 5–8 cm long, shallowly grooved above, pubescent, without ultrajugal part. *Leaflets* 7–9, terminal leaflet slightly equal to lateral ones, opposite; petiolules 3–5 mm long, pubescent; lamina oblong to obovate, 5–15 × 2.5–6 cm, apex cuspidate to caudate, base obtuse to rounded, margin entire, chartaceous, upper surface sparsely pubescent along mid-vein, sparsely pubescent along secondary veins, otherwise glabrous, lower surface densely brown pubescent; terminal leaflet equal to lateral ones or slightly larger, obovate; lateral veins 6–10 on each side, raised below; stipels absent. *Inflorescence* pseudoracemose, terminally congested, erect, 10–25 cm long, densely pubescent with ferruginous hairs. *Brachyblasts* wart-like, 0.5–2.5 mm long, bearing 3–5 flowers; floral bracts lanceolate, ca 2.5 × 1 mm, apex acute, margin and outside densely pubescent, inside glabrous; bracteoles linear-lanceolate, smaller than bracts, inserted at base of calyx tube. *Pedicels* 0.5–1.5 mm long, pubescent. *Calyx* cup-shaped, red or reddish-brown; tube 2.5–3 mm long; lobes 5, minutely toothed to subtruncate, margin pubescent, outside pubescent, inside glabrous. *Corolla* purple with dark purple longitudinal lines, rarely white; standard petal orbicular, 10–11 × 10–11 mm, claw ca 2 mm long, apex emarginate, base tapering into a claw, with basal callosities, margin entire, outside with sericeous hairs in upper part, glabrous in lower part, inside glabrous; wings oblong, 11–12 × ca 3 mm, claw ca 3 mm long, base truncate, apex obtuse, margin entire, both sides glabrous; keel falcate-oblong, 10–11 × 3 mm, claw 3.5–4 mm long, apex rounded, base obtuse, margin entire, outside pubescent with sericeous hairs in apical part, inside glabrous, lateral pocket (pouch) ca 3 × 2 mm. *Stamens* pseudo-monadelphous, with basal fenestrae 1–2 mm long; staminal tube 8–9 mm long; filaments 2–2.5 mm long; anthers ca 0.5 × 0.2 mm, with tufted hairs at base. *Disk* free, shallowly crenate. *Ovary* densely pubescent, ca 3 mm long, 1–4-ovuled; style 5–6 mm long, pubescent at base, glabrous towards apex. *Fruits* strap-shaped, laterally compressed, elliptic, oblong or obovate, 5–8 × 1.5–2.5 cm, densely brownish-tomentose, beaked at apex. *Seeds* 1–4, orbicular, 8–10 × 8–10 × 2–2.5 mm, smooth, shiny and dark brown.

Thailand.— SOUTH-WESTERN: Ratchaburi [Suan Phueng District, The Natural Science Park Project, dry evergreen forest along stream, 7 Aug. 2020, fr., 13°31′15.6″N, 99°14′41.2″E, *Thananthaisong et al. 135* (**BK**, **BKF**-2 sheets); ibid., mixed deciduous forest, 23 Apr. 2021, fl., 13°30′3″N, 99°15′33″E, *Thananthaisong et al. 429* (**BK**, **BKF**-3 sheets); ibid., mixed forest with bamboos, growing on hill slope, roadsides near Khao Chone waterfall, in semi-shaded to fully exposed areas to sunlight, 23 Nov. 2021, fr., *Sirichamorn YS2021-16* (**BKF**)]; Phetchaburi [along a road to Pala-U Waterfall, Kaeng Krachan National Park, 12°33′36″N, 99°35′06″E, 26 July 2013, *Meeboonya et al. 200* (**AAU**, **BK**, **BKF**, **E**, **K**, **L**, **US**)]; Prachuap Khiri Khan, Hua Hin District, Nong Plup subdistrict, along Road No. 3218 at a sharp curve, on the way to Sai En check point, 14 July 2019, fr. 12°33′44.2″N 99°38′09.5″ E, *Mattapha s.n.* (**BK**, **BKF**); ibid., Huai Sat Yat subdistrict, at the roadside along Road No. 3218, near the Fa Prathan reservoir, ca 29 km to Pala-U Waterfall, Kaeng Krachan National Park, alt. ca 140 m, 14 July 2019, fr. 12°31′47.7″N 99°32′07.6″E, *Mattapha s.n.* (**BK**, **BKF**)].

Distribution.— Endemic, currently only known from Southwestern Thailand. It is likely to occur in Myanmar.

Ecology.— Dry evergreen forest along streams, in sunny places along roads, open and disturbed areas in mixed deciduous forests; 150–300 m alt. Flowering April–May; fruiting July–August.

Vernacular.— Muang ratcha sirin (ม่วงราชสิริน) (name given by H.R.H. Princess Maha Chakri Sirindhorn).

Etymology.— The specific epithet is chosen to honour Her Royal Highness Princess Maha Chakri Sirindhorn of Thailand for her dedication to science and encouragement of conservation in Thailand.

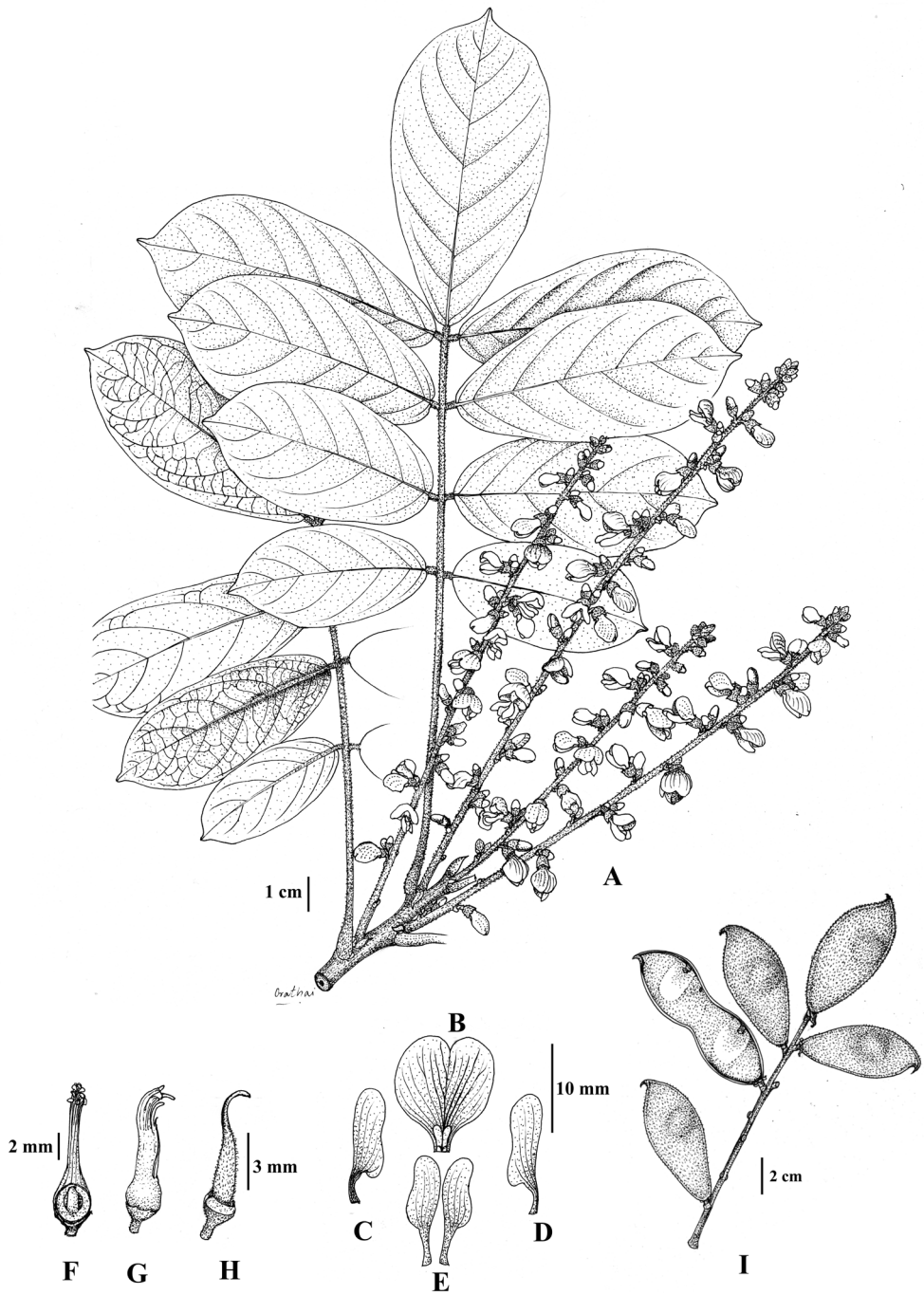

Figure 1. *Millettia sirindhorniana* Mattapha, Thanant., Kaewmuan & Suddee; A. Leaves and inflorescences; B. Standard showing basal callosities on inner surface; C. & D. Wings; E. Keel petals, lateral pockets not shown; F. & G. Stamens showing the basal fenestrae (an opening pore) and side view, respectively; H. Ovary; I. Fruits. A.–H. drawn from *Thananthaisong et al. 429*; I. drawn from *Thananthaisong et al. 135*. Illustrations by Orathai Kerdkaew.

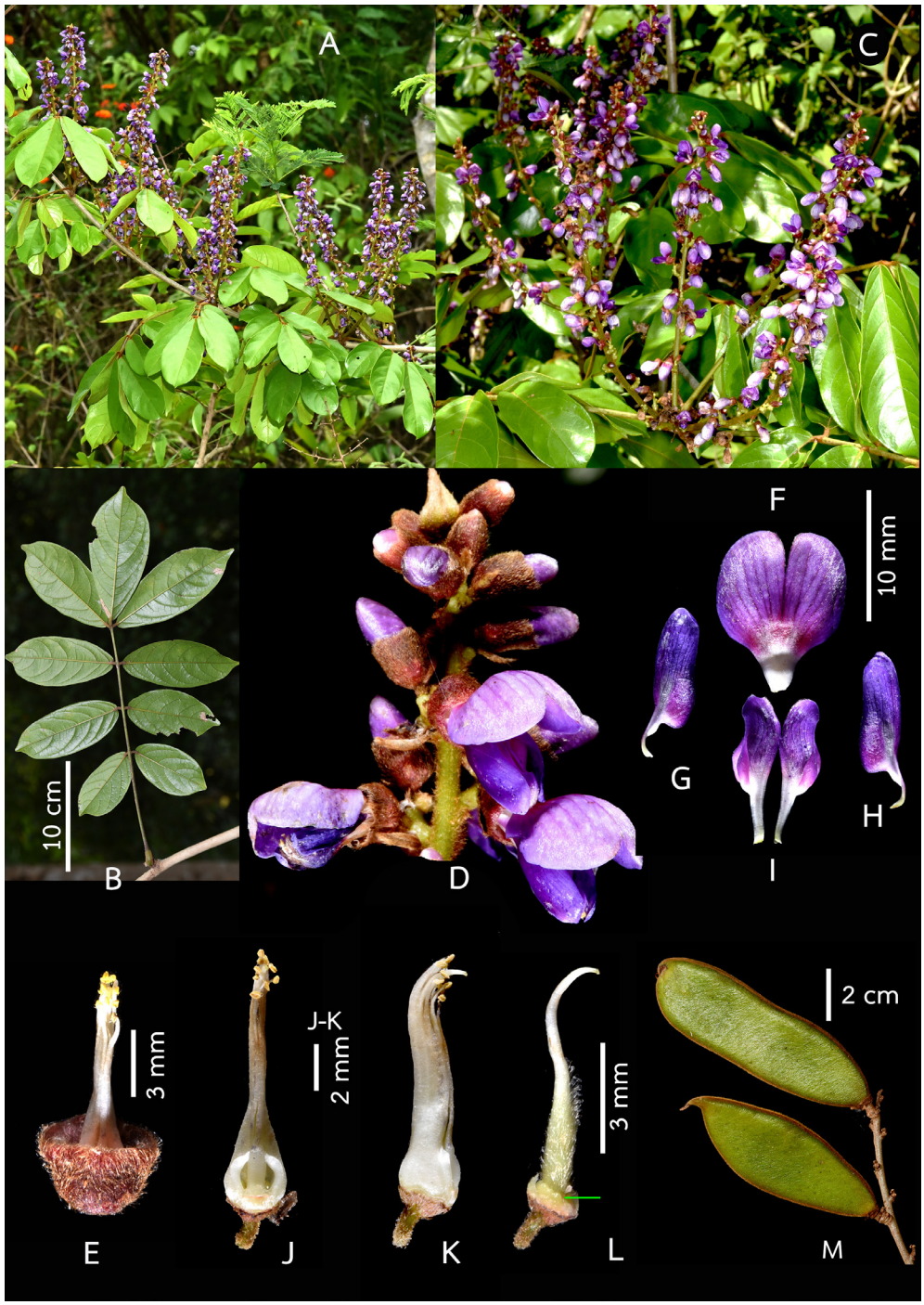

Figure 2. *Millettia sirindhorniana* Mattapha, Thanant., Kaewmuan & Suddee; A. Leaves and inflorescences; B. Leaf; C. Inflorescences; D. Close up of inflorescence; E. Calyx with stamens inside; F. Standard; G. & H. Wing petals; I. Keel petals showing lateral pockets in inner side; J. Stamens showing basal fenestrae; K. Side view of stamens; L. Ovary with 10 shallowly crenate lobes (green line); M. Fruits. All photos by Theerawat Thananthaisong.

Conservation status.— Least Concern (LC). The taxon is only known from five locations with six collections. Of these, four of the currently known locations, all with a few individuals of mature plants from preliminarily observations, are situated in protected areas. One location where the first author collected this species near the Fa Prathan Reservoir, along roadsides, is outside of the protected area, and the population consisted of a few plants nearby villages and resorts, and it can be inferred that the population is likely to suffer a decline in the number of individual plants in the near future due to deforestation for agriculture and road construction. Based on GeoCat (Bachman *et al.*, 2011), the species has an Extent of Occurrence (EOO) of 652.77 km^2 and an Area of Occupancy (AOO) of 20.00 km^2. According to this calculation, the species could meet the Endangered criterion, however populations of the species were mostly found in protected areas. Therefore, we assess it the conservation status as Least Concern, following the IUCN criteria (IUCN, 2019).

Notes.— 1. The fruiting specimens were initially identified as *Millettia extensa* because of the liana habit with oblong to obovate leaflets. However, when additional specimens with flowers were later collected, they showed several clear-cut morphological differences from *M. extensa*, as outlined in the diagnosis above.

2. No fully developed seeds were observed when the fruits were examined. Therefore, the seed description was written based on immature seeds. Additional information of the seed morphology will be provided after a future study.

2. Millettia tomentosa Mattapha & Tetsana **sp. nov.**

This species is most similar to *Millettia suddeei* Mattapha & Tetsana, being a liana with up to 9 leaflets, the terminal leaflet being mostly obovate and in having pseudoracemes but it differs in the absence of stipels (present in *M. suddeei*), the standard with swollen basal callosities (absent in *M. suddeei*), monadelphous stamens and presence of the tubular floral disk. It is also similar to *M. extensa* in having a brown tomentose indumentum on young branches, the colour and length of standard, monadelphous stamens and a tomentose ovary, but differs in having 5–9 leaflets (vs 7–11 leaflets in *M. extensa*), absence of stipels (vs present in *M. extensa*), having 4–5 pairs of secondary veins (vs 8–12 pairs in *M. extensa*), each brachyblast bearing ca 10 flowers (vs 1–3 flowers in *M. extensa*), the standard with basal callosities on the inner side in the middle of the claw and presence of the tubular floral disk. Type: Thailand; Phetchabun Province, Pha Son Kaeo temple, ca 800 m, 16°47′19.7″N 101° 02′55.2″E, 10 June 2019, *Mattapha s.n.* (holotype **BKF!**; isotypes **BK!**, **BKF!**, **KKU!**, **QBG!**)]. Figs. 3–4.

Woody climber or scandent shrub; young twigs densely brown tomentose. *Leaves* imparipinnate, spiral; petioles 4–10 cm long, densely tomentose; rachis 5–10 cm long, pubescent, shallowly grooved above; ultrajugal part 8–11 mm long; stipules triangular, ca 2 ×1.5 mm, densely tomentose, persistent. *Leaflets* 5–9, opposite; petiolules 4–5 mm long, pubescent; lamina elliptic to ovate or obovate, terminal leaflet mostly obovate, slightly larger than lateral ones, (5–)8–15 ×3–6 cm, apex acute to acuminate, base cuneate, margin slightly undulate, chartaceous, upper surface glabrous, lower surface sparsely pubescent along veins, otherwise glabrous; secondary veins 4–5-paired; stipels absent. *Inflorescence* pseudoracemose, terminal and axillary, (8–)14–22 cm long, densely ferruginous. *Flowers* white to light pink. *Brachyblasts* wart-like, bearing ca 10 flowers; floral bracts ovate, ca 1 × 0.5 mm, outside densely tomentose, inside glabrous, caducous; bracteoles ovate, similar to floral bracts, inserted on base of calyx. *Pedicels* 2–2.5 mm long, densely tomentose. *Calyx* cup-shaped; tube 2.5–3 mm long; lobes minute, densely pubescent. *Corolla* white to light pink: standard suborbicular, 10–11 × 12–13 cm, wider than long, apex retuse, base not-auriculate, with swollen basal callosities at the middle of the claw, margin entire, outside densely golden sericeous, inside glabrous, claw ca 2 mm long; wings falcate, 7–8 × 3.5–4 mm, base truncate, apex acute, margin entire, both sides glabrous, claw ca 3 mm long; keel falcate to oblong, 6–6.5 × 3–4 mm, apex rounded, margin entire, outside densely tomentose, inside glabrous, claw 3–3.5 mm long; lateral pocket (pouch) ca 2 × 1.5 mm. *Stamens* monadelphous with basal fenestrae 1–2 mm long; staminal tube 6–7 mm long, glabrous; filaments 2–2.5 mm long; anthers ca 0.8 × 0.4 mm, tomentose at base. *Disk* tubular, ca 1 mm long. *Ovary* densely tomentose, 3–4-ovuled; style ca 5 mm long, tomentose at base. *Fruits*

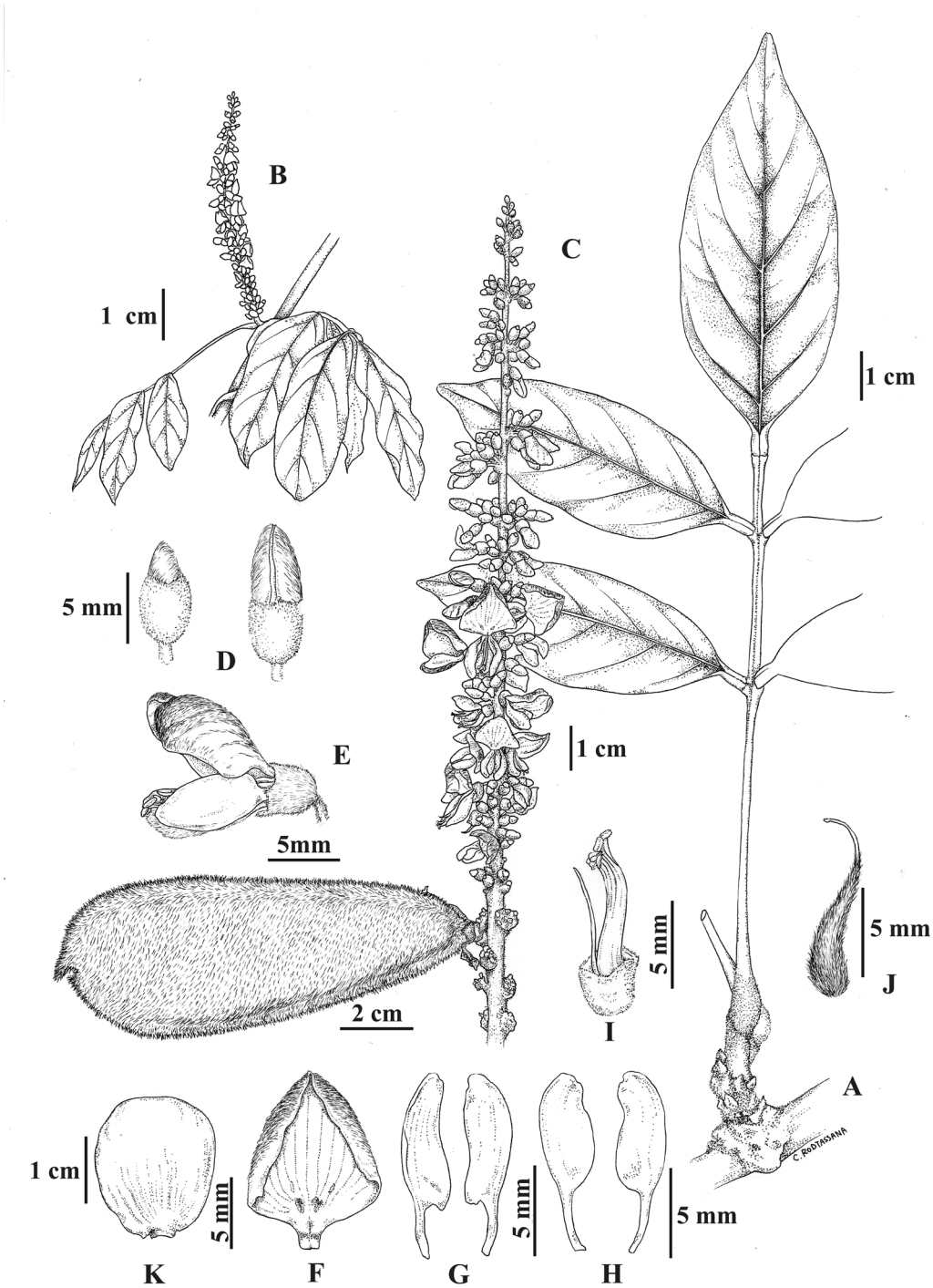

Figure 3. *Millettia tomentosa* Mattapha & Tetsana. A. Leaf; B. Leaves and inflorescences; C. Inflorescences and fruit; D. Young floral buds; E. Mature flower (side view); F. Standard; G. Wing petals; H. Keel petals; I. Calyx with stamens inside; J. Ovary; K. Seed. Drawn from *Mattapha s.n.* Illustrations by Chadtip Rodtassana.

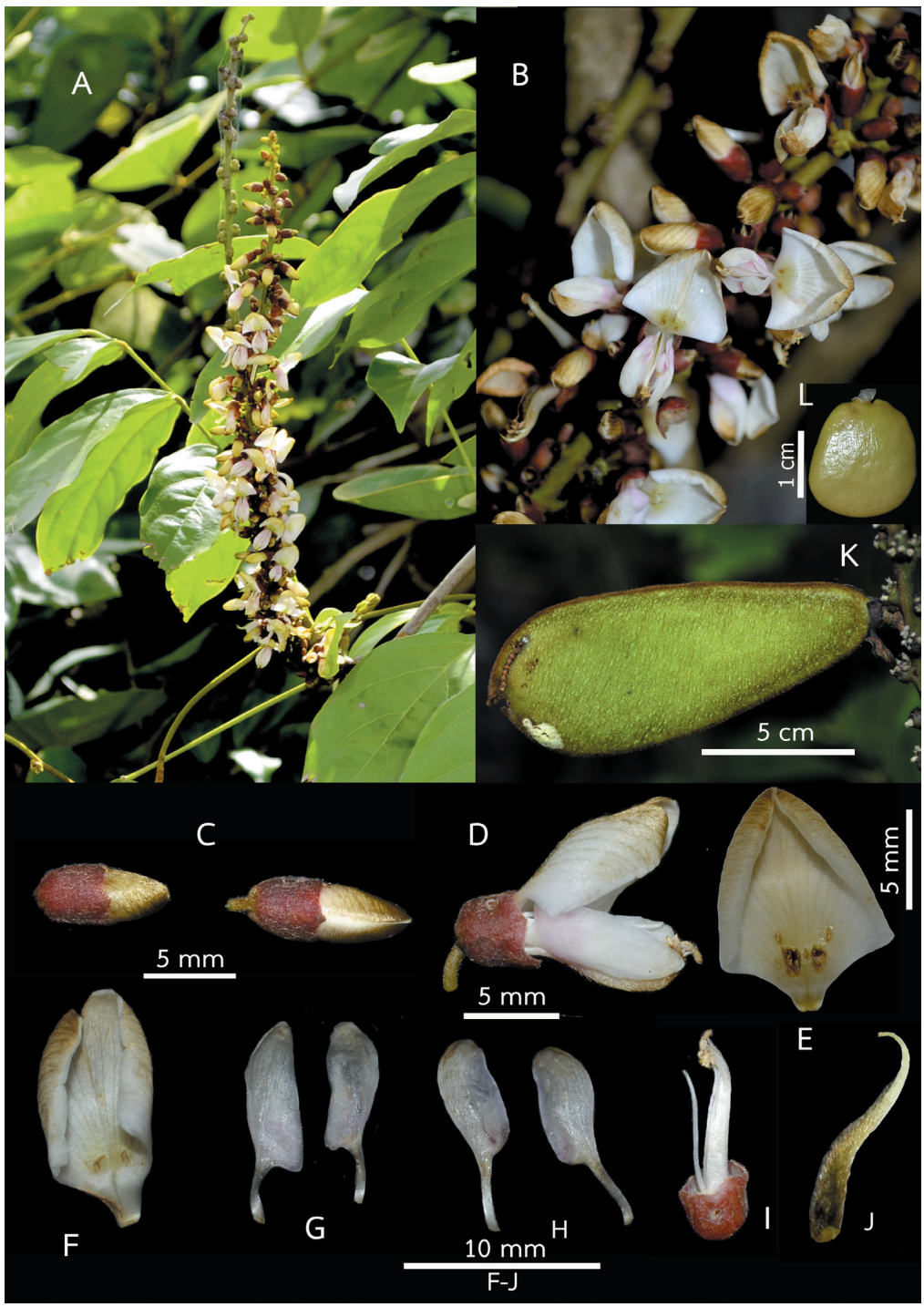

Figure 4. *Millettia tomentosa* Mattapha & Tetsana; A. Leaves and inflorescences; B. Part of inflorescence with close up of flowers; C. Young floral buds; D. Mature flower; E. & F. Standard petals; G. Wing petals; H. Keel petals showing abaxial surface; I. Calyx with stamens inside; J. Ovary; K. Fruit; L. Seed. All photos by Sawai Mattapha.

strap-shaped, oblong to slightly obovate, more or less flattened, 8–11 × 2–2.5 cm, densely tomentose with dense ferruginous hairs. *Seeds* 1–4, orbicular, 18–20 × 15–16 × ca 5 mm.

Thailand.— NORTHERN: Chiang Rai [Khun Kon Waterfall, 14 Jan. 2014, *Mattapha 2013/G* (**BKF**); Tham Luang-Khun Nam Nang Non National Park, 1 July 2020, *Tetsana et al. 1731* (**BKF**)]; NORTH-EASTERN: Phetchabun [Pha Son Kaeo temple, 10 June 2019, *Mattapha s.n.* (**BK**, **BKF**, **KKU**, **QBG**)].

Distribution.— Endemic to Thailand.

Ecology.— Evergreen forest, mostly found along streams, ca 800 m alt. Flowering April–May; fruiting June–July.

Vernacular.— Son kaeo (ซ่อนแก้ว) (proposed here).

Etymology.— The specific epithet refers to the densely tomentose ovary and fruits.

Conservation status.— Least Concern (LC). This new species is known from three locations, distributed from the northern to north-eastern parts of Thailand. Two collections were found inside of protected areas, while another collection was known from the type locality close to a village and temple, and subject to cutting for house and road construction in the near future. By following GeoCat (Bachman *et al.*, 2011), the species has an Extent of Occurrence (EOO) of 8,592.027 km^2 and an Area of Occupancy (AOO) of 12.000 km^2, using a 2 km cell size. The species could meet the Endangered criterion, however individual mature plants and also seedlings of this species were found to be abundant in the protected areas. Therefore, we include the species in the Least Concern category.

Notes.— 1. A fruiting specimen, *Mattapha 2013/G* (**BKF**), collected during the botanical expedition to Khun Kon Waterfall in 2014, was initially considered as *Millettia caerulea* Baker because of its fruits with dense ferruginous hairs. But after receiving more flowering and fruiting material we observed that *Mattapha 2013/G* is not *M. caerulea* but a new species characterised by the following characters: the standard with swollen basal callosities (vs absent in *M. caerulea*), the keel petals densely tomentose on the outer surface (vs glabrous in *M. caerulea*), the presence of floral disk (vs absent in *M. caerulea*) and fruits with dense ferruginous hairs (vs dense sericeous hairs in *M. caerulea*).

2. Two collections, *Put 193* (**BK**-SN210699) from Baw Re [Bo Rae], Kanchanaburi and *Maxwell 94-655* (**CMUB**-04745) from Pha Toop [Pha Tup] waterfall, Doi Khun Tan National Park, Lampang are close in leaf morphology to the new species, but both are in relatively poor condition and could not be definitively identified; additional material is needed to confirm the identity of these populations.

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