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Diospyros phuwuaensis (Ebenaceae), a new species from North-Eastern Thailand

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ABSTRACT

Diospyros phuwuaensis, a new species from Phu Wua Wildlife Sanctuary, North-Eastern Thailand is described and illustrated. Photographs, ecological information and an IUCN conservation status are provided. The distinctive morphological characters of the new species and its related species are discussed. Based on cpDNA data, the new species is confirmed as an independent lineage and placed in the *Diospyros* clade V *sensu* Duangjai *et al.* (2009). It has phylogenetic affinities with *Diospyros mollis*, and then *D. fulvopilosa* and *D. kurzii*. Our result supports the assignment of the new species to *Diospyros* section *Kurzella*. A revised description and a key to the species of *Diospyros* section *Kurzella* is presented.

KEYWORDS: *Diospyros*, morphology, new species, phylogeny.

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INTRODUCTION

The genus *Diospyros* L. in the family Ebenaceae includes over 600 species distributed in the tropics and subtropics (Wallnöfer, 2001; Duangjai *et al.*, 2006, 2009). The greatest species diversity occurs in the Asia-Pacific region with several species used as timber or with edible fruits (Lemmens *et al.*, 1995; Wallnöfer, 2001), and many others are used as primary sources of medicines (Wallnöfer, 2001; Lemmens & Bunyapraphatsara, 2003). Within Thailand, 63 species have been reported, of which 60 were recorded in the Flora of Thailand treatment of 1981 (Phengklai, 1981). Three of these 60 species have since been reduced to synonymy, viz. *D. curraniopsis* Bakh., *D. pubicalix* Bakh. and *D. tahanensis* Bakh. (Ng, 2001). Three more new species have been described after that (Phengklai, 2005; Duangjai *et al.*, 2018).

Phu Wua Wildlife Sanctuary and adjacent areas in Bueng Kan Province are botanically unique, with many new taxa of flowering plants having recently been described from the area, e.g. *Curcuma* L. (Leong-Škorničková *et al.*, 2017), *Elettariopsis* Baker (Saensouk & Saensouk, 2014), *Garcinia* L. (Ngernsaengsaruay & Suddee, 2016), *Hoya* R.Br. (Kidyoo, 2016), *Litsea* Lam. (Ngernsaengsaruay, 2004), and *Platostoma* P.Beauv. (Suddee, 2010; Suddee *et al.*, 2019). During botanical exploration of Phu Wua Wildlife Sanctuary by staff of the Forest Herbarium (BKF) in the period 2007–2019, specimens of an unknown species of *Diospyros* were collected. After comparison to similar species and a study using DNA sequence data, it was concluded that these specimens were of an undescribed species. The new species is morphologically similar to *Diospyros kurzii* Hiern and *D. heishi* Govaerts in the leaves and the shape of the male flowers. However, it can be distinguished from them by having fewer stamens and in features of the fruiting calyx lobes.

The two most morphologically similar species to the new species are members of the Asian section *Diospyros* sect. *Kurzella* Bakh. (Bakhuizen van den Brink, 1936–1955). When Bakhuizen van den Brink established this section, it comprised seven species, the two mentioned above along with *D. benghalensis* Bakh., *D. mollis* Griff., *D. pubicalyx* Bakh., *D. pubicarpa* Ridl., and *D. wrayi* King & Gamble.

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However, both *Diospyros pubicarpa* and *D. wrayi* were reduced to synonyms of *D. kurzii* by Ng (1978). Later, *Diospyros pubicalyx* was reduced to a synonym of *D. montana* Roxb., a species belonging to *Diospyros* sect. *Acanthebenus* Bakh. (Ng, 2001). In 2005, Singh transferred the Indian species *Diospyros benghalensis* to his new section *Diospyros* sect. *Trichophylla*. Based on its morphology, there is another Thai species that may belong to *Diospyros* sect. *Kurzella*, *Diospyros fulvopilosa* H.R.Fletcher. These developments result in four species in *Diospyros* sect. *Kurzella*: *D. fulvopilosa*, *D. heishi*, *D. kurzii* and *D. mollis*. The fruiting calyx lobes of the new species are quite different from the other species of *Diospyros* sect. *Kurzella*. All other members of this section have small fruiting calyx lobes that are shorter than the fruit, lobes that are nearly symmetrical, ovate, obovate or ovate-elliptic, and incurved. However, the fruiting calyx lobes of the new species are large and longer than the fruit, lanceolate, spreading horizontally or twisted and somewhat similar to *Diospyros caudisepala* Bakh. from *Diospyros* sect. *Caudifera* Bakh. DNA sequence data and phylogenetic analysis have been shown to be useful for examining relationships within *Diospyros* (Duangjai *et al.*, 2006; 2009; 2018). A molecular phylogenetic study would, therefore, be valuable to examine the placement of this new species as well as for testing the monophyly of *Diospyros* sect. *Kurzella*.

The most comprehensive phylogenetic study of Asian *Diospyros* species was that of Duangjai *et al.* (2009), which included 51 Asian species and other 68 species from other regions. They used DNA sequence data from eight plastid regions, i.e. *rbcL*, *atpB*, *matK*, *ndhF*, *trnK* intron, *trnL* intron, *trnL-trnF* spacer, and *trnS-trnG* spacer to examine relationships within the genus. Eleven strongly supported major clades within the genus *Diospyros* were identified (Fig. 1 – modified from Duangjai *et al.*, 2009). The Asian species of *Diospyros* fall into eight different major clades. Four of them are small and consist only

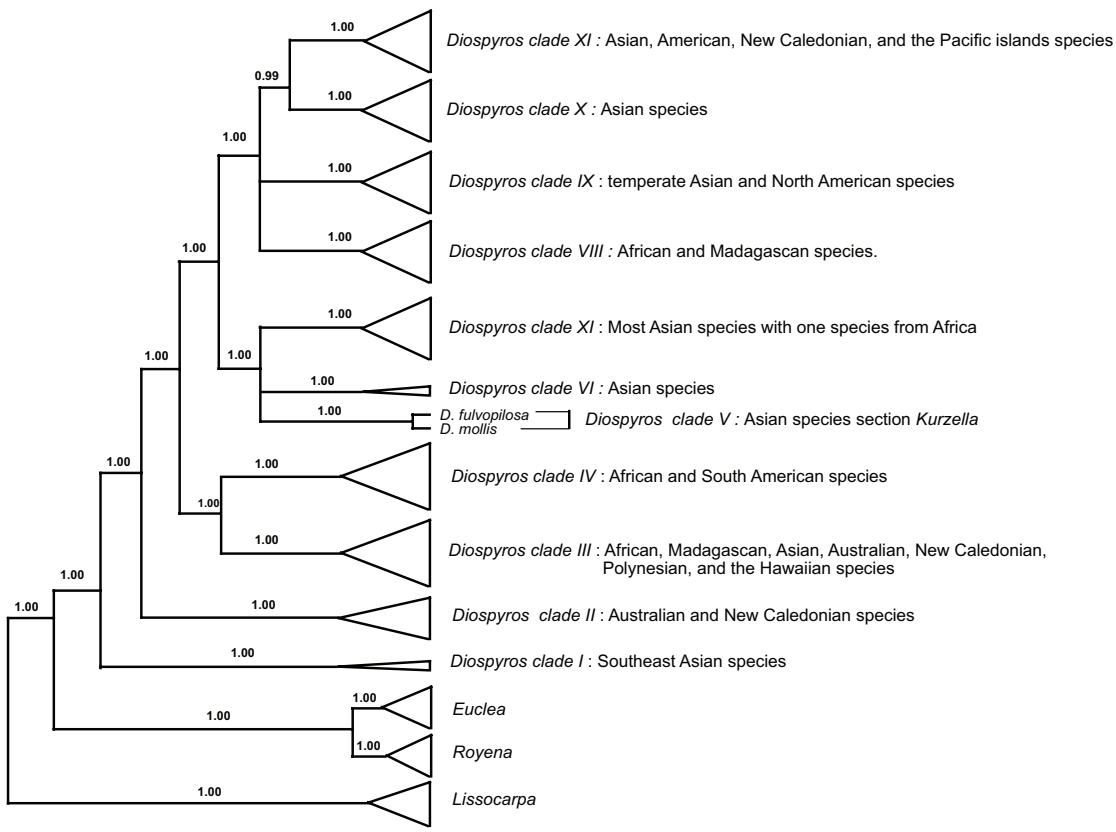

Figure 1. Schematic diagram summarizing relationships among eleven well-supported clades within the genus *Diospyros* (modified from Duangjai *et al*., 2009)

of Asian species. The largest clade is clade XI which contains 38 species from Asia, New Caledonia, North America and South America. Two species of *Diospyros* sect. *Kurzella* and *D. pubicalyx* were included in that study. *Diospyros fulvopilosa* and *D. mollis* fall into clade V (Fig. 1). *Diospyros* pubicalyx falls into the largest clade XI and is close to *D. ebenum* J.Koenig ex Retz (*Diospyros* sect. *Ebenus* Bakh.) rather than to *D. montana*.

In this study, we examine the taxonomic status of a *Diospyros* species from Phu Wua Wildlife Sanctuary, North-Eastern Thailand based on morphological and molecular evidence. We clarify its phylogenetic placement and test the monophyly of *Diospyros* sect. *Kurzella*.

MATERIALS AND METHODS

Collections were made, processed, deposited in BK, BKF, K and SING, and compared to herbarium specimens of *Diospyros* (including type specimens and digital images) at BK, BKF, BM, E, K, L and P (herbarium acronyms according to Index Herbariorum, Thiers, continuously updated). Material of the new species was also compared to descriptions in the relevant literature (Hiern, 1873; Bakhuizen van den Brink, 1936–1955; Ng, 1978; 2001; Phengklai, 1981; 2005; Lee *et al.*, 1996; Singh, 2005; Huang *et al.*, 2015; Udayan *et al.*, 2015; Duangjai *et al.*, 2018). The description below is based on both herbarium specimens and on field surveys during the period 2007–2019. The conservation status of the new species was evaluated following the IUCN Red List Categories and Criteria (IUCN Standards and Petitions Committee, 2019).

To clarify the taxonomic status and phylogenetic placement of the new species, we conducted phylogenetic analyses of the genus *Diospyros* and three other closely related genera in the family Ebenaceae based on sequence data of eight plastid regions (*rbcL*, *atpB*, *matK*, *ndhF*, *trnK* intron, *trnL* intron, *trnL-trnF* spacer, and *trnS-trnG* spacer). In total, 16 accessions representing 15 species are added to the already published data sets (Duangjai *et al.*, 2018). These are new sequence data from two accessions of the new species and one of *Diospyros kurzii*, along with thirteen other *Diospyros* species which have genome sequence data available on GenBank, namely *Diospyros blancoi* A.DC. (KX426216), *D. cathayensis* Steward (MF288576), *D. dumetorum* W.W.Sm. (MF179487), *D. glaucifolia* Metcalt (KM504956), *D. hainanensis* Merr. (MH778100), *D. kaki* L.f. (KT223565), *D. lotus* L. (KM522849), *D. maclurei* Merr. (MH778101), *D. oleifera* W.C.Cheng (KM522850), *D. rhombifolia* Hemsl. (MF288578), *D. strigosa* Hemsl. (MF179495), *D. virginiana* L. (MF288577), and *Diospyros* sp. 'deyangshi' (MF288575). The DNA extraction, PCR amplification, and sequencing of the new species and *Diospyros kurzii* was conducted using the procedures outlined in Duangjai *et al.* (2009). Phylogenetic analyses were performed using both maximum parsimony (MP) and Bayesian inference (BI). Members of *Euclea*, *Lissocarpa*, and *Royena* were chosen as outgroups.

RESULTS AND DISCUSSION

After morphological examination and comparison to the type material and protologues of known *Diospyros* species, it is concluded that the collections of *Diospyros* from Phu Wua Wildlife Sanctuary, North-Eastern Thailand represent a new species, which we describe and illustrate below as *Diospyros phuwuaensis* Duangjai, Rueangr. & Suddee. The morphological differences between the new species and other closely related species are shown in Table 1.

Based on the morphology of the leaves, male flowers and fruits it would appear that the new species is allied to *Diospyros kurzii* and *D. heishe* but it differs from those two species mainly in the number of stamens and in characters of the fruiting calyx lobes (Table 1).

According to sequence data (details provided below), *Diospyros phuwuaensis* is closer to *D. mollis* than to *D. kurzii*. However, it differs from *Diospyros mollis* in flower and fruit characters: it has a white corolla (vs orange-yellow), only 8–10 stamens (vs 14–24), and a 4-locular ovary (vs 8-locular); it also differs in characters of the fruiting calyx lobes.

The new species can be distinguished from *Diospyros fulvopilosa* by its white corolla (vs yellow) and the absence of tomentose hairs on all parts (vs tomentose hairs present). Its fruiting calyx lobes are lanceolate and much larger, spreading horizontally or twisted (vs small fruiting calyx with nearly symmetry lobes, ovate or obovate, and incurved).

Table 1. Morphological differences between *Diospyros phuwuaensis* Duangjai, Rueangr. & Suddee and closely related species and their distribution.

Characters & distribution	*D. phuwuaensis*	*D. kurzii*	*D. heishi*	*D. mollis*	*D. fulvopilosa*
Distribution	Endemic to North-Eastern Thailand	Andamans, Thailand (South-Western and Peninsular), Peninsular Malaysia, Borneo, the Philippines and Maluka	China, Indo-China and the Philippines	Myanmar, Thailand (except Peninsular), and Indo-China	South-Western and Peninsular Thailand
Habit	small trees, 2–3 m tall	medium size trees, 17–20 m tall	small to medium size trees, 5–25 m tall	medium size trees, up to 30 m tall	small trees, up to 7 m tall
Leaves	ovate to ovate-lanceolate or elliptic, (7.1–)7.7–11 × (2.5–)2.9–4.8 cm, glabrous on both surfaces	ovate, obovate, oblong or lanceolate, 4–12 × 2–5 cm, glabrous on both surfaces	lanceolate, oblong- lanceolate, 5–9 × 1.5–3.3 cm, subglabrous on both surfaces	ovate to ovate-oblong, 4–8 × 1.5–4 cm, pubescent then glabrescent on both surfaces	lanceolate, oblong- lanceolate, 5–10 × 2–4 cm, pubescent then glabrescent except pubescent midrib
Corolla colour	white	white	white	light green outside and orange yellow inside	yellowish green outside and yellow inside
Stamens	8–10	14–16	16	14–24	16
Ovary	4-locular, glabrous	4-locular, glabrous	4-locular, glabrous	8-locular, pubescent	4-locular, tomentose
Fruit size	1.3–1.8 cm in diameter	1.5–2.5 cm in diameter	1–1.25 cm in diameter	1.8–2.1 cm in diameter	1.5–2 cm in diameter
Fruiting calyx	lobes lanceolate, 19–30 × 4–6.3 mm, lobes much longer than fruit, not reflexed	lobes ovate or obovate, 5–7 × 4–5 mm, lobes shorter than fruit, lateral reflexed (incurved)	lobes ovate-elliptic, 5–7 × 3–5 mm, lobes shorter than fruit, lateral reflexed (incurved)	lobes ovate, 7–10 × 11–13 mm, lobes shorter than fruit, lateral reflexed (incurved)	lobes ovate or obovate, 6–8 × 6–8 mm, lobes shorter than fruit, lateral reflexed (incurved)

For this study, we generated 18 new sequences of eight plastid regions of the new species (voucher *Suddee et al. 5549* and *Suddee et al. 5565*) and *Diospyros kurzii* (voucher *Sinbumroong & Chalermwong 2019.sn*) and they were submitted to GenBank (GenBank accession numbers MN850778–MN850795). The aligned length of the combined dataset (*rbcL*, *atpB*, *matK*, *ndhF*, *trnK* intron, *trnL* intron, *trnL-trnF* spacer, and *trnS-trnG* spacer) was 8,293 bp, of which 1,975 sites were variable and 1,123 were informative. The MP analysis yielded 24,000 equally parsimonious trees with 3,435 steps (consistency index, CI = 0.67; retention index, RI = 0.84). Both maximum parsimony and Bayesian inference analyses were generally congruent. The Bayesian analysis is presented in Fig. 2A and part of the most parsimonious tree to show clades V–VII (as defined in Duangjai *et al.*, 2009) is shown in Fig. 2B. The clades in this study are congruent to those previously published (Duangjai *et al.* 2009; 2018).

The new species from Phu Wua Wildlife Sanctuary and *Diospyros kurzii* are placed in the *Diospyros* clade V. Within this clade, two accessions of *Diospyros phuwuaensis* are grouped together with high support (BP 100, PP 1.00) and have a sister relationship to *D. mollis* with high support (BP 100, PP 1.00). This clade has a sister relationship to the subclade of *Diospyros kurzii* + *D. fulvopilosa* (BP 100, PP 1.00). Clade V (BP = 100, PP = 1.00) is closely allied to clade VI (BP = 100, PP = 1.00) and clade VII (BP = 100, PP = 1.00). The DNA sequences of the two individuals of *Diospyros phuwuaensis* are identical and show substantial differences from other species of *Diospyros* (Fig. 2), supporting its recognition as a distinct taxon.

Two species of *Diospyros* sect. *Kurzella*, represented here by *D. mollis* and *D. kurzii*, are in *Diospyros* clade V along with *D. fulvopilosa* and *D. phuwuaensis*. The sister clade VI includes the two Asian species *Diospyros* borneensis Hiern and *D.* cf. *ulo* Merr. (Fig. 2). These two species have larger fruits (ca 5.0 cm in diameter) with a very thick epicarp, differing from those of *Diospyros* clade V (ca 1.0–2.5 cm in diameter). They also differ in their leaf size, with the species of clade VI having larger leaves (10.0–30.0 × 4.0–12.5 cm) than clade V (4.0–12.0 × 1.5–5.0 cm). Bakhuizen van den Brink placed *Diospyros borneensis* and *D. ulo* in *Diospyros* sect. *Truncicalyx* Bakh. From the molecular results, the monophyly of *Diospyros* sect. *Kurzella* can be maintained if *D. pubicalyx*, which resolves in clade XI and is close to *D. ebenum*, is excluded. From field observations by the first author, *D. pubicalyx* is indeed more similar to *D. ebenum* than to the other species of *Diospyros* sect. *Kurzella*. *Diospyros* sect. *Kurzella* now includes *D. fulvopilosa*, *D. heishi*, *D. kurzii*, *D. mollis* and *D. phuwuaensis*, as confirmed by our molecular results (Fig. 2), except for the placement of *D. heishi* which has not been sampled. However, *D. heishi* is morphologically very close to *D. kurzii* (Table 1) and its placement in the section is unlikely to change when DNA sequences becomes available.

The placement of the remaining 13 species included in the phylogenetic analysis of *Diospyros* is shown for the first time in Fig. 2A. The identifications of the two samples of *D. rhombifolia* will need to be investigated as they do not form a sister group.

TAXONOMIC TREATMENT

A revised description of *Diospyros* sect. *Kurzella* is provided here.

Leaves ovate, ovate-lanceolate, oblong-lanceolate or elliptic, 4–12 cm long, coriaceous or subcoriaceous, black when dry, secondary veins densely but thinly nerved. Inflorescence axillary, cymose, 4(–5)-merous. Corolla urceolate or tubular-urceolate, white or yellow, black when dry. Stamens 8–24, unequal, paired. Ovary 4-locular or 8-locular, each locule uniovulate. Fruits small, ca 1.5–2.5 cm in diameter, ovoid to ellipsoid, shining, black when ripe, endosperm smooth.

KEY TO THE SPECIES OF DIOSPYROS SECT. KURZELLA

1. Ovary 8-locular **D. mollis**
1. Ovary 4-locular
 2. Fruiting calyx lobes lanceolate, lobes much longer than fruit, not reflexed; stamens 8–10 **D. phuwuaensis**
 2. Fruiting calyx lobes ovate, ovate-elliptic or obovate, lobes shorter than fruit, incurved; stamens 14–16
  3. Corolla yellowish-green outside and yellow inside; young branches, leaves and mature fruit covering with dense fulvous-pilose hairs **D. fulvopilosa**
  3. Corolla white; young branches, leaves and mature fruit glabrous or sub-glabrous
   4. Fruit 1.5–2.5 cm in diameter **D. kurzii**
   4. Fruit 1.0–1.25 cm in diameter **D. heishi**

Diospyros phuwuaensis Duangjai, Rueangr. & Suddee, **sp. nov.** (Figs. 3–4).

Similar to *Diospyros kurzii* and *D. heishi* in leaf shape, texture and venation pattern, and in the tubular-urceolate and white corolla of the male flowers. *Diospyros phuwuaensis* differs in having 8–10 stamens (vs 14–16 in *D. kurzii* and *D. heishi*); larger, lanceolate calyx lobes which are much longer than the fruit (vs smaller, ovate, obovate or ovate-elliptic calyx lobes which are shorter than the fruit in *D. kurzii* and *D. heishi*). Type: Thailand, Bueng Kan, Bung Khla District, Phu Wua Wildlife Sanctuary, Tham Noi Waterfall, 246 m alt., 8 Feb. 2018, *Suddee, Hemrat & Kiewbang 5345* (holotype **BKF!**, isotypes **BK!**, **BKF!**, **K!**).

Shrub or small tree, 2.0–3.0 m tall. *Bark* smooth and sparsely lenticellate, blackish-brown to brown, inner bark thin, yellow, outer margin black; sapwood white; branches horizontal, arranged in pseudowhorls; young branchlets green, rusty puberulous, older branchlets green or greenish-brown, rusty puberulous, smooth; buds covered with shortly appressed brown hairs. *Leaves* alternate; petiole 1.5–3.0 mm long, with dense short brown hairs, glabrescent; lamina ovate, ovate-lanceolate or elliptic, (7.1–)7.7–11 × (2.5–)2.9–4.8 cm, apex acuminate, rarely acute, base rounded or obtuse, rarely cuneate, margin entire, subcoriaceous, dark green above, pale green below, glabrous on both surfaces, blackish when dry; midrib impressed

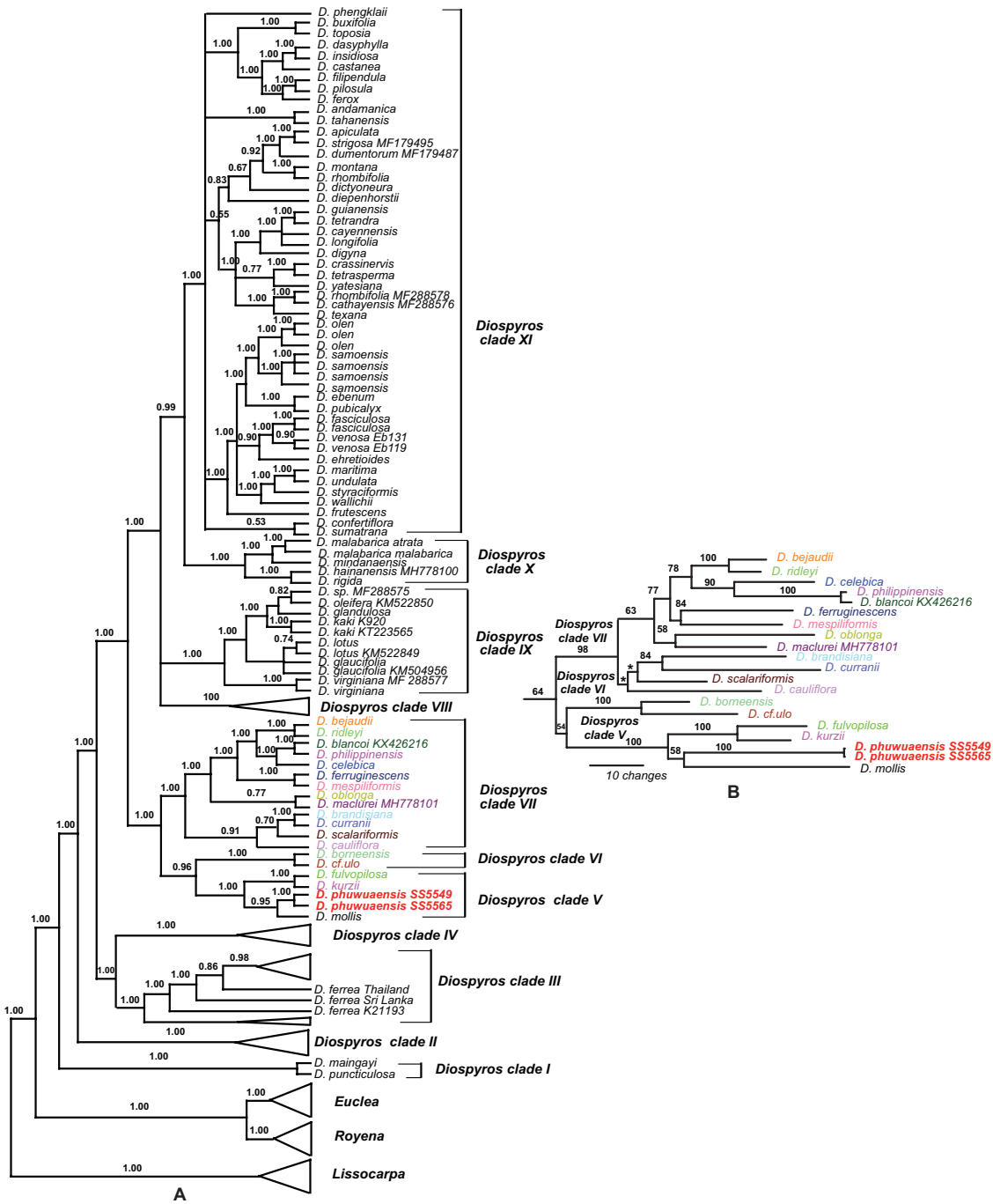

Figure 2. Phylogenetic trees of *Diospyros* and related genera based on DNA sequence data from eight plastid regions. The new species, *D. phuwuaensis* Duangjai, Rueangr. & Suddee, is indicated in bold font. A. 50 % majority-rule tree from Bayesian inference. Posterior probability values (PP) higher than 0.50 are given above branches. B. Phylogram of one of 24000 equally parsimonius trees, which only displays the details of *Diospyros* clade V-VII. Bootstrap percentages (BP) higher than 50 are given above branches. Nodes indicated by an asterisk are not resolved in the parsimony strict consensus tree.

above, raised below, glabrescent, secondary veins 7–10, slightly impressed above, raised below, faintly ascending towards apex, anastomosing. *Flowers* unisexual and plants dioecious (but some hermaphrodite flowers found on male plants). *Male flowers* in short 3-flowered cymes, 4(–5)-merous, sessile or subsessile, with short appressed hairs; calyx light green, bowl-shaped, lobes triangular, 0.6–1 mm long, pubescent outside, glabrous inside; corolla white, tubular-urceolate, 3.5–4.5 mm long, lobes ovate-triangular, one third of corolla length; stamens 8–10, united in pairs at the bases of unequal filaments; anthers broadly lanceolate, glabrous; rudimentary ovary glabrous. *Bisexual flowers* like the male flowers but slightly larger, solitary on older branches below the leaves, 4(–5)-merous, sessile or subsessile; calyx as in male flowers but slightly larger; corolla urceolate; stamens 8–10; ovary ovoid, glabrous, 4-locular; style single, glabrous. *Female flowers* solitary, in the axils of the leaves or on older branches below the leaves, 4(–5)-merous, sessile or subsessile; calyx green, without a tube, deeply divided, glabrous, lobes lanceolate, 4–5.3 mm long; corolla white, urceolate, 6–8 mm long, lobed to ⅖ of corolla length; ovary glabrous, 4-locular; style single, glabrous; staminodes 4. *Fruits* light green when immature, turning yellow and dark purple when mature and black when ripe, shiny, ovoid to ellipsoid, 1.3–1.8 × 1.3–1.8 cm, apex rounded, shortly apiculate, 4-locular; seeds 1–2 per fruit, 2–3 can abort, endosperm smooth; fruiting calyx divided to the base, lobes lanceolate, spreading horizontally or twisted, 19–30 × 4–6.3 mm; fruit stalk 1–1.5 mm long.

Thailand.— NORTH-EASTERN: Bueng Kan [Bung Khla District, Phu Wua Wildlife Sanctuary, Tham Noi Waterfall, 18°13′45.90″N, 103°21′54.26″E, 246 m alt., 8 Feb. 2018, fruits, *Suddee et al. 5345* (**BK!**, **BKF!**, **K!**); ibid, 180 m alt., 16 Oct. 2007, fruits, *Suddee et al. 3367* (**BKF!**); ibid, 18°13′52″N, 103°57′23″E, 237 m alt., 12 June 2013, female flowers and young fruits, *Suddee et al. 4498* (**BKF!**); ibid, 18°13′52″N, 103°57′23″E, 237 m alt., 12 June 2013, male flowers, *Suddee et al. 4500* (**BKF!**); ibid, 18°13′58″N, 103°57′50″E, 246 m alt., 15 Oct. 2019, fruits, *Suddee et al. 5565* (**BKF!**); Seka District, Phu Wua Wildlife Sanctuary, Tham Phra, 18°08′16″N, 103°59′50″E, 190 m alt., 6 Oct. 2015, fruits, *Middleton et al. 5936* (**BKF!**, **SING!**)]; ibid., 14 Oct. 2019, fruits, *Suddee et al. 5549* (**BKF!**)].

Vernacular.— Ma phlap phu wua (มะพลับภูวัว).

Distribution and habitat.— Endemic to North-Eastern Thailand, only known from Phu Wua Wildlife Sanctuary.

Ecology.— Along streams in dry evergreen forest at 180–300 m elevation.

Proposed IUCN conservation assessment.— This species is known only from two localities in Phu Wua Wildlife Sanctuary with an extent of occurrence of around 900 km^2. One population occurs near a popular waterfall which is disturbed by tourist activities. The overall population size is estimated to number fewer than 200 mature individuals. It is assessed here as Endangered, EN B1ab(iii), D, following IUCN criteria (2019).

Phenology.— Flowers have been collected in February and June, young fruits have been collected from February to October, and mature fruits in October 2007.

Etymology.— The epithet refers to the locality.

Notes.— There are several species of *Diospyros* found in Phu Wua Wildlife Sanctuary, eg. *D. bangoiensis* Lecomte, *D. filipendula* Pierre ex Lecomte, *D. strigosa* Hemsl., *D. undulata* Wall. ex G.Don and *D. winitii* H.R.Fletcher. *Diospyros phuwuaensis* closely resembles *D. kurzii* and *D. heishi*, which have similar male flowers and leaves. So far, *Diospyros phuwuaensis* is the only species in Thailand that has fruiting calyx lobes longer than fruit and this remarkable fruiting calyx distinguishes it from the other species of *Diospyros* sect. *Kurzella*.

Although dioecy is common amongst *Diospyros* species, there are some species that also have hermaphrodite flowers, such as *D. kurzii* and *D. heishi* (Bakhuizen van den Brink, 1936–1955). We have observed that *Diospyros mollis*, *D. discocalyx* Merr., *D. gracilis* H.R.Fletcher, and *D. wallichii* King & Gamble also have hermaphrodite flowers. Some of the male plants of the new species *Diospyros phuwuaensis* also have hermaphrodite flowers (Fig. 4E). The new species described here is compared to *D. kurzii*, *D. heishi*, *D. mollis* and *D. fulvopilosa* in Table 1, and cannot be confused with the other three species because of the lanceolate calyx lobes which are much longer than the fruit.

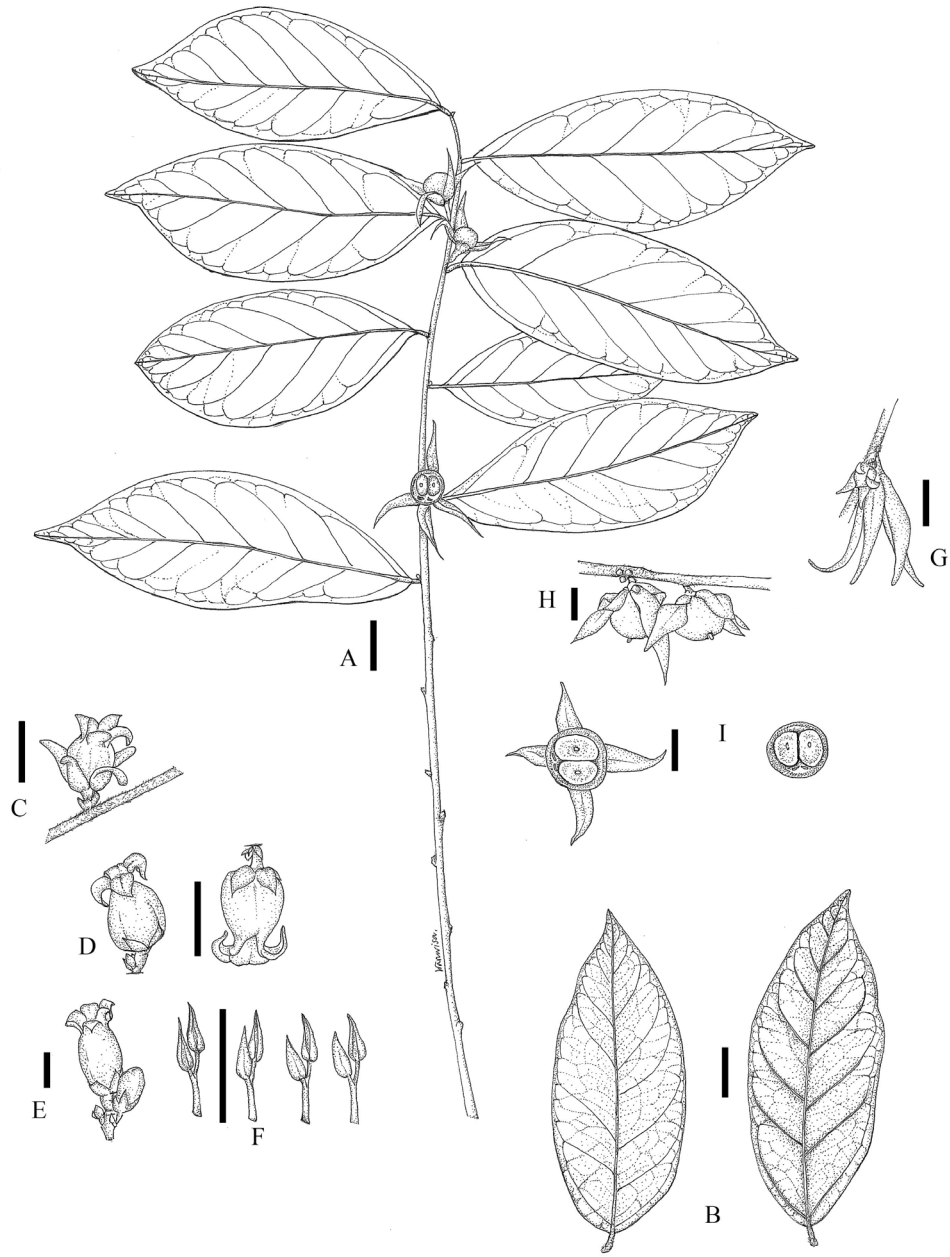

Figure 3. *Diospyros phuwuaensis* Duangjai, Rueangr. & Suddee. A. fruiting branchlet; B. adaxial (left) and abaxial (right) side of leaf; C. female flower; D. hermaphrodite flower; E. male flowers; F. stamens; G. young fruit; H–I. fruits (A and B from *Suddee et al. 5345* (**BKF**), C, D and G from photographs taken by Sukid Rueangruea on 12 June 2013, E and I from photographs taken by W. Kiewbang on 9 February 2018, F from *Suddee et al. 4498*, H from photographs taken by T. Phutthai on 16 October 2007. Scale bars: A–B and G–I = 2 cm, C–D and F = 5 mm, E = 3 mm. Drawn by W. Bhuchaisri.

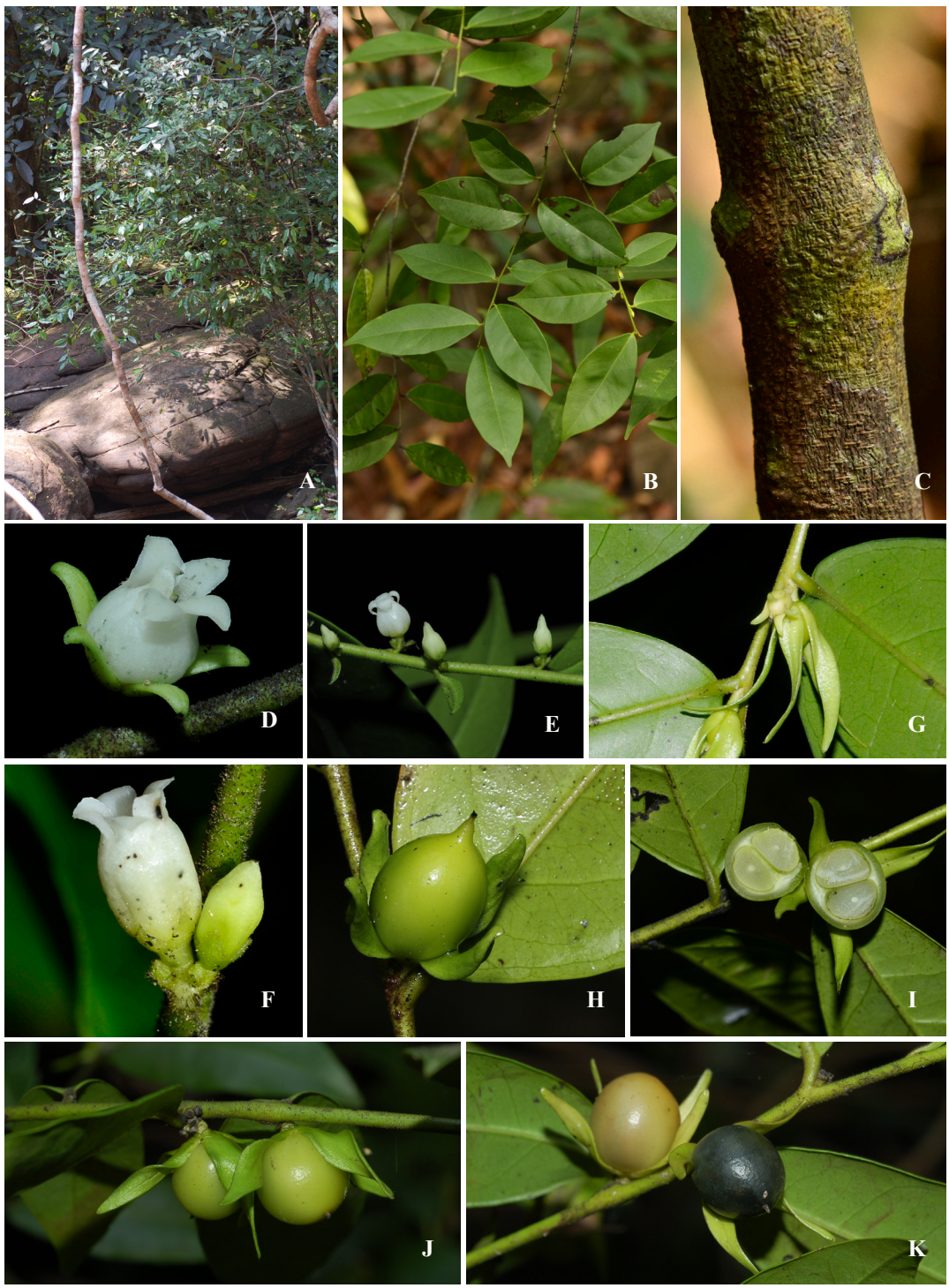

Figure 4. *Diospyros phuwuaensis* Duangjai, Rueangr. & Suddee. A. habit; B. leaves; C. stem & bark; D. female flower; E. hermaphrodite flower; F. male flower; G. young fruit; H–K. fruits. Photographed by T. Phutthai (A, J and K), W. Kiewbang (B–C, F and I), P. Trisarasri (D), S. Rueangruea (E–G), and P. Karaket (H).

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