



New records of flowering plants collected from the Phou Khao Khouay National Biodiversity Conservation Area for the flora of Laos

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ABSTRACT: We report 14 species of flowering plants as new additions to the flora of Laos. These are *Illex viridis* (Aquifoliaceae), *Capparis erycibe* (Capparaceae), *Euphorbia bokorensis* (Euphorbiaceae), *Exacum darae* (Gentianaceae), *Aeschynanthus cambodiensis* (Gesneriaceae), *Tetraphyllum roseum* (Gesneriaceae), *Utricularia gibba* (Lentibulariaceae), *Macrosolen brandisianus* (Loranthaceae), *Decaschistia siamensis* (Malvaceae), *Nyssayunnanensis* (Nyssaceae), *Adenia penangiana* var. *penangiana* (Passifloraceae), *Pentaphylax euryoides* (Pentaphylacaceae), *Wikstroemia bokorensis* (Thymelaeaceae), and *Debregeasia wallichiana* (Urticaceae). We discovered the species during a botanical survey of the Phou Khao Khouay National Biodiversity Conservation Area (PKKNBCA) of Lao PDR in 2015–2019. In addition, nine rarely collected flowering plant species in Laos are newly reported for the PKKNBCA.

Keywords: unreported species, flowering plants, flora, Phou Khao Khouay National Biodiversity Conservation Area (PKKNBCA), Lao PDR

The flora of Laos is one of the least known in the region, primarily due to the lack of botanical exploration, expertise, and research, also hampered by the Indochinese wars (Newman et al., 2007). Since Newman et al. (2007) compiled a checklist for vascular plants of Lao PDR as having 5,005 species, there have been a steady increase in new records of vascular plants in Laos. For example, Lanorsavanh and Chantaranonthai (2013, 2019), Lanorsavanh et al. (2020) reported new records and species of *Argostemma* (Rubiaceae); Leong-Škorničková et al. (2014), Newman (2015), Souvannakhoummane and Leong-Škorničková (2018), and Tanaka et al. (2020) reported new species and records of Zingiberaceae; Souvannakhoummane and Suksathan (2015) reported two new species of *Impatiens* (Balsaminaceae); Lim et al. (2015) reported three unrecorded species: *Phyllagathis tuberosa* (Melastomataceae), *Tolypanthus pustulatus* (Loranthaceae), and *Lonicera bournei* (Caprifoliaceae); Fici (2016), Fici et al. (2017, 2020), Souvannakhoummane et al. (2018), and Fici and Souvannakhoummane (2020) reported new

species of *Capparis* (Capparaceae); Prosperi et al. (2018) reported 27 taxa from Khammouane Limestone Area (Phou Hin Poun NBCA); Rodda and Meve (2017) reported *Ceropegia laotica* (Apocynaceae); Souladeth et al. (2017) reported *Strobilanthes namkadingensis* (Acanthaceae); Suetsugu et al. (2018) reported *Lecanorchis taiwaniana* (Orchidaceae); Tagane et al. (2018b) reported *Monoon namkadingense* and *Neouvaria laosensis* (Annonaceae); Tagane et al. (2018a) reported 30 new records of flowering plants from Nam Kading National Protected Area; Yang et al. (2018) reported *Begonia namkadingensis* (Begoniaceae); Souladeth et al. (2019) reported two new species of *Camellia* (Theaceae); Nagahama et al. (2019) reported *Gentiana bolavenensis* (Gentianaceae); Souvannakhoummane et al. (2019) and Souvannakhoummane and Phonepaseuth (2020) reported new species of *Didymocarpus* (Gesneriaceae); Panyadee et al. (2020) reported two new records of Gesneriaceae (*Damrongia triseipala* and *Didymocarpus formosus*); Souladeth et al. (2020) reported two new records of *Eriocaulon*

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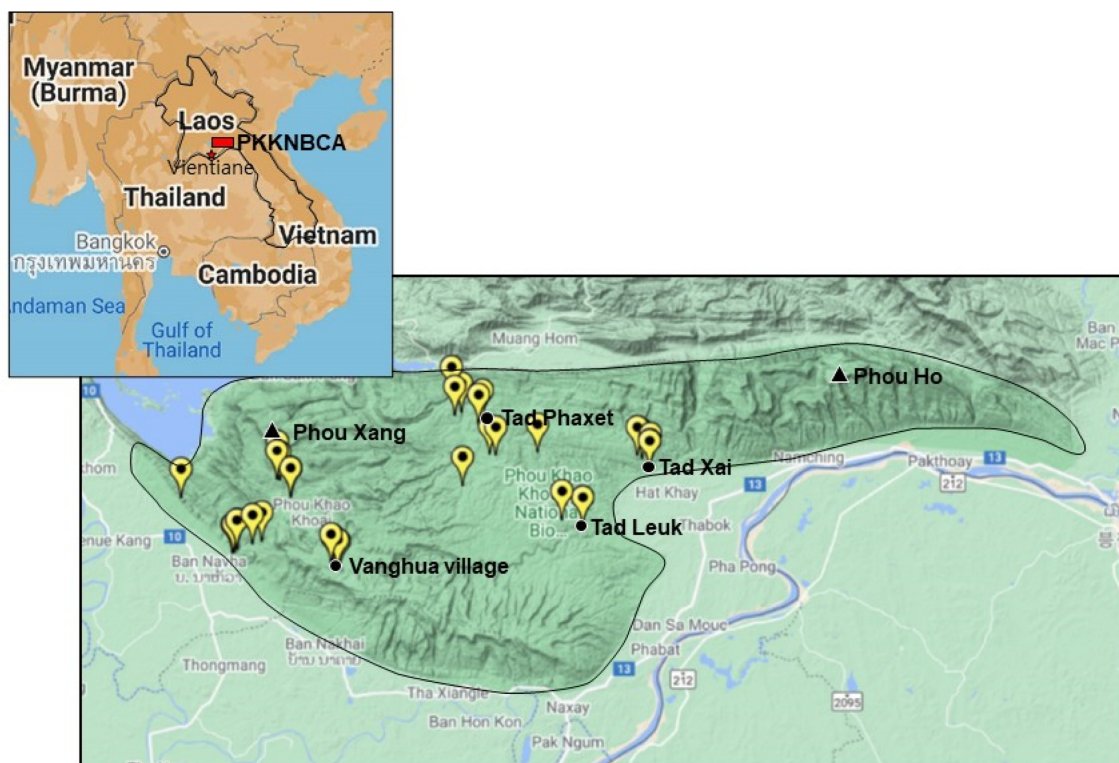


Fig. 1. Map showing the geographical location of Phou Khao Khouay National Biodiversity Conservation Area (PKKNBCA), Lao PDR, and the collection sites of the new records of flowering plants from PKKNBCA presented in this paper.

(Eriocaulaceae); Suddee et al. (2020) reported *Coleus bolavenensis* (Lamiaceae); Yang et al. (2020) reported a new species and two new records of *Goniothalamus* (Annonaceae); Tagane et al. (2020a) and Tagane et al. (2020b) successively reported new plant records from Bolaven Plateau of southern Laos - two new species and 18 new plant records, and 25 new plant records, respectively; Tagane et al. (2020c) reported *Diospyros laoensis* (Ebenaceae); Phonepaseuth et al. (2021a) reported two new *Sonerila* species, *S. erectifolia* and *S. souvannii* (Melastomataceae); Phonepaseuth et al. (2021b) reported new species of *Paraboea* and *Middletonia* (Gesneriaceae); Souladeth et al. (2021) reported *Impatiens subfalcata* (Balsaminaceae); Yamazaki et al. (2021a, 2021b) reported *Strobilanthes bolavenensis* and *Justicia vagabunda* var. *laxiflora* (Acanthaceae), respectively. Therefore, the checklist of vascular plants of Lao PDR is continuously being updated (Newman et al., 2017–present; <https://padme.rbge.org.uk/laos/>).

Phou Khao Khouay National Biodiversity Conservation Area (PKKNBCA) is one of the 23 national protected areas of Lao PDR, located ca. 40 km northeast of Vientiane, the capital of the country (Fig. 1). PKKNBCA is stretched over Vientiane and Bolikamxai provinces, ranging from 100 m to 1,700 m in

elevation. PKKNBCA ranges from evergreen dipterocarp to mixed deciduous, dry dipterocarp, and coniferous forest and fire-climax grasslands (Soukhavong et al., 2013; Nanthavong, 2015). Between December 2015 and September 2019, we collected and surveyed the area to document the seed plant biodiversity of the area, in collaboration with the Department of Forestry, Ministry of Agriculture and Forestry, of the Lao PDR. Here, we are reporting 14 flowering plant species new for the flora of Laos and nine rarely collected species that are first reported for PKKNBCA.

Materials and Methods

We surveyed PKKNBCA between December, 2015 and September, 2019 and made ca. 1,180 collections. Specimens collected from PKKNBCA are deposited at the herbarium of National Institute of Biological Resources (KB), Ministry of Environment, Republic of Korea, with duplicates stored at the herbarium of Faculty of Forestry, National University of Laos (FOF) and Daegu University herbarium (DGU). Some collections with incomplete identification are currently stored at DGU and will be deposited both at KB and FOF, upon completion of

identification.

To identify species and confirm distribution records in Laos, we first checked relevant plant taxonomic literatures in the region, such as Flore du Cambodge, du Laos et du Vietnam (Aubreville et al. 1960–present), Flora of Thailand (Smitinand and Larsen, 1970–present), and Flora of China (Wu et al., 1994–2003), and the checklist of the vascular plants of Laos (Newman et al., 2017–present; <https://padme.rbge.org.uk/laos/>) were consulted. We also examined specimens at the Forest Herbarium, Bangkok (BKF), Bangkok Herbarium (BK), and Queen Sirikit Botanical Garden Herbarium (QBG), especially of Melastomataceae and Gesneriaceae. We also examined specimen images available on the web, such as the JSTOR Global Plant (<https://plants.jstor.org>), Royal Botanical Garden Edinburgh (E), (<http://data.rbge.org.uk>), Museum National d’Histoire Naturelle (P), and GBIF website.

Results and Discussion

We discovered 14 species of flowering plants that are new

for the flora of Laos, three are known endemics to Cambodia, one to Thailand, one to China, and one to Cambodia and Thailand. The other species are fairly widely distributed in SE Asia. Also, we found nine species of flowering plants, rarely collected from Laos. Two of the nine species are only known from type localities in Laos, and the others are only enlisted in Newman et al. (2017–present) without voucher information.

New flowering plant records for the flora of Laos, collected from PKKNBCA

Aquifoliaceae

1. *Ilex viridis* Champ. ex Benth., Hooker's J. Bot. Kew Gard. Misc. 4: 329, 1852 (Fig. 2A).

Ilex viridis is an evergreen small tree or shrub. For the flora of Laos, three *Ilex* species have been reported—*I. euginifolia* Pierre, *I. godajam* (Colebr.) Hook. f., and *I. rotunda* Thunb. (Newman et al., 2017–present). *Ilex viridis* is characterized by its axillary, 1 to few flowered cyme.

Distribution: China, Laos, Thailand, Vietnam.



Fig. 2. New record of flowering plants for the flora of Laos (1). **A.** *Ilex viridis* Champ. ex Benth. (Aquifoliaceae). **B.** *Capparis erycibe* Hallier. f. (Capparaceae). **C.** *Euphorbia bokorensis* H. Toyama & Tagane (Euphorbiaceae). **D.** *Exacum darae* Hul (Gentianaceae).

Specimens examined: LAOS. Vientiane: Thoulakhom District, PKKNBCA, at the thick forest east of the Nam Mang River, at east of the Nam Mang 3 Dam, near Vang Hua village, along the trail in thick forest, 18°21'27.6"N, 102°48'27.3"E, elev. 761 m, 2 Jun 2017, *Hyosig Won et al. 15670* (DGU, FOF, KB).

Capparaceae

2. *Capparis erycibe* Hallier. f., Bull. Herb. Boissier 6: 216, 1898 (Fig. 2B).

Capparis erycibe is a perennial climber, characterized by its inflorescences consisted of subumbels arranged in panicle and leaves elongate, obovate or oblong (Chayamarit, 1991).

Distribution: Indochina, Malay Peninsula, Sumatra, Java, Borneo, Thailand.

Specimens examined: LAOS. Bolikamxai: Thaphabat District, PKKNBCA, at the north part of the Nam Leuk Reservoir, near Tad Phaxet, at the road junction between Nam Leuk and Muang Hom, at rocky area under shaded forest, 18°30'35.2"N, 102°56'38.7"E, elev. 526 m, 22 Aug 2016, *Hyosig Won et al. 15418* (DGU, FOF, KB); Thaphabat District, PKKNBCA, near the Tad Xai Waterfall, 18°27'16.9"N, 103°08'29.3"E, elev. 330 m, 19 Jul 2017, *Hyosig Won et al. 15999* (DGU, FOF, KB).

Euphorbiaceae

3. *Euphorbia bokorensis* H. Toyama & Tagane, Acta Phytotax. Geobot. 67: 92, 2016 (Fig. 2C).

Toyama et al. (2016) described *E. bokorensis* based on specimens collected from Bokor National Park, Cambodia. Until now, *E. bokorensis* has only been reported from the Bokor National Park, and the current discovery of *E. bokorensis* from Laos suggests that *E. bokorensis* may also be distributed widely in Indochina. It is distributed in the understory of dense humid evergreen forests along a stream leading to the Tad Xai Waterfall of PKKNBCA.

Distribution: Cambodia, Laos.

Specimens examined: LAOS. Bolikamxai: Thaphabat District, PKKNBCA, about 1.5 km NW of the Tad Xai Waterfall, at the margin of the open rock bed, 18°27'47.2"N, 103°08'03.3"E, elev. 394 m, 12 Nov 2017, *Hyosig Won et al. 16236* (DGU, FOF, KB).

Gentianaceae

4. *Exacum darae* Hul, Edinburgh J. Bot. 67: 155, 2010 (Fig. 2D).

Newman et al. (2007) reported two *Exacum*, *E. pteranthum* Wall. ex G. Don and *E. tetragonum* Roxb., for the flora of Laos. Hul (2010) recognized a slender and smaller form of *E.*

sutapaense Hosseus ex Craib (var. *gracile*) as a distinct species, *E. darae*. *Exacum darae* is distributed in the Cardamom Mountains areas of Cambodia at ca. 1,000 m elevation and Me Tawn and Me Sawi (ca. 1,550–1,700 m), Doi Suthep (ca. 1,600 m), Doi Pui (ca. 1,600 m) of Chiang Mai Province and Khao Pawta Luang Keow (ca. 1,200–1,300 m) of the peninsular area of Thailand. The new collections were made from the open grassy area of Mt. Phou Xang, elevations ranging from 1,400–1,600 m.

Distribution: Cambodia, Laos, Thailand.

Specimens examined: LAOS. Vientiane: Thoulakhom District, PKKNBCA, along the south ridge leading to the rim of Phu Xang, open grassy slopes, 18°26'27.7"N, 102°45'08.5"E, elev. 1,440 m, 9 Sep 2019, *Hyosig Won et al. 17058* (DGU, FOF, KB); Thoulakhom District, PKKNBCA, along the middle ridge leading to the rim of Phu Xang, open grassy area, 18°27'05.8"N, 102°44'59.3"E, elev. 1,609 m, 9 Sep 2019, *Hyosig Won et al. 17077* (DGU, FOF, KB).

Gesneriaceae

5. *Aeschynanthus cambodiensis* D. J. Middleton, Edinburgh J. Bot. 66: 408, 2009 (Fig. 3A).

Aeschynanthus cambodiensis has been reported as endemic of Cambodia, only collected from Ratanakiri Province so far. *Aeschynanthus cambodiensis* was collected from three different places in PKKNBCA during our field trip in November 2017. These collections match exactly with the description and key characteristics of *A. cambodiensis*, recognized by Middleton (2009). Compared to *A. longicaulis* Wall. ex R. Br., distributed in eastern Myanmar, western and southern Thailand, and Peninsular Malaysia, *A. cambodiensis* has glabrous calyx lobes almost the length of corolla, while *A. longicaulis* has calyx lobes glabrous or with sparse glandular hairs about 1/2 the length of corolla (Middleton, 2016).

Distribution: Cambodia, Laos.

Specimens examined: LAOS. Bolikamxai: Thaphabat District, PKKNBCA, near Tad Xai Waterfall, along the trail in thick forest, 18°27'20.0"N, 103°08'31.7"E, elev. 334 m, 12 Nov 2017, *Hyosig Won et al. 16233* (DGU); Thaphabat District, PKKNBCA, about 2 km NW of the Tad Xai Waterfall, along the trail in thick forest, near the open rock area, 18°27'58.6"N, 103°07'44.9"E, elev. 410 m, 12 Nov 2017, *Hyosig Won et al. 16240* (DGU). Vientiane: Thoulakhom District, PKKNBCA, at restaurant near the river crossing over the Nam Mang River, downstream of the Nam Mang 3 Dam, near the Vang Hua Village, 18°21'07.4"N, 102°48'50.6"E, elev. 748 m, 10 Nov 2017, *Hyosig Won et al. 16162* (DGU, FOF, KB).

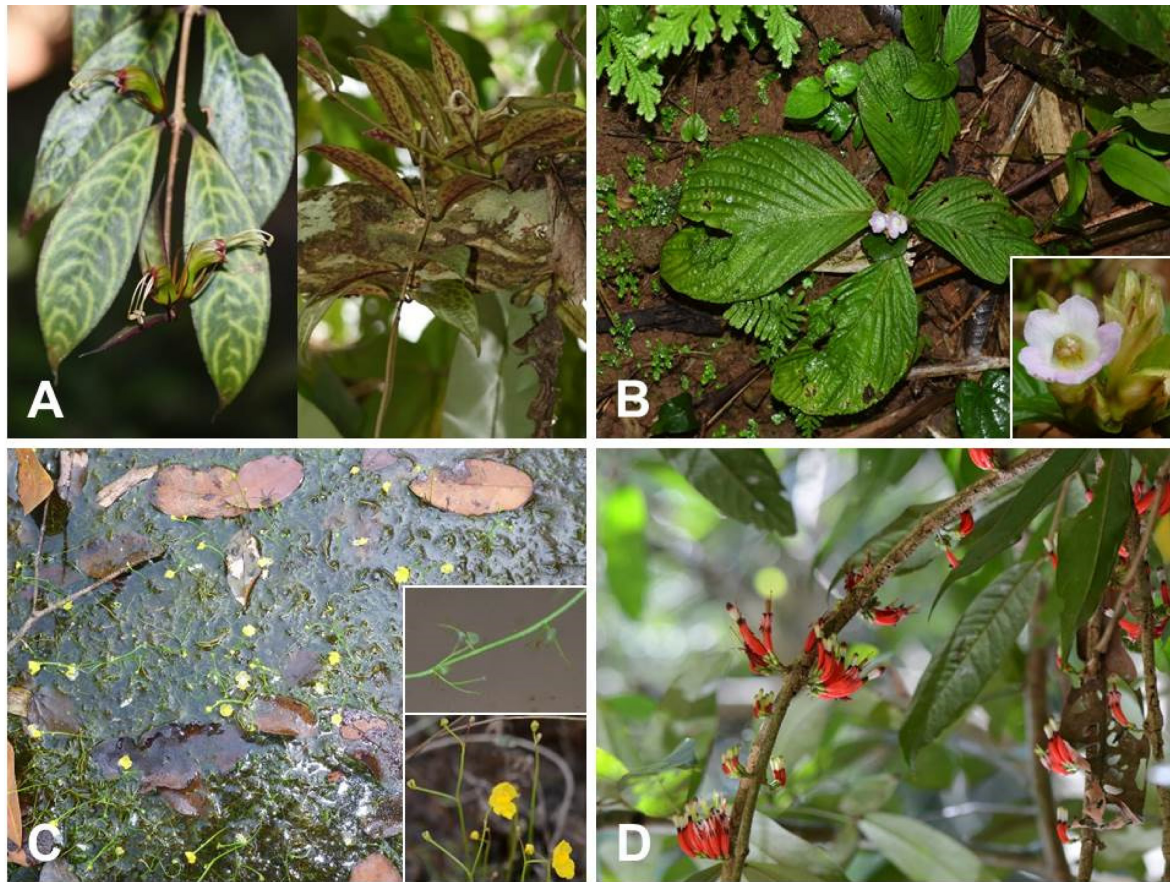


Fig. 3. New record of flowering plants for the flora of Laos (2). **A.** *Aeschynanthus cambodiensis* D.J. Middleton (Gesneriaceae). **B.** *Tetrphyllum roseum* Stapf (Gesneriaceae). **C.** *Utricularia gibba* L. (Lentibulariaceae). **D.** *Macrosolen brandisianus* (Kurz) Tiegh. (Loranthaceae).

6. *Tetrphyllum roseum* Stapf, J. Linn. Soc., Bot. 32: 524, 1896. (Fig. 3B).

Tetrphyllum spp. are perennial herbaceous plants and characterized by its four leaves in a whorl on top of stem (Möller et al., 2017; Weber et al., 2020). So far three species, *T. bengalensis* C. B. Clarke, *T. confertiflorum* (Drake) B. L. Burtt, and *T. roseum*, have been recognized in the world, and this is the first time *Tetrphyllum* is reported for the flora of Laos. *Tetrphyllum roseum* lives on vertical earth bank in partly shaded area and flowers in July. Like *Didymocarpus* spp., it develops much smaller and hairy leaves before the start of the dry season and the larger leaves are dried and fall off over the dry season. The larger leaves develop with the start of the rainy season.

Distribution: Malaysia, Laos, Thailand.

Specimens examined: LAOS. Vientiane: Thoulakhom District, PKKNBCA, along the old trail toward Vang Hua village, north of Ban Phonemuang, on vertical slope, 18°22'08.0"N, 102°42'12.4"E, elev. 235 m, 22 Jul 2017, *Hyosig*

Won et al. 16105 (DGU); Thoulakhom District, PKKNBCA, along the stream leading to the Nam Pot IDP reservoir, flowing from PKKNBCA, along the old trail, north of Ban Phonemuang on steep earth surface along the stream, 18°22'10.0"N, 102°42'15.6"E, elev. 252 m, 10 Nov 2017, *Hyosig Won et al. 16154* (DGU, FOF, KB).

Lentibulariaceae

7. *Utricularia gibba* L., Sp. Pl. 1: 18, 1753 (Fig. 3C).

Utricularia gibba shows pan-tropical distribution and has been reported widely, but no record from Laos, yet (Taylor, 1989; Parnell, 2011). *Utricularia gibba* is aquatic with filiform leaves and stems, characterized with a few, sparsely attached traps, unlike *U. aurea* with numerous traps. *Utricularia gibba* is more or less common in PKKNBCA, in small ponds, ditches, and marshes.

Distribution: Widespread, pan-tropical.

Specimens examined: LAOS. Bolikamxai: Thaphabat District, PKKNBCA, around Tad Leuk Waterfall, 18°23'42.0"N,

103°04'18.3"E, elev. 196 m, 15 Dec 2015, *Hyosig Won et al. 13480* (DGU, FOF, KB); Thaphabat District, PKNBCA, around Tad Leuk Waterfall, at the edge of the river, rock pool, 18°23'42.5"N, 103°04'17.9"E, elev. 196 m, 26 Feb 2016, *Hyosig Won et al. 13734* (DGU, FOF, KB); Thaphabat District, PKNBCA, at the Nam Leuk Dam site, sip area at the southern end of the dam, open area, 18°26'08.2"N, 102°56'41.8"E, elev. 403 m, 28 Feb 2016, *Hyosig Won et al. 13794* (DGU, FOF, KB)

Loranthaceae

8. *Macrosolen brandisianus* (Kurz) Tiegh., Bull. Soc. Bot. France 42: 442, 1895. *Loranthus brandisianus* Kurz, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 40: 63, 1871 (Fig. 3D).

Macrosolen spp. are parasitic shrubs (Barlow, 2002) and three species, *M. cochinchinensis* (Lour.) Tiegh., *M. lowii* (King) Tregn., and *M. tricolor* (Lecomte) Dans., have been reported for the flora of Laos (Newman et al., 2017–present). *Macrosolen brandisianus* is characterized by its lanceolate to narrowly ovate leaves and deep red corolla tube with black

band at the neck.

Distribution: Laos, Myanmar, Thailand.

Specimens examined: LAOS. Vientiane: Thoulakhom District, PKNBCA, along the stream leading to the Nam Pot IDP reservoir, flowing from PKNBCA, along the old trail, north of Ban Phonemuang along the rocky stream, 18°22'06.1"N, 102°42'08.5"E, elev. 225 m, 4 Jun 2017, *Hyosig Won et al. 15767* (DGU, FOF, KB)

Malvaceae

9. *Decaschistia siamensis* Craib, Bull. Misc. Inform. Kew 1912: 146, 1912 (Fig. 4A).

Phuphathanaphong (1999) recognized three *Decaschistia*, *D. parviflora* Kurz, *D. intermedia* Craib, and *D. siamensis*, for the flora of Thailand. *Decaschistia parviflora* and *D. intermedia* have also been reported for Cambodia and Laos, respectively, while *D. siamensis* is endemic to Thailand. We collected *D. siamensis* in three different localities in PKNBCA – near Vang Hua village, at Tad Leuk and Tad Xai Waterfalls. It is usually

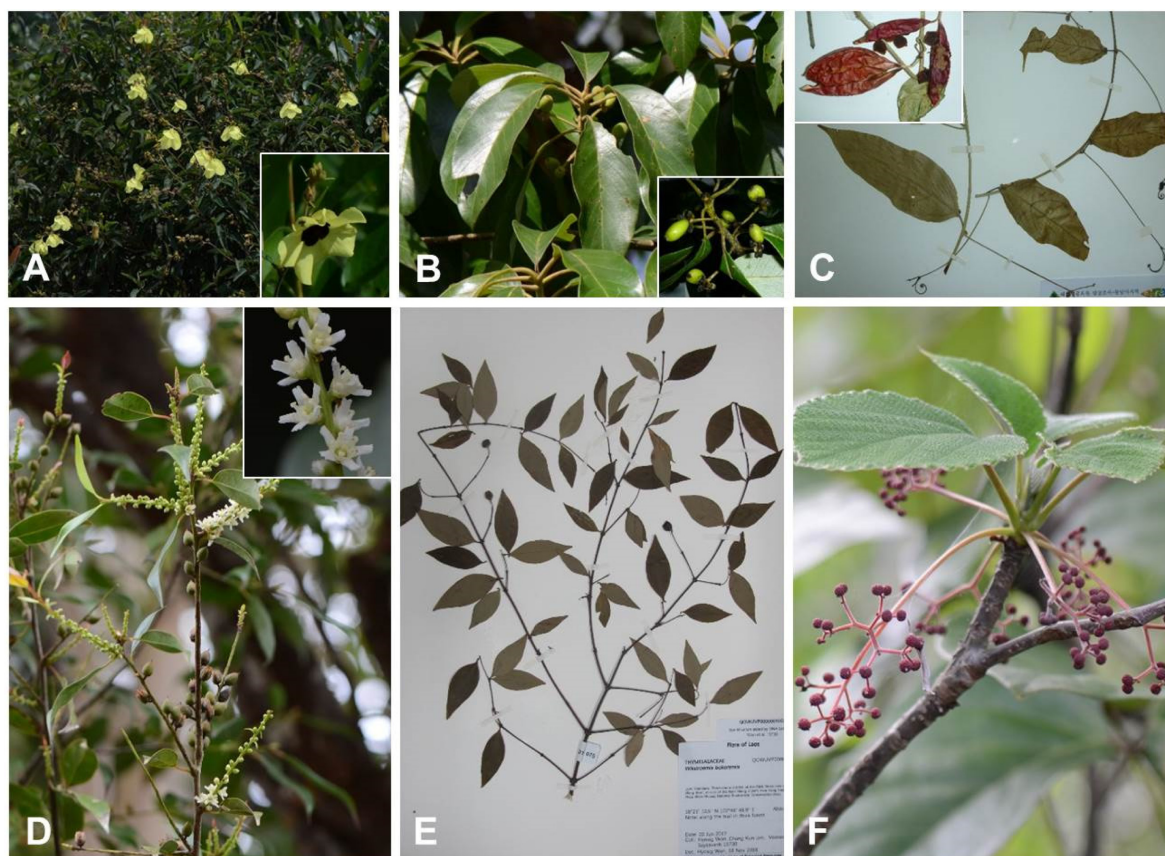


Fig. 4. New record of flowering plants for the flora of Laos (3). **A.** *Decaschistia siamensis* Craib (Malvaceae). **B.** *Nyssa yunnanensis* W. Q. Yin ex H. N. Qin & Phengklai (Nyssaceae). **C.** *Adenia penangiana* (Wall. ex G. Don) W. J. de Wilde var. *penangiana* (Passifloraceae). **D.** *Pentaphylax euryoides* Gardner & Champ. (Pentaphylacaceae). **E.** *Wikstroemia bokorensis* E. Oguri & Tagane (Thymelaeaceae). **F.** *Debregeasia wallichiana* (Wedd.) Wedd. (Urticaceae).

distributed in dry places on rock plateau with fairly open ground.

Distribution: Laos, Thailand.

Specimens examined: LAOS. Bolikamxai: Thaphabat District, PKKNBCA, at Tad Xai Waterfall, open, flat rock area, about 500 m NNE of the Tad Xai Waterfall, 18°27'33.6"N, 103°08'35.0"E, elev. 369 m, 25 Feb 2016, *Hyosig Won et al.* 13697 (DGU, FOF, KB); Thaphabat District, PKKNBCA, at Tad Xai Waterfall, along the trail to the waterfall, about 200 m south of the waterfall, 18°27'09.6"N, 103°08'32.0"E, elev. 320 m, 23 Aug 2016, *Hyosig Won et al.* 15482 (DGU, FOF, KB); Thaphabat District, PKKNBCA, along the stream to the Tad Phaxet Waterfall, near the Tad Phaxet, open flat rock area, 18°30'02.0"N, 102°57'45.4"E, elev. 608 m, 11 Nov 2017, *Hyosig Won et al.* 16196 (DGU, FOF, KB). Vientiane: Thoulakhom District, PKKNBCA, near the river crossing over the Nam Mang River, downstream of the Nam Mang 3 Dam, near the Vang Hua Village, forest near the river, 18°21'05.2"N, 102°48'55.1"E, elev. 729 m, 20 Aug 2016, *Hyosig Won et al.* 15195 (DGU, FOF, KB).

Nyssaceae

10. *Nyssa yunnanensis* W. Q. Yin ex H. N. Qin & Phengklai, Fl. China 13: 303, 2007 (Fig. 4B).

Nyssa species are dioecious trees with drupe. So far only *N. javanica* (Blume) Wangerin has been reported for Laos (Newman et al., 2017–present). We have made two collections of *Nyssa* from PKKNBCA, one with glabrous branchlets, pedicels and leaf abaxially side (*Won et al.* 16456, collected on 26 Jul 2018), the other with densely pilose ones (*Won et al.* 15673). Based on Qin and Phengklai (2007), the former matches well with the key characters of *N. javanica*, while the latter with *N. yunnanensis*.

Distribution: China, Laos.

Specimens examined: LAOS. Vientiane: Thoulakhom District, PKKNBCA, at the thick forest east of the Nam Mang River, at east of the Nam Mang 3 Dam, near Vang Hua village, along the trail in thick forest, 18°21'27.6"N, 102°48'27.3"E, elev. 761 m, 2 Jun 2017, *Hyosig Won et al.* 15673 (DGU, FOF, KB).

Passifloraceae

11. *Adenia penangiana* (Wall. ex G. Don) W. J. de Wilde var. *penangiana*, Blumea 15: 266, 1968. *Passiflora penangiana* Wall. & G. Don, Gen. Hist. 3: 55, 1834 (Fig. 4C).

Adenia penangiana (incl. *A. nicobarica* (Kurz.) Ridl.) is distributed in Andaman and Nicobar Islands, Peninsular Thailand, and also in Sumatra and Peninsular Malaysia (de Wilde and Duyfjes, 2010). Two varieties, var. *penangiana* and

var. *parvifolia* (Gagnep.) W.J. de Wilde, are recognized for Thailand, where var. *parvifolia* has sometimes lanceolate-linear leaves, while var. *penangiana* has ovate-elliptic to lanceolate leaves. Current collections from PKKNBCA have leaves matching with var. *penangiana*. Although other *Adenia* species, such as *A. viridiflora* Craib (incl. *A. pierrei* Gagnep.), *A. heterophylla* (Blume) Koord. (incl. *A. chevalieri* Gagnep. and *A. parviflora* (Blanco) G. Cusset), *A. cardiophylla* (Mast.) Engl., and *A. pimatisecta* (Craib) Craib have also been reported for Laos (Newman et al. 2017–present; de Wilde and Duyfjes, 2010), but *A. penangiana* is distinct from other *Adenia* by its unlobed and elliptic leaves.

Distribution: Laos, Malaysia, Sumatra, Thailand.

Specimens examined: LAOS. Bolikamxai: Thaphabat District, PKKNBCA, along the road to the north part of the Nam Leuk Reservoir, near Tad Phaxet, 18°31'34.3"N, 102°56'00.5"E, elev. 451 m, 5 Jun 2017, *Hyosig Won et al.* 15801 (DGU, FOF, KB); Thaphabat District, PKKNBCA, along the road to the water duct, branching from the road to the Nam Leuk Dam, in thickets, roadside, 18°28'02.2"N, 102°58'24.3"E, elev. 434 m, 20 Jul 2017, *Hyosig Won et al.* 16051 (DGU, FOF, KB). Vientiane: Thoulakhom District, PKKNBCA, at the thick forest east of the Nam Mang River, at east of the Nam Mang 3 Dam, near Vang Hua village along the trail in thick forest, 18°21'20.7"N, 102°48'25.7"E, elev. 775 m, 1 Nov 2016, *Chang-Kun Lim & Veosavanh Saysavanh Lim* 708 (DGU, FOF, KB).

Pentaphragaceae

12. *Pentaphragax euryoides* Gardner & Champ., Hooker's J. Bot. Kew Gard. Misc. 1: 245, 1849 (Fig. 4D).

Pentaphragax is a monotypic genus with 5-merous flowers. Its flower has five petals, sepals, and stamens, and pistils are 5-celled. Stamens are basifixed and dehiscing with apical pores. It is distributed on fairly open rock area near Tad Phaxet Waterfall.

Distribution: China, Indonesia, Laos, Malaysia, Vietnam.

Specimens examined: LAOS. Bolikamxai: Thaphabat District, PKKNBCA, along the road to the north part of the Nam Leuk Reservoir, near Tad Phaxet, open flat rock area, along the stream to Tad Phaxet waterfall, 18°30'10.1"N, 102°57'57.5"E, elev. 624 m, 27 Feb 2016, *Hyosig Won et al.* 13766 (DGU, FOF, KB).

Thymelaeaceae

13. *Wikstroemia bokorensis* E. Oguri & Tagane, Phytotaxa 317: 281, 2017 (Fig. 4E).

Oguri et al. (2017) described *W. bokorensis* based on the

specimens collected from Bokor National Park, Kampot Province, Cambodia. Recently, *W. bolovenensis* Tagane & Soulad. was described from the specimens collected from Bolaven Plateau, Paksong District, Champasak Province of Laos (Tagane et al., 2020a). Tagane et al. (2020a) distinguished the two species based on the inflorescence type, length of peduncle, and their phenology: *W. bokorensis* has umbellate or rarely very shortly racemose inflorescence with 3–6 flowers, while *W. bolovenensis* has racemose inflorescence with 10–14 flowers. The length of peduncle is 1.2–3 cm long and slender for *W. bokorensis*, while *W. bolovenensis* is 0.5–1 cm long and slightly flattened. *Wikstroemia bokorensis* flowers in May with immature fruits, while *W. bolovenensis* flowers and fruits maturing in December. The collection from PKKNBCA (Won et al. 15730) has typical morphological characteristics of *W. bokorensis*—umbellate inflorescence with slender peduncle 1.5–2 cm long, a few number of flowers (fruits), and mature fruits in June. It is unusual to discover *W. bokorensis* in PKKNBCA, which is more than 510 km north of Bokor National Park, Cambodia. Overall morphology and molecular data (unpublished data) confirms its identity in PKKNBCA. Additional surveys on the area will be necessary to collect flowering material and to assess its conservation status.

Distribution: Cambodia, Laos.

Specimens examined: LAOS. Vientiane: Thoulakhom District, PKKNBCA, at the thick forest east of the Nam Mang River, at east of the Nam Mang 3 Dam, near Vang Hua village, along the trail in thick forest, 18°21'10.5"N, 102°48'48.9"E, elev. 748 m, 3 Jun 2017, *Hyosig Won et al. 15730* (DGU, FOF, KB).

Urticaceae

14. *Debregeasia wallichiana* (Wedd.) Wedd., Ann. Mus. Hist. Nat., Paris 9: 464, 1956–7. *Debregeasia wallichiana* Wedd., Arch. Mus. Hist. Nat. viii. 464, 1855–6 (Fig. 4F).

Debregeasia spp. are shrubs or small trees, and there are about six species mainly in tropics and subtropics of E Asia (Chen et al., 2003). *Debregeasia wallichiana* is characterized by its broadly ovate to orbicular leaves with white tomentose abaxial surface and dichotomously branching inflorescences longer than 5 cm.

Distribution: Bangladesh, Bhutan, Cambodia, India, Myanmar, Laos, Sikkim, Sri Lanka, Thailand

Specimens examined: LAOS. Vientiane: Thoulakhom District, PKKNBCA, at the thick forest east of the Nam Mang River, at east of the Nam Mang 3 Dam, near Vang Hua village, along the trail in thick forest, 18°21'30.1"N, 102°48'22.1"E, elev. 765 m, 2 Jun 2017, *Hyosig Won et al. 15675* (DGU, FOF, KB).

Taxa newly recorded from PKKNBCA, previously reported for the flora of Laos

Asteraceae

1. *Strobocalyx arborea* (Buch.-Ham.) Sch. Bip., Jahresber. Pollichia 18–19: 171, 1861. *Vernonia arborea* Buch.-Ham., Trans. Linn. Soc. London 14: 218, 1824 (Fig. 5A).

Strobocalyx arborea is a large tree species of Asteraceae, distributed in SE Asia. Based on the DNA sequence data and morphological data, Robinson et al. (2008) transferred seven species formerly placed in *Vernonia* to *Strobocalyx*. The collection was made from a tree ca. 20 m tall and D.B.H. of ca. 30 cm.

Distribution: Bangladesh, China, India, Indonesia, Laos, Malaysia, Myanmar, Philippines, Thailand, Vietnam,

Specimen examined: LAOS. Bolikamxai: Thaphabat District, PKKNBCA, along the road to Nam Leuk Dam, branched from the road between Ban Tha and Muang Hom, 18°28'07.9"N, 103°01'26.1"E, elev. 568 m, 11 Nov 2017, *Hyosig Won et al. 16211* (DGU, KB).

Euphorbiaceae

2. *Croton poomae* Esser, Thai Forest Bull., Bot. 30: 1, 2002 (Fig. 5B).

Croton poomae is a tree to ca. 10 m tall. Esser (2002) recognized *C. poomae* for the flora of Thailand. Specimens (incl. Type) of *C. poomae* were collected from Phu Wua Wildlife Sanctuary, Bungkhla, Nong Khai, Thailand, which is near the border with Laos, close to the Mekong River. Also, Newman et al. (2017–present) reported its presence at Nam Kading NPA from the collection made by Tagane et al. *Croton poomae* is characterized by its long, narrowly ovate leaves with 13–16 pairs of side veins, acute-acuminate leaf apex, completely silvery-pubescent leaf abaxial surface, globose schizocarp 15–17 mm long, and brownish pubescent and smooth schizocarp surface.

Distribution: Laos, Thailand.

Specimen examined: LAOS. Bolikamxai: Thaphabat District, PKKNBCA, at the north part of the Nam Leuk Reservoir, near Tad Phaxet, at thick forest along the cliff of the road, 18°30'23.7"N, 102°56'12.5"E, elev. 417 m, 22 Aug 2016, *Hyosig Won et al. 15383* (DGU, KB); Thaphabat District, PKKNBCA, along the road to the water duct, branching from the road to the Nam Leuk Dam, in thickets, roadside, 18°29'54.7"N, 102°57'42.1"E, elev. 596 m, 20 Jul 2017, *Hyosig Won et al. 16039* (DGU, KB); Thaphabat District, PKKNBCA, along the road to the water duct, branching from the road to the Nam Leuk Dam, in thickets, roadside, 18°27'58.0"N,

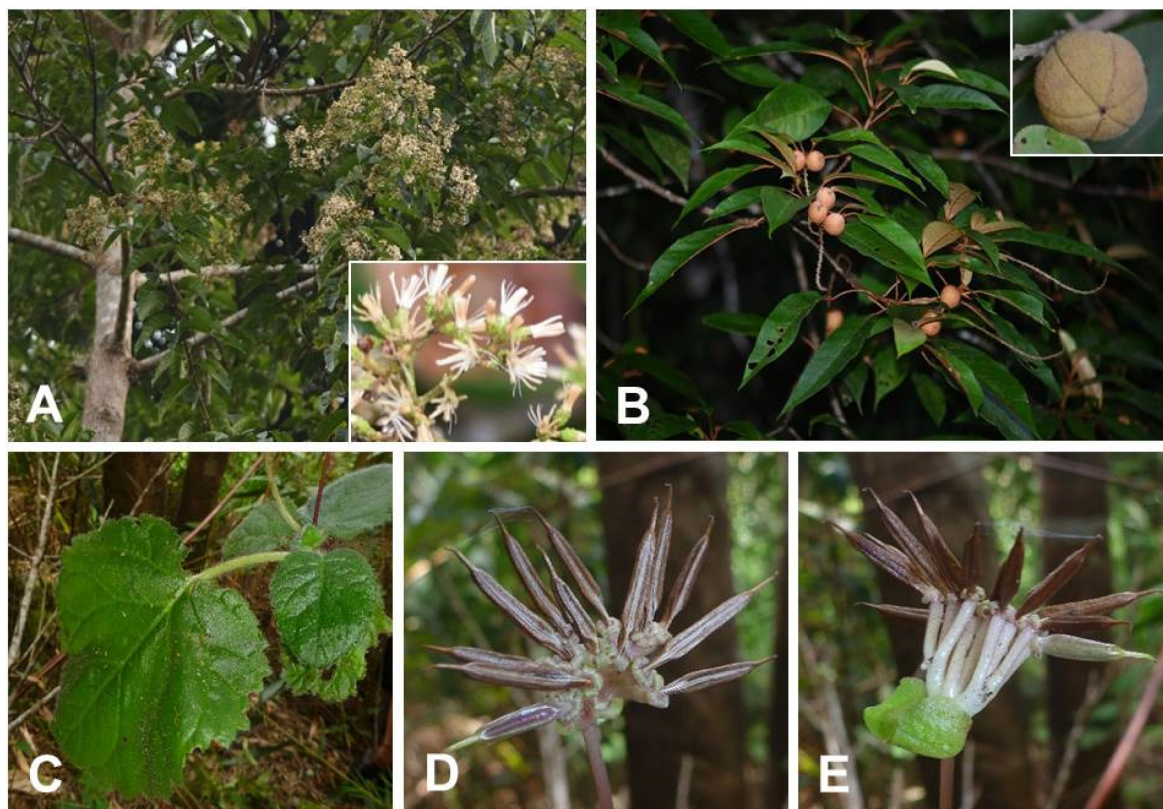


Fig. 5. New record of flowering plants from PKKNBCA. **A.** *Strobocalyx arborea* (Buch.-Ham.) Sch. Bip. (Asteraceae). **B.** *Croton poomae* Esser (Euphorbiaceae). **C–E.** *Beccarinda tonkinensis* (Pellegr.) B. L. Burtt (Gesneriaceae).

102°58'48.5"E, elev. 469 m, 20 Jul 2017, *Hyosig Won et al. 16054* (DGU, KB). Vientiane Province: Thoulakhom District, PKKNBCA, along the old trail to Vang Hua village, 18°22'08.1"N, 102°42'11.7"E, elev. 230 m, 26 Jul 2018, *Hyosig Won et al. 16450* (DGU, KB).

Gesneriaceae

3. *Beccarinda tonkinensis* (Pellegr.) B. L. Burtt, Notes Roy. Bot. Gard. Edinburgh 22: 64, 1965. *Slackia tonkinensis* Pellegr., Bull. Soc. Bot. France 73: 428, 1926 (Fig. 5C–E).

Beccarinda tonkinensis is a perennial herb with umbel-like inflorescence, distributed from China to India (Gammi et al., 2020). Newman et al. (2017–present) reported its presence in Khammouan District. We found a small population on rock surface in a shaded forest of PKKNBCA.

Distribution: China, India, Laos, Vietnam.

Specimen examined: Laos. Vientiane Province: Thoulakhom District, PKKNBCA, along the trail from the army camp (near the lake) to Phou Xang, about 4 km north from the camp, on rock surface in shaded forest, 18°25'29.3"N, 102°45'49.0"E, elev. 1,112 m, 8 Sep 2019, *Hyosig Won et al. 17056* (DGU, KB).

4. *Didymocarpus albiflorus* Souvann. & Phonepaseuth, Taiwania 65: 109, 2020 (Fig. 6A).

Souvannakhoummane and Phonepaseuth (2020) reported *D. albiflorus* as a new endemic species of Laos, collected from Darn Sinxay Temple area, Naxaythong District, Vientiane Capital. The type locality is west of Vientiane, and we found the same species also in PKKNBCA, located east of Vientiane.

Distribution: Laos.

Specimen examined: LAOS. Vientiane: Thoulakhom District, PKKNBCA, near the waterfall in the valley, along the old PKKNBCA trail toward the Vang Hua village, north of Ban Phonemuang, on steep rock surface, 18°22'21.6"N, 102°42'26.1"E, elev. 281 m, 22 Jul 2017, *Hyosig Won et al. 16129* (DGU, KB); Thoulakhom District, PKKNBCA, near the waterfall in the valley, along the old PKKNBCA trail toward the Vang Hua village, north of Ban Phonemuang, on rock boulder, 18°22'20.9"N, 102°42'25.1"E, elev. 274 m, 10 Nov 2017, *Hyosig Won et al. 16150* (DGU); Thoulakhom District, PKKNBCA, along the old trail to Vang Hua village, on top and on the vertical surface of boulder, along the stream, 18°22'48.7"N, 102°44' 00.8"E, elev. 706 m, 28 Jul 2018,

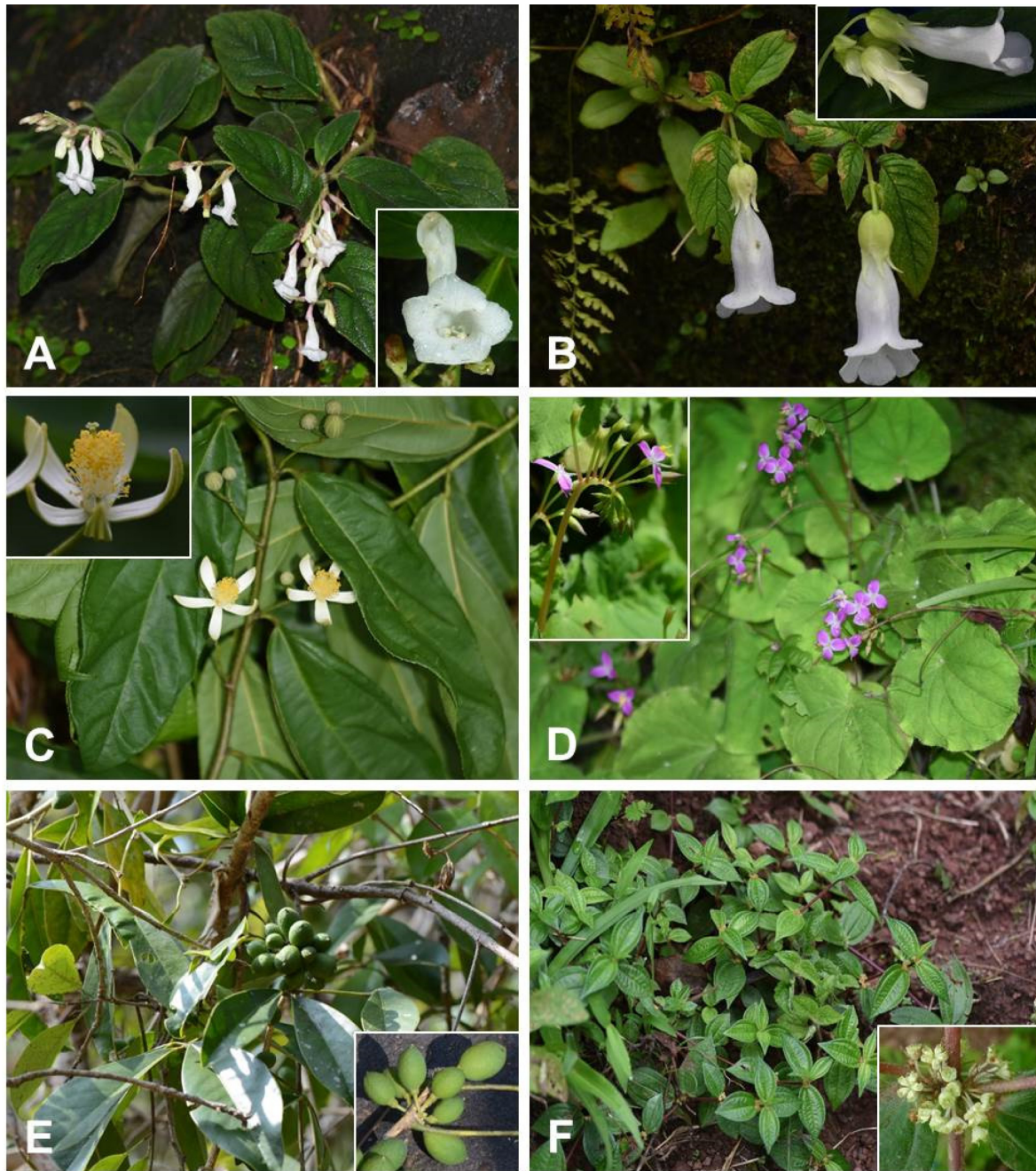


Fig. 6. New record of flowering plants from PKKNBCA **A.** *Didymocarpus albiflorus* Souvann. & Phonepaseuth (Gesneriaceae). **B.** *Henckelia anachoreta* (Hance) D.J. Middleton (Gesneriaceae). **C.** *Grewia laevigata* Vahl (Malvaceae). **D.** *Sonerila souvannii* Phonep. & Soulad. (Melastomataceae). **E.** *Luvunga scandens* (Roxb.) Buch.-Ham. ex Wight & Arn. (Rutaceae). **F.** *Gonostegia hirta* (Blume) Miq. (Urticaceae).

Hyosig Won et al. 16487 (DGU); Thoulakhom District, PKKNBCA, along the old trail to Vang Hua village, on top and on the vertical surface of boulder, 18°22'39.6"N, 102°43'24.3"E, elev. 591 m, 28 Jul 2018, *Hyosig Won et al.* 16489 (DGU).

5. *Henckelia anachoreta* (Hance) D.J. Middleton, Taxon 60: 774, 2011. *Chirita anachoreta* Hance, Ann. Sci. Nat., Bot. sér. 5, 5: 231, 1866 (Fig. 6B).

Henckelia anachoreta shows wide distribution from southern China, India (Sikkim), Laos, Myanmar, northern Thailand and northern Vietnam (Weber et al., 2011). It grows on moist rock

surfaces. Yang, L. et al. (2020) examined one collection from Nakai Nam Theun NPA of Khammouan Province (M. F. Newman et al. *LAO* 385 [E]).

Distribution: China, India, Laos, Myanmar, Thailand, Vietnam.

Specimen examined: LAOS. Vientiane Province: Thoulakhom District, PKKNBCA, along the trail from the army camp (near the lake) to Phou Xang, about 4 km north from the camp, on rock surface in shaded forest, 18°25'27.7"N, 102°45'50.4"E, elev. 1,087 m, 8 Sep 2019, *Hyosig Won et al.* 17055 (DGU); Thoulakhom District, PKKNBCA, along the trail from the cow farm near the base of rim to Phu Xang to the army camp (near the lake), about 3 km north from the army camp, on a rock boulder, in shaded forest, 18°25'28.3"N, 102°45'49.0"E, elev. 1,092 m, 9 Sep 2019, *Hyosig Won et al.* 17084 (DGU).

Malvaceae

6. *Grewia laevigata* Vahl, *Symb. Bot. (Vahl)* 1: 34, 1790 (Fig. 6C).

Chung (2006) distinguished *G. laevigata* from the other *Grewia* as a scandent shrub, having twigs and peduncles glabrous or sparsely hairy, leaves elliptic, oblong, lanceolate or ovate, flower buds oblong, narrowly ellipsoid or narrowly ovoid.

Distribution: India, Laos, Malaysia, Philippines, Thailand, Vietnam.

Specimen examined: LAOS. Vientiane Province: Thoulakhom District, PKKNBCA, near the Dansavanh Nam Ngum Lake Resort, 18°25'25.4"N, 102°38'54.2"E, elev. 284 m, 25 Jul 2018, *Hyosig Won et al.* 16442 (DGU, KB).

Melastomataceae

7. *Sonerila souvannii* Phonpep. & Soulad., *Eur. J. Taxon.* 755: 141, 2021 (Fig. 6D).

Sonerila souvannii is an acaulescent herb characterized by its cordate leaves, glabrous inflorescences, petals and capsules, and cylindrical rhizome (Phonepaseuth et al., 2021a). We found a few populations of *S. souvannii* near the Tad Xai waterfall. Likewise *D. albiflora* (Gesneriaceae), *S. souvannii* was collected from Dam Sinxay Temple area, Naxaythong District, Vientiane Capital (Phonepaseuth et al., 2021a). The presence of both *D. albiflora* and *S. souvannii* suggests close floristic affinity between PKKNBCA and Dam Sinxay Temple area, Naxaythong District, located west of Vientiane Capital.

Distribution: Laos.

Specimen examined: LAOS. Bolikamxai: Thaphabat District, PKKNBCA, at Tad Xai waterfall, along a trail to the

waterfall, about 200 m south of the waterfall, 18°27'09.6"N, 103°08'32.0"E, elev. 320 m, 23 Aug 2016, *Hyosig Won et al.* 15483 (DGU, KB); Thaphabat District, PKKNBCA, near Tad Xai waterfall, at rock boulder along the stream, 18°27'12.1"N, 103°08'32.3"E, elev. 307 m, 12 Nov 2017, *Hyosig Won et al.* 16232 (DGU); Thaphabat District, PKKNBCA, at Tad Xai waterfall, along a trail to the waterfall, about 200 m south of the waterfall, under rock boulder, 18°27'09.6"N, 103°08'32.0"E, elev. 320 m, 10 Sep 2019, *Hyosig Won et al.* 17102 (DGU).

Rutaceae

8. *Luvunga scandens* (Roxb.) Buch.-Ham. ex Wight & Arn., *Ill. Ind. Bot.* 1: 108, 1838. *Limonia scandens* Roxb., *Fl. Ind.* ii. 380, 1832 (Fig. 6E).

Luvunga scandens is a woody climber with 3-foliolate leaves, usually distributed along riverbanks and valleys. Newman et al. (2017–present) enlisted *L. scandens* for the flora of Laos, without voucher information. Here we are providing a voucher information collected from PKKNBCA.

Distribution: Cambodia, China, India, Laos, Malaysia, Thailand, Vietnam.

Specimens examined: LAOS. Bolikamxai: Thaphabat District, PKKNBCA, at Tad Xang Waterfall, upstream of Tad Leuk waterfall along the Tad Leuk river, around the open rock river basin, 18°24'04.8"N, 103°02'58.4"E, elev. 228 m, 26 Feb 2016, *Hyosig Won et al.* 13715 (DGU, KB).

Urticaceae

9. *Gonostegia hirta* (Blume) Miq., *Ann. Mus. Bot. Lugduno-Batavi* 4: 303, 1869. *Urtica hirta* Blume, *Bijdr. Fl. Ned. Ind.* 10: 495, 1826. *Pouzolzia hirta* (Blume) Hassk., *Cat. Hort. Bot. Bogor (Hasskarl)* 80, 1844 (Fig. 6F).

Gonostegia hirta is a prostrate herb or subshrub, with ovate or elliptic leaves attached oppositely. It is found on open grassland near the rim of Phu Xang of PKKNBCA.

Distribution: Cambodia, China, India, Laos, Malaysia, Thailand, Vietnam.

Specimens examined: LAOS. Vientiane Province: Thoulakhom District, PKKNBCA, along the south ridge leading to the rim of Phu Xang, open grassy slopes, 18°26'32.0"N, 102°44'56.8"E, elev. 1,475 m, 9 Sep 2019, *Hyosig Won et al.* 17065 (DGU, KB).

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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