THAI FOREST BULL., BOT. 47(1): 82–90. 2019.
DOI https://doi.org/10.20531/tfb.2019.47.1.12

Flora of Nam Kading National Protected Area V: Two new species of *Camellia* (Theaceae), *C. namkadingensis* and *C. rosacea*

PHETLASY SOULADETH[1,*], SHUICHIRO TAGANE[2] & TETSUKAZU YAHARA[3]

ABSTRACT

Two new species of *Camellia* (Theaceae), *C. namkadingensis* and *C. rosacea*, from Nam Kading National Protected Area, Central Laos, are described. Illustrations, DNA barcodes for *rbcL* and *matK* and IUCN conservation status assessments also provided.

KEYWORDS: Ericales, flora, Indochina, new species, taxonomy.

Accepted for publication: 7 May 2019. Published online: 6 June 2019

INTRODUCTION

Camellia L. is the largest genus in the family Theaceae, distributed in eastern and southeastern Asia, ranging from northeastern India in the west to Japan and the Philippines in the east and to Indonesia in the south. The genus is characterized by an evergreen habit, imbricate bracteoles and sepals, basally connate petals, numerous stamens in 2–6 whorls, usually large and apically dehiscent capsules, and wingless (semi-)globose or polygonal seeds (Ming & Bartholomew, 2007; Orel & Wilson, 2010).

Our knowledge on the genus *Camellia* in Indochina is insufficient. Only 24 species were recognized in *Camellia* during the 1920s (Melchior 1925), but the number of species has increased substantially, with recent authors recognizing between 120 (Ming & Bartholomew, 2007) and 280 species (Chang, 1998), indicating a lack of consensus. Additionally, as many as 19 new species have been reported from Vietnam alone since 2010 (e.g. Orel & Wilson, 2010, 2012a, b; Orel *et al.*, 2012, 2014; Luu *et al.*, 2015; Dung *et al.*, 2016; Le *et al.*, 2017; Nguyen *et al.*, 2018), suggesting that more species remain to be discovered in the Indochina region when we conduct intensive floristic surveys.

In Laos, eleven species and two varieties of *Camellia* are listed in the checklist of vascular plants of Laos (Newman *et al.*, 2007): *Camellia bolovenensis* (Gagnep.) H.T.Chang & S.X.Ren, *C. candida* H.T.Chang, *C. caudata* Wall., *C. chrysantha* (Hu) Tuyama, *C. drupifera* Lour. (a synonym of *C. oleifera* C.Abel), *C. furfuracea* (Merr.) Cohen-Stuart var. *furfuracea*, *C. kissii* Wall. var. *kissii*, *C. kissii* var. *confusa* (Craib) T.L.Ming, *C. laotica* (Gagnep.) T.L.Ming, *C. oleifera*, *C. sasanqua* Thunb., *C. sinensis* (L.) Kuntze and *C. sinensis* var. *assamica* (J.W.Mast.) Kitam.

Here we describe and illustrate additional two species of *Camellia*, *C. namkadingensis* Soulad. & Tagane and *C. rosacea* Tagane, Soulad. & Yahara, as new based on our recently collected materials from the Nam Kading National Protected Area, Central Laos. We also provide DNA barcodes of partial region of *rbcL* and *matK* (CBOL Plant Working Group, 2009; Kress & Erickson, 2012). DNA barcoding methods followed published protocols (Kress *et al.*, 2009; Dunning & Savolainen, 2010).

[1] Faculty of Forest Science, National University of Laos, Vientiane, Laos.

[2] The Kagoshima University Museum, Kagoshima University, Kagoshima, Japan.

[3] Center for Asian Conservation Ecology, Kyushu University, Fukuoka, Japan.

* Corresponding author: p.souladeth@nuol.edu.la

TAXONOMIC TREATMENT

Camellia namkadingensis Soulad. & Tagane, **sp. nov.** Figs. 1–2.

Camellia namkadingensis is characterized by glabrous twigs, sessile flowers, pinkish petals, a glabrous ovary and persistent bracteoles in fruit, by which combination it is clearly distinguished from all other species known from Indochina. Type:— Laos. Bolikhamxay Province, Nam Kading National Protected Area, in evergreen forest, 18°10'54.6"N, 104°24'45.9"E, 228 m elev., 23 Dec. 2016, with flowers, *Yahara T., Tagane S., Zhang M., Okabe N., Hyakumura K., Souladeth P., Sengthong A., Vorasane H., Chayer S. L5* (holotype **FOF** [FOF004903!], isotypes **HNL!**, **K!**, **KAG!**, **KYO!**, **P!**).

Small tree, ca 5 m tall. *Leafy bud* scales ovate to elliptic, (0.1–)0.5–1.5 × 0.3–1 cm, glabrous. *Twigs* whitish to light grey, glabrous. *Leaves* alternate, blade obovate to elliptic, 8–13 × 2.8–6 cm, coriaceous, apex acuminate, base acute, margin shortly serrate, ca 42 teeth per side, pale yellowish-green adaxially when dry, lighter abaxially, glabrous, midrib sunken adaxially, prominent abaxially, secondary veins 8–10 pairs, sunken adaxially, prominent abaxially, tertiary veins reticulate, slightly prominent and distinct abaxially; petiole 1–1.2 cm long, curved, concave adaxially, rounded abaxially, light green when dry, glabrous. *Flower* axially, solitary, ca 6 cm in diam., sessile, bracteoles and sepals 10, imbricate, yellowish-green, glabrous, ovate, enlarging toward the apex, basal-most (and smallest) one 0.5 × 0.5 cm, apex acute, largest one 1.5 × 1.2 cm, apex obtuse. *Petals* 6, spirally arranged, imbricate, connate at base, outer one free from other 4, adnate to androecium, obovate, ca (2–)2.5–2.7 × 1.5–2.2 cm, pink, glabrous. *Stamens* more than 350, filaments ca 1.3–2.6 cm long, glabrous, filaments in outer whorl basally connate for ¾ of their length, adnate to petals for ca 0.5 cm from base of petals, inner filaments free, ca 8 whorls, 0.9–2.2 cm long, connate to petals at base, anther ca 3 mm long, yellow. *Ovary* ellipsoid, ca 4 mm long, ca 2 mm in diam., glabrous, 3-locular; style 3, ca 3 cm long, glabrous. *Capsule* oblate or 2-coccal, ca 1.6 cm tall, ca 2.5 cm in diam., 1–3-seeded, pericarp ca 1.2 mm thick, bracteoles persistent. *Seed* depressed globose to subglobose, 1.5–1.8 cm in diam., brown, villous.

Additional specimen examined (paratype).— Laos. Bolikhamxay Province, Nam Kading National Protected Area, in evergreen forest, 18°10'54.6"N, 104°24'45.9"E, 228 m elev., 30 June 2017, with fruits, *Tagane et al. L1208* (**FOF** [FOF004901!, **FU!**, **K!**, **P!**).

Distribution and ecology.— Laos (Nam Kading Protected Area). *Camellia namkadingensis* is only known along dry streams on limestone karst at ca 230 m elevation, where it grows with *Caryota monostachya* Becc. (Arecaceae), *Epiprinus siletianus* (Baill.) Croizat (Euphorbiaceae), *Callerya atropurpurea* (Wall.) Schot (Fabaceae), *Garcinia nuntasaenii* Ngerns. & Suddee (Clusiaceae), *Litsea verticillata* Hance (Lauraceae), *Urobotrya siamensis* Hiepko (Opiliaceae), *Symplocos banaensis* Guillaumin (Symplocaceae) and *Xerospermum noronhianum* Blume (Sapindaceae).

Vernacular.— Sa nam kading (ຊານ້ຳກະດິ່ງ) (suggested here).

Phenology.— Flowering in December and fruiting in June.

Etymology.— The specific epithet refers to the protected area in which the species is found.

GenBank accession no.— *Yahara et al. L5*: LC329341 (*rbcL*), LC329342 (*matK*). The *matK* sequences of *C. namkadingensis* shows 1 bp differences of the total 781 bp from *C. tonkinensis* (Pit.) Cohen-Stuart, *C. petelotii* (Merr.) Sealy and *C. japonica* L.

Preliminary conservation status.— Critically Endangered (CR; D1) (IUCN, 2012). *Camellia namkadingensis* is only known from a single population. This single population comprises about 10 flowering/fruiting individuals, which were found along a dry stream within an area of approximately 20 × 20 m. In view of the very low number of individuals known, the species should be considered Critically Endangered (CR) according to IUCN Criterion D. Although the species grows inside a protected area of Nam Kading National Protected Area, the habitat is still subject to poaching and illegal logging.

Notes.— The following morphological characters of *Camellia namkadingensis* suggest this species should be placed within Subg. *Camellia* Sect. *Camellia*, as defined by Sealy (1958) and Ming & Bartholomew (2007): flowers subsessile, bracteoles and sepals imbricate, petals basally connate, androecium and gynoecium subequal in length to petals,

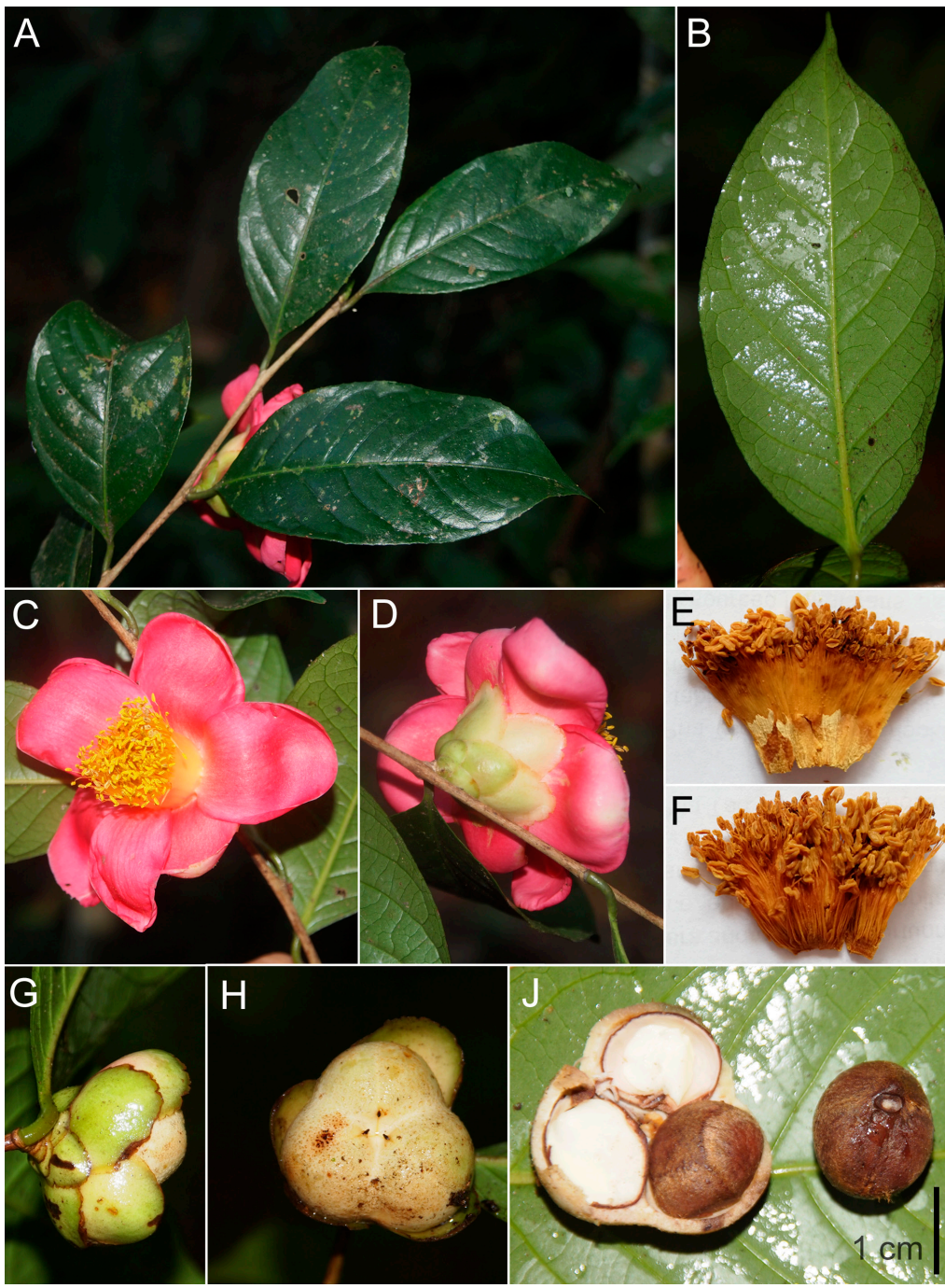

Figure 1. *Camellia namkadingensis* Soulad. & Tagane. A. Flowering branch; B. Abaxial surface of leaf; C. Front view of flower showing petals and stamens; D. Side view of flower showing bracteoles and sepals; E. Outer filaments; F. Inner filaments; G. Side view of fruit which is covered by bracteoles and sepals; H. Front view of fruit; J. Horizontal section of fruit with seeds. Photos A–D from *Yahara et al. L5* and E–J from *Tagane et al. L1208*.

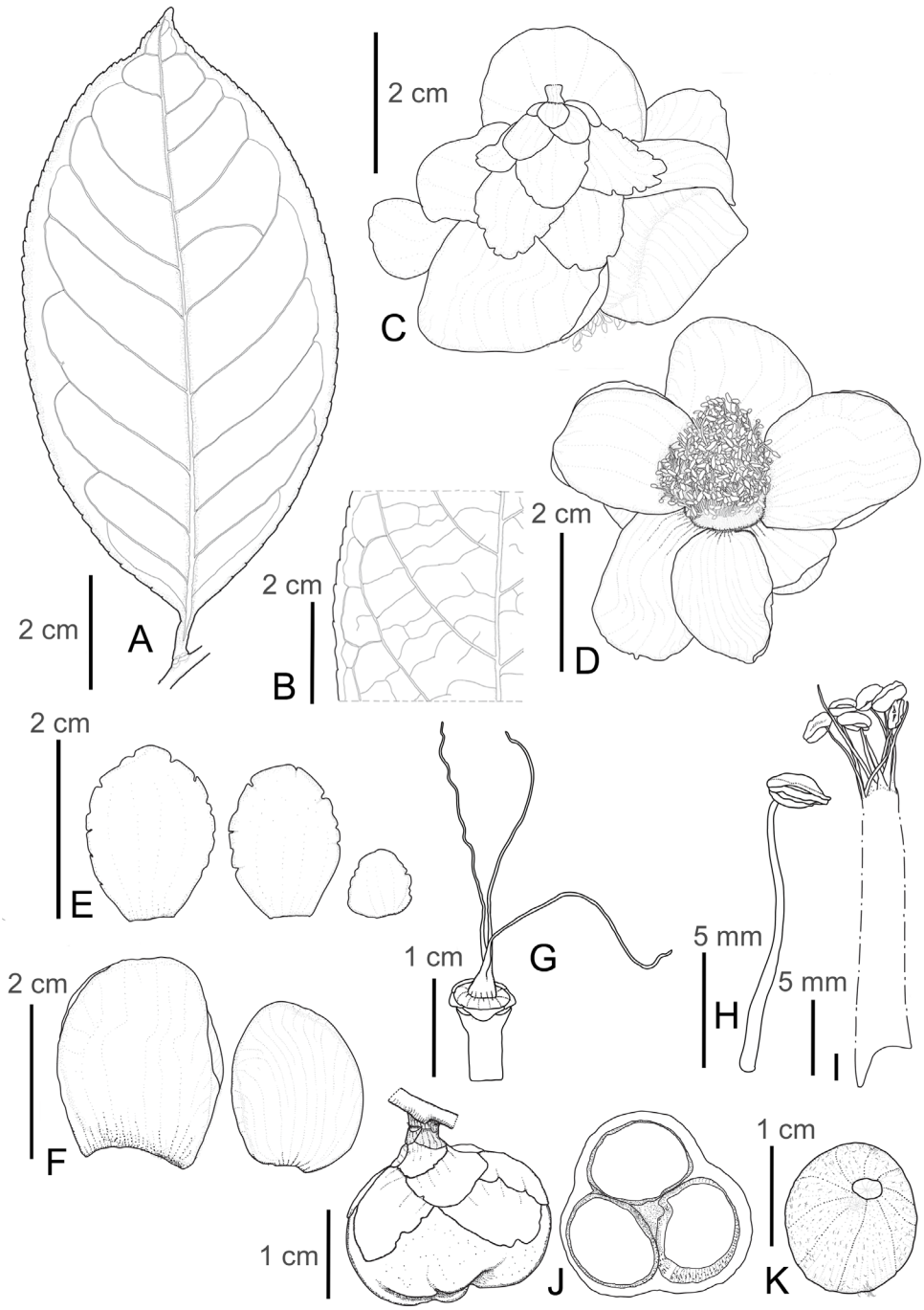

Figure 2. *Camellia namkadingensis* Soulad. & Tagane. A. Leaf (adaxial side); B. Venation (abaxial side); C. Side view of flower showing bracteoles, sepals and petals; D. Front view of flower showing petals and stamens; E. Bracteoles; F. Petals; G. Pistil; H. Stamen from inner whorl; I. Stamens from outer whorl (filaments connate); J. Side view of fruit which is covered by bracteoles and sepals (left) and cross section of fruit (right); K. Seed. Photos A–I from *Yahara et al. L5* and J & K from *Tagane et al. L1208*. Drawn by K. Souvannakhoummane.

outer filament whorl connate for basal ⅘, styles connate near base and divided into 3 above, ovary 3-locular. However, all bracteoles and sepals are persistent in this new species, contrasting with the typical situation for Subg. *Camellia* Sect. *Camellia* comprising caducous bracteoles and sepals (or, in some cases, caducous bracteoles and ± persistent sepals). *Camellia namkadingensis* might provide interesting additional knowledge for the infrageneric classification of *Camellia*. In Indochina, only one species of Sect. *Camellia*, *C. yokdonensis* Dung bis & Hakoda, has been reported, but *C. yokdonensis* is a quite different species from *C. namkadingensis* in having orange-red petals, larger leaves (15–20 cm long vs 8–13 cm long), more petals (7–10 petals) and fewer stamens (170 vs more than 350). In Laos, *C. namkadingensis* is apparently similar to *C. bolovenensis* and *C. furfuracea* in leaf shape and size, and subsessile flowers, but distinguished from the former by its larger petals (ca 2 cm long in *C. namkadingensis* vs 1.5–1.7 cm long in *C. bolovenensis*), glabrous petals (vs densely silky hairy on axial surface), persistent fruit bracteoles (vs caducous) and a glabrous ovary (vs hairy), and from the latter by pinkish petals (vs white in *C. furfuracea*) and glabrous ovary (vs pubescent).

Camellia rosacea Tagane, Soulad. & Yahara, **sp. nov.** Figs. 3–4.

Camellia rosacea is distinct from the other previously known species in the region in having a combination of densely hairy young twigs, petioles and lower leaf surfaces, and nodding flowers subtended by many reddish bracteoles that look like petals. Type:— Laos. Bolikhamxay Province, Nam Kading National Protected Area, in evergreen forest, along a logging road, 18°12’09.8”N, 104°23’16.1”E, 258 m elev., 25 Dec. 2016, *Yahara T., Tagane S., Zhang M., Okabe N., Souladeth P., Sengthong A., Chayer S. L407* (holotype **FOF** [FOF004904!], isotypes **FU!**, **HNL!**, **K!**, **KYO!**, **P!**).

Small tree, ca 4 m tall. *Leafy bud* scales ovate-triangular, densely appressed hairy outside, glabrous inside. *Twigs* whitish to light grey, densely covered by two kinds of hairs, longer hairs ca 0.8 mm long, shorter ones ca 0.25 mm long. *Leaves* alternate, blade oblong to oblong-elliptic, 9.2–14.5 × 4.2–5 cm, coriaceous, apex shortly acuminate, base obtuse, margin shortly serrate, ca 38 teeth per side, drying pale yellowish-green adaxially, lighter abaxially, glabrous adaxially, hairy abaxially, midrib sunken adaxially, prominent abaxially, secondary veins 10–12 pairs, sunken adaxially, prominent abaxially, tertiary veins reticulate, slightly prominent and distinct abaxially; petiole 4–9 mm long, concave adaxially, rounded abaxially, darkish-brown when dry, covered by two kinds of hairs (as for the twigs). *Flower* terminal, rarely axillary near the shoot apex, solitary, nodding, 5–6 cm in diameter, pale red; pedicel ca 1–4 cm long, covered with 10–12 bracteoles and sepals (appearing sessile), bracteoles ovate-triangular to ovate-oblong, enlarging toward the apex, basal-most (and smallest) one 2 × 2 mm, apex acute, largest one 5 × 2.8 cm, apex acuminate, acumen to 1.2 cm long, wine red to pale red toward the petals in anthesis, later greenish, silky hairy outside, glabrous inside, margin ciliate. *Petals* 5 or 6, spirally arranged, imbricate, free, adnate to androecium, obovate, 3–3.5 × 2.5–2.7 cm, pink, glabrous. *Stamens* more than 400, filament 1.5–3 cm long, pubescent except near the basal and upper parts which are glabrous, filaments in outer whorl basally connate for ¼ of their length, adnate to petals at 0.3 cm from the base of the petals, inner filaments free, in ca 5 whorls, 1–2.5 cm long, anther ca 2 mm long, yellow. *Ovary* ovoid, ca 6 × 8 mm, glabrous, 3-locular; style ca 2.7 cm long, split into 3-lobes from near base, densely silky hairy. *Fruits* and seeds not seen.

Distribution and ecology.— Laos (Nam Kading Protected Area). Only a single individual of *C. rosacea* was found at the edge of lowland evergreen forest dominated by *Amesiodendron chinense* (Merr.) Hu (Sapindaceae), *Dipterocarpus grandiflorus* (Blanco) Blanco (Dipterocarpaceae), *Epiprinus siletianus* (Baill.) Croizat (Euphorbiaceae), *Fernandoa collignonii* (Dop) Steenis (Bignoniaceae), *Lagerstroemia calycina* Koehne (Lythraceae), *Neo-uvaria namkadingensis* Tagane & Soulad. (Annonaceae) and *Symplocos banaensis* Guillaumin (Symplocaceae).

Vernacular.— Sa koulap deang (ຊາກຫຼາບແດງ) (suggested here).

Phenology.— Flowering in December.

Etymology.— The species epithet *rosacea* is derived from the appearance of its flowers, which are rose-like.

Figure 3. *Camellia rosacea* Tagane, Soulad. & Yahara. A. Leafy twig; B. Portion of lower leaf surface; C–E. Flowers; F. Flower with petals and stamens removed to show pistil; G. Petals, anthers, bracteoles and pistils dissected from a single flower. All photos from *Yahara et al. L407*.

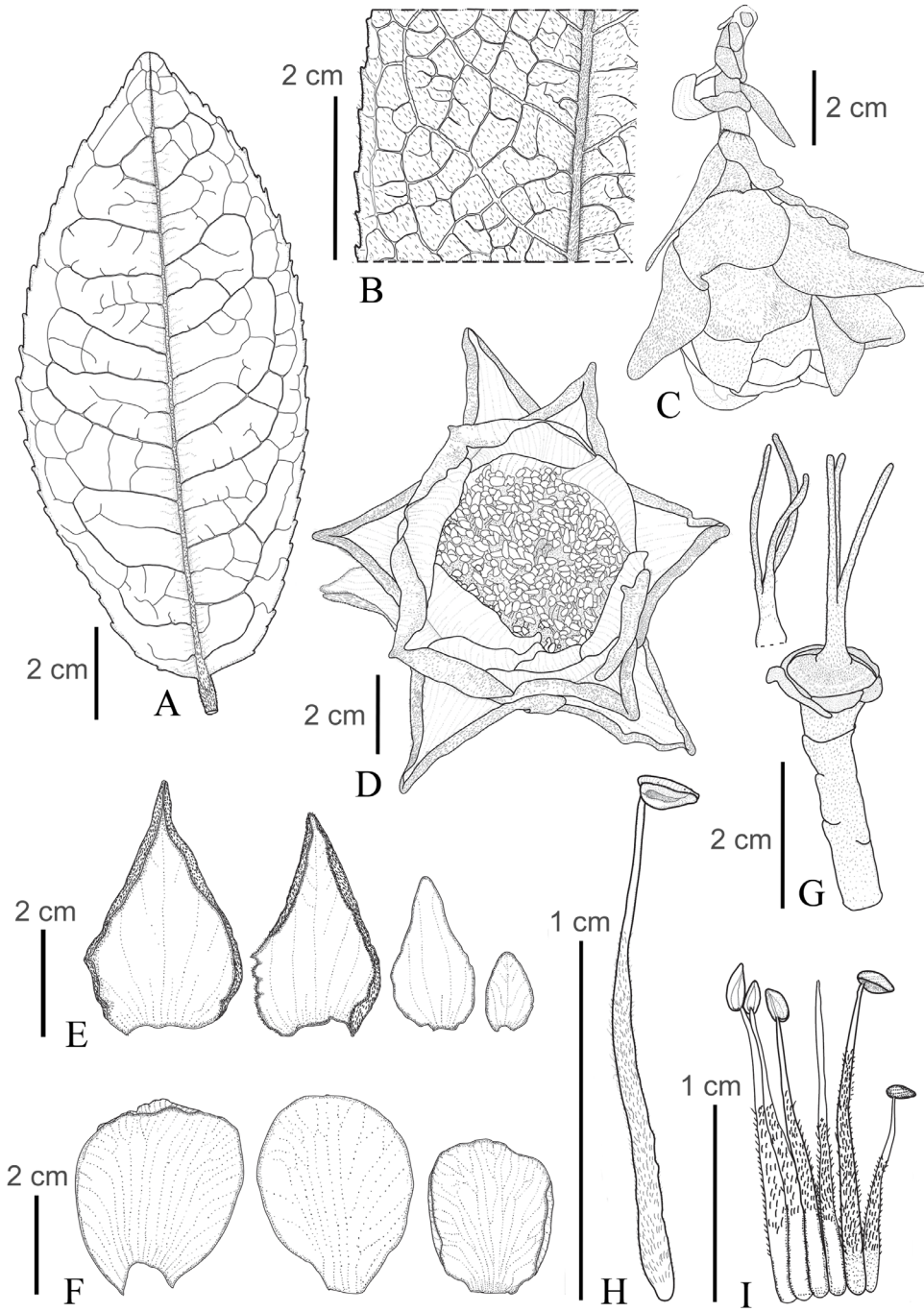

Figure 4. *Camellia rosacea* Tagane, Soulad. & Yahara. A. Leaf (adaxial side); B. Venation (abaxial side); C. Side view of flower showing bracteoles and sepals; D. Front view of flower showing stamens, petal and bracteoles; E. Bracteoles and sepals; F. Petals; G. Pistil and 3-lobed style; H. Free stamen from outer whorl; I. Basally fused stamens from inner whorl. All materials from *Yahara et al. L407*. Drawn by K. Souvannakhoummane.

GenBank accession no.:— *Yahara et al. L407*: LC329343 (*rbcL*), LC329344 (*matK*).

Preliminary conservation status.— Critically Endangered (CR; D1) (IUCN, 2012). Only one flowering individual was found along a logging road. Despite repeated searches in the vicinity of the type locality for a total of ten days in 2016 and 2017 (Tagane *et al.*, 2018), no other individuals were located. Given this situation, we consider the IUCN category of CR based on the Criterion D to be appropriate. The individual grows inside a protected area of Nam Kading National Protected Area, but the habitat is affected by human disturbance from the logging road.

Notes.— *Camellia rosacea* is easily distinguished from the other previously known species in the region in having densely hairy young twigs, petioles and lower leaf surfaces, oblong to oblong-elliptic leaf blades, nodding flowers and ca 12 reddish to greenish bracteoles that look like petals. Concerning its infrageneric placement, it is difficult for *C. rosacea* to be classified at present because of the following three reasons: (1) the combination of the floral characters of *C. rosacea* do not fully match those of any of the previously circumscribed subsections, (2) although it is important for classification to examine fruit characters, we have not seen fruits and seeds of this species yet, and (3) the two DNA markers of *rbcL* and *matK* used in this study are not effective for resolving the relationships among species in *Camellia*. It is hoped that additional studies based on fruiting material as well as phylogenetic analyses using other DNA markers will shed light on the classification of this and other *Camellia* species in Laos.

ACKNOWLEDGEMENTS

The authors are grateful to the managers and staff of Nam Kading National Protected Area for supporting our botanical inventory in the protected area. We thank the curators of BKF, FOF, FU, KAG, RUPP, SAR,TNS and VNM for allowing us to study their specimens, Mariko Akama and Keiko Mase (both Kyushu University) for their help in DNA sequencing, Keooudone Souvannakhoummane (The Agro-Biodiversity Initiative, Laos) for his line drawings of the new species, and Stephan Gale (Kadoorie Farm and Botanic Garden, Hong Kong) for his helpful comments on the manuscript. This study was supported by the Environment Research and Technology Development Fund (4-1601) of the Ministry of the Environment, Japan, and MEXT/JSPS KAKENHI Grant Number JP15H02640.

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