



Flora of Nam Kading National Protected Area IV: Two new species of Annonaceae, *Monoon namkadingense* and *Neo-uvaria laosensis*

SHUICHIRO TAGANE^{1,*}, PHETLASYS SOULADETH², MENG ZHANG¹ & TETSUKAZU YAHARA¹

¹ Center for Asian Conservation Ecology, Kyushu University, 744 Motoooka, Fukuoka, 819-0395, Japan.

² Faculty of Forest Science, National University of Laos, Dongdok campus, P.O.Box 7322, Vientiane, Lao PDR.

*Authors for correspondence: stagane29@gmail.com

Abstract

Two new species of Annonaceae, *Monoon namkadingense* and *Neo-uvaria laosensis*, from Nam Kading National Protected Area, Bolikhamxay Province, Central Laos, are described and illustrated. DNA barcodes of *rbcL* and *matK*, vernacular name and primary conservation assessment are also provided. Both species are considered to be endemic to this area and categorized as Endangered (EN). The distribution of *Neo-uvaria laosensis* represents northern limit of distribution range for the genus.

Kew words: DNA barcoding, flora, Indochina, Magnoliales, taxonomy

Introduction

Annonaceae Jussieu (1789: 283), with about 105 genera and over 2,500 species (Chatrou *et al.* 2012, Christenhusz & Byng 2016), are one of the important components in tropical evergreen forest. The species are widely distributed in the tropics, especially in the Old World (Li & Gilbert 2011, Utteridge & Bramley 2014). The Southeast Asia represents one of the main centres of species diversity for the family, in which many new species continue to be described (e.g. Saunders *et al.* 2004, Chaowasku *et al.* 2011, 2012, Chaowasku & Keßler 2013, Turner 2013, Tagane *et al.* 2015, Ngoc *et al.* 2016, Turner & Utteridge 2016, Lý *et al.* 2017).

While carrying out botanical surveys in the Nam Kading National Protected Area in central Laos (Souladeth *et al.* 2017, Tagane *et al.* 2017, Yang *et al.* 2018), we discovered populations of trees that refers to two undescribed species of the genus *Monoon* Miquel (1865: 15) and *Neo-uvaria* Airy Shaw (1939: 278).

The new species, *M. namkadingense* Souladeth & Tagane, *Neo-uvaria laosensis* Tagane & Souladeth, are herein described. The illustrations, preliminary conservation assessment and DNA barcodes of the two plastid regions of *rbcL* and *matK* are also presented for them.

Methods

The specimens, collected during the field studies in Nam Kading National Protected Area in December 2016 and July 2017, were checked with the related literature (e.g. Chaowasku *et al.* 2011, Li & Gilbert 2011, Xue *et al.* 2012, Turner *et al.* 2014, Turner & Utteridge 2016, Ly 2017).

The specimens of the new species were compared with the type specimens and the other representative vouchers kept in BKF, FOF, HNL, KYO, SAR, TNS herbaria (abbreviations following Thiers 2016) and digital specimen images of JSTOR Global Plants (<https://plants.jstor.org/>).

DNA was extracted from the silica-dried leaf pieces using a modified CTAB method. The two partial genes for the large subunit ribulose-1, 5-bisphosphate carboxylase oxygenase (*rbcL*) and maturase K (*matK*) were sequenced following published protocols (Kress *et al.* 2009, Dunning and Savolainen 2010) as in Toyama *et al.* (2015).

Taxonomy

Monoon namkadingense Souladeth & Tagane, *sp. nov.* (Fig 1.)

TYPE:—LAOS. Bolikhamxay Province: Nam Kading National Protected Area, 288 m elev., 18°11'56.5"N, 104°23'48.1"E, 23 December 2016, Tagane S., Yahara T., Zhang M., Okabe N., Hyakumura H., Souladeth P., Sengthong A., Chayer S. L54 [fl. & fr.] (holotype FOF!, isotypes HNL!, FU!, K, KYO!, P).

Monoon namkadingense is similar to *M. simiarum* (Buchanan-Hamilton ex Hooker & Thomson) Xue *et al.* (2012: 1033) in having greenish yellow flowers mostly along twigs behind leaves, but differs by having smaller leaves (4.5–11.6 × 1.5–3.4 cm vs. 12–20 × 5–8 cm), fewer secondary veins (6–12 vs 11–20 pairs), few-flowered inflorescences and smaller flowers (sepal up to 1.3 mm long vs. 3–5 mm long; outer petals ca. 1.3 cm long vs. 2.5–4 cm long).

Tree, 15 m tall, 66 cm in dbh. Twig densely pubescent when young, glabrescent, grayish brown. Petiole 3–6 mm long, pubescent when young, glabrescent, blackish, concave adaxially, rounded abaxially; leaf blade elliptic, elliptic-oblong, elliptic-obovate, 4.5–11.6 × 1.5–3.4 cm, ±thickly chartaceous, dark dull greenish brown adaxially, greenish yellow and slightly glossy abaxially, glabrous, midrib sunken adaxially, prominent abaxially, glabrous, secondary veins (6–)10–12 pairs, at angle of (45°–)50°–65° from the midrib, almost flat adaxially, prominent abaxially, tertiary veins scalariform, faintly visible abaxially. Inflorescences on twigs behind leaves, sometimes on branches, single- to 3-flowered. Flowering pedicel 1.2–1.4 cm long, widening distally, covered with minute pale brown hairs, with 1 bract at or above middle point of pedicel; bracts ovate-triangular, ca. 0.8 × 0.8 mm long, densely short pale brown hairy abaxially, glabrous adaxially, apex acute, sepals 3, broadly ovate-triangular, ca. 1.3 × 2.3 mm, reflexing, outside covered with minute pale brown hairs, inside glabrous, margin ciliate, apex broadly obtuse, petals 6 in 2 whorl of 3, thickly chartaceous, oblong-oblongate, greenish yellow *in vivo*, yellowish brown when dry, apex acute, outer petals ca. 1.3 × 0.4 cm, outside ±sparsely covered with minute pale brown hairs, inside sparsely hairy except near basal 1/5 which is glabrous, inner petals slightly longer than outer petals, 1.5–1.6 × ca. 0.4 cm, hairy as in outer petals on both sides, stamens 98–108 per flower, 0.8–0.9 mm long, glabrous, anthers 0.6–0.7 mm long, connectives ca. 0.15 mm long, apex truncate, glabrous; carpels 40 per flower, ovary cylindrical, 0.5–0.6 mm long, 4-(or 5-)angular, hairy along angles, stigmas connivent cylindrical, 0.4–0.6 mm long, slightly angled, hairy only near apex. Fruiting pedicel 1.6–2.6 cm long, ca. 3 mm thick, blackish when dry, glabrous; monocarp stipe 1.6–2.6 cm long; monocarp ellipsoid, 1.6–2.5 cm long, 1.2–1.5 cm in diam., glabrous, reddish *in vivo*, blackish when dry. Seed 1 per monocarp, ellipsoid, ca. 1.4–2. cm long, 1–1.2 cm in diam., yellowish brown.

Additional specimens examined:—LAOS. Bolikhamxay Province: Nam Kading National Protected Area, 459 m elev., 18°42'37.4"N, 104°11'45.3"E, 28 June 2017, Tagane S., Souladeth P., Okabe N., Yang C.-J. L1097 [fr.] (FOF!, FU!); 282 m elev., 18°10'27.5"N, 104°28'21.2"E, 26 December 2016, Tagane S., Yahara T., Zhang M., Okabe N., Souladeth P., Sengthong A., Chayer S. L411 [fl. & fr.] (FOF!); 268 m elev., 18°12'06.8"N, 104°23'18.7"E, 25 December 2016, Yahara T., Tagane S., Zhang M., Okabe N., Souladeth P., Sengthong A., Chayer S., L363 [ster.] (FOF!); 268 m elev., 18°12'06.8"N, 104°23'18.7"E, 27 June 2017, Tagane S., Souladeth P., Okabe N., Yang C.-J. L1054 [fl.] (FOF!, FU!); 258 m elev., 18°12'09.8"N, 104°23'16.1"E, 27 June 2017, Tagane S., Souladeth P., Okabe N., Yang C.-J. L1005 [fl.] (FOF!, FU!).

Distribution:—Laos, Bolikhamxay Province (so far known only from Nam Kading National Protected Area).

Habitat and Ecology:—In lowland evergreen forest, also in evergreen forest on limestone hills; 250–460 m elevation.

Phenology:—Flowering and fruiting specimens were collected both in June and December.

DNA barcodes:—GenBank accession no. LC317009 (*rbcL*), LC317010 (*matK*); we sequenced Tagane *et al.* L54. DNA sequences of the barcoding regions of *M. namkadingense* are identical with *Polyalthia viridis* Craib (1914: 4) [= *Monoon viride* (Craib) Xue *et al.* (2012: 1034)] (GenBank accession no. AY319040, identities: 516/516), in *rbcL*, and *Polyalthia lateriflora* (Blume, 1825: 20) King (1892: 58) [= *M. laterifolium* (Blume) Miquel (1865: 19)] (accession no. AY518781, identities: 828/828) and *Monoon kingii* (Baker, 1924: 3) Xue *et al.* (2012: 1032) (JX227877, 789/789) in *matK*.

Etymology:—The specific epithet refers to the geographical location of the find and is derived from the name of the adjacent Nam Kading National Protected Area.

Vernacular name:—ພິພ່ວນນອຍນາມກັດງິ (Phiphouan Noy Nam Kading, suggested here).

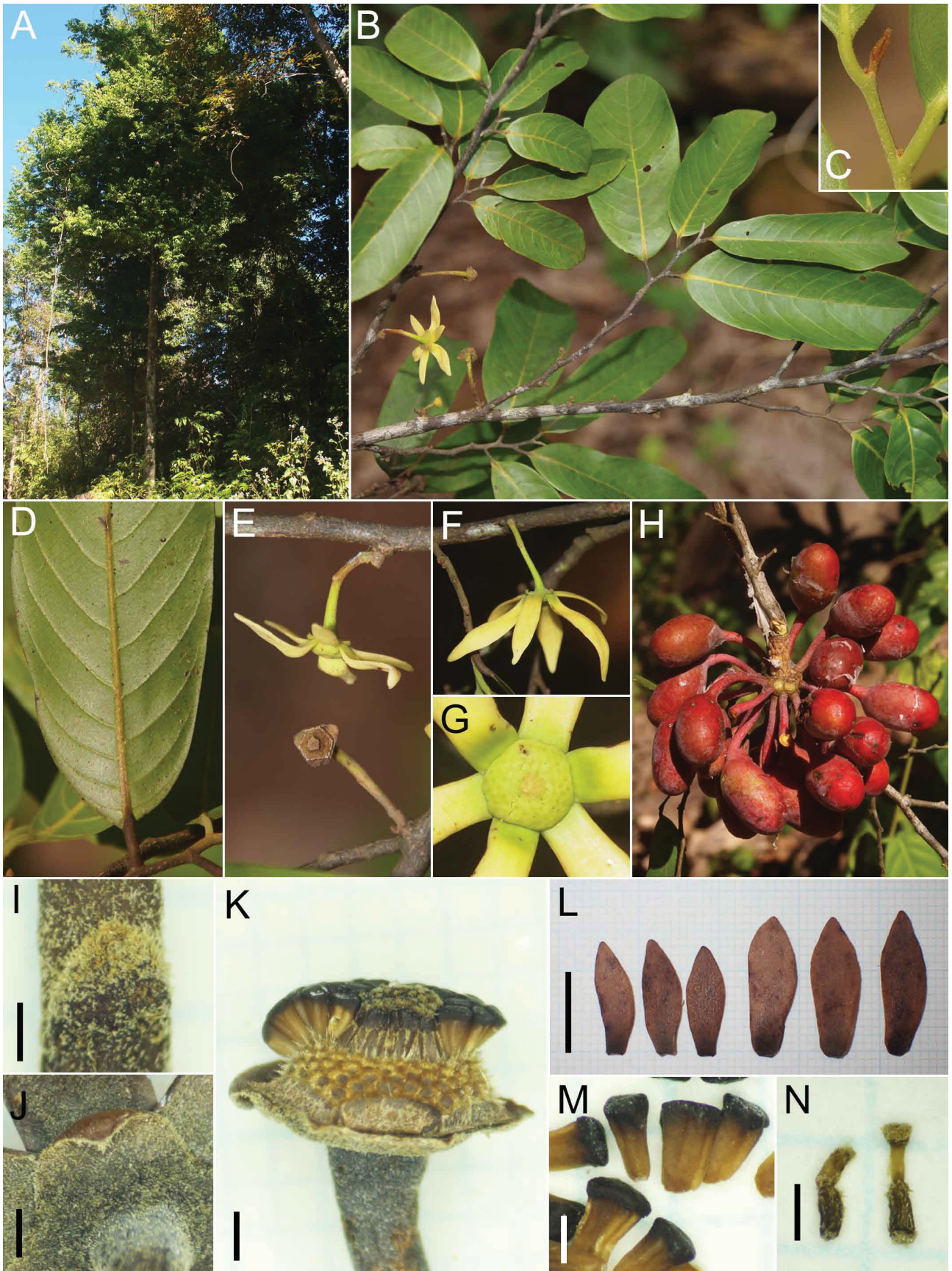


FIGURE 1. *Monoon namkadingense* Souladeth & Tagane. A) Habit, B) Flowering twig, C) Top branch, D) Portion of lower leaf surface, E) Flowering (above) and petals-dropped flower after anthesis (below), F) Flower, G) Stamens and carpels, H) Monocarps, I) Bracteole, J) Sepal, K) flower petals and some stamens removed, L) Outer petals (left three) and inner petals (right three), M) Stamens, N) Carpels. Materials (I–N) from *Tagane et al. L54* (FU). Scale bars I, M & N = 5 mm; J & K = 1 mm; L = 1 cm.

Primary conservation assessment:—Endangered (EN). From our collections and field observation, *M. namkadingense* is considered to be widely distributed in lower elevations (200–600 m) of Nam Kading National Protected Area and the area occupancy for this species is estimated to be less than 2000 km². Given the lowland evergreen forest is gradually cleared or selectively logged even in the protected area recently for timber collection and/or conversion to the cassava field, we suggest the category of this species as EN according to the IUCN criteria of B1a & b (IUCN 2012).

Note:—The genus *Monoon* was recently reinstated from *Polyalthia* Blume (1830: 68) *sensu lato* based on chloroplast DNA sequence data and anatomical observations by Xue *et al.* (2012). It consists of ca. 60 species distributed in tropical and subtropical Asia, from India to Japan, extending to Australia. Whereas several species are known in surrounding countries: 13 species from Thailand (Pooma & Suddee 2014), eight species from Vietnam (Ly 2017), two species from Cambodia (Finet & Gagnepain 1907), five species from China (Li & Gilbert 2011), and only one species of *Monoon*, *M. simiarum* has been known from Laos (Newman *et al.* 2007, Xue *et al.* 2012). *Monoon namkadingense* is easily distinguished from the other species in neighboring areas by a combination of its relatively smaller leaves less than 11.6 cm long, fewer secondary veins, solitary to 3-flowered inflorescences produced on twigs behind leaves, sometimes on branches and 1.2–1.4 cm long flowering pedicels.

Neo-uvaria laosensis Tagane & Souladeth, *sp. nov.* (Fig 2.)

TYPE:—LAOS. Bolikhamxay Province: Nam Kading National Protected Area, in semi-evergreen forest dominated by *Lagerstroemia calyculata* Kurz, along logging road, 313 m elev., 18°12'30"N, 104°23'57"E, 24 December 2016, Tagane S., Yahara T., Zhang M., Okabe N., Souladeth P., Sengthong A., Chayer S. L287 [fl. & fr.] (holotype FOF!, isotypes BKF, FU!, HNL! K, KKU, KYO!, P).

Diagnosis. Similar to *N. telopea* Chaowasku (2011: 32) of Peninsular Thailand in the density of the indumentum, flower shape and large fruit size, but it differs in having fewer secondary veins ((12–)14–17 pairs in *N. laosensis* vs. 17–18 pairs in *N. telopea*), solitary to 5-flowered inflorescences (vs. only solitary in *N. telopea*), smaller inner petals (10–11 × 5–5.5 mm vs. 8.5–10 × 7.5–8.5 mm), smaller stamens (1.0–1.3 mm long vs. 1.6–1.7 mm long) and more carpels (9 vs. 5–8). Also, similar to *N. acuminatissima* (Miquel (1865: 6)) Airy Shaw (1939: 279) of Peninsular Malaysia and Borneo, but different in having larger flowers (vs. outer petals ca. 3.6 × 2.5 mm, inner petals ca. 3.8 × 3.0 mm in *N. acuminatissima*) and much larger monocarps (vs. 1.7 cm in diam.).

Tree, 11 m tall, 47 cm in dbh, all parts generally covered with stellate hairs intermixed with simple hairs. Young twig ca. 2.5 mm in diam., densely velvet-villous. Petiole 3–5 mm long, 2–3 mm in diam., densely velvety-villous. Leaves elliptic-oblong, (6.5–)11–18.7 × (2–)4–7 cm, chartaceous, apex acuminate, acumen up to 2.5 cm long, base acute to obtuse, rarely rounded, sparsely hairy adaxially, densely villous abaxially, midrib slightly sunken, velvety adaxially, prominent densely velvety-villous abaxially, secondary veins (12–)14–17 pairs, prominent abaxially, at angle of (40°–)45°–55° from the midrib, tertiary veins scalariforming, faintly visible adaxially, slightly prominent abaxially. Inflorescences axillary or at older leafless nodes, solitary to 5-flowered. Flowers cream, 2–2.5 cm in diam., bracts triangular to suborbicular, to 3 mm long, densely covered with golden-brown hairs. Sepals ovate-triangular, ca. 6 × 6 mm, connate ca. 0.5 mm from base, densely covered with golden-brown hairs, indumentum on inner side shorter and lighter colored. Outer petals ovate-elliptic, 11–12 × 6–6.5 mm, ±appressed velvety-tomentose abaxially, shortly cobwebbed adaxially except basal ca. 1/5 which is glabrous. Inner petals ovate-rhombic, 10–11 × 5–5.5 mm, shortly cobwebbed on both surfaces except basal ca. 1/5 adaxially. Stamens 18 per flower, 1.0–1.3 mm long, connective tissue flat-topped, shortly appressed hairy. Carpels 9 per flower, ovaries 1.2 mm long, slightly curved, densely covered with light golden-brown hairs, ovules 1 per ovary, stigmas ellipsoid-cylindrical, 0.5–0.7 mm long, glabrous, apex covered with mucilage. Monocarps 1–3 per fruit, sessile, ellipsoid-ovoid, 6–6.5 cm long, 4–4.5 cm in diam., densely covered by velvety dark brown hairs. Seed 1 per monocarp, ellipsoid, 4.3–4.5 cm long, ca. 3 cm in diam.

Additional specimen examined:—LAOS. Bolikhamxay Province, Nam Kading National Protected Area, 313 m elev., 18°12'09.8"N, 104°23'16.1"E, 25 December 2016, Tagane S., Yahara T., Zhang M., Okabe N., Souladeth P., Sengthong A., Chayer S. L406 [fl.] (FOF!, FU! (flowers in spirit collection), HNL!, K, KYO!, P); *ibid.*, 27 June 2017, Tagane S., Souladeth P., Okabe N., Yang C.-J. L981 [fr.] (FOF!, FU!); 459 m elev., 18°42'37.4"N, 104°11'45.3"E, Tagane S., Souladeth P., Okabe N., Yang C.-J. L1096 [ster.] (FOF!, FU!).

Distribution:—Laos, Bolikhamxay Province (so far known only from Nam Kading National Protected Area).

Habitat and Ecology:—*Neo-uvaria laosensis* is scattered in evergreen forests, also on limestone, at 260–460 m elevation. The forest the above type specimen collected is dominated by *Dipterocarpus grandiflorus* (Blanco, 1837: 451) Blanco (1845: 315) and *Lagerstroemia calyculata* Kurz (1872: 307).

Phenology:—Flowering specimens were collected in December; fruiting in July and December.

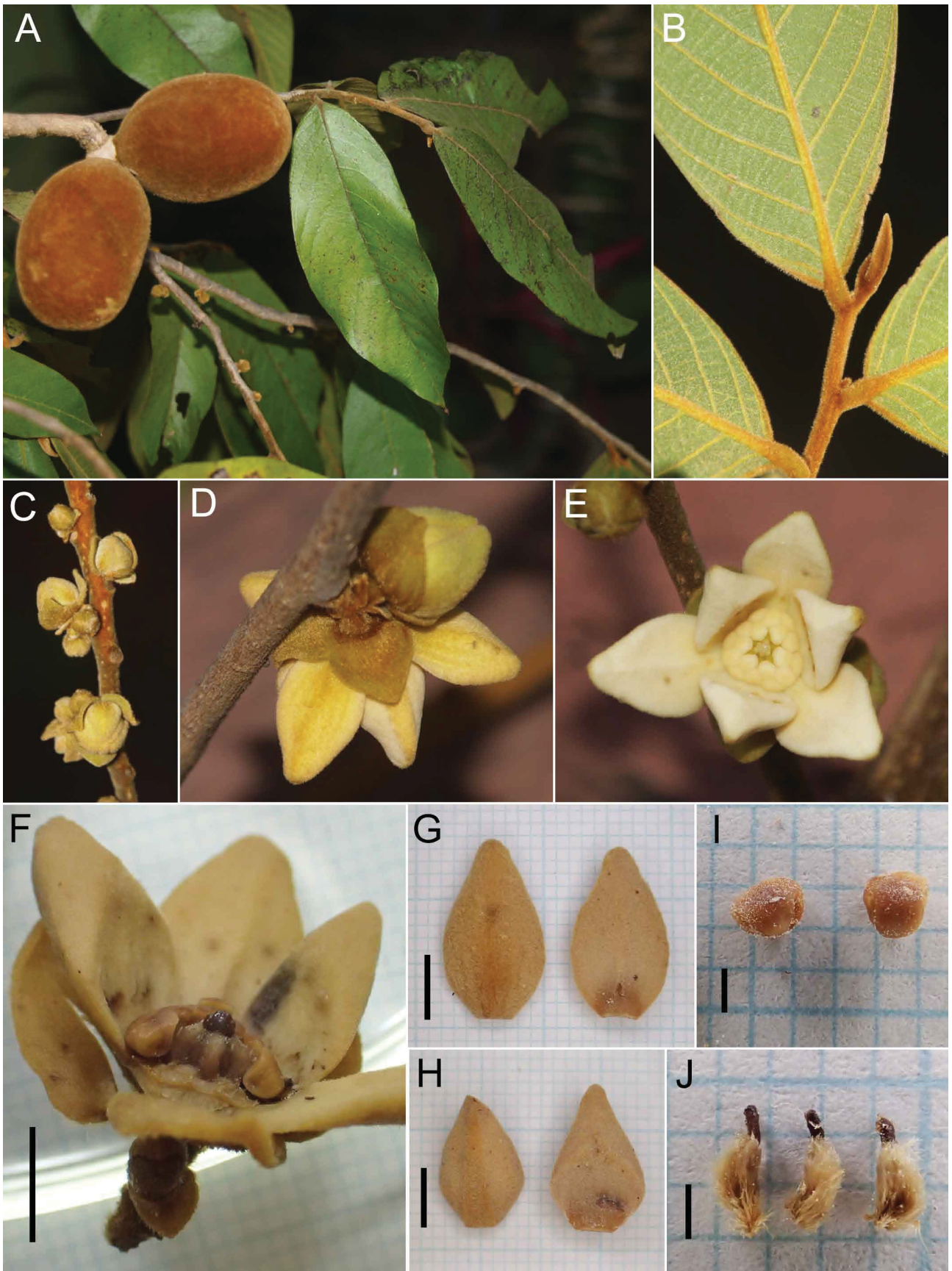


FIGURE 2. *Neo-uvaria laosensis* Tagane & Souladeth. A) Fruiting twig, B) Top branch and portion of lower leaf surface, C) Flower buds, D & E) Flowers, F) Flower one inner petal and some stamens removed, G) Outer petals, H) Inner petals, I) Stamens, J) Carpels. Materials F–J from Tagane *et al.* L426 (FU). Scale bars F–H = 5 mm; I & J = 1 mm.

DNA barcodes:—GenBank accession no. LC317011 (*rbcL*), LC317012 (*matK*); we sequenced *Tagane et al.* L287. The BLAST similarity search based on the *rbcL* sequence of *N. laosensis* resulted in homology as high as 510/511 bp with the sequence of *Neo-uvaria acuminatissima* (AY318999) and also *Neo-uvaria teropea* (KY988309) in the DNA database. The *matK* sequence of *N. laosensis* differs 2 bp of the total 755 bp from *Neo-uvaria acuminatissima* (AY518793) and 3 bp of the total 758 bp from *Neo-uvaria telopea* (JX544751).

Etymology:—The specific epithet refers to the country where the new species is known to occur.

Vernacular name:—*ກະແຂງດົງນາກະດົງ* (Ka Xaeng Dong Nam Kading, suggested here).

Primary conservation assessment:—Endangered (EN). *Neo-uvaria laosensis* is widely scattered in Nam Kading National Protected Areas as in *Monoon namkadingense*, and often the two species occur sympatrically. For the same reason to *M. namkadingense* (B1a & b), the IUCN category of this species is proposed as EN.

Note:—The genus *Neo-uvaria* is a small genus consisting of 9–15 species in the family Annonaceae and all the previously known species are distributed in Malesia region (southern Thailand, Peninsular Malaysia, Borneo, Sumatra and the Philippines) (Chaowasku *et al.* 2011). Our discovery documents for the first time the occurrence of *Neo-uvaria* outside Malesia, representing the northern limit of its distribution range.

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