

A TAXONOMIC KEY FOR YELLOW CAMELLIAS IN THE CENTRAL HIGHLANDS OF VIETNAM

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Abstract

Eighteen yellow Camellia species are found in the Central Highlands of Vietnam. Their morphological characteristics are described and illustrated. Based on the morphological characteristics of the leaves, flowers, and fruit, a dichotomous key has been constructed.

Keywords: Central Highlands; Taxonomy; Vietnam; Yellow camellias.

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1. INTRODUCTION

The Central Highlands includes Kon Tum, Gia Lai, Dak Lak, Dak Nong, and Lam Dong provinces; with an area of 54,600 km², they account for 1/6 of the area of Vietnam. A high diversity of flora in this area has been reported, including 4782 species of vascular plants (Bùi et al., 2020). Many species have been named according to their geographic distribution, which is also the case for *Camellia* species, such as *C. langbianensis* (Phạm, 1991), *C. dalatensis* (Tran & Luong, 2012), *C. dilinhensis* (Tran & Luong, 2013) in Lam Dong and *C. yokdonensis* in Dak Lak.

As of 2022, 98 species and 2 varieties of the genus *Camellia* had been reported in Vietnam, of which 18 yellow *Camellia* species are found in the Central Highlands (Hoang et al., 2022, Lê et al., 2020, Quach et al., 2022, Truong et al., 2022). Studies of the taxonomy of the genus *Camellia* from the Central Highlands can be divided into two periods: from 1896 to 1943 (Gagnepain, 1942; Humbert & Gagnepain, 1943; Pierre, 1896, 1897; Pitard, 1910) and from 1991 to the present (Hoang et al., 2022; Luong et al., 2016; Luong et al., 2016; Luong & Le, 2016; Nguyễn, 2017; Orel, 2006; Orel & Curry, 2015; Orel et al., 2012, 2013, 2014; Orel & Wilson, 2010; Phạm, 1991; Quach, Doudkin, et al., 2021, Quach et al., 2022; Quach, Luong, et al., 2021; Rosmann, 1998; Tran & Luong, 2012, 2013; Truong et al., 2020; Truong et al., 2022). A large number of new species have been reported from this area. In early 2022, three yellow *Camellia* species in the Central Highlands were described as new species, including *C. quynhii* (Quach et al., 2022), *C. thuanana* (Hoang et al., 2022), and *C. sphamii* (Truong et al., 2022). Thus, 18 yellow *Camellia* species have been recorded in the Central Highlands, accounting for 37% of yellow *Camellia* species found in Vietnam.

In this study, we establish a taxonomic key for yellow *Camellia* species in the Central Highlands. It should be a helpful tool for the investigation and classification of *Camellia* species in general and yellow *Camellia* species in particular. It also creates a basis for the study and conservation of endemic species.

2. METHODOLOGY

Morphological characteristics of yellow *Camellia* species from the Central Highlands have been described in detail. A dichotomous key of the 18 yellow *Camellia* species found in the Central Highlands has been constructed based mainly on the morphological characteristics of the leaves, flowers, and fruit.

3. RESULTS

3.1. Morphological characteristics of yellow *Camellia* species in the Central Highlands

3.1.1. Habit

Shrubs or small trees, 2–5(7) m high, evergreen; smooth bark, usually gray-white, the young branches round, rarely flat (*Camellia inusitata*), glabrous, pubescent, or hirsute.

3.1.2. Leaves

Leaves simple, alternate, petiolate or rarely sessile, stipules absent; leaf blade leathery to thinly leathery, margin serrate, serrulate, or rarely entire; the blades elliptic, oblong, lanceolate, or ovoid; apex usually acute to acuminate, base usually cuneate, obtuse, occasionally rounded or cordate, the size very great, 8–55 cm long, 3–12 cm wide; the upper surface usually shiny and deep green, glabrous, the lower surface light green, glabrous, hairy, or sparsely villous; the midrib always protruding below, venation may be either prominent or obscure.

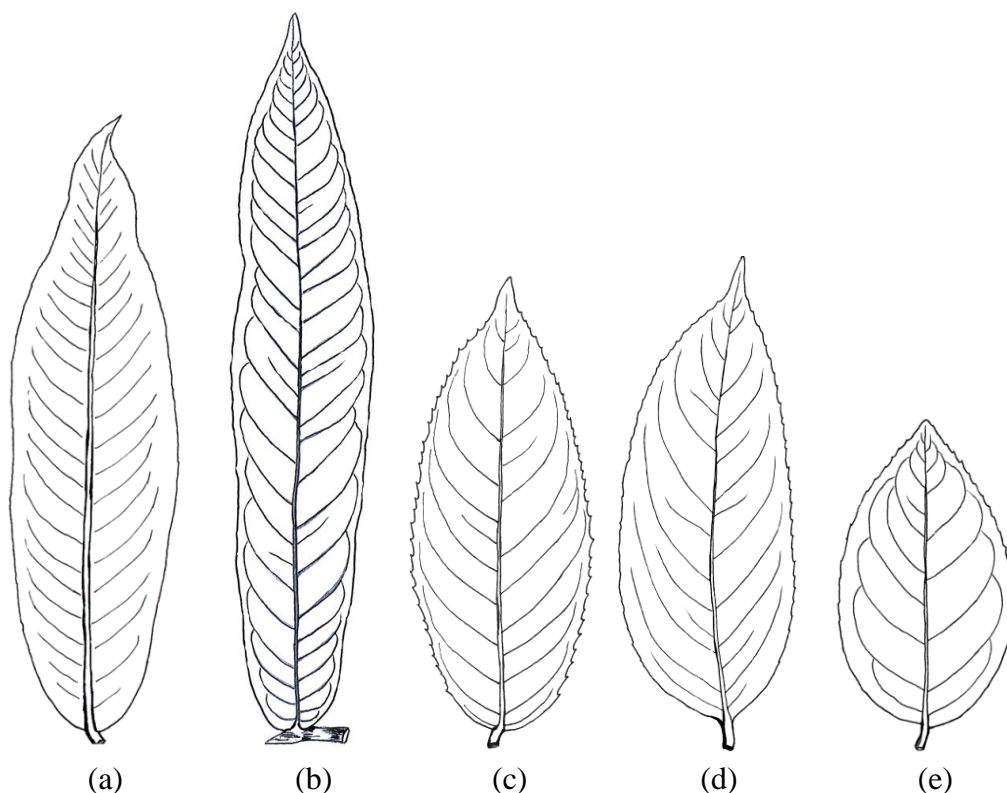


Figure 1. Morphology of the leaves

Note: (a) Oblong-elliptic (*Camellia proensis*); (b) Narrowly lanceolate (*Camellia sphaemii*); (c) Elliptic (*Camellia luteopallida*); (d) Elliptic (*Camellia thuongiana*); (e) Broad ovoid (*Camellia bidoupensis*).

Source: Luong Van Dung.

3.1.3. Flowers

Flowers axillary or subterminal, solitary or 2–3(4) in a cluster, sometimes in clusters of 9–12(14) forming a simple umbellar structure (*C. capitata*) (Orel et al., 2014); pedicellate or subsessile, glabrous or pubescent; bracteoles differentiated from sepals or not differentiated, scales, triangular, caducous or persistent, glabrous or pubescent. Sepals scale, pentagonal, orbicular, or subglobose. Petals 5–8(12), subglobose, suborbicular, obovate, ovate, or pentagonal, yellow, light yellow, or yellow with pink on edges, basally connate.

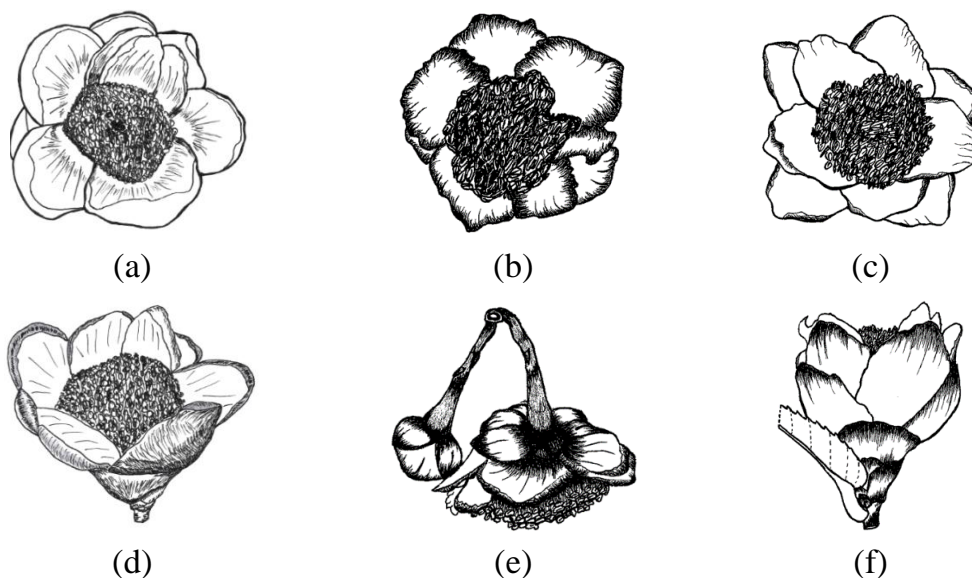


Figure 2. Flowers

Note: (a), (d) *Camellia luteopallida*; (b), (e) *Camellia langbianensis*; (c), (f) *Camellia quynhii*.
Source: Luong Van Dung.

Androecium numerous, in 3–6 whorls, stamens yellow or yellow with light pink at base, glabrous or pubescent; outer filament whorl basally connate into a tube or cup and adnate to petals; anthers dorsifixed, 2 locular laterally and longitudinally dehiscent, yellow or light yellow. Gynoecium superior; ovary ovoid or flattened globose, glabrous or tomentose, 3–5 locular, ovules 2–5 per locule; styles free or united, caducous or persistent on fruit, glabrous or tomentose.

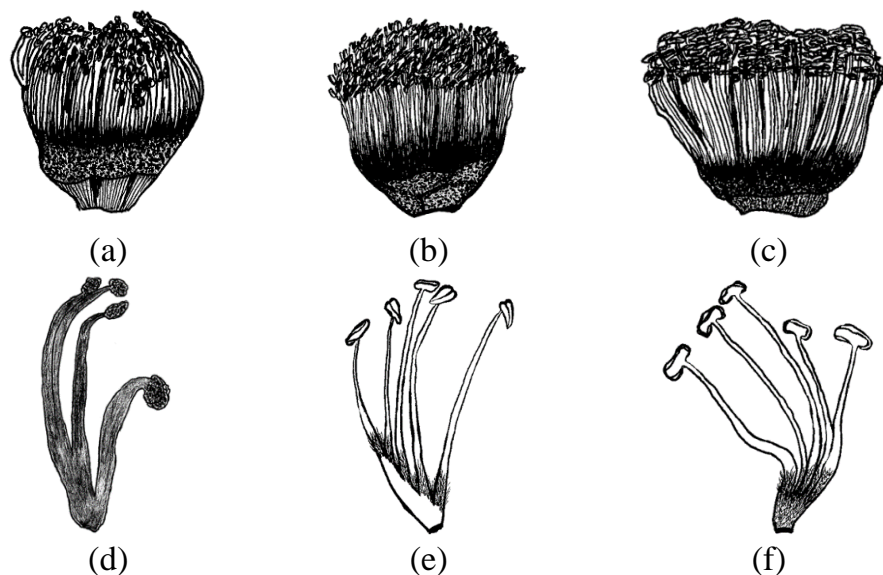


Figure 3. Androecium and stamens

Note: (a), (d) *Camellia bidoupensis*; (b), (e) *Camellia quynhii*; (c), (f) *Camellia langbianensis*.
Source: Luong Van Dung.

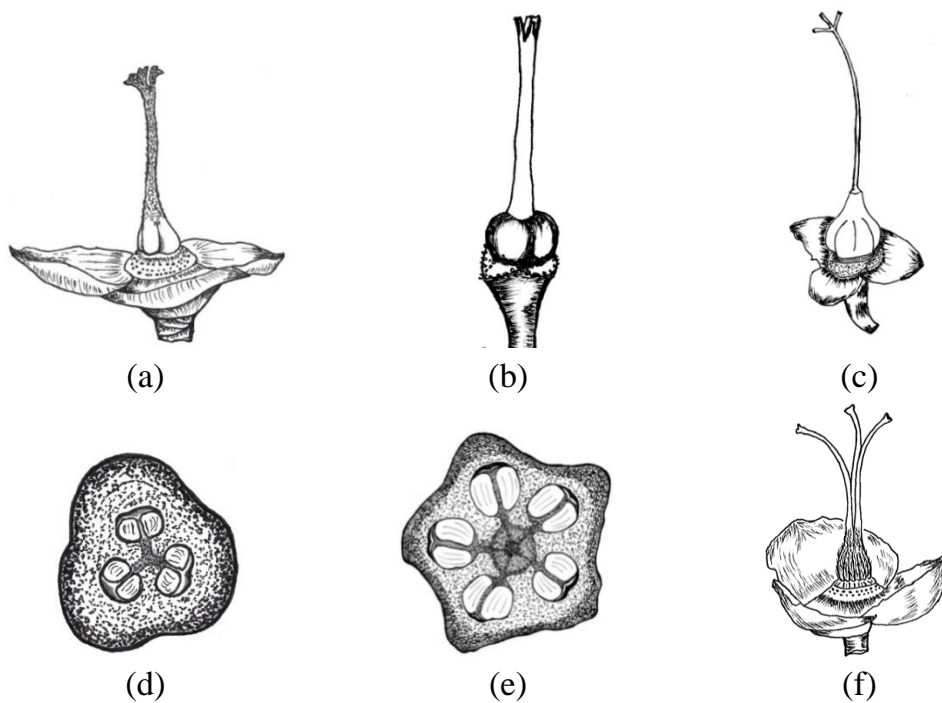


Figure 4. Gynoecium and ovary

Note: (a), (d) Ovary 3 locular (*Camellia luteopallida*); (b), (e) Ovary 5 locular (*Camellia dormoyana*); (c) Ovary with style united (*Camellia capitata*); (f) Ovary with style free (*Camellia ninhii*).

Source: Luong Van Dung.

3.1.4. Fruit

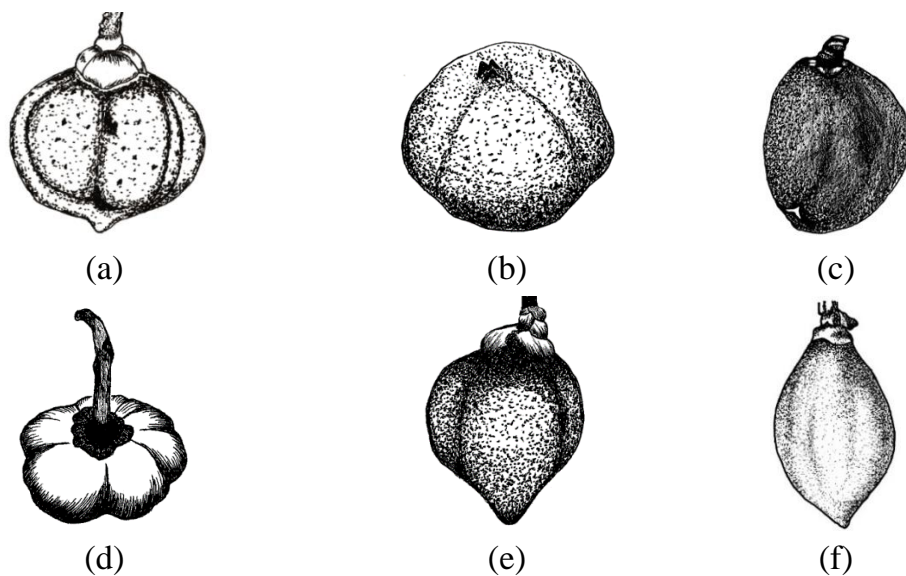


Figure 5. Morphology of the fruit

Note: (a) Subglobose (*Camellia capitata*); (b) Slightly flattened-globose (*Camellia ninhii*); (c) Asymmetrically ovoid (*Camellia bidoupensis*); (d) Flattened-globose (*Camellia langbianensis*); (e) Ovoid (*Camellia quynhii*); (f) Obovoid (*Camellia dilinhensis*).

Source: Luong Van Dung.

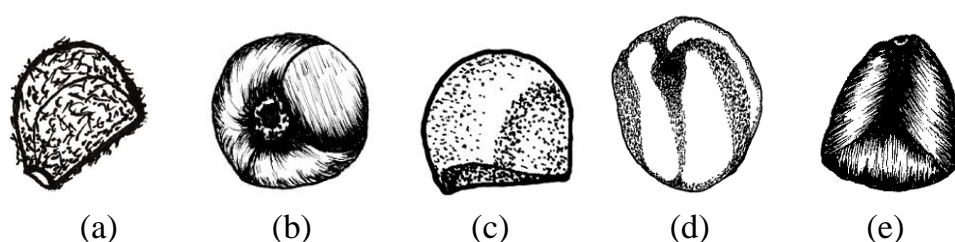


Figure 6. Morphology of the seeds

Note: (a) Cuneate (*Camellia capitata*); (b) Semiglobose (*Camellia inusitata*); (c) Cuneate (*Camellia dilinhensis*); (d) Ellipsoidal (*Camellia bidoupeensis*); (e) Cuneate (*Camellia quynhii*).

Source: Luong Van Dung.

Capsule flattened-globose, subglobose, ovoid or obovoid; smooth or furfuraceous, glabrous or sparsely villous; 3–5 locules, sometimes reduced to 1 locule by abortion, dehiscent distally into 3–5 valves from apex, 1–5 seeds per locule, columella persistent or lacking. Seeds globose, semiglobose, cuneate or ellipsoidal, dark brown, glabrous, or pubescent.

3.2. The key to yellow camellias of the Central Highlands

- 1a. Leaves less than 15 cm long.....2
- 2a. Young branches flat.....*Camellia inusitata*
- 2b. Young branches round.....3
- 3a. Leaves glabrous.....4
- 4a. Flowers 2–2.5 cm in diameter, petals pale yellow with purple stripes at the base.....*Camellia bidoupeensis*
- 4b. Flowers 4.5–5 cm in diameter, petals bright yellow.....*Camellia thuongiana*
- 3b. Leaves pubescent.....5
- 5a. Petals pubescent towards the apex inside.....*Camellia ninhii*
- 5b. Petals glabrous on both surfaces.....*Camellia thuanana*
- 1b. Leaves more than 15 cm long.....6
- 6a. Leaves oblong.....7
- 7a. Leaves pubescent.....8
- 8a. Leaves cordate at the base.....*Camellia dalatensis*

8b. Leaves broadly cuneate or obtuse at the base.....	<i>Camellia langbianensis</i>
7b. Leaves glabrous.....	9
9a. Leaves cordate at the base.....	<i>Camellia sphamii</i>
9b. Leaves cuneate or obtuse at the base.....	10
10a. Flowers yellow.....	11
11a. Fruit 1.5 cm high, 2.7 cm wide.....	<i>Camellia vidalii</i>
11b. Fruit 4.0–5.5 cm high, 8.5–10 cm wide.....	<i>Camellia proensis</i>
10b. Flowers yellow with pink pigmentation on edges.....	12
12a. Petals 5–6, roughly obovate.....	<i>Camellia oconoriana</i>
12b. Petals 8, pentagonal shape.....	<i>Camellia dongnaiensis</i>
6b. Leaves elliptic or oval.....	13
13a. Leaves pubescent.....	<i>Camellia capitata</i>
13b. Leaves glabrous.....	14
14a. Ovary 3 locular.....	15
15a. Ovary pubescent.....	<i>Camellia dilinhensis</i>
15b. Ovary glabrous.....	16
16a. Styles fused.....	<i>Camellia luteopallida</i>
16b. Styles free.....	<i>Camellia quynhii</i>
14b. Ovary 4–5 locular.....	17
17a. Flowers yellowish, styles fused for two thirds of their length	<i>Camellia dormoyana</i>
17b. Flowers distinctly intense yellow, styles always uniformly fused	<i>Camellia luteocerata</i>

REFERENCES

- Bùi, V. T., Nguyễn, T. C., Nguyễn, T. V. A., & Nguyễn, V. S. (2020). Phát triển nguồn tài nguyên cây thuốc và tri thức bản địa khu vực Tây Nguyên [Development of

medicinal plant resources and indigenous knowledge in the Central Highlands]. *Tạp chí Khoa học và Công nghệ Việt Nam*, 4, 45-48.

- Gagnepain, F. (1942). Ternstroemiaceae nouvelles d'Indochine [New Ternstroemias from Indochina]. *Notulae Systematicae*, 10(3), 112-131.
- Hoang, T. T., Le, H. E., & Nguyen, T. L. (2022). *Camellia thuanana* (*Camellia* sect. *Chrysantha*) – A new species from the Central Highlands, Vietnam. *Dalat University Journal of Science*, 12(3), 18-26. <https://tckh.dlu.edu.vn/index.php/tckhdhdl/article/view/931>
- Humbert, H., & Gagnepain, F. (1943). *Supplément à la flore générale de l'Indo-Chine*, Tome 1 [Supplement to the general flora of Indochina, Vol. 1]. Museum National d'Histoire Naturelle.
- Lê, N. H. N., Luong, V. D., Nguyễn, V. C., Phạm, T. T. D., Luu, T. T., & Phạm, V. T. (2020). An updated checklist of Theaceae and a new species of *Polyspora* from Vietnam. *Taiwania*, 65(2), 216-227. <http://doi.org/10.6165/tai.2020.65.216>
- Luong, V. D., Lê, A., Nguyễn, T. H., & Nguyễn, T. L. (2016). *Camellia thuongiana*: A new yellow *Camellia* species from Vietnam. *Dalat University Journal of Science*, 6(3), 338-344. [https://doi.org/10.37569/DalatUniversity.6.3.78\(2016\)](https://doi.org/10.37569/DalatUniversity.6.3.78(2016))
- Luong, V. D. & Le, N. H. N. (2016). *Camellia ninhii* – A new yellow *Camellia* species of Viet Nam. *International Camellia Journal*, 488, 117.
- Luong, V. D., Luu, H. T., Nguyen, T. Q. T., & Nguyen, Q. D. (2016). *Camellia luteopallida*, a new species from Vietnam. *Annales Botanici Fennici*, 53(1-2), 135-138. <https://doi.org/10.5735/085.053.0224>
- Nguyễn, H. H. (2017). *Thực vật chí Việt Nam – Theaceae D. Don* [Flora of Vietnam], Vol. 19. NXB. Khoa học Tự nhiên và Công nghệ.
- Orel, G. (2006). A new species of *Camellia* section *Piquetia* (Theaceae) from Vietnam. *Novon*, 16(2), 244-248. [https://doi.org/10.3417/1055-3177\(2006\)16\[244:ANSOCS\]2.0.CO;2](https://doi.org/10.3417/1055-3177(2006)16[244:ANSOCS]2.0.CO;2)
- Orel, G., & Curry, A. S. (2015). *In pursuit of hidden camellias: 32 camellia species from Vietnam and China*. Theaceae Exploration Associates.
- Orel, G., & Wilson, P. G. (2010). *Camellia luteocerata* sp. nov. and a new section of *Camellia* (*Dalatia*) from Vietnam. *Nordic Journal of Botany*, 28(3), 280-284. <https://doi.org/10.1111/j.1756-1051.2010.00652.x>
- Orel, G., Wilson, P. G., Curry, A. S., & Luu, H. T. (2012). *Camellia inusitata* (Theaceae), a new species forming a new section (*Bidoupia*) from Vietnam. *Edinburgh Journal of Botany*, 69(2), 347-355. <https://doi.org/10.1017/S0960428612000170>
- Orel, G., Wilson, P. G., Curry, A. S., & Luu, H. T. (2013). *Camellia oconoriana* (Theaceae), a new species from Vietnam. *Edinburgh Journal of Botany*, 70(3), 439-447. <https://doi.org/10.1017/S0960428613000103>

- Orel, G., Wilson, P. G., Curry, A. S., & Luu, H. T. (2014). Four new species and two new sections of *Camellia* (Theaceae) from Vietnam. *Novon*, 23(3), 307-318. <https://doi.org/10.3417/2012076>
- Phạm, H. H. (1991). *Cây cỏ Việt Nam: An illustrated flora of Vietnam, Vol. 1*. NXB. Trẻ.
- Pierre, J. B. L. (1896). *Flore Forestière de la Cochinchine*. Octave Doin.
- Pierre, J. B. L. (1897). *Flore Forestière de la Cochinchine*. Octave Doin.
- Pitard, C. J. (1910). Temstroemiaceés. In P. H. Lecomte (Ed.), *Flore Générale de l'Indo-Chine* [General flora of Indochina] (pp. 330-352). Masson et Cie.
- Quach, V. H., Doudkin, R. V., Truong, Q. C., Le, V. S., Luong, V. D., Kim, S., & Yang, S. (2021). Rediscovery of *Camellia langbianensis* (Theaceae) in Vietnam. *Phytotaxa*, 480(1), 085-090. <https://doi.org/10.11646/phytotaxa.480.1.8>
- Quach, V. H., Luong, V. D., Doudkin, R. V., Averyanov, L. V., Bui, B. T., Nguyen, T. L., & Luu, H. T. (2021). *Camellia proensis* (Theaceae, sect. *Piquetia*), a new species from southern Vietnam. *Phytotaxa*, 479(1), 137-141. <https://doi.org/10.11646/phytotaxa.479.1.12>
- Quach, V. H., Luong, V. D., Hoang, T. T., Nong, V. D., Bui, D. C., & Doudkin, R. V. (2022). *Camellia quynhii* (Theaceae, sect. *Stereocarpus*), a new yellow species from the Central Highlands, Vietnam. *Dalat University Journal of Science*, 12(3), 3-9. [https://doi.org/10.37569/DalatUniversity.12.3.848\(2022\)](https://doi.org/10.37569/DalatUniversity.12.3.848(2022))
- Rosmann, J. C. (1998). Une nouvelle espece de *Camellia* (Theaceae) du Viet-Nam [A new species of *Camellia* from Vietnam]. *Adansonia*, 21(2), 319-322.
- Tran, N., & Luong V. D. (2012). *Camellia dalatensis*: A new species and precious gene should be conserved. *VNU Journal of Science, Natural Sciences and Technology*, 28(2S), 34-36.
- Tran, N., & Luong, V. D. (2013). *Camellia dilinhensis*: A new species from Vietnam. *International Camellia Journal*, 45, 87-89
- Truong, Q. C., Le, V. H., Le, V. S., Le, Q. M., Hoang, G., & Luu, H. T. (2022). *Camellia sphamii* (Theaceae, sect. *Piquetia*), a new taxon of yellow flower from Langbiang Biosphere Reserve, Vietnam. *Dalat University Journal of Science*, 12(3), 10-17. [https://doi.org/10.37569/DalatUniversity.12.3.947\(2022\)](https://doi.org/10.37569/DalatUniversity.12.3.947(2022))
- Truong, Q. C., Luong, V. D., Le, V. S., Tran, N., & Curry, A. (2020). *Camellia bidoupensis* – A new species of *Camellia* section *Theopsis* (Theaceae) from Bidoup Nui Ba National Park in Vietnam. *International Camellia Journal*, 52, 125-128.