

New species and new status
of *Urophyllum* Wall. (Rubiaceae)
from Cambodia and Vietnam

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New species and new status of *Urophyllum* Wall. (Rubiaceae) from Cambodia and Việt Nam

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MOTS CLÉS
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espèces nouvelles.

ABSTRACT

Five new species of *Urophyllum* Wall. endemic to Cambodia and Vietnam are herein described and illustrated, and *U. annamense* (Pierre ex Pit.) Yooprasert, Culham & Utteridge, stat. nov. is raised to species status. The new species are unique due to the morphological combination of indumentum, secondary venation, stipule shape and inflorescence structure as follows: *U. bidoupense* Yooprasert, Culham & Utteridge, sp. nov.: plant almost glabrous, secondary veins weakly brochidodromous, stipule glabrous, oblong-lanceolate; *U. chinense* subsp. *latistipulum* Yooprasert, Culham, Yahara & Utteridge, subsp. nov.: similar appearance to the *U. bidoupense* but differs with stipule ovate to elliptic, hairy along the midline; *U. brochidodromum* Yooprasert, Culham & Utteridge, sp. nov.: stem and branches hairy, adaxial leaf surface hairy on midrib and secondary veins, secondary veins conspicuously brochidodromous, stipule hairy, lanceolate; *U. pulchristipulum* Yooprasert, Culham & Utteridge, sp. nov.: plant glabrous, secondary veins festooned brochidodromous, stipule glabrous and subcordate, inflorescence sessile; *U. pseudoschmidtii* Yooprasert, Culham, Yahara, Tagane & Utteridge, sp. nov.: stem and branches hairy to subglabrous, secondary veins festooned brochidodromous, stipule sparsely to densely hairy, linear-lanceolate to oblong-lanceolate, pistillate flower with no staminodes. An identification key to *Urophyllum* species of Cambodia, Laos and Vietnam is provided. Point occurrence maps are presented for each species, as well as provisional conservation assessments based on IUCN guidelines.

RÉSUMÉ

Nouvelles espèces et statut nouveau d'Urophyllum Wall. (Rubiaceae) du Cambodge et du Vietnam. Cinq nouvelles espèces d'*Urophyllum* Wall. endémiques du Cambodge et du Vietnam sont décrites et illustrées ici, et *U. annamense* (Pierre ex Pit.) Yooprasert, Culham & Utteridge, stat. nov. est élevé au rang d'espèce. Les nouvelles espèces sont uniques en raison de la combinaison morphologique de l'indumentum, de la nervation secondaire, de la forme de la stipule et de la structure de l'inflorescence, ainsi : *U. bidoupense* Yooprasert, Culham & Utteridge, sp. nov. : plante presque glabre, nervures secondaires faiblement brochidodromes, stipule glabre, oblongue-lancéolée ; *U. chinense* subsp. *latistipulum* Yooprasert, Culham, Yahara & Utteridge, subsp. nov. : apparence similaire à l'*U. bidoupense* mais diffère par une stipule ovale à elliptique, velue le long de la ligne médiane ; *U. brochidodromum* Yooprasert, Culham & Utteridge, sp. nov. : tige et branches velues, surface adaxiale des feuilles velue sur la nervure médiane et les nervures secondaires, nervures secondaires ostensiblement brochidodromes, stipule velue, lancéolée ; *U. pulchristipulum* Yooprasert, Culham & Utteridge, sp. nov. : plante glabre, nervures secondaires ostensiblement brochidodromes, stipule glabre et subcordée, inflorescence sessile ; *U. pseudoschmidtii* Yooprasert, Culham, Yahara, Tagane & Utteridge, sp. nov. : tige et branches velues à subglabres, veines secondaires festonnées-brochidodromes, stipule peu ou densément velue, linéaire-lancéolée à oblongue-lancéolée, fleur pistillée sans staminodes. Une clé d'identification des espèces d'*Urophyllum* du Cambodge, du Laos et du Vietnam est fournie. Des cartes d'occurrence ponctuelle sont présentées pour chaque espèce, ainsi que des évaluations provisoires de conservation basées sur les directives de l'UICN.

INTRODUCTION

Urophyllum Wall. is a genus in the coffee family (Rubiaceae), comprised of c. 120 species mostly of understorey treelets and shrubs in subtropical and tropical Asia from India to Papua New Guinea (Metcalf *et al.* 1998; Govaerts *et al.* 2020). The genus was first published in Flora of India by Nathaniel Wallich in Roxburgh (1824) with two species: *Urophyllum villosum* Wall. and *U. glabrum* Wall. As *U. villosum* is the first species mentioned in this publication, it has been selected as the type species of the genus by Wong *et al.* (2019). Members of *Urophyllum* can be recognised by their usually long linear-lanceolate to oblong stipules, acuminate leaf apex, secondary veins usually festooned brochidodromous or weakly brochidodromous, inflorescence axillary, flowers urn shaped,

stigma with 4-5 lobes, and baccate fruits bearing numerous seeds with an alveolate surface (Yooprasert 2021).

The genus in mainland Indochina has been revised at a regional scale and published in local Floras and checklists including Pitard (1923) for Indochina; Pham (2000) for Vietnam; Schumann in Schmidt (1902) for Koh Chang and Puff *et al.* (2005) for Thailand; Chen & Taylor (2011) for China; and Nagahama *et al.* (2019) for Bidoup-Nui Ba National Park, Vietnam.

There are 20 species of *Urophyllum* already described in mainland Southeast Asia (excluding Peninsular Malaysia) (Schmidt 1902; Pitard 1923; Anonymous 1931; Craib 1932; Taylor *et al.* 2011; Wong *et al.* 2019). In Cambodia, Laos and Vietnam, eight species have been recorded; of these, three species are endemic to Vietnam (*U. argenteum* Pit., *U. lecomtei* Pit. and



FIG. 1. — **A–D**, Stipule shape and indumentum: **A**, ovate and hairy along midline (*Urophyllum chinense* Merr. & Chun subsp. *latistipulum* Yooprasert, Culham, Yahara & Utteridge, subsp. nov.); **B**, oblong-lanceolate and subglabrous, hairy only at apex (*U. bidoupense* Yooprasert, Culham & Utteridge, sp. nov.); **C**, linear-lanceolate and hairy all over (*U. brochidodromum* Yooprasert, Culham & Utteridge, sp. nov.); **D**, subcordate and glabrous (*U. pulchristipulum* Yooprasert, Culham & Utteridge, sp. nov.); **E–G**, secondary venation and looping patterns: **E**, weakly brochidodromous (*U. bidoupense* Yooprasert, Culham & Utteridge, sp. nov.); **F**, festooned brochidodromous (*U. pseudoschmidtii* Yooprasert, Culham, Yahara, Tagane & Utteridge, sp. nov.); **G**, conspicuously brochidodromous (*U. brochidodromum* Yooprasert, Culham & Utteridge, sp. nov.); **H, I**, calyx lobe morphology: **H**, teeth (*U. bidoupense* Yooprasert, Culham & Utteridge, sp. nov.); **I**, lobes (*U. argenteum* Pit.); **J, K**, abaxial corolla hair distribution: **J**, glabrous (*U. bidoupense* Yooprasert, Culham & Utteridge, sp. nov.); **K**, hairy (*U. lecomtei* Pit.). Scale bars: 5 mm.

U. tonkinense Pit.) (Pitard 1923). As a result of taxonomic study from both fieldwork and herbarium specimen observations of *Urophyllum* in the area: two species previously reported to be endemics in Yunnan Province, China (Taylor *et al.* 2011), have been found in Laos and Vietnam (*U. parviflorum* F.C.How ex H.S.Lo – Maxwell 12-139 (CMUB!; L[L.3956697]!) and *U. tsaiianum* F.C.How ex H.S.Lo – Tirvengadam *et al.* 3230 & 3239 (AAU!), respectively) (pers. comm.); and five new taxa of *Urophyllum* and a new status for *U. annamense* (Pierre ex Pit.) Yooprasert, Culham & Utteridge, stat. nov. (based on *U. longifolium* (Wight) Hook.f. var. *annamense* Pierre ex Pit.) were identified. Within these, four taxa are endemic to Viêt-

nam: *U. bidoupense* Yooprasert, Culham & Utteridge, sp. nov., *U. brochidodromum* Yooprasert, Culham & Utteridge, sp. nov., *U. chinense* Merr. & Chun subsp. *latistipulum* Yooprasert, Culham, Yahara & Utteridge, subsp. nov., *U. pseudoschmidtii* Yooprasert, Culham, Yahara, Tagane & Utteridge, sp. nov.; and a single species endemic to Cambodia, *U. pulchristipulum* Yooprasert, Culham & Utteridge, sp. nov.

All these species, except the new species from Cambodia, have been included in phylogenetic analyses of both whole plastid genomes and nrDNA cistrons by the first author (Yooprasert 2021). The studies supported the recognition of the new status and new taxa at species or subspecies level as presented here. In

the plastid tree, the position of *U. annamense* (Pierre ex Pit.) Yooprasert, Culham & Utteridge, stat. nov. (syn.: *U. longifolium* var. *annamense*) is segregated from other populations of *U. longifolium* (Wight) Hook.f.; while in nrDNA tree, it is a sister to the other populations (Yooprasert 2021). This evidence, together with a distribution range in Vietnam and green co-

rolla for the new species, in contrast with a distribution range in India, Myanmar and Thailand and white corolla like other populations, thus suggested that the previously recognised variety should be a different species than *U. longifolium*.

Urophyllum chinense subsp. *latistipulum* Yooprasert, Culham, Yahara & Utteridge, subsp. nov., is a sister to *U. chinense* subsp.

KEY TO *UROPHYLLUM* WALL. SPECIES IN CAMBODIA, LAOS AND VIETNAM

1. Stipule glabrous to subglabrous abaxially, sparse hairs present at margin and dense at base adaxially or only at apex abaxially, sometimes hairy only along midline; netted veins conspicuous *in sicco* 2
— Stipule hairy abaxially throughout; netted veins inconspicuous *in sicco*..... 4
2. Petiole glabrous to the naked eye; inflorescence pedunculate umbellate; Vietnam 3
— Petiole hairy to the naked eye on canalicular ridges; inflorescence sessile umbellate; Cambodia
..... *Urophyllum pulchrestipulum* Yooprasert, Culham & Utteridge, sp. nov.
3. Stipule glabrous to subglabrous with hairs only at the apex
..... *Urophyllum bidoupense* Yooprasert, Culham & Utteridge, sp. nov.
— Stipule hairy along the midline from base to apex
..... *Urophyllum chinense* subsp. *latistipulum* Yooprasert, Culham, Yahara & Utteridge, subsp. nov.
4. Petiole hairs conspicuously denser on canalicular ridges, sometimes hairy only on the ridges 5
— Petiole hairs similar density all over 7
5. Stipule margin with hairs denser than other areas; petiole hairy throughout, but with hairs along canalicular ridges distinctly paler and contrasting *Urophyllum parviflorum* F.C.How ex H.S.Lo
Stipule hair density similar throughout; petioles variously hairy, but hairs the same colour throughout and without any contrasting colours 6
6. Staminate inflorescence sessile umbellate; staminodes absent in pistillate flowers; Vietnam
..... *Urophyllum pseudoschmidtii* Yooprasert, Culham, Yahara, Tagane & Utteridge, sp. nov.
Staminate inflorescence pedunculate umbellate; staminodes present in pistillate flowers; Thailand and Cambodia.....*Urophyllum schmidtii* C.B.Clarke
7. Secondary veins weakly brochidodromous (loops inconspicuous) or eucamptodromous 8
Secondary veins conspicuously brochidodromous or festooned brochidodromous 10
8. All parts covered with long sericeous hairs; corolla with sparse sericeous hairs abaxially
..... *Urophyllum argenteum* Pit.
All parts subglabrous or covered with hairs but not sericeous; corolla glabrous abaxially 9
9. Leaves coriaceous, abaxial lamina densely appressed hairy; stipules appressed to the stem, sometimes recurved at margins but not folded; inflorescence single flower or pedunculate umbellate, small number of flowers usually < 5; corolla white *Urophyllum chinense* subsp. *chinense* Merr. & Chun
Leaves chartaceous, abaxial lamina glabrous; stipule folded toward adaxial side; inflorescence compound cymose, many flowers > 7; corolla green
..... *Urophyllum annamense* (Pierre ex Pit.) Yooprasert, Culham & Utteridge, stat. nov.
10. Adaxial leaf veins glabrous; leaf reddish brown *in sicco*; tertiary veins not prominent, inconspicuous abaxially; inflorescence peduncle long 5-10 mm, sparsely hairy; abaxial corolla surface glabrous.....
..... *Urophyllum tsaiianum* F.C.How ex H.S.Lo
Adaxial leaf veins hairy, sometimes only on midrib; leaf yellowish or greenish brown to dark grey *in sicco*; tertiary veins prominent, conspicuous abaxially; inflorescence peduncle short or sessile 0-2.9 mm, densely hairy; abaxial corolla surface hairy 11
11. Mature leaves with secondary veins hairy adaxially, brochidodromous without a series of small loops outside the main loop or inconspicuous; flower and fruit calyx lobes recurved
..... *Urophyllum brochidodromum* Yooprasert, Culham & Utteridge, sp. nov.
Mature leaves with secondary veins glabrous, brochidodromous with a series of small loops (festooned); flower and fruit calyx lobes erect or folded toward adaxial side 12
12. Pistillate plant with pedunculate umbellate inflorescence *Urophyllum lecomtei* Pit.
Pistillate plant with sessile umbellate inflorescence *Urophyllum tonkinense* Pit.

chinense with *U. bidoupense* Yooprasert, Culham & Utteridge, sp. nov. as a sister to the two taxa in both whole plastid and nrDNA trees (Yooprasert 2021). Evidence of close relationship between the two subspecies of *U. chinense* is consistent. In the case of *Urophyllum brochidodromum* Yooprasert, Culham & Utteridge, sp. nov., it is a sister to *U. lecomtei* Pit. and *U. schmidtii* C.B. Clarke with *U. pseudoschmidtii* Yooprasert, Culham, Yahara, Tagane & Utteridge, sp. nov. as a sister to the group in the plastid tree; while it is a sister to *U. lecomtei* and *U. pseudoschmidtii* Yooprasert, Culham, Yahara, Tagane & Utteridge, sp. nov. in a nrDNA tree (Yooprasert 2021). This evidence suggested the close relationship between these four species. The new taxa bring the total number of *Urophyllum* species to 12 in Cambodia, Laos and Vietnam. Due to the difficulty of species identification within the genus, and the resulting number of misidentified specimens of *Urophyllum* in Indochina, the first complete regional key is provided for the species recorded from Cambodia, Laos and Vietnam aligning with the scope of the regional Flora project Flore du Cambodge, du Laos et du Vietnam.

During the taxonomic study of *Urophyllum* in Thailand and Indochina, there are several characters which are especially useful to distinguish species: shape and indumentum of stipules (Fig. 1A–D), secondary venation and looping patterns (Fig. 1E–G), inflorescence type (e.g. pedunculate vs sessile umbellate – see Figs 4D; 11D), calyx lobe morphology (Fig. 1H, I) and abaxial corolla hair distribution (Fig. 1J, K) (Tan *et al.* 1995; Yooprasert 2021); these were used as diagnostic characters in this study.

MATERIAL AND METHODS

This taxonomic study of *Urophyllum* Wall. in Vietnam and Cambodia was based primarily on herbarium specimens from AAU, FU, K and newly collected specimens from fieldwork in Vietnam in May–June 2019, where they were used for morphological character measurement and examination; herbarium specimens from BM, C, CMUB, E, HN, HNU and VNM, and online digitised records from NY, P and the Naturalis Biodiversity Centre BioPortal (specimens of L, U and WAG available at <http://biportal.naturalis.nl/>) were also examined. The locations visited in the fieldwork were selected based upon type locality information, herbarium specimens examined and in-country knowledge from Vietnamese botanists. All specimens cited have been seen, unless indicated by “n.v.”. Leaf vein morphological terms follow Hickey (1979) and Leaf-Architecture Working Group (1999), other morphological terms are from Beentje (2016). The conservation assessments were estimated following the IUCN Red list categories and criteria v3.1 (IUCN 2012) and IUCN guidelines (IUCN 2019). The Extent Of Occurrence (EOO) and Area Of Occupancy (AOO) were calculated using the GeoCAT software (Bachman *et al.* 2011) with the cell size set to 2 × 2 km. Google Earth Pro v7.3.3.7786 was used to view the quality of habitat at different time periods (from 2008 to 2020), such as the changes in the amount of existing forest compared

to expansion of urban and cultivation areas. Protected areas and IUCN Management Categories were referenced using the World Database on Protected Areas (UNEP-WCMC & IUCN 2020). If the category was not assigned in this database, the reports in Biodiversity and Protected areas – Cambodia, Laos, and Vietnam (Clarke 2000a, b, c), were used. The descriptions of species used in this study were based upon herbarium specimens and the fieldwork in 2019, they could not be used to estimate population size and trends as required for criteria A and C, as well as quantitative analysis of population viability (criterion E); thus, only the criteria B and D have been applied. The point occurrence maps were generated on R (R Core Team 2019).

TAXONOMIC TREATMENT

Family RUBIACEAE Juss.

Subfamily RUBIOIDEAE Verdc.

Tribe UROPHYLLAE Bremek. ex Verdc.

Genus *Urophyllum* Wall.

Urophyllum annamense (Pierre ex Pit.)

Yooprasert, Culham & Utteridge, stat. nov.

(Fig. 2A, B)

Urophyllum longifolium (Wight) Hook.f. var. *annamense* Pierre ex Pit. in H. Lecomte, *Flore générale de l'Indo-Chine* 3: 202 (Pitard 1923). — TYPE: **Vietnam**. Bao Chiang [in Bien Hoa, Dong Nai Province], VII.1877, *Pierre 1840* (♀) (lecto-, designated here, P[P03922480]); isolecto-, BM!, C!, K!, NY photo!, P[P03922444, P03922481]!, **syn. nov.**

Urophyllum annamense (Pierre ex Pit.) Yooprasert, Culham & Utteridge, stat. nov. is similar to *U. longifolium* (Wight) Hook.f. in most of the appearance but differs in its corolla colour, which is green instead of white. It also differs from *U. glabrum* and *U. schmidtii* C.B. Clarke in having stipules which are folded toward the adaxial side rather than stipules appressed to the stem but not folded. The species also differs from *U. schmidtii* in its compound cymose inflorescence and calyx with small teeth or nearly entire (not conspicuously lobed), instead of pedunculate umbellate inflorescences and calyx lobed, that are found in *U. schmidtii*.

SPECIMENS EXAMINED. — **Vietnam**. Lam Dong Province, Bao Loc, piste menant à la montagne [track leading to the mountain], 16.VII.1984, *Tirvengadam 1637* (♀) (AAU!). — Khanh Hoa Province, Khanh Vinh, Khanh Phu, Hon Ba NR, trail by the road, 12°6'48.4"N, 108°58'8"E, 884 m elev., 29.V.2019, *Yooprasert et al. VN 73-3* (sterile) (BKF!, HN!); 12°6'43.1"N, 108°58'25.9"E, 874 m elev., 29.V.2019, *Yooprasert et al. VN 74-5* (sterile) (BKF!).

DISTRIBUTION. — **Vietnam**. Khanh Hoa Province (Hon Ba Nature Reserve), Lam Dong Province (Bao Loc) and Dong Nai Province (Bien Hoa) (Fig. 3).

HABITAT. — Primary subtropical evergreen forest; elev. *c.* 800 m.

PHENOLOGY. — Collected in flower and young fruit from June to July.

CONSERVATION STATUS. — Vulnerable (VU) D2. To date, *Urophyllum annamense* (Pierre ex Pit.) Yooprasert, Culham & Utteridge, stat. nov. is found in southern Vietnam from Khanh Hoa to Dong Nai Provinces recorded from four specimens. The type specimen of



FIG. 2A. — Lectotype of *Urophyllum annamense* (Pierre ex. Pit.) Yooprasert, Culham & Utteridge, stat. nov. Digitised image from Muséum national d'Histoire naturelle, Paris (France), Collection: Vascular plants (P), Specimen P03922480.



FIG. 2B. — Detail of Fig. 2A. Digitised image from Muséum national d'Histoire naturelle, Paris (France), Collection: Vascular plants (P), Specimen P03922480.



FIG. 3. — Occurrences of *Urophyllum annamense* (Pierre ex Pit.) Yooprasert, Culham & Utteridge, stat. nov. (▲), *U. brochidodromum* Yooprasert, Culham & Utteridge, sp. nov. (●), *U. pulchrestipulum* Yooprasert, Culham & Utteridge, sp. nov. (■) and *U. pseudoschmidtii* Yooprasert, Culham, Yahara, Tagane & Utteridge, sp. nov. (◆).

the species, *Pierre 1840*, was collected in Bao Chiang, Cochinchine where it can be traced to Bien Hoa Province from the specimen of *Dialium cochinchinense* Pierre, *Pierre 1814* (P00330626). The type specimen was not included for evaluating the conservation status due to historic date of collection (1877) and declining forest habitat in the locality (Bien Hoa Province) visible on the Google Earth imagery, leaving three specimens collected from two locations in Bao Loc City and Hon Ba Nature Reserve (IUCN category not reported) to be reviewed. A visit to the nature reserve in 2019 showed it was in a good condition and well managed by the reserve staff. Although agriculture reached to the border of the reserve, the population of *U. annamense* (Pierre ex Pit.) Yooprasert, Culham & Utteridge, stat. nov. is further away from the edge. With these small number of locations found and restricted AOO (8 km²), the species is rated as Vulnerable (VU). Further collections are recommended to provide a full assessment of species existence.

REMARKS

Urophyllum annamense (Pierre ex Pit.) Yooprasert, Culham & Utteridge, stat. nov. was first published as *U. longifolium* var. *annamense* by Pitard using the manuscript of Pierre in Flore Générale de l'Indo-Chine with no taxon diagnosis but five specimens were listed without indication of a type (Pitard 1923). These specimens are *Eberhardt 3867* (P03922483, P03922489), *Chevalier 38709* (P03922491), *Lecomte & Finet 681* (P03922485) and *713* (P03922490), *Pierre 1251* (BKF!, C!, E!, K!, L[L.2970625], P[P03922472, P03922473, P03922474]) and *Pierre 1840* (BM!, C!, K!, P-photo!). After observing the specimens, they can be classified into two known taxa: *U. chinense* subsp. *chinense* Merr. & Chun (*Eberhardt 3867*, *Chevalier 38709*, and *Lecomte & Finet 681* and *713*) and *U. schmidtii* (*Pierre 1251*). The specimen of *Pierre 1840* is

different from these two taxa and shows morphological characters similar to *U. longifolium*. Despite the lack of diagnosis in the original description of the taxon, and that most parts of the taxon description were not specific to any one of the specimens, there were two unique elements of the description that identify the specimen of *Pierre 1840* which were the axillary, cymose inflorescences, and the illustration of a flower in the publication, the original of which is attached to the specimen. Therefore, the specimen of *Pierre 1840* is selected here to represent as a type specimen of the variety. The herbarium specimen deposited in P was chosen as the lectotype based upon Pierre's biography in Taxonomic Literature Second edition (Stafleu & Cowan 1983) showing that he went back to Paris in 1877 and worked on the manuscript there.

Populations of *U. longifolium* var. *longifolium* are recorded from Tenasserim, Myanmar through Peninsular Thailand with the most southern in Songkhla Province (Yooprasert 2021). However, specimens assigned to *U. longifolium* var. *annamense* are found only in Vietnam, further away and disjunct from other populations of *U. longifolium*. These specimens can also be distinguished by their corolla colour (green instead of white). Together, these data support the change in taxonomic status from the variety to recognition at species rank as *Urophyllum annamense* (Pierre ex Pit.) Yooprasert, Culham & Utteridge, stat. nov.

Urophyllum bidoupense

Yooprasert, Culham & Utteridge, sp. nov.

(Figs 4; 5)

Urophyllum bidoupense Yooprasert, Culham & Utteridge, sp. nov. is similar to *U. chinense* subsp. *chinense* Merr. & Chun, but differs in: the stipules which are subglabrous abaxially, the hairs (if present) are only around the apex, and the leaves are glabrous to the naked eye and sparsely hairy with magnification. While *U. chinense* subsp. *chinense* has uniformly densely hairy stipules, and hairy leaves to the naked eye. It differs from *U. chinense* subsp. *latistipulum* Yooprasert, Culham, Yahara & Utteridge, subsp. nov., as the stipules have hairs along the midline from base to apex.

TYPE. — **Vietnam**. Lam Dong Province, Lac Duong District, Bidoup-Nui Ba National Park, Trail by Ranger station Hon Giao, border to Son Thai, Khanh Vinh District, 12°11'14.3"N, 108°42'51.7"E, 1633 m elev., 1.VI.2019, *Yooprasert et al. VN 91-1* (♀) (holo-, HN!; iso-, BKF!).

ADDITIONAL SPECIMENS EXAMINED. — **Vietnam**. Khanh Hoa Province, Khanh Son District, 41 km to NE from Dalat city, E macroslope of Hon Giao mt. ridge, 12°11'N, 108°43'E, 1500-1600 m elev., 22.IV.1997, *Averyanov et al. VH 4154* (♂) (AAU!; HN!); Khanh Vinh District, Son Thai, 12°11'47.7"N, 108°43'33.2"E, 1518 m elev., 28.VI.2018, *Tagane et al. V 9201* (♂) (DLU n.v.; FU!; KAG!). — Lam Dong Province, Lac Duong District, Bidoup-Nui Ba NP, trail by Ranger Station Hon Giao, 12°11'11.8"N, 108°42'53.3"E, 1575 m elev., 1.VI.2019, *Yooprasert et al. VN 85-3* (♂) (BKF!; K!); 1651 m elev., 1.VI.2019, *Yooprasert et al. VN 87-1* (♂) (BKF!); *Yooprasert et al. VN 87-3* (♂) (BKF!); *Yooprasert et al. VN 87-4* (♂) (BKF!); municipality Da Chay [Da Chais Commune], 35 km to NE from Dalat City, W macroslope of Gia Rinht mt. ridge, 12°9'N, 108°41'E, 1700-1800 m elev., 18.IV.1997, *Averyanov et al. VH 4059* (♀) (AAU!, HN!).

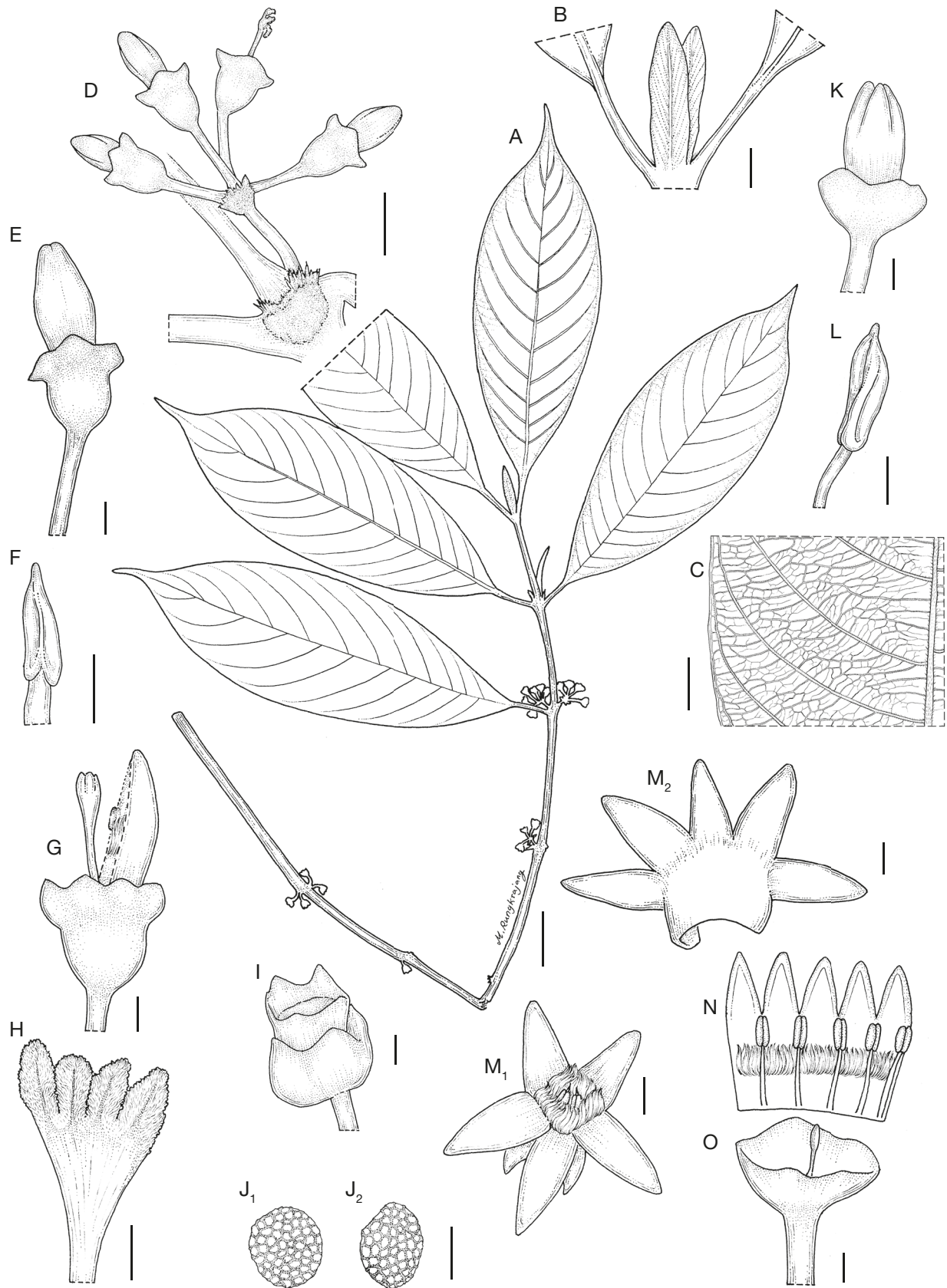


FIG. 4. — *Urophyllum bidoupense* Yooprasert, Culham & Utteridge, sp. nov.: A, flowering branch; B, stipules; C, abaxial leaf lamina; D–J, pistillate plant: D, inflorescence; E, flower bud; F, staminode; G, immature stigma positioning in a flower; H, stigma; I, fruit; J, seed, top view (J₁) and side view (J₂); K–O, staminate plant: K, flower bud; L, stamen; M, corolla, adaxial side (M₁) and abaxial side (M₂); N, corolla opened out to show stamens and throat hairs arrangement; O, calyx and pistillode. Drawn by Mahsarakha Rungkrajang. Drawn from: A, H, I, Averyanov et al. VH 4154; B–G, O, Yooprasert et al. VN 91-1; J–N, Yooprasert et al. VN 87-1. Scale bars: A, 2 cm; B, 4 mm; C, 5 mm; D, 3 mm; E, G, I, K, M–O, 1 mm; F, H, J, L, 0.5 mm.



FIG. 5. — Isotype of *Urophyllum bidoupense* Yooprasert, Culham & Utteridge, sp. nov.

ETYMOLOGY. — The specific epithet refers to its type locality, Bidoup-Nui Ba National Park.

DISTRIBUTION. — Vietnam: Lam Dong (Bidoup-Nui Ba National Park) and Khanh Hoa (Son Thai) Provinces (Fig. 6).

HABITAT. — Primary broadleaved evergreen montane forest mixed with conifers in the Hon Giau mountain range; elev. 1500–1800 m.

PHENOLOGY. — Collected in flower and fruit from April to June.

CONSERVATION STATUS. — Least Concern (LC). *Urophyllum bidoupense* Yooprasert, Culham & Utteridge, sp. nov. is known from only two previous collected specimens within the area of Bidoup-Nui Ba National Park (IUCN category Ia) in 1997. The species was still found in the same locality in 2018 and 2019, close to the Hon Giau Ranger Station, where the habitat was observed to be undisturbed, and the species is common: the plot survey in Hon Giau by third and fourth authors recorded 108 individuals within 0.1 ha. Despite a small AOO (8 km²), the species is not at risk, therefore it can be rated as Least Concern (LC).

DESCRIPTION

Shrub or treelet to 10 m high, 10 cm in DBH, almost glabrous. Branches terete; young shoots flattened, ridged. Stipules caducous, 1–2 nodes at shoot, oblong-lanceolate to elliptic, 1–2 cm long, 0.3–0.6 cm wide, appressed to the stem but not folded, abaxially glabrous to subglabrous, hairs present at around apex; conspicuous to inconspicuous netted veins. Leaves coriaceous, elliptic to obovate, 7–15 cm long, 3–5 cm wide, apex acuminate, base cuneate, adaxially glabrous, abaxially glabrous to the naked eye, sparsely hairy with short hairs < 0.5 mm long under magnification, drying dull yellowish green to brown adaxially, usually shiny yellowish green abaxially with reddish-brown midrib; secondary veins [10]12–16 pairs, weakly brochidodromous; tertiary veins mixed percurrent, angle increasing basally, middle of the leaves subperpendicular to obtuse, veins diverging at angle of *c.* 95°–110° to the midrib; petioles [0.8–]1.1–1.7 cm long, canalliculate. Inflorescence axillary, pedunculated umbellate, peduncle 0.8–4.0 mm long, bract triangular with dense hairs at base and margin, 1–2 mm long, bearing 3–6 flowers in staminate plant, 3–4 flowers in pistillate plant; nectary disk annular, present in both sexes. Staminate flowers calyx fused, teeth 5, 1.1–1.6 mm long; corolla fused forming a tube at base approaching 1/3 their length, lobes 5, valvate, 2–4 mm long, densely hairy at throat inside; stamens 5, filament fused to the corolla tube, anthers 2-celled, dorsifixed, introrse; pistillode present, ovary vestigial. Pistillate flowers calyx fused, teeth to shallow lobes 5, 1–2 mm long; corolla as staminate flowers; staminodes 5, anthers lacking pollen; ovary cupuliform, locules 5; style *c.* 2 mm long, sparsely scaly; stigma lobes 5 *c.* 0.5 mm long, covered with scales. Fruits baccate, subglobose, *c.* 3 mm diam. *in sicco*; calyx and disk persistent. Seed numerous, subelliptic, surface alveolate, orange brown *in sicco*.

REMARKS

Urophyllum bidoupense Yooprasert, Culham & Utteridge, sp. nov. is recognised by its abaxially glabrous to subglabrous stipules. Additional characters useful for identifying the species are coriaceous leaves, abaxially usually a shiny olive colour, glabrous to the naked eye but sparsely hairy under magnification, fruits



FIG. 6. — Occurrences of *Urophyllum bidoupense* Yooprasert, Culham & Utteridge, sp. nov. (●) and *U. chinense* Merr. & Chun subsp. *latistipulum* Yooprasert, Culham, Yahara & Utteridge, subsp. nov. (▲).

glabrous, calyx persistent with small teeth to shallow lobes. *Urophyllum bidoupense* Yooprasert, Culham & Utteridge, sp. nov. is similar to *U. chinense* subsp. *latistipulum* Yooprasert, Culham, Yahara & Utteridge, subsp. nov. and their distribution overlaps within Bidoup-Nui Ba National Park. While *U. chinense* subsp. *latistipulum* Yooprasert, Culham, Yahara & Utteridge, subsp. nov. is widely distributed in the national park, *U. bidoupense* Yooprasert, Culham & Utteridge, sp. nov. is restricted to Hon Giau and its adjacent area. The main morphological character that differs between these two taxa are the stipule and leaf morphologies. In *U. bidoupense* Yooprasert, Culham & Utteridge, sp. nov., the stipules are subglabrous abaxially, hairs present only at apex with coriaceous leaves drying shiny abaxially, whereas the stipules of *U. chinense* subsp. *latistipulum* Yooprasert, Culham, Yahara & Utteridge, subsp. nov. are abaxially hairy along midline with leaves usually chartaceous drying dull abaxially. Other species found in the National Park and nearby area (Giang Ly and Iar Giang) are *U. pseudoschmidtii* Yooprasert, Culham, Yahara, Tagane & Utteridge, sp. nov. and *U. lecomtei* Pit. The distinguishing character of *U. bidoupense* Yooprasert, Culham & Utteridge, sp. nov. from these two species is stipules which are subglabrous abaxially, whereas the latter two have conspicuously hairy stipules.

Urophyllum brochidodromum

Yooprasert, Culham & Utteridge, sp. nov.
(Figs 7; 8)

Urophyllum brochidodromum Yooprasert, Culham & Utteridge, sp. nov. is similar to *U. lecomtei* Pit. but differs in the secondary veins strongly joining together to form closed loops close to the leaf margin

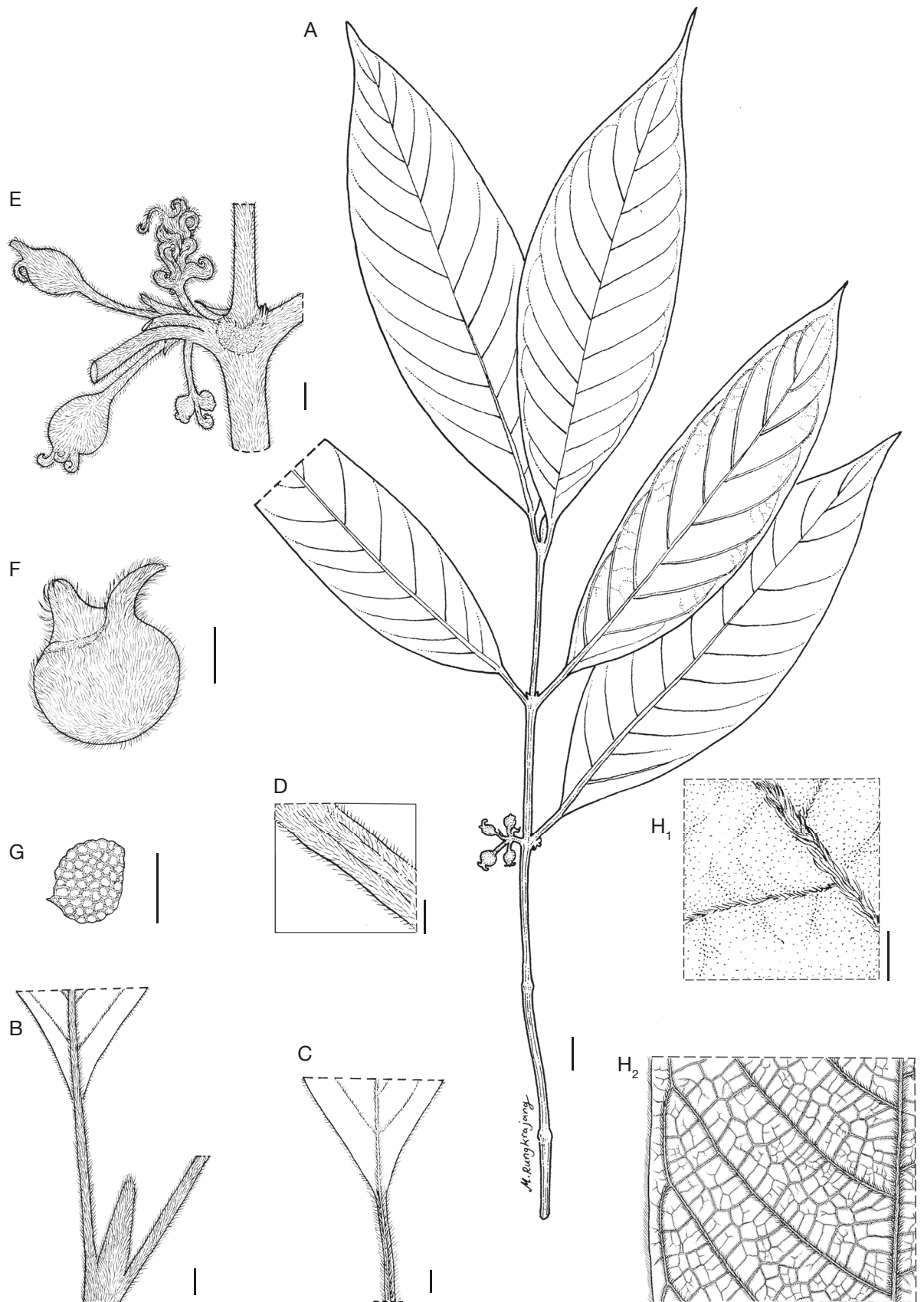


FIG. 7. — *Urophyllum brochidodromum* Yooprasert, Culham & Utteridge, sp. nov., illustration of pistillate plant: **A**, fruiting branch; **B**, stipule and abaxial petiole; **C**, adaxial petiole; **D**, young stem; **E**, infructescence; **F**, fruit; **G**, seed; **H**, leaf lamina, adaxial side showing midrib and secondary veins (**H₁**) and abaxial side showing midrib and veins (**H₂**). Drawn by Mahsarakha Rungkrajang. Drawn from *Averyanov et al. VH 1648*. Scale bars: A, 1 cm; B, C, 2 mm; D, F, 1 mm; E, 3 mm; G, 0.5 mm; H₁, 1.5 mm; H₂, 5 mm.



FIG. 8. — Holotype of *Urophyllum brochidodromum* Yooprasert, Culham & Utteridge, sp. nov.

with no additional sets of loops (conspicuously brochidodromous), while in *U. lecomtei*, the veins are joined with a series of small loops (festooned brochidodromous). The species also differs in its calyx lobes, which are recurved, at least at the fruiting stage compared to the erect to incurved lobes found in *U. lecomtei*.

TYPE. — **Việt Nam.** Kon Tum Province, Dak Gley [Dak Glei District], about 12 km to N of Dak Gley town (24 km by road), near Mang Khen Village, 1100–1200 m elev., 14.XI.1995, *Averyanov et al. VH 1648* (♀) (holo-, AAU!).

ADDITIONAL SPECIMENS EXAMINED. — **Việt Nam.** Bin Tri Thien [Quang Binh, Quang Tri and Thua Thien Hue Provinces], 9.VIII.1980, *Hoang 67* (♀) (HN!). — Kon Tum Province, Ngoc Linh Nature Reserve, 15°12'24.2"N, 107°46'10.4"E, 1365 m elev., 14.II.2017, *Tagane et al. V 6648* (♀) (DLU n.v.; FU!). — Quang Binh Province, Bo Trach District, Hung Trach municipality, Phong Nha-Ke Bang NP, between km 51 and 56 of west branch of Ho Chi Minh Road., 17°27'30"N, 106°23'6"E, c. 650 m elev., 4.VII.2004, *Wu et al. WP 928* (♀) (HN!). — Thua Thien Hue Province, A Luoi District, 25.V.2005, *Binh & Cuong VN 1506* (♂) (HN!).

ETYMOLOGY. — The specific epithet refers to the conspicuously brochidodromous lateral veins.

DISTRIBUTION. — **Việt Nam:** Kon Tum Province (Ngoc Linh Nature Reserve), Quang Binh Province (Phong Nha-Ke Bang National Park) and Thua Thien Hue Province (A Luoi District) (Fig. 3).

HABITAT. — Evergreen forest to evergreen montane forest, by streams; elev. 650–1400 m.

PHENOLOGY. — Flowers collected in May and fruits from August to February.

CONSERVATION STATUS. — Vulnerable (VU) B1ab(iii)+2ab(iii)+D2. The species has an estimated EOO of 2470 km² and AOO of 16 km² both below the Endangered (EN) threshold, and is only known from three locations; however, two locations are within the protected areas of Ngoc Linh Nature Reserve (IUCN category IV) and Phong Nha-Ke Bang National Park (IUCN category II) where the risk of deforestation is unlikely to increase dramatically. One specimen was collected in A Luoi District which is not a protected area, with concerns for the expansion of agriculture land use growing *Acacia* species and *Cassava* in the future (Pham 2019). Therefore, the species is rated as Vulnerable. However, there is Phong Dien Nature Reserve (IUCN category IV) which has continuous forest to the northeast of A Luoi District viewing on the Google Earth in 2021. If further collections reveal the presence of the species in this area, the rating could be reviewed as Near Threatened.

DESCRIPTION

Shrub or treelet to 2 m high. Indumentum of appressed to erect hairs, 0.5–1.5 mm long, scattered on old stems, dense on other parts except adaxial leaf lamina. Branches terete; young shoots flattened, ridged. Stipules caducous usually left only at shoot, lanceolate 1.1–1.4 cm long, 0.15–0.33 cm wide, appressed to the stem but not folded, abaxially densely hairy. Leaves chartaceous, elliptic to oblong, 13.0–15.1 cm long, 3.9–4.8 cm wide, apex attenuate to acuminate, base cuneate; adaxially glabrous, abaxially densely hairy, drying dull dark yellowish green adaxially, lighter abaxially with yellowish brown veins, adaxially midrib hairy; secondary veins 13–17 pairs, adaxially densely hairy, conspicuously brochidodromous, usually without additional sets of small loops; tertiary veins alternate percurrent, angle increasing exmedially, obtuse to

midrib; petioles 1.0–1.5 cm long, canaliculate. Inflorescence axillary, pedunculated umbellate, peduncle 2.2–2.9 mm long, bracts lanceolate, 3–4 mm long, only fruit bearing pistillate plant known. Fruits baccate, subglobose, c. 3 mm diam. *in sicco*; petiole c. 5 mm; calyx fused, lobes 5, persistent, 1–2 mm long, recurved. Seed numerous, subelliptic, surface alveolate, orange brown *in sicco*.

REMARKS

Urophyllum brochidodromum Yooprasert, Culham & Utteridge, sp. nov. is recognised by having strongly brochidodromous and dense hairs on both adaxial midrib and secondary venation. The persistent recurved calyx is an additional diagnostic character. The species is similar to *U. lecomtei* in its erect dense hairs over all parts but differs by the characters previously stated in the diagnosis: *U. lecomtei* has hairs only on the adaxial midrib, secondary veins festooned brochidodromous (main loops with sets of smaller loops) and calyx erect or sometimes curved toward adaxial side in fruit. There are records of *U. argenteum* Pit. found in Bach Ma National Park, Thua Thien Hue Province. This national park is further south c. 70 km away from A Luoi District where one population of *U. brochidodromum* Yooprasert, Culham & Utteridge, sp. nov. was found. *Urophyllum argenteum* is distinguished from *U. brochidodromum* Yooprasert, Culham & Utteridge, sp. nov. by its coriaceous leaves, adaxial leaf side shiny and glabrous, secondary veins eucamptodromous to weakly brochidodromous with inconspicuous loops and erect calyx lobes.

Urophyllum chinense Merr. & Chun subsp. *latistipulum* Yooprasert, Culham, Yahara & Utteridge, subsp. nov. (Figs 9; 10)

Urophyllum chinense subsp. *latistipulum* Yooprasert, Culham, Yahara & Utteridge, subsp. nov. is similar to *U. chinense* subsp. *chinense* Merr. & Chun, but differs in its stipules, which are broadly ovate to elliptic, 4.4–7.6 mm wide and with hairs present only along the midline; whereas in *U. chinense* subsp. *chinense*, the stipules are linear-oblong to ligulate, 1.7–2.9 mm wide with hairs present all over. The subspecies also differs in its leaves which are abaxially glabrous to the naked eye and sparsely hairy under magnification, instead of conspicuously densely hairy, visible to the naked eye in *U. chinense* subsp. *chinense*.

TYPE. — **Việt Nam.** Lam Dong Province: Lac Duong District, Da Nhim Commune, Bidoup-Nui Ba NP, Trail next to Ranger station Dung Iar Gieng, 12°09'35.9"N, 108°32'10.1"E, 1621 m elev., 3.VI.2019, *Yooprasert et al. VN 112-2* (♀) (holo-, HN!; iso-, BKF!).

ADDITIONAL SPECIMENS EXAMINED. — **Việt Nam.** Lam Dong Province, 15 kilomètres au nord de Dankia [north of Dankia], Langbiang, 1500–1800 m elev., 27.X.1930, *Poillane 18661* (♀) (P[P04950968]!); Da Lat City, Rong Phon Forest, Suoivang, 1500 m elev., 1.I.1998, *Wongprasert 981-15* (♀) (BKF!); Da Tong, Bidoup Nui Ba NP, beside the road no. DT722, across a stream, 12°5'50.4"N, 108°22'36"E, 1711 m elev., 4.VI.2019, *Yooprasert et al. VN 116-5* (♀) (BKF!; K!); Dam Rong District, Da Long, Bidoup Nui Ba NP, beside the road to Ranger station Da Long, 12°9'21.5"N, 108°21'57.6"E, 1495 m elev., 2.VI.2019, *Yooprasert et al. VN 105-1* (sterile) (BKF!); Lac Duong District, Da Chay [Da Chais Commune], 29 km to NE from Dalat City, on main peak of Bi Dup mt. system, 12°5'N, 108°40'E,

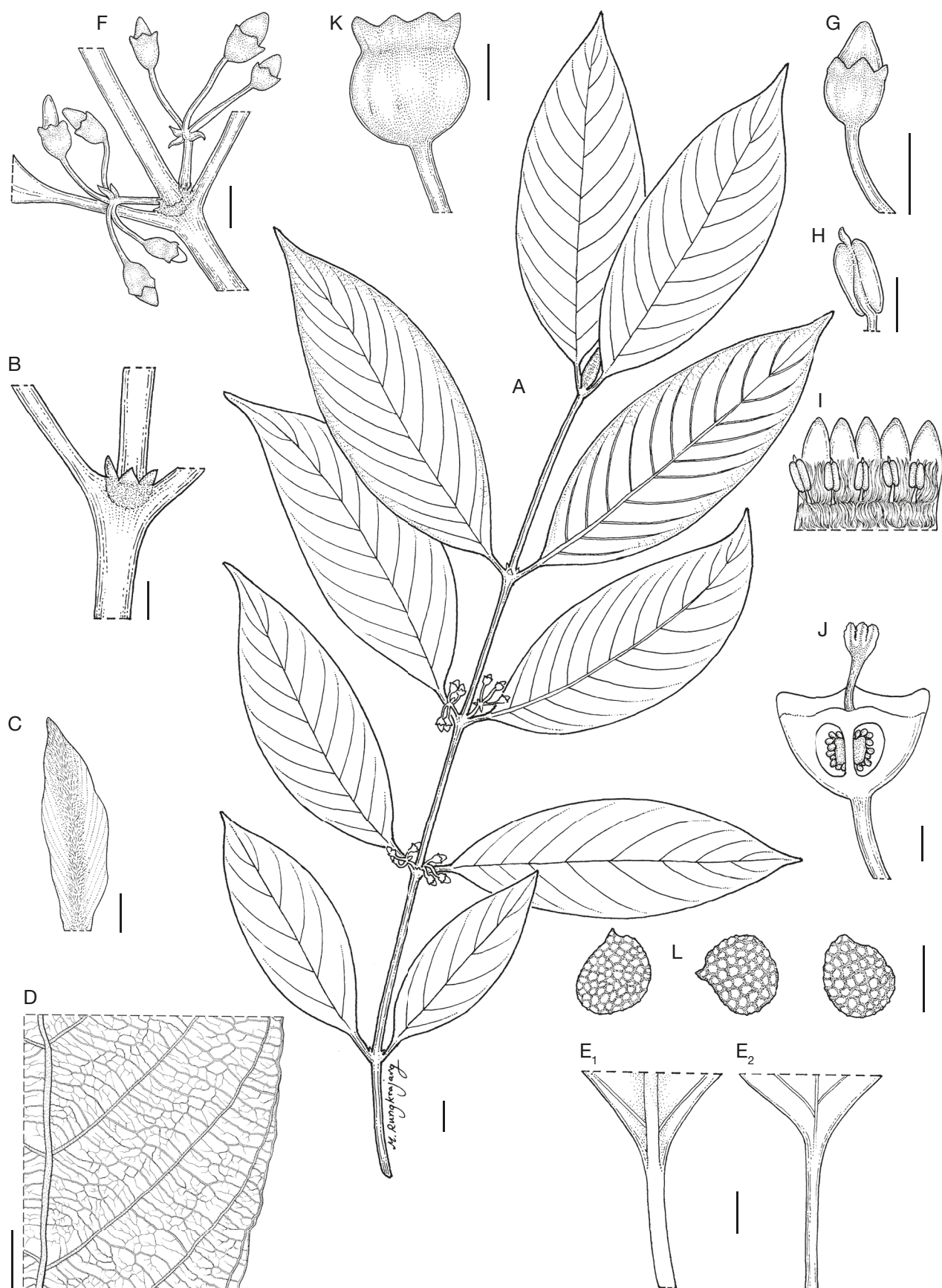


FIG. 9. — *Urophyllum chinense* Merr. & Chun subsp. *latistipulum* Yooprasert, Culham, Yahara & Utteridge, subsp. nov., illustration from pistillate plant: **A**, flowering branch; **B**, stem and stipule scar; **C**, stipule; **D**, abaxial leaf lamina; **E**, petiole, abaxial side (**E**₁) and adaxial side (**E**₂); **F**, inflorescence; **G**, flower bud; **H**, staminode; **I**, adaxial corolla showing staminodes and throat hairs arrangement; **J**, immature stigma positioning in a flower; **K**, fruit; **L**, seed. Drawn by Mahsarakha Rungkrajang. Drawn from Yooprasert *et al.* VN 112-2. Scale bars: **A**, 1 cm; **B**, **C**, **E**-**G**, **K**, 3 mm; **D**, 5 mm; **H**, **L**, 0.5 mm; **I**, **J**, 1 mm.



FIG. 10. — Isotype of *Urophyllum chinense* Merr. & Chun subsp. *latistipulum* Yooprasert, Culham, Yahara & Utteridge, subsp. nov.

2260 m elev., 21.III.1997, *Averyanov et al. VH 2981* (♀) (AAU!); 31 km NE of Dalat City, vicinities Klong Lanh village, NW macroslope of Bi Dup mt system, 12°8'N, 108°39'E, 1850-1950 m elev., 15.III.1997, *Averyanov et al. VH 2651* (♀) (AAU!); 20.III.1997, *Averyanov et al. VH 2941* (♀) (AAU!); 35 km to NE from Dalat City, W macroslope of Gia Rinht mt. ridge, 12°9'N, 108°41'E, 1800 m elev., 18.IV.1997, *Averyanov et al. VH 4075* (♀) (AAU!); Bidoup Nui Ba NP, 12°2'48.13"N, 108°26'6.67"E, 1918 m elev., 24.VI.2018, *Tagane et al. V 8982* (sterile) (DLU n.v.; FU!); Mt. Langbian, 12°2'46.3"N, 108°26'1.5"E, 1905 m elev., 25.III.2018, *Yahara et al. V 7930* (sterile) (FU!); Trail by Ranger Station Giang Ly, 12°8'44.6"N, 108°40'17.2"E, 1510 m elev., 1.VI.2019, *Yooprasert et al. VN 102-7* (♀) (BKF!); 12°8'48.3"N, 108°40'16.6"E, 1487 m elev., 1.VI.2019, *Yooprasert et al. VN 100-1* (♀) (BKF!; HN!); Trail opposite Ranger Station Giang Ly, crossing a stream, 12°10'47.5"N, 108°41'6.9"E, 1490 m elev., 1.VI.2019, *Yooprasert et al. VN 96-1* (sterile) (BKF!, HN!); *Yooprasert et al. VN 96-2* (sterile) (BKF!); Da Nhim Commune, Bidoup Nui Ba NP, Trail next to Ranger station Dung Iar Gieng [12°7'59.9"N, 108°39'1.9"E], 1439 m elev., 3.VI.2019, *Yooprasert et al. VN 107-2* (sterile) (BKF!); trail to Thac Thien Thai Waterfall, 12°8'41.4"N, 108°31'47.5"E, 1510 m elev., 31.V.2019, *Yooprasert et al. VN 82-1* (sterile) (BKF!).

ETYMOLOGY. — The subspecific epithet derived from the stipule's broader shape.

DISTRIBUTION. — Vietnam. Endemic, to date only known from Lam Dong Province (Fig. 6).

HABITAT. — Primary broadleaved evergreen montane forest and mixed evergreen deciduous forest and bamboo thickets, on slope; elev. 1400-2300 m.

PHENOLOGY. — Collected in flower in June and fruit all year around.

CONSERVATION STATUS. — Vulnerable (VU) B1ab(iii)+2ab(iii). The taxon is endemic and known from 18 collections within six locations in Lam Dong Province (*c.* 15 km radius). The estimated EOO (441 km²) and AOO (44 km²) are within the threshold for the Endangered (EN) category, however five locations are in Bidoup-Nui Ba National Park (IUCN category Ia) where the risk of extinction is low. Only one population in Rung Thong Da Lat Cultural and Historical Site has shown the slowly expanding urban and cultivation areas in the past 12 years on the Google Earth imagery, however the area is listed in IUCN category V where the land use can be balanced between human and nature. For these reasons, this endemic subspecies is rated as Vulnerable.

DESCRIPTION

Shrub or treelet to 7 m, almost glabrous. Branches terete; young shoots flattened, ridged. Stipules caducous usually left only at apex, ovate to elliptic 1.2-2.1 cm long, 0.44-0.76 cm wide, appressed to the stem but not folded, abaxially densely hairy along midline, conspicuous netted veins. Leaves chartaceous, rarely coriaceous, usually elliptic to oblong, rarely ovate to obovate, 10.0-16.2 cm long, 3.3-6.4 cm wide, apex acuminate, base cuneate, adaxially glabrous, abaxially glabrous to the naked eye, sparsely hairy with short hairs < 0.5 mm long under magnification, drying dull yellowish green to brown adaxially, dull (rarely shiny) yellowish green abaxially with yellow to brown veins; secondary veins 7-11 pairs, weakly to festooned brochidodromous; tertiary veins mixed percurrent, angle increasing basally, middle of the leaves subperpendicular to obtuse, veins diverging at angle of *c.* 89°-113° from the midrib; petioles [0.5-]0.7-1.4[-2.1] cm long, canaliculate.

Inflorescence axillary, pedunculate to subsessile umbellate, peduncle [0.5-]2.2-7.6[-16.9] mm long, bracts triangular, densely hairy at base, *c.* 1 mm long, bearing 4-5 flowers in pistillate plant, nectary disk annular, only pistillate plant known. Pistillate flowers calyx fused, 1.0-2.2 mm long, teeth to shallow lobes 5, 0.3-0.8 mm deep; corolla fused forming a tube at base approaching 1/3 their length, lobes 5, valvate, immature lobes *c.* 1.5 mm long, densely hairs at throat inside; staminodes 5, anthers without pollen; ovary cupuliform, locules 5; style *c.* 0.8 mm long in flower bud, sparsely scaly; stigma lobes 5, *c.* 0.8 mm long, covered with scales. Fruits baccate, subglobose, 5.1-5.8 mm diam. *in sicco*; calyx and disk persistent. Seed numerous, subelliptic, surface alveolate, orange brown *in sicco*.

REMARKS

Urophyllum chinense subsp. *latistipulum* Yooprasert, Culham, Yahara & Utteridge, subsp. nov. is sympatric with *U. bidoupense* Yooprasert, Culham & Utteridge, sp. nov. in Bidoup-Nui Ba National Park. They are morphologically similar being superficially glabrous in appearance, only sparsely hairy on the abaxial leaf surface under magnification. However, the taxon differs to *U. bidoupense* Yooprasert, Culham & Utteridge, sp. nov. by its stipules being hairy along the midline abaxially and usually chartaceous leaves drying dull abaxially instead of subglabrous stipules with hairs found only at apex and coriaceous leaves drying shiny abaxially found in *U. bidoupense* Yooprasert, Culham & Utteridge, sp. nov. Other taxa found in the area are as discussed in the Remarks to *U. bidoupense* Yooprasert, Culham & Utteridge, sp. nov., which are *U. pseudoschmidtii* Yooprasert, Culham, Yahara, Tagane & Utteridge, sp. nov. and *U. lecomtei*. The taxon differs from these taxa by its stipule hairy in the midline, while in the others stipule is hairy all around.

Urophyllum pulchristipulum

Yooprasert, Culham & Utteridge, sp. nov.

(Figs 11; 12)

Urophyllum pulchristipulum Yooprasert, Culham & Utteridge, sp. nov. is similar to *U. schmidtii* C.B. Clarke and *U. pseudoschmidtii* Yooprasert, Culham, Yahara, Tagane & Utteridge, sp. nov., but differs in its stipules, which are broadly subcordate, with conspicuous netted veins and abaxially glabrous, whereas in *U. schmidtii*, they are linear-oblong, have only inconspicuous netted veins and abaxially densely hairy. Its inflorescences are sessile umbellate rather than pedunculate umbellate as always found in *U. schmidtii*.

TYPE. — Cambodia. Ratanikiri [Ratanakiri] Province: Virachay [Virachey] National Park, Western slopes and ridge leading to Mt. Yak Kham, East of Ho Chi Minh trail, 48P. 756282: 1587299 [14°20'45.24"N, 107°22'34.25"E], 800-1100 m elev., 13.XII.2005, *Thomas et al. 26* (♀) (holo-, E[E00220453]!; iso-, L[L.2972067]!).

ETYMOLOGY. — The specific epithet refers to its stipules which have beautiful subcordate shape and neatly arranged network venation.

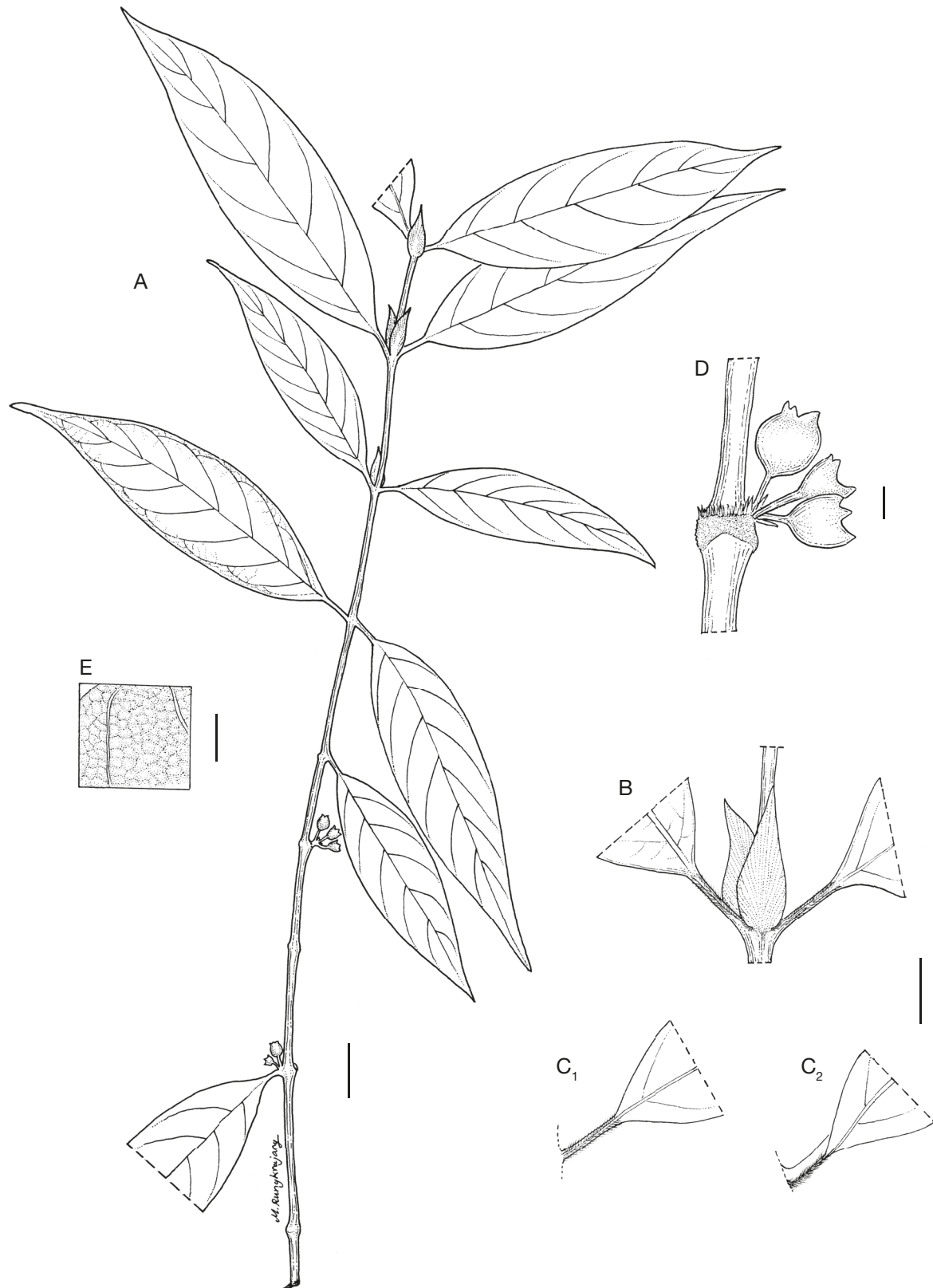


FIG. 11. — *Urophyllum pulchristipulum* Yooprasert, Culham & Utteridge, sp. nov.: **A**, fruiting branch; **B**, stipule; **C**, petiole, adaxial view (**C1**), side view (**C2**); **D**, infructescence; **E**, abaxial leaf lamina. Drawn by Mahsarahka Rungkrajang. Drawn from Thomas *et al.* 26. Scale bars: A, 1 cm; B, C, 0.5 mm; D, E, 3 mm.

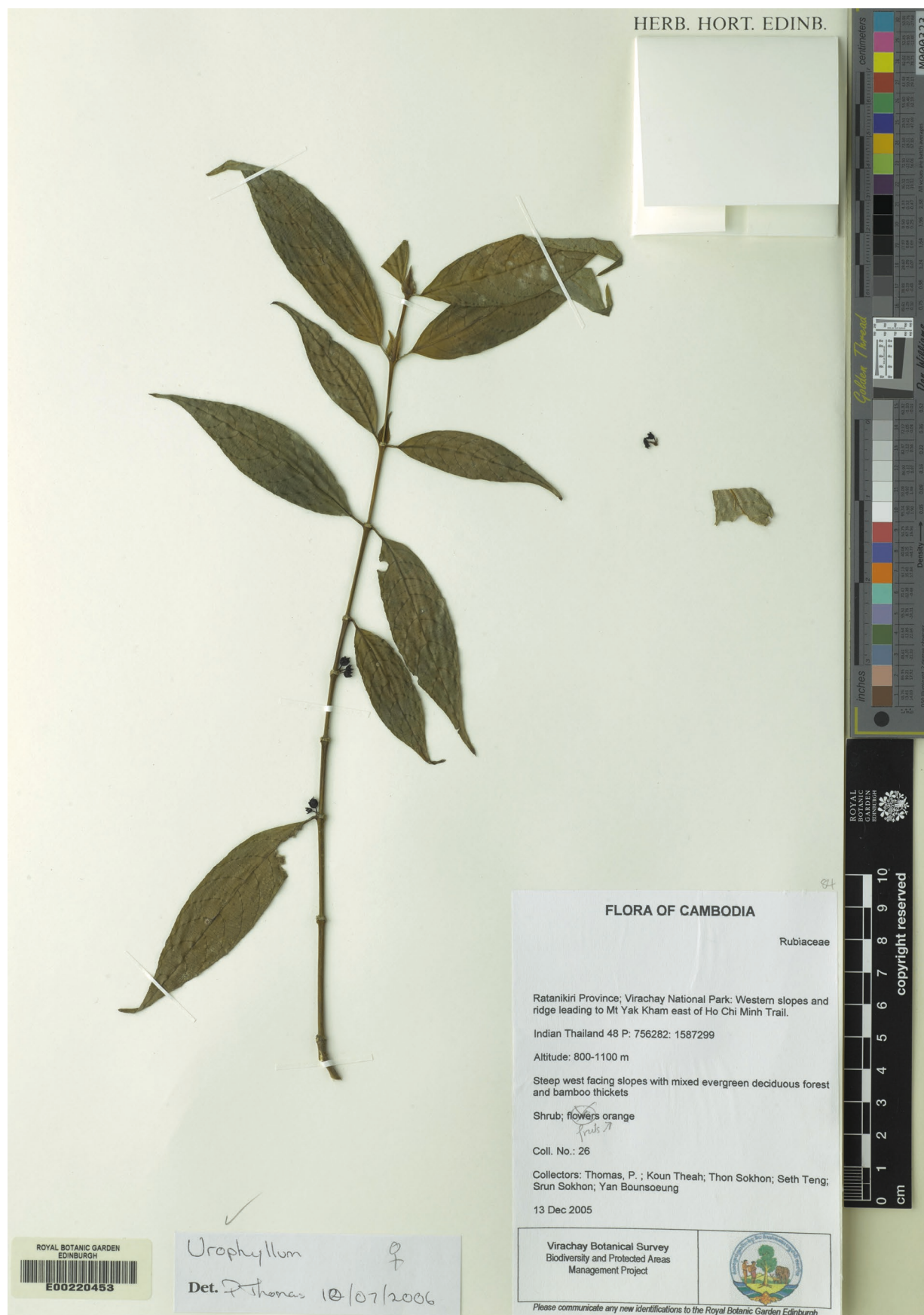


FIG. 12. — Holotype of *Urophyllum pulchrestipulum* Yooprasert, Culham & Utteridge, sp. nov. Digitised image from Royal Botanic Garden Edinburgh (E), Specimen E00220453 (<http://data.rbge.org.uk/herb/E00220453>).

DISTRIBUTION. — Cambodia: Ratanakiri Province. Endemic, to date only known from the type specimen from Virachey National Park (Fig. 3).

HABITAT. — Mixed evergreen forest and bamboo thickets, on slope; elev. 800–1100 m.

PHENOLOGY. — Flower season is unknown. A specimen with fruits collected in December.

CONSERVATION STATUS. — Data deficient (DD). Because only one specimen of *Urophyllum pulchrestipulum* Yooprasert, Culham & Utteridge, sp. nov. has been collected from Virachey National Park (IUCN category II) in Cambodia, it does not provide enough data to estimate EOO and AOO for this species. The species has a potential to be found within nearby National Parks including Chu Mom Ray (in Vietnam, IUCN category II), Dong Ampham and Xe Pian National Protected Areas (In Laos PDR, both in IUCN category VI) where the habitat is similar. Further collections in the areas should be carried out to assess existence of the species.

DESCRIPTION

Shrub. Indumentum almost glabrous, hairy only on petiole ridges, stipule base and margin. Branches quadrate to terete; young shoots flattened, ridged. Stipules caducous, usually left only at shoot, subcordate, 9–11 mm long, 3–5 mm wide, appressed to the stem but not folded, abaxially glabrous, conspicuous netted veins *in sicco*. Leaves chartaceous, elliptic to oblong, 5.4–8.3 cm long, 1.3–2.2 cm wide, apex acuminate, base cuneate to obtuse; adaxially glabrous, abaxially sparsely hairy on veins, drying dull brown to dark green adaxially, dull light yellowish brown abaxially; secondary veins 7–8 pairs, festooned brochidodromous, angle decreasing basally; tertiary veins mixed percurrent, angle decreasing exmedially and increasing basally, obtuse angle to the midrib; petioles 3.7–5.3 mm long, canaliculate, adaxially densely hairy on ridges, abaxially glabrous. Inflorescence axillary, sessile umbellate, bracts lanceolate leafy-like, *c.* 1.9 mm long, only fruits bearing pistillate plant known. Fruits baccate, subglobose, 1.6–2.5 mm diam. *in sicco*; pedicel 1.4–1.9 mm; calyx lobes 5, persistent, 0.7–0.9 mm long.

REMARKS

Despite lacking flowers and staminate plants for *Urophyllum pulchrestipulum* Yooprasert, Culham & Utteridge, sp. nov., it is unique by its subcordate stipules with the abaxial side glabrous, sessile umbellate inflorescence in pistillate plants and is only species recorded from north-eastern Cambodia (Ratanakiri Province) to date. The other *Urophyllum* species found in Cambodia is *U. schmidtii* recorded from eastern Thailand (Chanthaburi and Trat provinces) through southwestern Cambodia (Koh Kong and Kampong Speu provinces), which has linear-lanceolate stipules, abaxially densely hairy and a pedunculate umbellate inflorescence. An additional morphologically similar species is *U. pseudoschmidtii* Yooprasert, Culham, Yahara, Tagane & Utteridge, sp. nov., however the stipules also differ from *U. pulchrestipulum* Yooprasert, Culham & Utteridge, sp. nov. in the same way as *U. schmidtii*.

Urophyllum pseudoschmidtii

Yooprasert, Culham, Yahara, Tagane & Utteridge, sp. nov.
(Figs 13; 14)

Urophyllum streptopodium Wall. in Pitard in H. Lecomte, *Flore générale de l'Indo-Chine* 3: 200 (Pitard 1923), *auct. non. Urophyllum streptopodium* Wall. ex Hook.f., *The Flora of British India* 3: 99 (Hooker 1880), **syn. nov.**

Urophyllum pseudoschmidtii Yooprasert, Culham, Yahara, Tagane & Utteridge, sp. nov. is similar to *U. schmidtii* C.B. Clarke, but differs in its pistillate flowers, which lack staminodes which are always found in pistillate flowers of *U. schmidtii*. The species also differs in its staminate inflorescences, which are sessile umbellate and the flowers are seemingly sessile having very short pedicels; whereas *U. schmidtii* has pedunculate umbellate inflorescences and the flowers with conspicuous pedicels.

TYPE. — **Vietnam.** Ha Tinh Province: Vu Quang National Park, along trail to the summit of Mt. Rao CO, 18°12'49.7"N, 105°23'42.8"E, 904 m elev., 21.VI.2016, *Yahara et al. V 5618a* (♀) (holo-, K!; iso-, DLU n.v.; FU!).

ADDITIONAL SPECIMENS EXAMINED. — **Vietnam.** s.loc., 7.VI.1921, Hayata 205 (♀) (P[P03922484]!). — Ha Tinh Province, Vu Quang NP, in transect line 2, 18°16'9.1"N, 105°21'17.5"E, 649 m elev., 24.VII.2015, *Yahara et al. V 3614* (sterile) (DLU n.v.; FU!); along trail to the summit of Mt. Rao CO, 18°12'49.7"N, 105°23'42.8"E, 904 m altitude, 21.VI.2016, *Yahara et al. V 5618b* (♂) (DLV n.v.; K!; FU!). — Lam Dong Province, Grand Piton Lang-Bian [Lang Bian], près du village de Beneur [near the village Beneur], 1500–2000 m elev., 15.II.1914, *Chevalier 30836* (♀) (P[P03922421]!); Lac Duong District, Da Chais Commune, Bidoup Nui Ba NP, Trail by Ranger station Giang Ly, 12°8'49.1"N, 108°40'16.2"E, 1469 m elev., 1.VI.2019, *Yooprasert et al. VN 99-1* (♂) (BKF!); Da Nhim Commune, Bidoup Nui Ba NP, Trail next to Ranger station Dung Lar Gieng, 12°9'35.9"N, 108°32'10.1"E, 1621 m elev., 3.VI.2019, *Yooprasert et al. VN 112-1a* (♂) (BKF!; K!); *Yooprasert et al. VN 112-1b* (♂) (BKF!; HN!).

ETYMOLOGY. — The specific epithet refers to its similar morphological characters to *U. schmidtii*.

DISTRIBUTION. — **Vietnam.** Ha Tinh Province (Vu Quang National Park) and Lam Dong Province (Bidoup-Nui Ba National Park) (Fig. 3).

HABITAT. — Evergreen hill forest, lower montane forest, by stream; elev. *c.* 600–2000 m.

PHENOLOGY. — Collected in flower in June. Fruit is only known from two herbarium specimens collected in February and June.

CONSERVATION STATUS. — Vulnerable (VU) D2. The conservation status of *Urophyllum pseudoschmidtii* Yooprasert, Culham, Yahara, Tagane & Utteridge, sp. nov. is assessed using six specimens collected from four locations in Bidoup-Nui Ba National Park (IUCN category Ia) and Vu Quang National Park (IUCN category II). The other two specimens, *Chevalier 30836* and *Hayata 205*, were not included due to lacking precise localities and old ages (in 1914 and 1921, respectively). The estimated AOO (16 km²) of these six specimens is within the Endangered threshold, however the species is found in protected areas where the deforestation has limited chance. Even though, the estimated EOO (5135 km²) is within the Vulnerable threshold, there is a big gap between these two National Parks that causing habitat fragmentation and meaning estimated EOO is not reflected the real species occurrence. Therefore, *U. pseudoschmidtii* Yooprasert, Culham, Yahara, Tagane & Utteridge, sp. nov. is rated as Vulnerable with restricted AOO (< 20 km²) and small number of locations found. This assessment could be reviewed to Near Threatened or Least Concern if there is an evidence of species existing in nearby area such as Nakai-Nam Theun National Park (Laos, IUCN category II) or Phong Nha-Ke Bang National Park (IUCN category II).

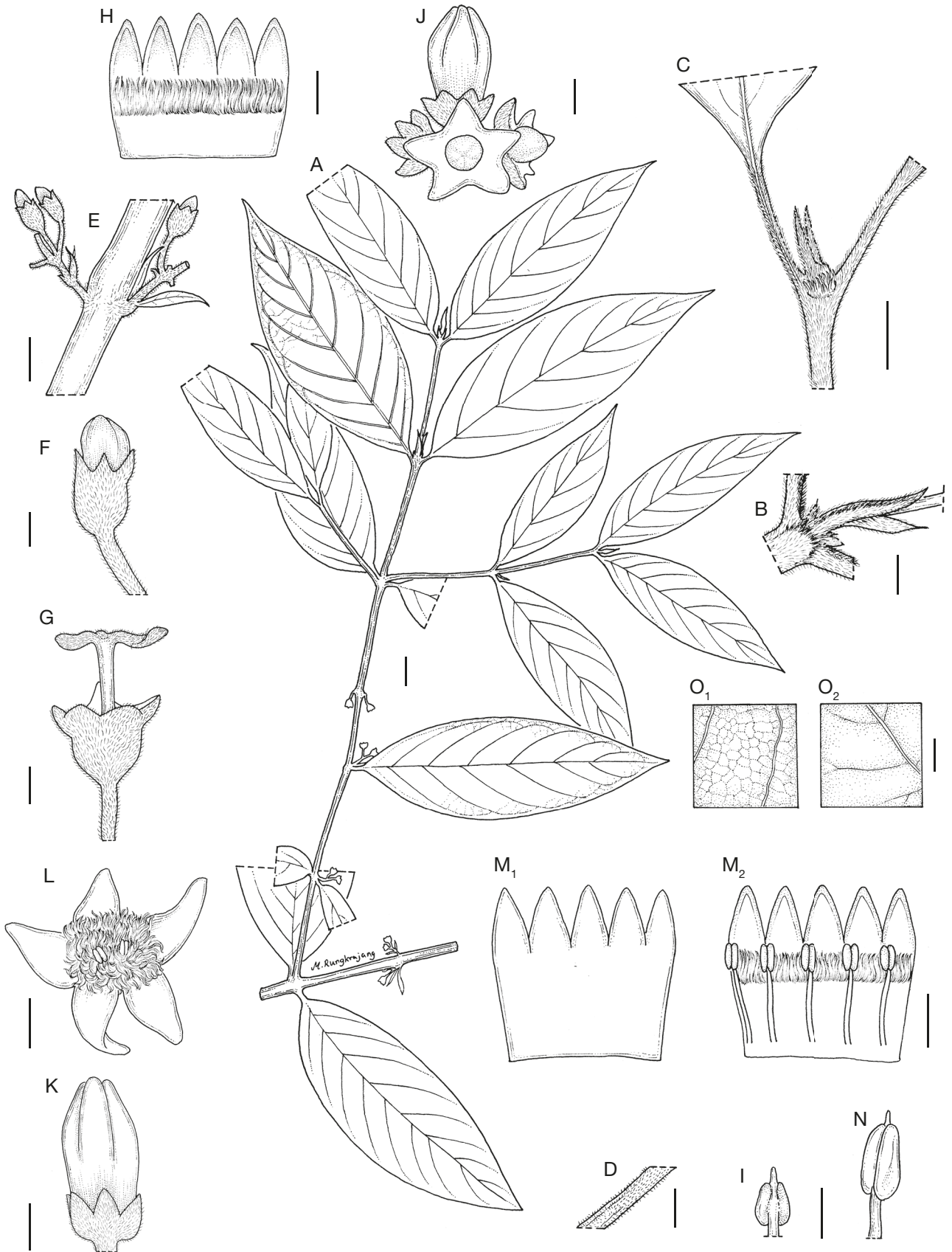


FIG. 13. — *Urophyllum pseudoschmidtii* Yooprasert, Culham, Yahara, Tagane & Utteridge, sp. nov.: **A**, flowering branch; **B**, stipules; **C**, petioles; **D**, young stem; **E-I**, pistillate plant: **E**, inflorescences; **F**, flower bud; **G**, stigma positioning in a flower; **H**, adaxial corolla showing throat hairs arrangement; **I**, staminode; **J-N**, staminate plant: **J**, inflorescence; **K**, flower bud; **L**, opening flower (top view); **M**, corolla, abaxial side (**M**₁), adaxial side showing stamens and throat hairs arrangement (**M**₂); **N**, stamen; **O**, leaf lamina, abaxial side (**O**₁) and adaxial side (**O**₂). Drawn by Mahsarahka Rungkrajang. Drawn from: **A-I**, **O**, Yahara et al. V 5618a; **J-M**, Yahara et al. V 5618b. Scale bars: **A**, 1 cm; **B-E**, **O**, 3 mm; **F-H**, **M**, **J-L**, 1 mm; **I**, **N**, 0.5 mm.

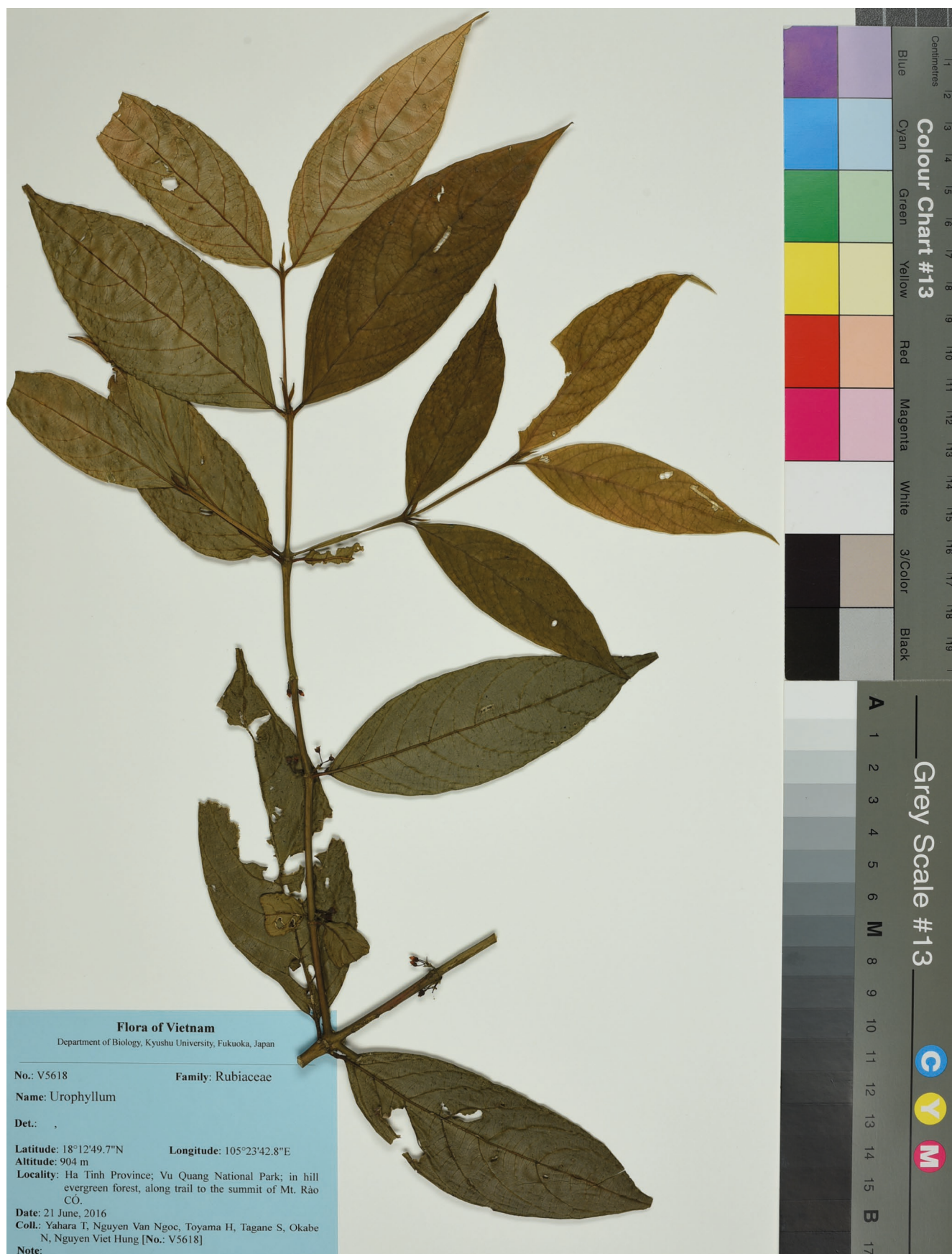


FIG. 14. — Holotype of *Urophyllum pseudoschmidtii* Yooprasert, Culham, Yahara, Tagane & Utteridge, sp. nov.

DESCRIPTION

Shrub to 1 m high. Indumentum sparsely to densely hairy except leaves and corolla. Branches terete; young shoots flattened, ridged. Stipules caducous, present 1-2 nodes at shoot, linear-lanceolate to oblong-lanceolate, 1.0-1.1 cm long, 0.8-1.4 mm wide, appressed to the stem but not folded, abaxially sparsely to densely hairy. Leaves chartaceous, ovate or elliptic, 10-13 cm long, 3.5-4.5 cm wide, apex acuminate, base cuneate to obtuse, adaxially glabrous, abaxially subglabrous, sparsely hairy with short hairs < 1 mm long on midrib to tertiary veins, drying dark greenish brown adaxially, yellowish to dark green abaxially with brown midrib and yellow veins; secondary veins [6-]8-10 pairs, festooned brochidodromous, angle decreasing basally; tertiary veins mixed percurrent, angle decreasing exmedially and increasing basally, obtuse angle to the midrib; petioles 4-6 mm long, canaliculate, adaxially densely hairy on ridges, abaxially sparsely hairy. Inflorescence axillary, staminate plant sessile umbellate, bracts minute triangular *c.* 0.8 mm long, adaxially and abaxially sparsely hairy, pedicels very short *c.* 0.5 mm long, nectary disk dome shaped; pistillate plant sessile, pedunculated to two-tier umbellate, peduncle 0-1.5 mm long, rachis 1.5-2 mm long, bracts lanceolate leafy-like, 2.3-5.2 mm long, adaxially glabrous, abaxially densely hairy, pedicels 2.8-7.9 mm long, nectary disk annular. Staminate flowers calyx fused, lobes 5, 0.5-0.8 mm deep; corolla lobes 5, valvate, fused to form a tube at base approaching $\frac{1}{3}$ - $\frac{1}{2}$ their length, lobed *c.* 1.5 mm long, densely hairy at throat inside; stamens 5, filament fused to the corolla tube, anthers 2-celled, dorsifixed, introrse; pistillode present, ovary vestigial. Pistillate flowers calyx and corolla as staminate flowers; staminodes absent; style *c.* 1.9 mm long, sparsely scaly; stigma lobes 5, *c.* 1.4 mm long, covered with scales.

REMARKS

Urophyllum pseudoschmidtii Yooprasert, Culham, Yahara, Tagane & Utteridge, sp. nov. is recognised by its pistillate flowers without staminodes. The population in Bidoup-Nui Ba National Park has a distribution overlapping with *U. lecomtei*. However, the species differs from *U. lecomtei* by its petioles, densely hairy on canalicular ridges, abaxial surface of corolla glabrous and pistillate flowers lacking staminodes, instead of petioles with similar hair density all over, abaxial surface of corolla hairy and pistillate flower with staminodes as found in *U. lecomtei*. Other taxa found in the same area are *U. bidoupense* Yooprasert, Culham & Utteridge, sp. nov. and *U. chinense* subsp. *latistipulum* Yooprasert, Culham, Yahara & Utteridge, subsp. nov. The differences have been discussed earlier in both taxa.

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REFERENCES

- ANONYMOUS 1931. — Contributions to the Flora of Siam. Additamentum XXXII. *Bulletin of Miscellaneous Information (Royal Botanic Gardens, Kew)* (9): 441-448. <https://doi.org/10.2307/4102478>
- BACHMAN S. P., MOAT J., HILL A., DE LA TORRE J. & SCOTT B. 2011. — Supporting Red List threat assessments with GeoCAT: geospatial conservation assessment tool. *ZooKeys* 150: 117-126. <https://doi.org/10.3897/zookeys.150.2109>
- BEENTJE H. 2016. — *The Kew Plant Glossary: an Illustration Dictionary of Plant Terms*. Kew publishing, Royal Botanic Gardens, Kew, Surrey, 184 p.
- CHEN T. & TAYLOR C. M. 2011. — *Urophyllum*, in WU Z. Y., RAVEN P. H. & HONG D. Y. (eds), *Flora of China*. Vol. 19. Science Press, Beijing and Missouri Botanical Garden Press, St. Louis: 353, 354.
- CLARKE J. E. 2000a. — Biodiversity and Protected Areas – Cambodia: Regional Environmental Technical Assistance 5771 – Poverty Reduction & Environmental Management in Remote Greater Mekong Subregion (GMS) Watersheds Project (Phase I).
- CLARKE J. E. 2000b. — Biodiversity and Protected Areas – Laos P.D.R.: Regional Environmental Technical Assistance 5771 – Poverty Reduction & Environmental Management in Remote Greater Mekong Subregion (GMS) Watersheds Project (Phase I).
- CLARKE J. E. 2000c. — Biodiversity and Protected Areas – Viet Nam: Regional Environmental Technical Assistance 5771 – Poverty Reduction & Environmental Management in Remote Greater Mekong Subregion (GMS) Watersheds Project (Phase I).
- CRAIB W. G. 1932. — *Flora Siamensis Enumeratio*. W. H. Mundie, The Bangkok Times Press, Bangkok, 166 p.
- GOVAERTS R., RUHSAM M., ANDERSSON L., ROBBRECHT E., BRIDSON D., DAVIS A., SCHANZER I. & SONK B. 2020. — World Checklist of Rubiaceae: Facilitated by the Royal Botanic Gardens, Kew (Published on the Internet). <https://wcsp.science.kew.org>
- HICKEY L. J. 1979. — A revised classification of the architecture of dicotyledonous leaves, in METCALFE C. R. & CHALK L. (eds), *Anatomy of the Dicotyledons*. Vol. 1. Clarendon Press, Oxford: 25-39.
- HOOKE J. D. 1880. — Order LXXV. Rubiaceae, in HOOKE J. D. (ed.), *The Flora of British India*. Vol. 3. L. Reeve & Co., London: 17-210. <https://www.biodiversitylibrary.org/page/455613>
- IUCN 2012. — *IUCN Red List Categories and Criteria, Version 3.1*. Gland and Cambridge, 32 p.
- IUCN 2019. — *Guidelines for Using the IUCN Red List Categories and Criteria, Version 14*. Prepared by the Standards and Petitions Committee.
- LEAF-ARCHITECTURE-WORKING-GROUP 1999. — *Manual of Leaf Architecture – Morphological Description and Categorization of Dicotyledonous and Net-Veined Monocotyledonous Angiosperms*. Leaf Architecture Working Group.
- METCALFE D. J., GRUBB P. J. & TURNER I. M. 1998. — The ecology of very small-seeded shade-tolerant trees and shrubs in lowland rain forest in Singapore. *Plant Ecology* 134 (2): 131-149. <https://doi.org/10.1023/A:1009789922595>

- NAGAHAMA A., TAGANE S., NGOC N. V., BINH H. T., CUONG T. Q., TOYAMA H., NAGAMASU H., TSUCHIYA K., ZHANG M., SUYAMA Y., MORITSUKA E., THU N. T. A., THINH N. C., MATSUO A., HIROTA S., NAIKI A., SON L. V., NHAN P. H. & YAHARA T. 2019. — *A Picture Guide for the Flora of Bidoup-Nui Ba National Park I: Mt. Langbian*. Center for Asian Conservation Ecology, Kyushu University, Fukuoka, 134 p.
- PHAM H. H. 2000. — *Cây cỏ Việt Nam: an Illustrated Flora of Vietnam*. Volume 2, Part 3. Youth Publishing House, Ho Chi Minh City, 1020 p.
- PHAM G. T. 2019. — *Soil Properties Mapping and Land Evaluation for Potential Agricultural Land Use Types in A Luoi District, Thua Thien Hue Province, Central Vietnam*. PhD Thesis, Georg-August-Universität Göttingen, 154 p.
- PITARD J. 1923. — Rubiacées, in LECOMTE H., HUMBERT H. & GAGNEPAIN F. (eds), *Flore générale de l'Indo-Chine*. Vol. 3. Masson et Cie, Paris: 20-442. <https://www.biodiversitylibrary.org/page/27562437>
- PUFF C., CHAYAMARIT K. & CHAMCHUMROON V. 2005. — *Rubiaceae of Thailand: a Pictorial Guide to Indigenous and Cultivated Genera*. The Forest Herbarium, Department of National Parks, Wildlife and Plant Conservation, Bangkok, 245 p.
- R CORE TEAM 2019. — *R: A Language and Environment for Statistical Computing*. Vienna, R Foundation for Statistical Computing. Available online at <https://www.R-project.org/>
- ROXBURGH W. 1824. — *Urophyllum* Wall., in CAREY W. (ed.), *Flora Indica*. Vol. 2. The Mission Press, Serampore: 184-186.
- SCHMIDT J. 1902. — Flora of Koh Chang: contributions to the knowledge of the vegetation in the Gulf of Siam. Part VI: Rubiaceae. *Botanisk Tidsskrift* 24: 329-367. <https://www.biodiversitylibrary.org/page/44723470>
- STAFLEU F. A. & COWAN R. S. 1983. — *Taxonomic Literature. A Selective Guide to Botanical Publications and Collections with Dates, Commentaries and Types*. Second edition. Volume IV: P-Sak. Bohn, Scheltema & Holkema; Dr. W. Junk b.v., Utrecht/Antwerpen; The Hague/Boston, 1214 p.
- TAN H. T. W., CHUA K. S. & TURNER I. M. 1995. — Rubiaceae of the Bukit Timah Nature Reserve, in CHIN S. C., CORLETT R. T., WEE Y. C. & GEE S. Y. (eds), *Rain Forest in the City: Bukit Timah Nature Reserve Singapore*. *Garden's Bulletin Singapore*. Supplement 3: 29-61.
- TAYLOR C. M., EHRENDORFER F., LANTZ H., FUNSTON A. M. & PUFF C. 2011. — Rubiaceae, in WU Z. Y., RAVEN P. H. & HONG D. Y. (eds), *Flora of China*. Vol. 19 (Cucurbitaceae through Valerianaceae, with Annonaceae and Berberidaceae). Science Press & Missouri Botanical Garden Press, Beijing, St. Louis: 57-368.
- UNEP-WCMC & IUCN 2020. — *Protected Planet: the World Database on Protected Areas (WDPA)*. UNEP-WCMC & IUCN, Cambridge.
- WONG K. M., TURNER I. M., WANG R. J., HARWOOD R., SEAH W. W., NG X. Y., LIM R. C. J., LUA H. K. & MAHYUNI R. 2019. — Rubiaceae, in MIDDLETON D. J., LINDSAY S. & LEONG-ŠKORNI KOVÁ J. (eds), *Flora of Singapore*. Vol. 13 (Gentianales). National Parks Board Singapore: 1-358.
- YOOPRASERT S. 2021. — *Taxonomy and Systematics of Urophyllum (Rubiaceae) in Thailand and Indochina*. PhD Thesis, University of Reading (unpublished thesis), 244 p.

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