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COMPOSITION AND STATUS OF SOME ENDEMIC SECTIONS OF THE GENUS *CAMELLIA* (THEACEAE) IN VIETNAM

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СОСТАВ И СТАТУС НЕКОТОРЫХ ЭНДЕМИЧНЫХ СЕКЦИЙ РОДА *CAMELLIA* (THEACEAE) ВО ВЬЕТНАМЕ

Abstract. Recently, many new species of *Camellia* have been discovered in Vietnam. They accompanied some new sections that have been added to the genus *Camellia*. This study aims to determine the species composition of some endemic sections, as well as their current status in Vietnam. The study was based on 27 literature sources and examined a series of specimens of *Camellia* species from the herbarium. A total of 14 endemic species to Vietnam belong to 5 sections were considered. The common morphological characteristics of each section were modified, which have changed following the change in the number of species. Taxonomy keys to species have been given for sections containing more than one species. Information on the distribution and status of 14 endemic species has been given.

Keywords: Section, *Capitatae*, *Dalatia*, *Yersinia*, *Bidoupia*, *Obvoidea*, *Camellia*, Vietnam.

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Аннотация. Недавно во Вьетнаме было обнаружено много новых видов. Они сопровождали некоторые новые секции, которые были добавлены к роду *Camellia*. Это исследование целится на определение видового состава некоторых эндемичных секциях, а также их современного статуса во Вьетнаме. Это исследование было основано на 27 литературных источниках и рассмотрело серию образцов видов *Camellia* из гербария. В общей сложности было рассмотрено 14 эндемичных для Вьетнама видов в 5 секциях. Общие морфологические характеристики каждой секции были изменены, которые изменились вместе с изменением количества видов. Таксономические ключи к видам даны для секций, содержащих более одного вида. Приведены сведения о распространении и статусе 14 эндемичных видов.

Ключевые слова: Секция, *Capitatae*, *Dalatia*, *Yersinia*, *Bidoupia*, *Obvoidea*, *Camellia*, Вьетнам.

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Introduction. *Camellia* is the largest genus in Theaceae family with about 280 species [2; 17]. According to a recent statistic of Ninh *et al.* (2020) there are 95 species of *Camellia* in Vietnam, and Vietnam is considered as one of the two centers of diversity of *Camellia* species [5; 7; 17]. Currently, there are 3 systems of Sealy (1958), Chang & Bartholomew (1984) and Ming & Bartholomew (2007) which are recognized and used more widely [5; 17]. Sealy (1958) divided species of the genus *Camellia* into 12 sections, including 2 groups. The first group consists of species that have flower apparently sessile, that bracteoles and sepals not distinguishable from one another. The other group consists of species with flower more or less distinctly pedicellate, bracteoles clearly distinguishable from sepals. Chang & Bartholomew (1984) divided this genus into four subgenera, including 20 sections. Then, perhaps, Ming & Bartholomew (2007) Ming based on Sealy's system divided the genus *Camellia* into two subgenera (*Camellia* and *Thea*), including 14 sections. Ninh (2002) divided the genus *Camellia* with Vietnamese representatives into 4 subgenera and 15 sections. Also, with the *Camellia* representatives of Vietnam, Hien (2017) divides this genus into 2 subgenera with 11 sections [3; 5; 15]. Recently, many new species of *Camellia* have been discovered in Vietnam [4; 6; 8; 11; 24], accompanied by some new morphological characteristics were discovered in the genus *Camellia*. As a result, new sections were added to the genus *Camellia* [14; 17; 20; 21]. Many of them are endemic to Vietnam. Some other studies also merged the sections together led to change the number of sections [26; 27]. This study aims to determine the species composition of some endemic sections, as well as their current status in Vietnam.

Materials and methods. The study was based on 27 literature sources and a range of specimens of *Camellia* species were also examined from the herbarium in Vietnam (VNM, HN, DLU, SGN, VAFS) and via online images from the other herbarium (P, K, A, NY, NSW). The scientific names were nomenclature checked according to Shenzhen code of International Association for Plant Taxonomy [25] together with online consulted from the Plant List (<http://www.theplantlist.org>), World Flora Online (<http://www.worldfloraonline.org>), and International Plant Names Index (<https://www.ipni.org>). The morphological characteristics were used to establish the taxonomy keys for all species in the sections.

Results and discussions. 1. *Camellia* sect. *Capitatae* Orel (2014), Novon 23 (3): 315 [21].

Leaves elliptic to oval, or almost oblong to obovate; flowers sessile, perules 8–10; petals 6, in 2 whorls; stamens numerous, outer stamens attached to inner petals, basally fused; anthers small, distinct, basifixed; style single, with apically shortly 3-fid, stout, glabrous; ovary 3-carpellate, roughly triangular, glabrous [21].

The sect. *Capitatae* consists of only *Camellia capitata* species and is endemic to Vietnam.

(1) *Camellia capitata* Orel, Curry & Luu (2014), Novon 23 (3): 315, fig. 4; Orel & Curry (2015), Pursuit Hidden Camellias Vietnam China: 142; Beech *et al.* (2017), The Red List of Theaceae: 23 [1; 17; 21].

Type: VIETNAM. Lam Dong Prov., Cat Tien Nat. Park, plot 511, ca. 4 km N of Phuoc Son forest station, at altitude of 200 m, 11 Nov. 2010 (fl.), Pham Hong Thai & Nguyen Danh Hiep CT5 (holotype, SGN; isotype, NSW).

Distribution and ecology: VIETNAM. *C. capitata* was found under canopy of the evergreen broad-leaved forest, which is situated within the Bu Gia Map Nat. Park in Bu Gia Map Dist., Binh Phuoc Prov. in southern Vietnam.

Conservation status: It is estimated of fewer than 5 mature individuals in a population. The habitat of this species is protected by the Bu Gia Map Nat. Park. It is listed as Critically Endangered (CR) according to of the Red List of Theaceae [1]. This is an endemic species to Vietnam.

2. *Camellia* sect. *Dalatia* Orel (2010), Nordic J. Bot. 28 (3): 281; Orel *et al.* (2014), Novon 23 (3): 313 [19; 21].

Flowers sessile or subsessile, rarely pedicellate (*C. decora* and *C. tadungensis*), mostly solitary, sometime geminate, yellow (except for *C. hongiaoensis*); perules (bracteoles and sepals) concave, persistent (except for *C. bugiamapensis*); petals vary in number 4-14, most yellow; filaments glabrous (except for *C. luteopallida*), outer filaments united each other and attached to the inner petals; style united or free to base; ovary 3-6-carpellate.

The section was established by Orel (2010) with the type species of *C. luteocerata*. Common characteristics were based on *C. luteocerata*. However, at present, the characteristics are not suitable due to many new species added to the section. Accompanying these species are some other characteristics added to the section. For example flower pedicellate in *C. decora* and *C. tadungensis*, flower pink in *C. hongiaoensis*, filaments finely hair and style 3 in *C. luteopallida*, style free to base in *C. hongiaoensis*, *C. decora*, *C. andersenii*, *C. insularis*, and *C. tienyenensis*. According to Luong *et al.* (2016) the section *Dalatia* consists of nine species including *C. luuana*. However, recently, *C. luuana* was proven to be a synonym of *Pyrenaria jonquieriana* [26]. Present, the sect. *Dalatia* consists of 9 species and is endemic to Vietnam.

Key to species of sect. *Dalatia*

- 1a. Style free to the base2
- 1b. Style united for some distance above the base, usually for most of their length.....6
- 2a. Perules tomentose; style tomentose or finely hairy3
- 2b. Perules glabrous; style glabrous4
- 3a. Flower pink to dark pink, campanulate shape *C. hongiaoensis*
- 3b. Flower yellow, rotate shape *C. decora*
- 4a. Young branches glabrous..... *C. andersenii*
- 4b. Young branches slightly or finely tomentose5
- 5a. Perules 9-12, petals 9-11 *C. insularis*
- 5b. Perules 2-3, petals 4-6 *C. tienyenensis*
- 6a. Styles glabrous *C. luteocerata*

- 6b. Styles tomentose or finely hair7
 7a. Perules hair on both sides; filaments sparsely hairy; ovary 3*C. luteopallida*
 7b. Perules glabrous on the adaxial; filaments glabrous; ovary (4-)5-68
 8a. Pedicel 0.3-0.5 cm; perules deciduous; ovary glabrous *C. bugiamapensis*
 8b. Pedicel 4-5 cm; perules persistent; ovary finely tomentose *C. tadungensis*
(2) *Camellia andersenii* Orel (2020), Int. Camellia J. 52: 129 [18].

Type: VIETNAM. Vinh Phuc Prov., foot of an unnamed mountain, 12. Dec.1999, G. Orel, A. S. Curry, R. Cherry, G. Richards, A. Raper & P. Cave. *Orel myt-3-23* (holotype, NSW).

Distribution and ecology: VIETNAM. *C. andersenii* grows in with wet conditions of the evergreen broad-leaved forest in Vinh Phuc Prov., in southern Vietnam.

Conservation status: Information on the distribution of *C. andersenii* is still restraint. The conservation status of this species has not been evaluated. This species is endemic to Vietnam.

(3) *Camellia bugiamapensis* Orel, Curry, Luu & Q. D. Nguyen (2014), Novon 23 (3): 313, fig. 3; Beech *et al.* (2017), The Red List of Theaceae: 23 [1; 21].

Type: VIETNAM. Binh Phuoc Prov., Bu Gia Map Natl. Park, low lying tropical forest ca. 1 km from Cambodia border, 18 December. 2011 (fl.), *Luu Hong Truong et al.* 698 (holotype, SGN; isotype, NSW).

Distribution and ecology: VIETNAM. *C. bugiamapensis* was found in moist conditions, under canopy of broad-leaved evergreen in the Bu Gia Map Nat. Park in southern Vietnam.

Conservation status: It is estimated there are fewer than 50 mature individuals in the population. The habitat of this species is protected by the Bu Gia Map Nat. Park. It is listed as CR [1]. This is an endemic species to Vietnam.

(4) *Camellia decora* Orel, Curry & Luu (2015), Pursuit Hidden Camellias Vietnam China: 173 [17].

Type: VIETNAM. Ninh Thuan Prov., 23 March 2009, Luu Hong Truong and staff of the Centre for Biodiversity and Development, *Luu VNM00012381* (holotype, NSW; isotypes, VNM).

Distribution and ecology: VIETNAM. This species grows in a forest within the Nui Chua Nat. Park in Ninh Thuan Prov. in central Vietnam.

Conservation status: Only few mature plants of *C. decora* is found at the discovery location. This species was provisionally assessed as Data Deficient (DD) according to the IUCN of Categories and Criteria [9].

(5) *Camellia hongiaoensis* Orel & Curry (2014), Telopea 17: 101, fig. 1, 2, 3, 4 [16].

Type: VIETNAM. Khanh Hoa Prov., in the vicinity of the Nha Trang City, 28 Nov. 2013, *Luong Van Dung, Cuong Quang Truong & Pham Huu Nhan, Orel & Curry OC36* (holotype, NSW).

Distribution and ecology: VIETNAM. *C. hongiaoensis* is found in the vicinity of Hon Ba Mt. in Khanh Hoa Prov. in central Vietnam.

Conservation status: This species is considered as Data Deficient (DD) according to the IUCN of Categories and Criteria [9]. This is an endemic species to Vietnam.

(6) *Camellia insularis* Orel & Curry (2015), Pursuit Hidden Camellias Vietnam China: 187 [17].

Type: VIETNAM. Quang Ninh Prov., estuarine islands, 5 Nov. 1999, G. Orel et al. 7219 (holotype, NSW).

Distribution and ecology: VIETNAM. *C. insularis* was found in an island near the coast in Quang Ninh Prov., Northern Vietnam. The habitat of *C. insularis* is in the shaded understory layer of an evergreen forest.

Conservation status: A few mature individuals of *C. insularis* were observed in discovery location. This species was provisionally assessed as Data Deficient (DD) according to the IUCN of Categories and Criteria [9; 17].

(7) ***Camellia luteocerata* Orel** (2010), *Nordic J. Bot.* 28(3): 280, fig. 1 [19].

Type: VIETNAM. Lam Dong Prov., the vicinity of Cat Tien National Park, 19 Dec. 2007, G. Orel, G. Richards, M. Richards and staff members of Cat Tien National Park, *Orel 0715* (holotype, NSW; isotypes, NSW, HN).

Distribution and ecology: VIETNAM. *C. luteocerata* was discovered in the understory layer of an evergreen broad-leaved forest in Cat Tien Natl. Park, in Lam Dong Prov. This species grow in conditions of low light and high humidity on nutrient-poor soils.

Conservation status: *C. luteocerata* is listed as Vulnerable (VU) of the Red List of Theaceae due to the number of individual of population is relatively small [1].

(8) ***Camellia luteopallida* Luong, T.Q.T. Nguyen & Luu** (2016), *Ann. Bot. Fenn.* 53: 135, fig. 1 [10].

Type: VIETNAM. Dak Nong Prov., Gia Nghia Town, 21 October 2014, *Luong Van Dung & Tran Trong Hung DL. 14.10.01* (holotype, DLU; isotype, SGN). 15 October 2015, *Luong Van Dung & Tran Trong Hung DL. 15.10.02* (paratypes, DLU, SGN).

Distribution and ecology: VIETNAM. The species was found in mixed bamboo forest and broad-leaved trees along the Dong Nai River, bordering Lam Dong and Dak Nong Prov.

Conservation status: Habitat of species is being lost due to agricultural expansion. The species was provisionally categorised as Critically Endangered (CR) [9; 10].

(9) ***Camellia tadungensis* Orel, Curry & Luu** (2015), *Pursuit Hidden Camellias Vietnam China*: 256 [17].

Type: VIETNAM. Dak Nong Prov., Ta Dung Nat. Res., 11 Jan. 2011, *Luu Hong Truong, Nguyen Quoc Dat & Nguyen Tran Quoc Trung, Luu, Nguyen & Nguyen TD 264* (holotype, NSW; isotypes, VNM).

Distribution and ecology: VIETNAM. *C. tadungensis* was found within the territory of Ta Dung Nature Reserves, in Dak Nong Prov., in Southern Vietnam.

Conservation status: *C. tadungensis* is being protected by the Ta Dung Nature Reserves. However, the species was assessed as Near Threatened (NT) according to IUCN categories and criteria [9; 17].

(10) ***Camellia tienyenensis* Orel & Curry** (2015), *Pursuit Hidden Camellias Vietnam China*: 234 [17].

Type: VIETNAM. Quang Ninh Prov., unnamed coastal region, 2 Dec. 1999, G. Orel, A. S. Curry, A. Luc, R. Cherry, G. Richards, A. Raper & P. Cave, *Orel & Curry 991202* (holotype, NSW; isotypes, NSW).

Distribution and ecology: VIETNAM. *C. tienyenensis* was found in a coastal region in Tien Yen Dist., Quang Ninh Prov., in Northern Vietnam.

Conservation status: At the present time, several mature plants were found in the type location. Therefore, *C. tienyenensis* was considered as Data Deficient (DD) according to IUCN categories and criteria [9; 17].

3. *Camellia* sect. *Yersinia* Orel (2015), Pursuit Hidden Camellias Vietnam China: 166 [17].

Leaves narrow elliptic, elliptic, to oval. Flowers axillary or terminal; axillary flowers mostly single, rarely geminate; terminal flowers strictly in a spike like inflorescence; bracteoles 2; petals 6, in 2 whorls; sepal 6, in two whorls; styles 5, glabrous, free to the base; ovary rotund, glabrous. Capsules large, unevenly globular. Seed large, globular, solitary [17].

This section has only *Camellia harlandii* species and is endemic to Vietnam. The species was listed as an unpublished species in Pursuit Hidden Camellias Vietnam China [17].

(11) *Camellia harlandii* Orel & Curry (2015), Pursuit Hidden Camellias Vietnam China: 166 [17].

Type: VIETNAM. Lam Dong Prov., Da Lat Plateau, 13 Jan. 2004, G. Orel, A. Curry, G. Richards & G. Wilkes 218 (holotype, isotype, NSW).

Distribution and ecology: VIETNAM. *C. harlandii* was found on Da Lat Plateau in Lam Dong Prov., Southern Vietnam. The species grow in understory layer of evergreen broad-leaved forest with wet conditions and relatively low elevations.

Conservation status: At the present time, several mature plants of *C. harlandii* were found in the type location. Therefore, *C. harlandii* was considered as Data Deficient (DD) according to IUCN categories and criteria [9; 16].

4. *Camellia* sect. *Bidoupia* Orel, Curry & Luu (2012), Edinburgh Journ. Bot. 69 (2): 348 [20].

Trunk strictly single, mostly branchless; young branches compressed, later rounded. Leaves distichous, leaf bases cordate to shallowly amplexicaul. Flowers pedunculate, solitary or geminate. Sepals 5. Petals 5 (6). Stamens not numerous. Styles, proximally fused, finely pubescent proximally; ovary densely tomentose, 3-carpellate. Mature fruit unevenly round, distinctly oblate, dehiscing into three parts, columella stout. Seed glabrous and laterally compressed [20].

This section includes only *Camellia inusitata* species and is endemic to Vietnam. This species is easily identified by its trunk strictly single, young branches compressed.

(12) *Camellia inusitata* Orel, Curry & Luu (2012). Edinburgh J. Bot. 69 (2): 348, fig. 1; Orel & Curry (2015), Pursuit Hidden Camellias Vietnam China: 95; Hien (2017), Fl. Vietnam: 219, fig. 89; Beech *et al.* (2017), The Red List of Theaceae: 27; Orel (2018), Int. Camellia J. 50: 68 [1; 3; 17; 20; 22].

Type: VIETNAM. Lam Dong Prov., Bidoup-Nui Ba Natl. Park, 19 Dec. 2010, Luu Hong Truong *et al.* 464 (holotype VNM; isotype NSW, VNM).

Distribution and ecology: VIETNAM. *C. inusitata* was found in an evergreen broad-leaved forest at Hon Giao Mountain of Bidoup-Nui Ba National Park, Lac Duong Dist. Lam Dong Prov.. This species grows on always wet and nutritionally relatively rich soils.

Conservation status: This species was assessed as Critically Endangered (CR) according to IUCN of Categories and Criteria and listed in the Red List of Theaceae [1; 9; 19]. This is an endemic species to Lam Dong Prov., Vietnam.

5. *Camellia* sect. *Obvoidea* Tran et Luong (2013), Int. Camellia J. 45: 87 [14].

Flowers yellow, terminal or axillary, medium large, yellow, pedicels bear two or three tiny bracteoles; ovary cylindrical, pubescent; style 3, free to the base; fruits obovoid.

This section consists of two *Camellia dilinhensis* and *Camellia vuquangensis* species and is endemic to Vietnam. The section was established by Dung (2013) because this is the first time he discovered that the genus *Camellia* possesses the characteristic of a fruit obovoid.

Key to the species of sect. *Obvoidea*.

1a. Petal 8–9, glabrous on both sides; leaves glabrous on both sides; young branches glabrous (13) *C. dilinhensis*

1b. Petal 13–14, pubescent on middle outer surface; leaves hirsute below; young branches pubescent

..... (14) *C. vuquangensis*

(13) *Camellia dilinhensis* Tran & Luong (2013), Int. Camellia J. 45: 87, fig 1; Ninh & Dung (2016), Dali Int. Camellia Cong. Dali Yunnan-China: 82; Beech *et al.* (2017), The Red List of Theaceae: 25 [1; 13; 14].

Type: VIETNAM. Lam Dong Prov., Cat Tien Dist., evergreen broadleaved forest, at altitudes of 500–600 m, 10 Oct. 2015, Luong Van Dung, Tran Trong Hung, Le Nguyet Hai Ninh, *DL.15.10.01* (holotype, DLU, HN; isotype, DLU).

Distribution and ecology: VIETNAM. This species was found in evergreen broad-leaved forest in Di Linh Dist. Lam Dong Prov. and in the mixed broad-leaved and bamboo forest in Da Mi Commune, Ham Thuan Bac Dist., Binh Thuan Prov.

Conservation status: This species assessed as Endangered (EN) according to The Red List of Theaceae [1]. This is an endemic species to Vietnam.

(14) *Camellia vuquangensis* Luong, Tran & L. T. Nguyen (2018), Korean J. Pl. Taxon. 48 (2): 115, fig. 1, 2 [12].

Type: VIETNAM. Ha Tinh Prov., Vu Quang Dist., 21 Aug. 2017 (fl), *Luong Van Dung et al. VN.0358* (holotype, DLU; isotype, VAFS).

Distribution and ecology: VIETNAM. This species was found at altitudes of 50–100 m in the forest of Vu Quang Int. Park, Vu Quang Dist., Ha Tinh Prov.

Conservation status: This species was assessed as Critically Endangered (CR) according to the IUCN of Categories and Criteria [9; 12].

Conclusions. This is first study on several endemic sections in the genus *Camellia* of Vietnam. Fourteen species from five sections have been reviewed. Three of them, the sections of *Capitatae*, *Yersinia* and *Bidoupia* consist of only one species for each section, sect. *Dalatia* consists of nine species, and sect. *Obvoidea* has two species. This is also first study that provides the complete taxonomic keys to species for two sections containing more than one species. A range of distribution locations for each species have been given. Most of the *Camellia* species are endemic to Vietnam, and they have been found in southern Vietnam (except *C. andersenii*, *C. andersenii*, *C. tienyenensis*

and *C. vuquangensis*). The current status of the species has been given. Most of the *Camellia* species endemic to Vietnam are endangered. Specifically, one species has not been evaluated, one species for each levels of Vulnerable (VU), Near Threatened (NT), and Endangered (EN), five species for each levels of Data Deficient (DD) and Critically Endangered (CR).

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