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Taxonomic reassessment of *Rehderodendron gongshanense* (Styracaceae) based on herbarium specimens and field observations

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Abstract

Since its publication in 1988, *Rehderodendron gongshanense* (Styracaceae) has been considered endemic to Gongshan County, Yunnan Province, China and northern Myanmar. Based on morphological data from detailed field observations and examination of herbarium specimens, we demonstrate that *R. gongshanense* is actually a synonym of *R. microcarpum*, a species until now neglected taxonomically. We provide an updated description of *R. microcarpum* that accommodates the variation in the newly expanded concept of the species, along with comments on distribution and ecology, conservation status, specimens cited, and images of the living plants.

Keywords: *Rehderodendron microcarpum*, synonymy, taxonomy

Introduction

Rehderodendron gongshanense Y.C.Tang (1988: 350) (Styracaceae) was described on the basis of a single fruiting collection, *Exped. Qinghai-Xizang 9227* (Fig. 1A) from Qinlangdang, Gongshan County, Yunnan Province, China. Until recently, *R. gongshanense* was known only from this type material. It was recorded as an endemic species in various floristic works such as the *Flora of Dulongjiang Region* (Li 1993), *Flora of China* (Hwang & Grimes 1996), *Flora of Gaoligong Mountain* (Li *et al.* 2000), and *Species Catalogue of China* (Yu *et al.* 2016). However, Ding *et al.* (2019) confirmed the presence of the species in Putao District, Kachin State, in northern Myanmar.

When Tang (1988) described *Rehderodendron gongshanense*, he compared it to *R. kweichowense* Hu (1932a: 109), a species distributed in southern China and northern Vietnam (Hwang & Grimes 1996). He apparently was not aware of the species *R. microcarpum* K.M.Feng ex T.L.Ming (1983: 410; see Bartholomew & Zhou 2007) described in *Flora Yunnanica Vol. 3*, which was collected near the type locality of *R. gongshanense*. *Rehderodendron microcarpum* was described on the fruiting specimen *P.Y. Mao 451* (Fig. 1B) collected from Dudu Village, Dulongjiang, Gongshan County (Ming 1983). Because the *Flora of China* treatment did not include the name *R. microcarpum*, this species has been neglected in taxonomic studies, being treated in only a few such studies (Li *et al.* 2000, Fritsch & Garrison 2010, Fritsch *et al.* 2016, Zhao *et al.* 2019). Based on the type material and one additional collection (*Gaoligong Shan Biodiversity Survey 32557*), Fritsch & Garrison (2010) considered *R. microcarpum* to differ from *R. gongshanense* by its subrounded to rounded leaf blade base (versus cuneate to subrounded), glandular-serrulate leaf blade margin (vs. entire), and a fruit that is 2.0–2.5 cm wide and 9- or 10-ribbed (vs. 1.7–2.0 cm wide and 5-ribbed).

The taxonomic knowledge of *Rehderodendron* Hu (1932b: 77) is still deficient and a taxonomic revision of the genus based on a detailed phylogenetic, herbarium, and field studies is needed (Zhao *et al.* 2019). Most of the species of the genus are based on single fruiting specimens, resulting in poorly understood and ill-defined species boundaries. To address this problem, we have been conducting systematic studies on *Rehderodendron* since 2017. In 2018, we examined the type specimens of *Rehderodendron* deposited in KUN and found that *R. gongshanense* does not distinctly

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differ from *R. microcarpum*, the only apparent differences being more sparsely distributed stellate trichomes on the leaf surfaces and a larger fruit size (5–7 × 2–2.5 cm vs. 4.8–5 × 1.6–1.8 cm) with more ribs (9 or 10 vs. 5; Fig. 1). In addition, the type material of *R. gongshanense* is a vegetative branchlet with fallen fruit. We suspected that the wider leaf blades of *R. gongshanense* versus *R. microcarpum* result from vegetative branchlets tending to be more robust than fertile branchlets in the genus.

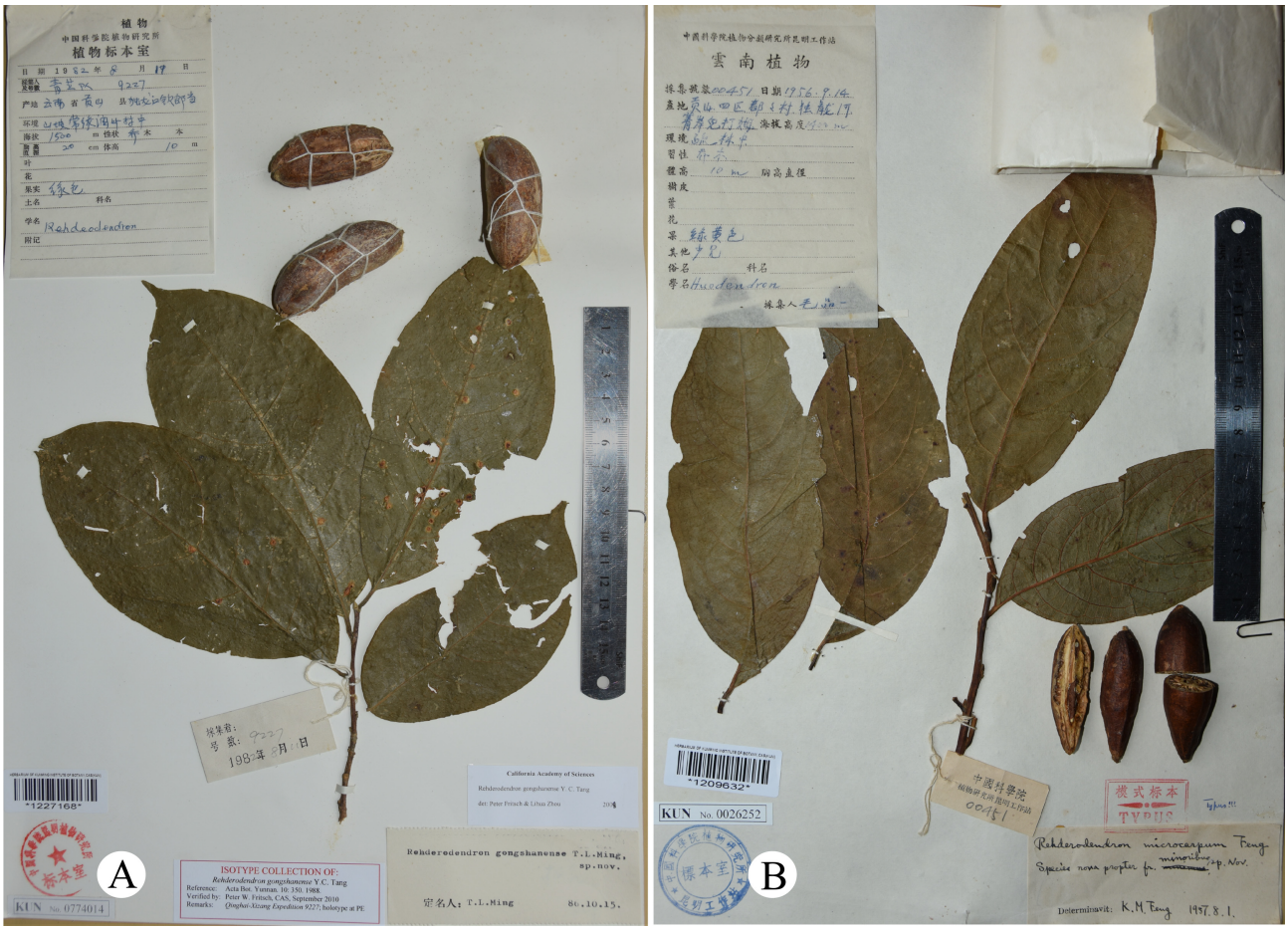

FIGURE 1. Specimens of *Rehderodendron microcarpum* K.M.Feng ex T.L.Ming and *Rehderodendron gongshanense* Y.C.Tang. **A.** Isotype of *R. gongshanense*, KUN0774014!. **B.** Holotype of *R. microcarpum*, KUN0026252!.

During three visits to the type locality of *Rehderodendron microcarpum* at Qinlangdang Village between 2018 and 2019 for field observation and specimen collection, we observed continuous morphological variation of fruit size and fruit ribbing (Fig. 2D) that spans the range of variation between this species and that of *R. gongshanense*. Specifically, most of the individual fruit characters were found to be consistent with those of *R. microcarpum*, whereas the surfaces of the leaves were found to be densely covered with stellate trichomes, as in *R. gongshanense* (Fig. 2E–F). Further, a good photograph of a fruiting branchlet of *R. gongshanense* is presented in Ding *et al.* (2019), in which the number of fruit ribs is consistent with that of *R. gongshanense* (8 to 10; Fig. 2A–B), but has nearly glabrous abaxial leaf surfaces, as in *R. microcarpum*. Based on our examination of herbarium specimens and observations in the field, we find no distinct morphological differences between *R. gongshanense* and *R. microcarpum*. On this basis, we relegate *R. gongshanense* to synonymy under *R. microcarpum*.

Moreover, both *Rehderodendron microcarpum* and *R. gongshanense* were described from fruiting specimens, and their floral characters were thought to be undocumented. In reality, however, F. Kingdon-Ward had collected a flowering specimen (E00663952!) in northern Myanmar in 1953. On this specimen, he made the note “stamens pubescent, style pilose”, and the specimen clearly has a panicle, a cup-shaped 5-ribbed hypanthium, and deltoid calyx teeth. After carefully comparing this specimen to the flowering specimens that we collected at Qinlangdang in 2019, we are confident that these specimens all belong to the same species. A description of *R. microcarpum* that incorporates the variation of *R. gongshanense* is provided below.

Taxonomic treatment

Rehderodendron microcarpum K.M.Feng ex T.L.Ming (1983: 410). Type:—CHINA. Yunnan: Gongshan County, Dulong River, Dudu Village, open forest, ca. 1400 m, 14 September 1956, *P.Y. Mao 451* (holotype KUN0026252!, isotypes KUN1293804!, KUN0026253!, KUN0026251!). Figs. 1–3.

= *Rehderodendron gongshanense* Y.C.Tang (1988: 350), *syn. nov.* Type:—CHINA. Yunnan: Gongshan County, Dulongjiang, Qinlangdang Village, in evergreen broad-leaved forest, ca. 1500 m, 11 August 1982, *Exped. Qinghai-Xizang 9227* (holotype PE00027882!, isotypes KUN0774015!, KUN0774014!, PE00027880!, PE00028881!).

Trees, deciduous, 6–12 m tall, trunk to 20 cm d.b.h., bark beige with closely spaced longitudinal shallow furrows; old branchlets brown, sparsely stellate-tomentose, annual branchlets green, densely golden brown-stellate-tomentose; vegetative buds with 2 caducous coriaceous densely golden brown-stellate-tomentose outer scales. *Leaves:* petiole 6–18 mm, concave adaxially, stellate-tomentose; blade elliptic to oblong, 10–23 × 4.2–10.5 cm, densely pubescent both sides when young, sparsely on mature leaf, abaxially sparsely stellate-tomentose, more densely so along veins, adaxially nearly glabrous except sparsely stellate-tomentose along veins, leaf base broadly cuneate to subrounded, margin minutely serrulate, apex acute to shortly acuminate, secondary veins 7 to 13 pairs, tertiary veins reticulate and conspicuous, venation raised on both sides. *Inflorescences:* paniculate, 1(or 2) per branchlet, axillary, 5–7 cm long, 5- to 15- (to 20-)flowered, peduncles ca. 1 mm or nearly absent, rachis stellate-tomentose; perules caducous, ovate, ca. 7 × 4 mm, abaxially stellate-tomentose, adaxially puberulent; articulation present at junction of pedicel and flower; pedicel 3–12 mm long, stellate-tomentose, bracteoles 2.0–3.5 mm long, linear, borne on proximal 1/2 of pedicel. *Flowers* opening before expansion of leaves (*F. Kingdon-Ward 22086*, *W.Y. Zhao & F. Ye ZWY-1389*), at same time as leaves (*W.Y. Zhao & F. Ye ZWY-1380*), or after anthesis, leaves still visible (*W.Y. Zhao & F. Ye ZWY-1392*), ovoid to globose in bud, 6–10 mm long, fragrant; hypanthium cup-shaped, stellate-tomentose, 3.2–4.0 × 2.0–2.7 mm, irregularly longitudinally ca. 5-ribbed; calyx lobes 5, deltoid, 0.3–1.5 mm long, apex acute; corolla white, campanulate, 10–17 mm long, densely pubescent abaxially, sparsely so adaxially, tube ca. 0.5 mm, glabrous, lobes 5, obovate, 9–16 × 5.5–7.0 mm, with conspicuous veins 3 to 5 per side, apex obtuse; stamens 10, shorter than corolla or subequal; tube glabrous, portion adnate to corolla ca. 1 mm; filaments white, planar, unequal, in alternating lengths with longer five 1.0–1.6 cm and the others about 1.5–2 mm shorter, abaxially glabrous, adaxially puberulent, bases connate about 4–8 mm; anthers oblong or narrowly deltoid, 1.8–2.7 × 0.9–1.2 mm, connectives yellow; style filiform, 9–15 mm, densely pubescent at base, becoming glabrous distally. *Fruit* ovoid-cylindrical to cylindrical or usually fusiform, 4.8–7.5 × 2.0–2.9 cm, shallowly 5- to 10-ribbed, sparsely stellate, rest of fruit nearly glabrous; persistent style conical-coracoid, 2–6 mm, sparsely stellate-pubescent; exocarp ca. 1 mm thick, mesocarp 7–10 mm thick, endocarp indurate, forming irregularly radiating rays through mesocarp extending to exocarp, lacunae in exocarp filled with spongy parenchyma; locules 2 or 3 (or 4), usually only one locule developing seeds, seldom 2. *Seeds* cylindrical-fusiform, brownish black, 3.5–4.2 × ca. 4 mm.

Distribution, ecology, and phenology:—*Rehderodendron microcarpum* has been documented as distributed in Gongshan, northwestern Yunnan Province in Southwest China, and Kachin State in northern Myanmar. It grows as a deciduous tree in montane monsoon forests at 500–2500 m a.s.l. It is known to flower in March and April, and fruit in June through October.

Conservation status:—From specimen records and our field survey, seven populations of *Rehderodendron microcarpum* are known to us. The species is distributed from Putao District in Kachin State of northern Myanmar to Gongshan County of northwestern Yunnan Province in China. In China this species has only been recorded in Dulongjiang Township, Gongshan County, Yunnan Province, where it grows along rivers, hillsides or near villages. All known populations are located near villages or along roads. In accordance with the IUCN Red List criteria (IUCN Standards and Petitions Subcommittee 2019), we propose a conservation status for *R. microcarpum* as VU (Vulnerable, A1c) because of the potential impact of human activities. Nonetheless, *R. microcarpum* may not be as rare as it appears from the still few numbers of collections made. The species is widely distributed in Kachin State and F. Kingdon-Ward indicated on the sheet of one collection (*F. Kingdon-Ward 22086*) "…fairly common on the mountains round Arahku…". On this basis, surveys for more populations of this species are warranted.

Additional specimens examined:—CHINA. **Yunnan. Gongshan County. Dulongjiang Township:** ca. 0.3 direct km S of Qinlangdang Village to Maku Village, 1270 m, 19 August 2006 [fruit], *Gaoligong Shan Biodiversity Survey 32557* (CAS!); Qinlangdang Village, 27°41′02.8″N, 98°16′57.7″E, 1317 m, 4 September 2018, *W.Y. Zhao &*

F. Ye ZWY-872 (BRIT!, SYS!); on the way from Qinlangdang Village to Maku, 27°41′03.9″N, 98°17′05.9″E, 1508 m, 4 September 2018 [fruit], *W.Y. Zhao & F. Ye ZWY-873* (BRIT!, SYS!); Qinlangdang Village, road side, 27°41′04.5″N, 98°16′37.7″E, 1316 m, 4 September 2018, *W.Y. Zhao & F. Ye ZWY-874* (BRIT!, SYS!); ibid. [fruit], *W.Y. Zhao & F. Ye ZWY-875* (SYS!); ibid. [fruit], *W.Y. Zhao & F. Ye ZWY-876* (BRIT!, IBSC!, SYS!); on the way from Qinlangdang Village to China-Myanmar boundary marker 41, 27°41′N, 98°16′E, 1250–1350 m, 13 April 2019 [flower], *W.Y. Zhao & F. Ye ZWY-1380* (BRIT!, SYS!); ibid. [flower], *W.Y. Zhao & F. Ye ZWY-1389* (BRIT!, SYS!); ibid. [flower], *W.Y. Zhao & F. Ye ZWY-1391* (BRIT!, SYS!); ibid. [flower], *W.Y. Zhao & F. Ye ZWY-1392* (same tree as *W.Y. Zhao & F. Ye ZWY-876*) (BRIT!, IBSC!, SYS!).

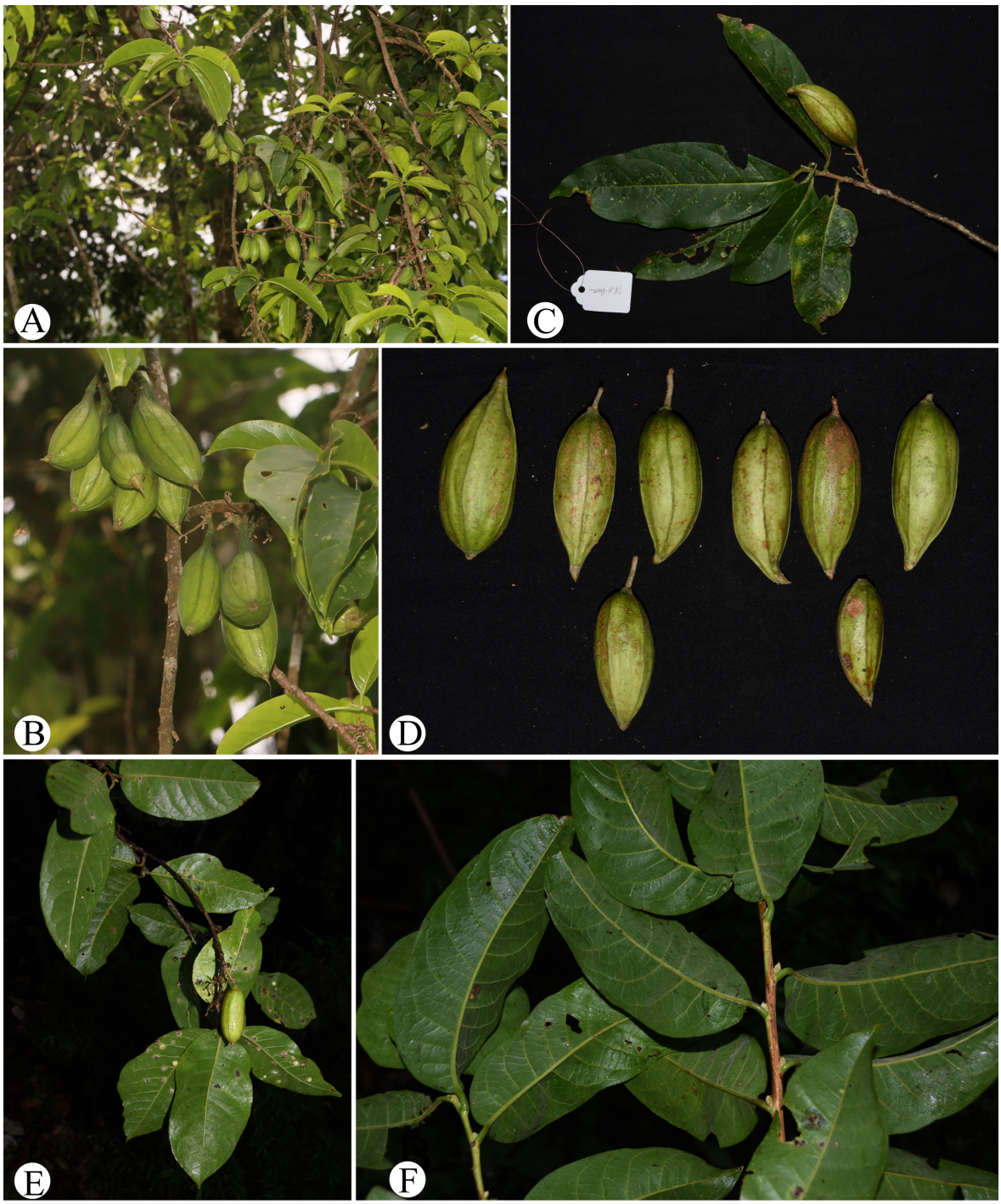

FIGURE 2. Variation in fruit morphology of *Rehderodendron microcarpum*. **A.** Fruiting branchlets, Kachin population. **B.** Fruit, Kachin population. **C.** Fruiting branchlet, Gongshan population. **D.** Fruit, Gongshan population. **E.** Fruiting branchlet, Gongshan population. **F.** Vegetative branchlets, Gongshan population. Photographs A–B taken by Yun-Hong Tan in Putao District, Kachin State, Myanmar; C–D taken by Wan-Yi Zhao in Gongshan County, Yunnan Province, China, voucher *W.Y. Zhao & F. Ye ZWY-876*; E–F taken by Wan-Yi Zhao in Gongshan, China, voucher *W.Y. Zhao & F. Ye ZWY-873*.

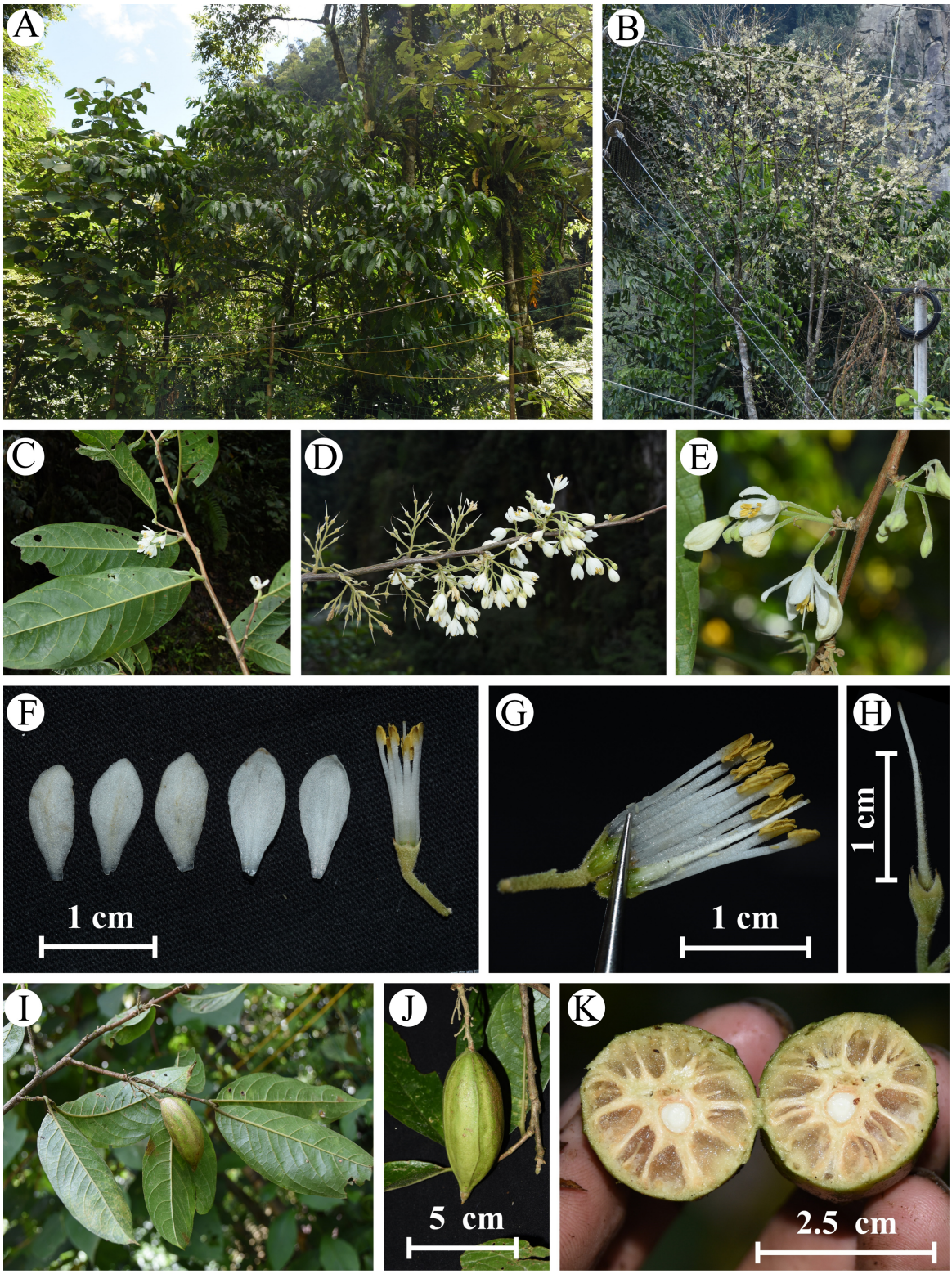

FIGURE 3. Images of living *Rehderodendron microcarpum*. **A.** Fruiting plant. **B.** Flowering plant. **C.** Flowering branchlet with old leaves. **D.** Flowers opening before leaves expand, panicle densely stellate-tomentose. **E.** Flower buds and flowers showing petals connate near base, and stamens shorter than the corolla. **F.** Dissected flower, showing filaments connate, abaxially glabrous, and petals obovate with inconspicuous veins. **G.** Flower with corolla removed to show filaments planar, unequal, adaxially puberulent, connectives greenish, and anther sacs yellow. **H.** Gynoecium and calyx showing style filiform, base densely pubescent, and calyx lobes deltoid. **I.** Fruiting branchlet. **J.** Fruit showing style persistent and conical-coracoid. **K.** Fruit cut transversely near middle showing endocarp tissue with radiating rays. A, C, E, I–K, voucher *W.Y. Zhao & F. Ye ZWY-876*; B, D, F–H, voucher *W.Y. Zhao & F. Ye ZWY-1389*. Photographs taken by Wan-Yi Zhao in Gongshan, China.

MYANMAR. **Kachin. Putao District:** Hponganrazi Wildlife Sanctuary, between Ye Khe Sap camp and Upper Thit Pin Cyi camp, 27°31′35.0″N, 96°58′6.8″E, 2454 m, 24 October 2016, *K. Armstrong et al. 2060* (NY02653551 digital image!); NaungMung Township, buffer zone of Hkakaborazi National Park, Pi Kot hill between NaungMung Village and Gumlin Village, 27°28′50.5″N, 97°50′37.7″E, 529 m, 15 June 2017 [immature fruit], *K. Armstrong et al. 2902* (NY02653967 digital image!, NY02654008 digital image!); Hkinlum, 1220 m, 28 April 1953 [immature leaf], *F. Kingdon-Ward 20738* (E00663951 digital image!); Arahku, 1525 m, 30 March 1953 [flower], *F. Kingdon-Ward 22086* (E00663952 digital image!); NaungMaung Township, 27°30′16.76″N, 97°47′21.66″E, 670 m, 21 December 2016, *Myanmar Exped. M1122* (HITBC); on the way from NaungMung to Maza, 27°31′37.33″N, 97°45′46.49″E, 590 m, 13 May 2017, *Myanmar Exped. M1694* (HITBC); on the way from Gathu to Langsa, 27°31′36.52″N, 97°56′34.91″E, 573 m, 31 May 2018, *Myanmar Exped. M3827* (HITBC, RAF); near Langsa, 27°31′37.98″N, 97°56′35.84″E, 571 m, 2 June 2018, *Myanmar Exped. M3938* (HITBC, RAF); NaungMaung Township, Khasanku Village, 27°33′16.30″N, 97°46′48.40″E, 615 m, 12 June 2018, *Myanmar Exped. M4405* (HITBC, RAF); ibid., *Myanmar Exped. M4432* (HITBC, RAF).

Notes:—Some morphological characters of *Rehderodendron microcarpum* exhibit a high level of variation. The number of ribs varies from 5 to 12, and pubescence on the abaxial surface of the leaf blade varies from moderately dense to nearly glabrous. Floral characters, however, are relatively stable (panicles densely stellate-tomentose, style densely pubescent). The flowers of *R. microcarpum* are very similar to those of *R. truongsonense* P.W.Fritsch, W.B.Liao & W.Y.Zhao in Zhao *et al.* (2019: 159). These two species share such features as a pubescent style and filaments that are connate to the middle or distally beyond. However, *R. microcarpum* differs from *R. truongsonense* in its deciduous habit (versus evergreen), and longer inflorescence and pedicels. All other species of *Rehderodendron* have a glabrous style and filaments that are connate merely to just beyond the base. Therefore, *R. microcarpum* is easily distinguished from other species of *Rehderodendron* by the combination of its deciduous habit, a densely pubescent style, and filaments that are connate to the middle or distally beyond.

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