



An updated checklist of Theaceae and a new species of *Polyspora* from Vietnam

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ABSTRACT: By reviewing all scientific names from more than 60 literature, the provided checklist has updated 43 newly discoveries species from Vietnam in the past twenty years. Currently, 126 species and five varieties of five genera of Theaceae in the country according to APG4 classification system are recorded, of which, 95 species and two varieties of *Camellia*, 13 species of *Polyspora*, eight species and two varieties of *Pyrenaria*, seven species of *Schima*, and three species and one variety of *Stewartia*. Each species or variety in the checklist is provided with an accepted scientific name and references. In addition, a new species *Polyspora cuongii* is described and illustrated. This species was found in Dak Lak province, southern Vietnam. Diagnostic features of the new species are a small tree, 1–3 pink solitary clustered flowers, 2–3 mm long of pedicel, 3(–4) bracteoles, numerous stamens, and outer filament whorl adnate with petals. The described species clearly differs from closely related *P. huongiana* in numerous ways: a pubescent young branch, a narrow-obovate or oblong-obovate leaf, a fewer secondary vein, a longer and sparse pubescent petiole, a shorter and pubescent pedicel, a abaxial surface pubescent and smaller petal, a 3-loculed ovary, a three free styles, as well as a smaller stigma.

KEY WORDS: *Camellia*, Dak Lak, *Gordonia*, Plant diversity, Plant taxonomy, *Polyspora*, Theaceae, Vietnam.

INTRODUCTION

The flowering plant family Theaceae s.s. comprises about nine genera and 460 species mainly distributed in East and Southeast Asia (Keng, 1962; Prince and Parks, 2001; Stevens *et al.*, 2004; Ming and Bartholomew, 2007; Prince, 2007; APG4, 2016). In Vietnam, Theaceae s.s. has the presence of 11 genera and about 80 species (Gagnepain, 1943; Pham, 1999; Nguyen, 2003, 2017). However, the species number of the family in the country is different depending on each classification system or changing by year because of many new species currently discovered. According to APG4 classification system (2016), *Hartia* was merged into *Stewartia*, *Archytaea* was placed in Bonnetiaceae, and four genera *Adinandra*, *Eurya*, *Ternstroemia*, *Tristylium* had been transferred to Pentaphyllaceae (Schönenberger *et al.*, 2005). And genus *Gordonia* probably comprises only two species *G. lasianthus* and *G. brandegeei* which species distribute in America (Prince and Parks 2001; Yang *et al.*, 2004; Gunathilake *et al.*, 2015). The *Gordonia* distinct from *Polyspora* in longer pedicels (3.0–7.0 cm vs. less than 1.2 cm), and fewer bracteoles (2–4 vs. 2–8) (Choisy, 1855; Airy-Shaw, 1936; Yang *et al.*, 2004; Ming and Bartholomew, 2007; Orel *et al.*, 2012a). It is suggested

that all current Asian *Gordonia* species are needed to transfer to *Polyspora*.

The genus *Polyspora* includes more or less 40 species distributed mainly in East and Southeast Asia (Ming and Bartholomew, 2007), of which, 12 species are native of Vietnam (Gagnepain, 1943; Hu, 1963; Ming, 1997; Chang, 1998a; Pham, 1999; Bartholomew and Ming, 2005; Ming and Bartholomew, 2007; Orel *et al.* 2012a, 2013a; Luru *et al.*, 2015; Luong *et al.*, 2016b; Nguyen, 2017; River, 2018). In addition, within this study, we describe a new species *Polyspora cuongii* and provide an updated checklist of Theaceae in Vietnam bringing the total number of *Polyspora* and *Theaceae* species known from the country to 13 and 126, respectively (listed in the Checklist). The new species is generally characterized by alternate and clustered leaves, 1–3 pink solitary clustered flowers, 2–3 mm long of pedicel, 3(–4) bracteoles, numerous stamens, and outer filament whorl adnate with petals. Furthermore, the new species has been compared with other close related species *P. huongiana* Orel, Curry & Luu (2012: 48) reported from Vietnam, which has a similar habit and some morphological characteristics, such as form, size, and color of flower, and numerous stamens.



MATERIALS AND METHODS

The updated checklist is prepared by reviewing all scientific names of Theaceae species recorded in Vietnam from more than 60 literature, but mainly focuses on four publications - “Supplément a la flore générale de l’Indo-Chine, 1” (Gagnepain, 1943), “Cây cỏ Việt Nam: An Illustrated Flora of Vietnam, vol. 1” (Pham, 1999), “Danh lục các loài thực vật Việt Nam (Checklist of Plant Species of Vietnam) vol. 2” (Nguyen, 2003), and “Thực vật chí Việt Nam (Flora of Vietnam), Họ Chè - Theaceae D. Don, vol. 19” (Nguyen, 2017). The most widely accepted classification system, APG4 (2016) is applied for the checklist. All the scientific names were nomenclature checked according to Shenzhen code of International Association for Plant Taxonomy (Turland *et al.*, 2018) together with online consulted from World Flora Online <<http://www.worldfloraonline.org/>>, The Plant List <<http://www.theplantlist.org/>>, and International Plant Names Index <<https://www.ipni.org/>>. The invalid names and cultivation species are not recorded in this checklist.

New species described here were collected by V.C. Nguyen and T.T.D. Pham in southern Vietnam, Dak Lak province on 30 April 2019. Photos were taken from living plants by T.T.D. Pham. Fresh inflorescences and flowers were preserved in 60–70% ethanol. Laboratory studies including measurements, data analysis, and morphologic descriptions were made by first, second and last authors (these authors also revise and prepare the checklist). All morphological characters were described using the general terminology by Harris and Harris (2006).

RESULTS AND DISCUSSION

Classification and statistic summary

Base on literature review, this checklist records 126 species and five varieties of five genera of Theaceae for current flora of Vietnam according to APG4 classification system (2016), of which, 95 species and two variety of *Camellia*, 13 species of *Polyspora*, eight species and two varieties of *Pyrenaria*, seven species of *Schima*, and three species and one variety of *Stewartia*. Following the checklist, the number Theaceae species is triple that of Gagnepain (1943) which study contained 34 species, double that of Pham (1999) or Nguyen (2003) which publications comprised 50 or 55 species (respectively), half as many again as a recent publication of Nguyen (2017) which literature indexed about 83 species (Fig.1). Most of addition species for the checklist belong to *Camellia* and *Polyspora* genera which recently discovering from Vietnam. In past twenty years, from the publication of Pham (1999), had not any species of *Pyrenaria*, *Schima*, and *Stewartia* discovered from Vietnam, while 47 of *Camellia* and seven species of *Polyspora* were described as new for science from the country (see the Checklist). With a large number of the new discovered species suggests that

Vietnam possible is an area of origin for genus *Camellia* and the most important center of Theaceae genetic diversity (Orel and Curry, 2015).

On other hand, some names are not accepted in the checklist by provided reasons although they were indexed in some literature. For example, a names *C. hamyensis* (Ninh and Ninh, 2005) was recognized as invalid names <<https://www.ipni.org/>>; five names *Camellia huulungensis*, *C. kirinoi*, *C. hakodae*, *C. tamdaoensis*, *C. tienii* (Nguyen, 2003, 2017; Ninh and Ninh 2007, 2013; Ninh, 2007), and *C. quephongensis* probably had never published or invalid names since we have not found original publications or specimens; *Camellia polyodonta* var. *longicaudata*, *C. lianshanensis*, *C. cordifolia*, and *Stewartia pteropetiolata* were indexed by Nguyen (2003, 2017) without evidence or voucher specimens; and two recorded species *Camellia japonica* and *C. sinensis* are cultivation species (Pham, 1999).

In addition, *Camellia langbianensis* is accepted name in this checklist since Zhao (2019) did not provided evidence data for proposing a new synonym name of *C. vidalli*.

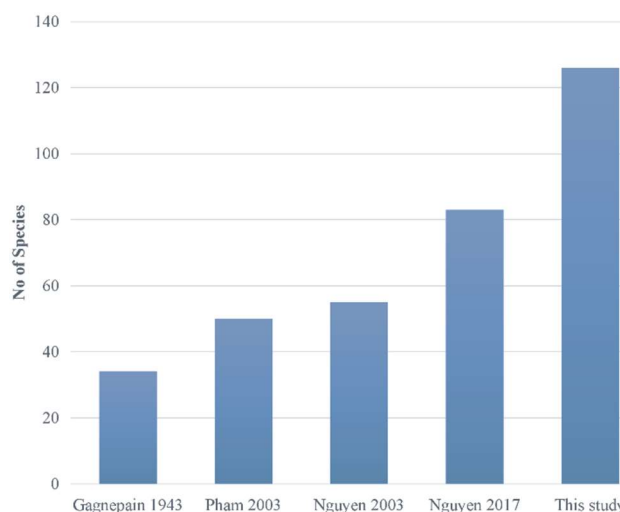


Fig. 1. Comparison of Theaceae species number in Vietnam between some past literatures with the checklist of this study.

TAXONOMIC TREATMENT

Polyspora cuongii V.D. Luong & V.T. Pham, *sp. nov.*

Đa tử trà cương Figs. 2 & 3

Type: VIETNAM, Dak Lak province, M'Drak district, Chu Mu mountain, Vong Phu forest, primary evergreen broad-leaved forests mix with conifers, small tree, 12°41'08.7"N 108°54'42.8"E, alt. 1400m, 30 April 2019, PVT 1008 (holotype: DLU; isotype: TAI).

Description: Small tree, 4–6 m tall; Young branches pubescent, dark-green; terminal buds short, narrow, erect, about 1.1 mm long, abaxial surface white pubescent, triangular, apex acute. **Leaves** alternate and clustered at

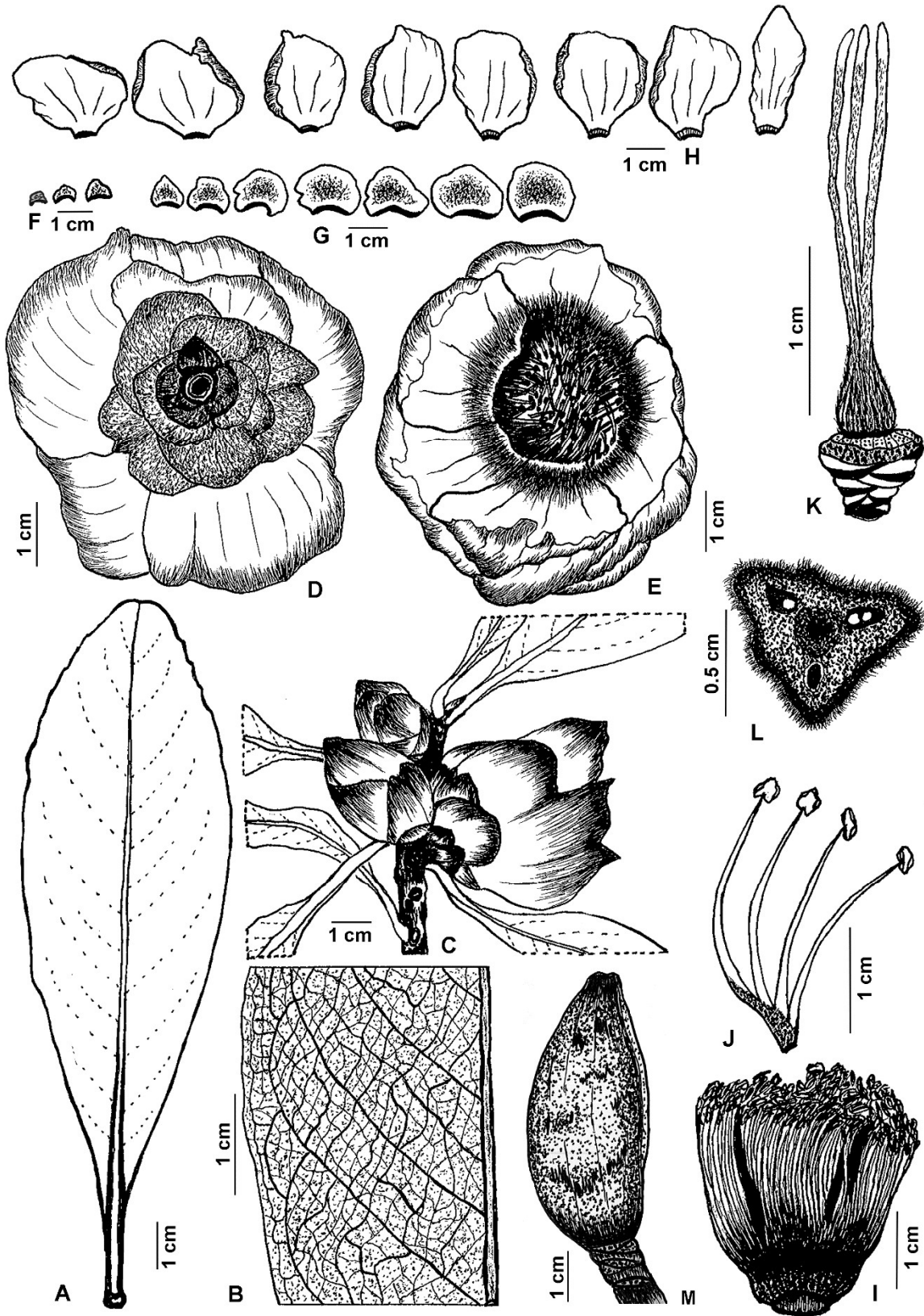


Fig. 2. *Polyspora cuongii* V.D. Luong & V.T. Pham. A. Leaf (adaxial view); B. Close up of abaxial surface leaf; C. Inflorescence; D. E. Flowers; F. Bracts (adaxial view); G. Sepals (adaxial view); H. Petals (adaxial view); I. J. Stamens; K. Pistil; L. Ovary (cross-section); M. Immature fruit. Draw by V.D. Luong

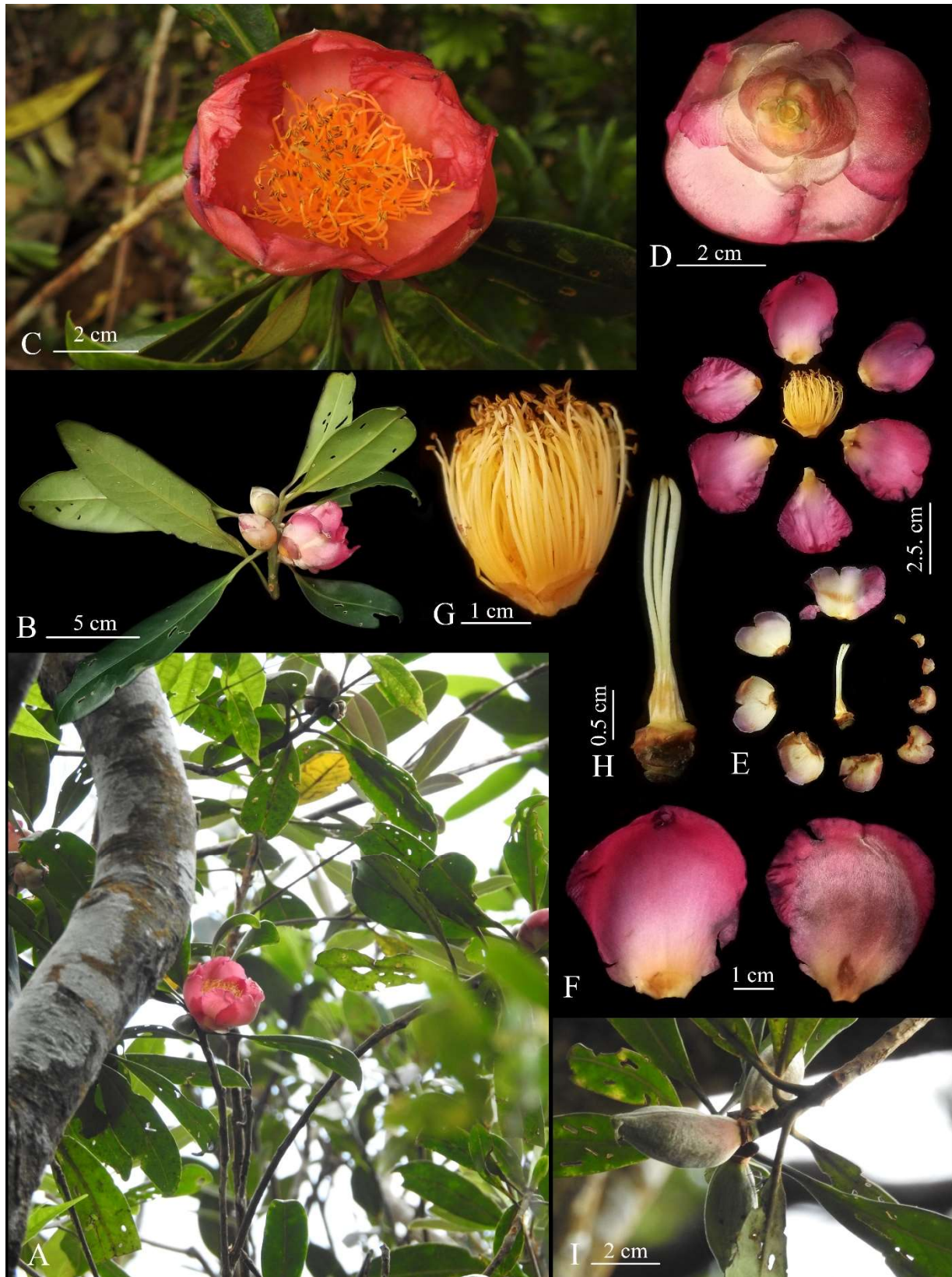


Fig. 3. *Polyspora cuongii* V.D. Luong & V.T. Pham. **A.** Flowering in nature habitat; **B.** Fresh inflorescence specimen; **C.** Flower (front view); **D.** Flower (back view); **E.** All separate parts of a flower (petals and stamens in upper, bracts, sepals and pistil in lower); **F.** Petals; **G.** Stamens; **H.** Pistil; **I.** Immature fruit. Photos by T.T.D. Pham.

**Table 1:** Comparison of diagnostic features of *Polyspora cuongii* with *P. huongiana*

Characteristic	<i>P. cuongii</i>	<i>P. huongiana</i>
Young branch		
Vestiture	pubescent	glabrous
Leaf		
Blade shape	narrow-obovate or oblong-obovate	narrowly elliptic
Size (cm)	13.0–15.5 × 4.0–4.7	11.0–12.5 × 4.0–4.8
Apex	obtuse to near round	acute to acuminate
Base	cuneate slightly attenuate	cuneate
Secondary vein	8–11 pairs	up to 20 pairs
Abaxially midrib	sparse pubescent	Glabrous
Petiole length (cm)	2.0–2.5	0.8–1.2
Petiole vestiture	sparse pubescent	glabrous
Flower		
Pedicel length (mm)	2–3	8–10(–12)
Pedicel vestiture	pubescent	glabrous
Bracteole and sepal number	9–11	5–6
Bracteole and sepal smallest size (mm)	3–4.5 × 5–8	11–12 × 7–9
Bracteole and sepal biggest size (mm)	10–17 × 9–18	18–20 × 25–27
Petal number	7–8	5–7
Petal shape	subglobose, broadly obovate to oblong	obovate
Petal size (cm)	2.9–3.3 × 1.3–3.4	4.0–5.0 × 3.5–4.5
Petal vestiture	abaxial surface pubescent	glabrous
Pistil		
Ovary locule	3-loculed	3–4(–5)-loculed
Ovary shape	narrow conical to ovoid,	cylindrical
Ovary size (mm)	5.0–6.0 × 4.0–4.5	8.0–10.0 × 5.0–6.0
Style	3, free to the base	united
Style length (cm)	2.1–2.2	2.2–2.6
Stigma wide (mm)	ca. 0.5	1.0–2.0
Distribution and elevation	Dak Lak prov., 1300–1500 m a.s.l.	Lam Dong prov., 1800–2000 m a.s.l.

the top of branch; petiole slightly curved, dark-brown, parse pubescent, 2–2.5 cm long, ca. 2 mm in diam. **Leaf blade** narrow-obovate or oblong-obovate, 13–15.5 cm long, 4–4.7 cm wide, coriaceous, curved, apex obtuse to near round, base cuneate, slightly attenuate, margins entire, adaxially surface dark-green, shiny, glabrous, abaxially surface green-yellow, sparse pubescent on midrib; venation pinnate, adaxially surface obscure, abaxial surface distinct, lateral veins 8–11 pairs. **Flower buds** conical when young, elliptic at near anthesis, about 5 cm long, 3 cm in diam., abaxial covered by white tomentose scale-like sepals; flowers axillary, 1–3 solitary clustered at the top of branch, cup-shaped at horizontal view, 5–6 cm in diam., almost pink; pedicel 2–3 mm long, pubescent; bracteoles 3–(4), scale-like, semicircular, apex rounded, concave, white-brown, transition in size to sepal, 3–4.5 mm long, 5–8 mm wide, abaxial pubescent with white finely hairs, caducous. **Sepals** 6–7, semicircular to orbicular, concave, apex rounded, white-brown, transition in size to petal, 1–1.7 cm long, 0.9–1.8 cm wide, pubescent with white finely hairs. **Petals** 7–8, broad-obovate to orbicular, base acute to obtuse, apex rounded, concave, 2.9–3.3 cm long, 1.3–3.4 cm wide, abaxial surface pubescent with white finely hairs, near margin pink, curly, glabrous, base yellowish, adaxial surface glabrous, almost pink, base yellowish. **Stamens** numerous, ca. 260, 4(–5)-whorl, shorter than petals; filaments 2.5–3 cm long, light yellow, villous at base; anthers dorsifixed, ovate-oblong, 2.5–3 mm long, 1.5–2 mm wide, outer filaments united for 1–2 mm from

the base by group to nectar disk. **Pistil** tomentose; ovary superior, narrow conical to ovoid, 3-loculed, 5–6 mm long, 4–4.5 mm at widest, lightly striated; style 3, free to the base, 2.1–2.2 cm long, ca. 0.7 mm in diam., white tomentose; stigma narrowly, ca. 0.5 mm wide. Capsule ca. 4 cm long and 2 cm wide.

Distribution & habitat: The species is only known from Dak Lak Province of Vietnam, in primary evergreen broad-leaved forests mix with conifers at elevations of 1300–1500 m, near stream of granite mountain side.

Phenology: Flowers were observed at the end of May. Immature fruits were observed in September.

Etymology: The specific epithet is named in honor of Mr. Nguyen Van Cuong, who is father of author V.C. Nguyen.

Conservation status: Through a short field survey, a small population of the new species was found and distributed in an area about 1 km² which is not belong to any protected forest. According to IUCN Redlist 2017 criteria, the species is may be listed as DD (Data deficient). The future expeditions of botanical survey are need for complete conservation assessment of the species.

Taxonomic remarks: The described species is closely allied to *P. huongiana* from Vietnam in habit and some morphological characteristics, such as flower form and color, or numerous stamens. However, it differs from *P. huongiana* in having pubescent young branches, narrow-obovate or oblong-obovate leaves (vs. narrowly elliptic), fewer secondary veins, longer and sparse pubescent petioles, shorter and pubescent pedicels, abaxial surface



pubescent and smaller petals, 3-loculed ovary (vs. 3–4(–5)-loculed), three free styles (vs. united), smaller stigma, and many others. A detailed comparison between *P. cuongii* and *P. huongiana* are given in Table 1.

Vietnamese Theaceae updated checklist

Each species or variety in the checklist is provided with an accepted scientific name, follows by origin publication, and literature or other names and literature which were recorded for Vietnam.

Camellia albata Orel & Curry, Pursuit Hidden Camellias Vietnam China: 239 2015.

Camellia amplexicaulis (Pit.) Cohen-Stuart, Meded. Proefst. Thee 40: 67 1916; Pham, An Illust. Fl. Vietnam V1: 429 1999; Nguyen, Checkl. Pl. Spec. Vietnam V2: 344 2003; Nguyen, Fl. Vietnam: 185 2017. - *Thea amplexicaulis* Pitard, Gagnep., in Lecomte, Suppl. Fl. Indo-Chine 1: 343 1910; Gagnep., in Lecomte, Suppl. Fl. Indo-Chine 1: 304 1943. - *Camellia cylindracea* T.L.Ming, Acta Bot. Yunnan. 16(4): 343 1994; Nguyen, Fl. Vietnam: 198 2017; Zhao, Phytotaxa 419(1): 100 2019.

Camellia aurea H.T. Chang, Acta Sci. Nat. Univ. Sunyatseni 1979(3): 71 1979; Nguyen, Checkl. Pl. Spec. Vietnam V2: 344 2003; Nguyen, Fl. Vietnam: 178 2017; Ming & Bartholomew, in Wu *et al.*, Fl. China, 12: 368 2007.

Camellia bugiamapensis Orel, Curry, Luu & Q.D. Nguyen, Novon 23(3): 313 2014.

Camellia calcicola T.L.Ming, Acta Bot. Yunnan. 15: 7 1993; Nguyen, Checkl. Pl. Spec. Vietnam V2: 344 2003; Nguyen, Fl. Vietnam: 234 2017.

Camellia campanulata Orel, Curry & Luu, Pursuit Hidden Camellias Vietnam China: 154 2015.

Camellia capitata Orel, Curry & Luu, Novon 23(3): 315 2014.

Camellia cattienensis Orel, Kew Bull. 66(4): 566 2012.

Camellia caudata Wall., Cat. 978. 1829 et Pl. Asiat. Rar. (Wallich). 3(11): 36 1832; Pham, An Illust. Fl. Vietnam V1: 431 1999; Nguyen, Checkl. Pl. Spec. Vietnam V2: 344 2003; Nguyen, Fl. Vietnam: 232 2017; Ming & Bartholomew, in Wu *et al.*, Fl. China, 12: 391 2007. - *Thea caudata* Seem., Trans. Linn. Soc. London 22(4): 348 1859; Pham, An Illust. Fl. Vietnam V1: 341 1999; Nguyen, Checkl. Pl. Spec. Vietnam V2: 344 2003. - *Camellia assimilis* Champ. ex Benth., Hooker's J. Bot. Kew Gard. Misc. 3: 309 1851; Pham, An Illust. Fl. Vietnam V1: 341 1999; Nguyen, Checkl. Pl. Spec. Vietnam V2: 344 2003. - *Thea assimilis* Seem., Trans. Linn. Soc. London 22(4): 349 1859; Gagnep., in Lecomte, Suppl. Fl. Indo-Chine 1: 313 1943.

Camellia concinna Orel & Curry, Pursuit Hidden Camellias Vietnam China: 270 2015

Camellia corallina (Gagnep.) Sealy, Rev. Gen. Camell. 132 1958; Pham, An Illust. Fl. Vietnam V1: 427 1999; Nguyen, Checkl. Pl. Spec. Vietnam V2: 344 2003; Nguyen, Fl. Vietnam: 209 2017; Zhao *et al.*, Phytotaxa 292(2): 174 2019. - *Thea corallina* Gagnep., Notul. Syst. (Paris) 10: 126 1942; Gagnep., Suppl. Fl. Indo-Chine 1: 308-309 1943.

Camellia cordifolia (Metcalfe) Nakai, Jap. Bot. 16: 692 1940; Nguyen, Fl. Vietnam: 235 2017.

Camellia crassiphyllo Ninh & Hakoda, Int. Camellia J. 30: 76 1998; Nguyen, Fl. Vietnam: 215 2017.

Camellia cuongiana Orel & Curry, Pursuit Hidden Camellias Vietnam China: 180 2015.

Camellia curryana Orel & Luu, Nordic J. Bot. 32(1): 42 2014.

Camellia cylindracea T.L.Ming, Acta Bot. Yunnan. 16: 343 1994; Nguyen, Checkl. Pl. Spec. Vietnam V2: 344 2003; Nguyen, Fl. Vietnam: 217 2017.

Camellia dalatensis V.D. Luong & Ninh & Hakoda in Tran *et al.* Int. Camellia J. 44: 161 2012; Tran & Luong, VNU J. Sci. Nat. Sci. Technol. 28(2S): 35 2012; Le, in: Li J-Y., Proc. Dali Int. Camellia Cong. Dali-Yunnan-China: 87 2016.

Camellia decora Orel, Curry & Luu, Pursuit Hidden Camellias Vietnam China: 173 2015.

Camellia dilinhensis Ninh & V.D. Luong, Int. Camellia J. 45: 87 2013.

Camellia dongnaiensis Orel, Novon 16(2): 244 (-247; fig.1) 2006; Nguyen, Fl. Vietnam: 163 2017.

Camellia dormoyana (Pierre) Sealy, Rev. Gen. Camell. 45 1958; Pham, An Illust. Fl. Vietnam V1: 424 1999; Nguyen, Checkl. Pl. Spec. Vietnam V2: 345 2003; Nguyen, Fl. Vietnam: 245 2017. - *Thea dormoyana* Pierre ex Laness., Pl. Util. Col. Franc.: 296 1886; et Fl. For. Cochinch. Fasc. 8: t.118 1887; Gagnep., in Lecomte, Suppl. Fl. Indo-Chine 1: 319 1943.

Camellia duyana Orel, Curry & Luu, Novon 23(3): 308 2014.

Camellia elizabethae Orel & Curry, Pursuit Hidden Camellias Vietnam China: 195 2015.

Camellia elongata (Rehder & E.H.Wilson) Rehder, J. Arnold Arbor. 3: 224 1922; Pham, An Illust. Fl. Vietnam V1: 431 1999; Nguyen, Checkl. Pl. Spec. Vietnam V2: 345 2003; Nguyen, Fl. Vietnam: 228 2017. - *Thea elongata* Rehd. et Wils., Pl. Wilson. 2(2): 392–393 1915; Gagnep., in Lecomte, Suppl. Fl. Indo-Chine 1: 318 1943.

Camellia erubescens Orel & Curry, Pursuit Hidden Camellias Vietnam China: 245 2015.

Camellia euphobia Merr. ex Sealy, Kew Bull. 4: 216 1949; Pham, An Illust. Fl. Vietnam V1: 428 1999; Nguyen, Checkl. Pl. Spec. Vietnam V2: 345 2003; Nguyen, Fl. Vietnam: 193 2017; Ming & Bartholomew, in Wu *et al.*, Fl. China, 12: 370 2007.

Camellia flava (Pit.) Sealy, Kew Bull. 4: 217 1949; Pham, An Illust. Fl. Vietnam V1:429 1999; Nguyen, Checkl. Pl. Spec. Vietnam V2: 345 2003; Nguyen, Fl. Vietnam: 172 2017. - *Thea flava* Pitard, Gagnep., in Lecomte, Suppl. Fl. Indo-Chine 1: 319 1943; - *Camellia cordatula* Merrill, J. Arnold Arbor. 20: 348 1939; Nguyen, Fl. Vietnam: 173 2017. - *Camellia cucphuongensis* Ninh & Rosmann, Int. Camellia J. 30: 71 1998; Nguyen, Checkl. Pl. Spec. Vietnam V2: 345 2003; Nguyen, Fl. Vietnam: 174 2017; Zhao, Phytotaxa 419(1): 102 2019.

Camellia fleuryi (A.Chev.) Sealy, Kew Bull. 4: 217 1949; Pham, An Illust. Fl. Vietnam V1: 428 1999; Nguyen, Checkl. Pl. Spec. Vietnam V2: 345 2003; Nguyen, Fl. Vietnam: 239 2017; Zhao *et al.* Phytotaxa 292(2): 175 2019. - *Thea fleuryi* A.Chevalier, Bull. Écon. Indochine n.s., 21: 531 1919; Gagnep., in Lecomte, Suppl. Fl. Indo-Chine 1: 306 1943.

Camellia forrestii (Diels) Cohen-Stuart, Meded. Proefst. Thee 40: 63, 68 1916; Nguyen, Checkl. Pl. Spec. Vietnam V2: 345 2003; Nguyen, Fl. Vietnam: 224 2017; Ming & Bartholomew, in Wu *et al.*, Fl. China, 12: 382 2007. - *Thea forrestii* Diels, Notes Roy. Bot. Gard. Edinburgh 5(25): 284 1912. - *Theopsis forrestii* (Diels) Nakai, J. Jap. Bot. 16(12): 705 1940.



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- Camellia indochinensis* Merr., Arnold Arbor. 20: 347 1939; Pham, An Illust. Fl. Vietnam V1: 430 1999; Nguyen, Checkl. Pl. Spec. Vietnam V2: 346 2003; Nguyen, Fl. Vietnam: 195 2017; Ming & Bartholomew, in Wu *et al.*, Fl. China, 12: 371 2007; Zhao *et al.* Phytotaxa 292(2): 172 2019. - *Thea indochinensis* Merr. Gagnep., in Lecomte, Suppl. Fl. Indo-Chine 1: 307 1943; Ming & Bartholomew, in Wu *et al.*, Fl. China, 12: 372 2007.
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