



## *Camellia wumingensis* (Theaceae), a neglected species from Guangxi, China

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**ABSTRACT:** *Camellia wumingensis*, a neglected species known only from limestone areas of Guangxi, China, is formally described and illustrated here. It is morphologically similar to *C. flavida* var. *patens* in having current-year branchlets purplish red, petiole adaxially grooved, flowers axillary or terminal, ovary glabrous, capsule oblate, and seeds brown, but is readily distinguished by the leaf texture and size, number of secondary veins, flower size, flower bud shape and size, number of petals, degree of fusion of the outer filaments, and pericarp thickness. Other related species *C. flavida* and *C. pinguoensis* var. *terminalis* are also compared with *C. wumingensis* in the paper, and the differences between them are obvious. In addition to a diagnosis and detailed description, information on the geographical distribution, images of morphological characters and pollen grains, and a provisional conservation status assessment are provided for this species.

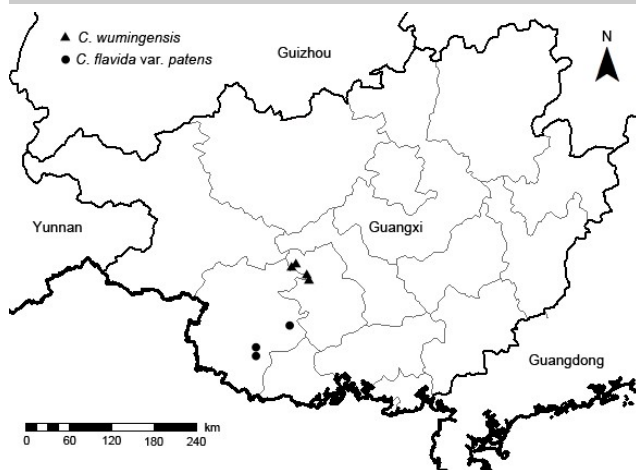
**KEY WORDS:** *Camellia flavida*, *Camellia pinguoensis* var. *terminalis*, limestone areas, morphology, palynology, taxonomy.

### INTRODUCTION

The genus *Camellia* is the largest genera within the family Theaceae, consists of about 280 species (Chang and Ren, 1998; Gao *et al.*, 2005), and widely distributes in East and Southeast Asia (Chang and Ren, 1998; Ming and Bartholomew 2007; Le *et al.*, 2020). The *Camellia* species with yellow flowers, known as yellow Camellias, are commercially important plants in having high horticultural and medicinal value (Liang, 1993; He *et al.*, 2016; Chen *et al.*, 2022; Wei *et al.*, 2022). In China, yellow Camellias comprises about 21 species, including five new species reported in recent years (Huang *et al.*, 2014; Hu *et al.*, 2019; Liu *et al.*, 2019, 2020; Zhang *et al.*, 2022). All yellow *Camellia* species are rare and highly endemic, and being exploited or overexploited in the wild. Currently, all of them are listed as Grade-II in China's newly published National Key Protected Wild Plant List (<http://www.forestry.gov.cn/>). To date, study on yellow Camellias has never interrupted, including Horticulture, Taxonomy, Medicinal botany, Conservation biology and so on. Taxonomic incongruence of yellow Camellias species is still in discussion for decades (Chang, 1981, 1991; Ming and Zhang, 1993; Ming, 2000; Tang *et al.*, 2004; Liang, 2007; Ye and Xue, 2013, Wei *et al.*, 2022), among which *Camellia wumingensis* S.Ye Liang & C.R.Fu is a special one.

From 1980 to 1982, several specimens of *Camellia* were collected from limestone areas of Wuming by Tei Zheng Ching, Cui Rong Fu, and Sheng Ye Liang. Subsequently, Sheng Ye Liang realized that these specimens may represent an undescribed species but only provided the provisional name '*Camellia wumingensis* S.Y. Liang & C.R. Fu' on the herbarium label for the specimens.

Wang (1985) expressed her point that supported of *C. wumingensis* as a new species basis of pollen morphology, without a description or diagnosis or a reference made earlier descriptions or diagnoses. Therefore, it was invalidly published and the name of '*C. wumingensis* S.Ye Liang & C.R. Fu' was regarded as a *nomen nudum* (Turland *et al.*, 2018). But even so this article was mistakenly regarded as the original literature of *C. wumingensis* over the years (Liang, 1990; <http://www.iplant.cn>; <https://www.tropicos.org/home>). Liang (1990) provided a morphological description in Chinese but no Latin description of *C. wumingensis*. In the classification of Ming and Bartholomew (2007), *C. wumingensis* S.Ye Liang & C.R.Fu, *Camellia longgangensis* var. *patens* S.L.Mo & Y.C.Zhong, *C. quinqueloculosa* S.L.Mo & Y.C.Zhong, and *C. multipetala* S.Ye Liang & C.Z.Deng were treated as heterotypic synonyms of *C. flavida* var. *patens* (S.L.Mo & Y.C.Zhong) T.L.Ming. However, other researchers of *Camellia* have proposed different taxonomic treatments of these four taxa. Ye *et al.*, (1993) conducted a systematic study on *Camellia* sect. *Chrysantha* and recognized *C. quinqueloculosa* as an independent species, and *C. longgangensis* var. *patens* and *C. multipetala* as synonyms of *C. quinqueloculosa*. In addition, *C. wumingensis* was treated as a synonym of *C. flavida* Hung T.Chang. Ye and Xue (2013) studied the morphology of *C. flavida*, and examined the relevant type specimens and original literature, and concluded that *C. longgangensis* var. *patens* and *C. multipetala* should be classified as synonyms of *C. quinqueloculosa*, and that *C. wumingensis* is an independent species. Wei *et al.*, (2022) provided a clear resolution of the relationships of these four taxa based on molecular and morphological evidence, and the taxonomic conclusions for these taxa were consistent



**Fig. 1.** Known geographical distribution of *Camellia wumingensis* and *C. flavida* var. *patens*.

with those of Ye and Xue (2013). Thus, in summary, *C. quinqueloculosa*, *C. longgangensis* var. *patens*, and *C. multipetala* have been concluded to be conspecific by previous researchers. However, the taxonomic status of *C. wumingensis* remains controversial.

In pursuit of an improved understanding of the relationships of *C. wumingensis* and its close relatives, we conducted a detailed comparative analysis of morphological and palynological evidence considered in combination with the results of a previous phylogenetic analysis. According to the results presented here, we conclude that *C. wumingensis* warrants recognition as a distinct species.

## MATERIAL AND METHODS

Except for material of *C. wumingensis*, specimens were identified based on the taxonomic classification for Theaceae in the *Flora of China* (Ming and Bartholomew, 2007), i.e., *C. longgangensis* var. *patens*, *C. multipetala*, and *C. quinqueloculosa* were considered to be synonyms of *C. flavida* var. *patens*. An intensive field survey of wild populations of *C. wumingensis* and *C. flavida* var. *patens* was conducted, covering the entire known geographical range of each taxon, from 2019 to 2023. Fresh specimens were collected for examination and comparison, and have been deposited in IBK (herbarium acronyms follow those listed in the Index Herbariorum). Historical specimens housed in relevant herbaria (IBK, SYS, and GXFI) and digital photographs of *C. wumingensis* and *C. flavida* var. *patens* specimens, preserved in the Chinese Virtual Herbarium (<http://www.cvh.org.cn/>), were examined. A map of the geographical distributions of the two taxa was prepared using ArcMap GIS 9.2 (ESRI, 2009) and subsequently edited. Observation of pollen morphology was undertaken using a scanning electron microscope (ZEISS EVO 18, Oberkochen, Germany) and digital micrographs of the taxa were compared.

## RESULTS

A total of seven subpopulations of *C. wumingensis* and *C. flavida* var. *patens* were located in the field. Specifically, four subpopulations of *C. wumingensis* were found only in Guangxi Thirty-six Nong-Longjun Regional Nature Reserve in Wuming District, Nanning City (Fig. 1). The three subpopulations of *C. flavida* var. *patens* were distributed in the Guangxi Chongzuo White-Headed Langur National Nature Reserve and the surrounding area at Chongzuo City (Fig. 1). Detailed comparison of their morphology revealed that *C. wumingensis* and *C. flavida* var. *patens* share numerous character states, such as current-year branchlets purplish red, petiole adaxially grooved, flowers axillary or terminal, ovary glabrous, capsule oblate, and seeds brown. However, *C. wumingensis* is readily distinguished from *C. flavida* var. *patens* in having smaller, thinly leathery leaves, fewer secondary veins, smaller flowers and flower buds, fewer petals, fewer stamens, a thinner pericarp, and outer filaments basally connate only in the lower quarter (Table 1, Figs. 2, 3).

The pollen grains of *C. wumingensis* are 3-colporate, prolate,  $35\text{--}40 \times 23\text{--}30 \mu\text{m}$ , amb circular, and the exine ornamentation is rugulate occasionally perforate (Fig. 4A-C). In contrast, the pollen grains of *C. flavida* var. *patens* are 3-colporate, spheroidal,  $29.5\text{--}32 \times 28\text{--}33 \mu\text{m}$ , amb semi-angular, and the exine ornamentation is granulate (Fig. 4D-F).

## DISCUSSION

Although the name *Camellia wumingensis* S.Ye Liang & C.R.Fu was previously a *nomen nudum* and was not validly published, some researchers of *Camellia* have recognized it as an independent species in their studies (Wang, 1985; Liang, 1990, 1993, 2007; Ye and Xue, 2013; Wu *et al.*, 2019; Wei *et al.*, 2022). By contrast, the name was treated as a synonym of *C. flavida* var. *patens* by Ming and Bartholomew (2007). The petals of *C. wumingensis* lack any red or purple streaks or spots, having smaller flowers, leaves, and lesser stamens, which is a readily visible difference from *C. flavida* (Table 1). The present comparison of morphology confirmed that *C. wumingensis* can be readily distinguished from *C. flavida* var. *patens* (Table 1, Figs. 2–3), which is consistent with results reported previously (Ye and Xue, 2013; Wei *et al.*, 2022). Pollens are fairly steady in properties at species level in genus *Camellia*, so they are very useful in plant taxonomy (Ao *et al.*, 2002). Pollen grains traits in present study such as 3-colporate, prolate and perforated exine, are consistent with the characteristics described in Wang (1985). In addition, sampling of both taxa from the same locality for molecular phylogenetic analyses previously indicated that *C. wumingensis* is genetically distinct from *C. flavida* var. *patens* (Wei *et al.*, 2022). In that study, *C.*

**Table 1.** Comparison of key morphological characters among *C. wumingensis*, *C. flavida* var. *patens*, *C. flavida* and *C. pingguoensis* var. *terminalis*.

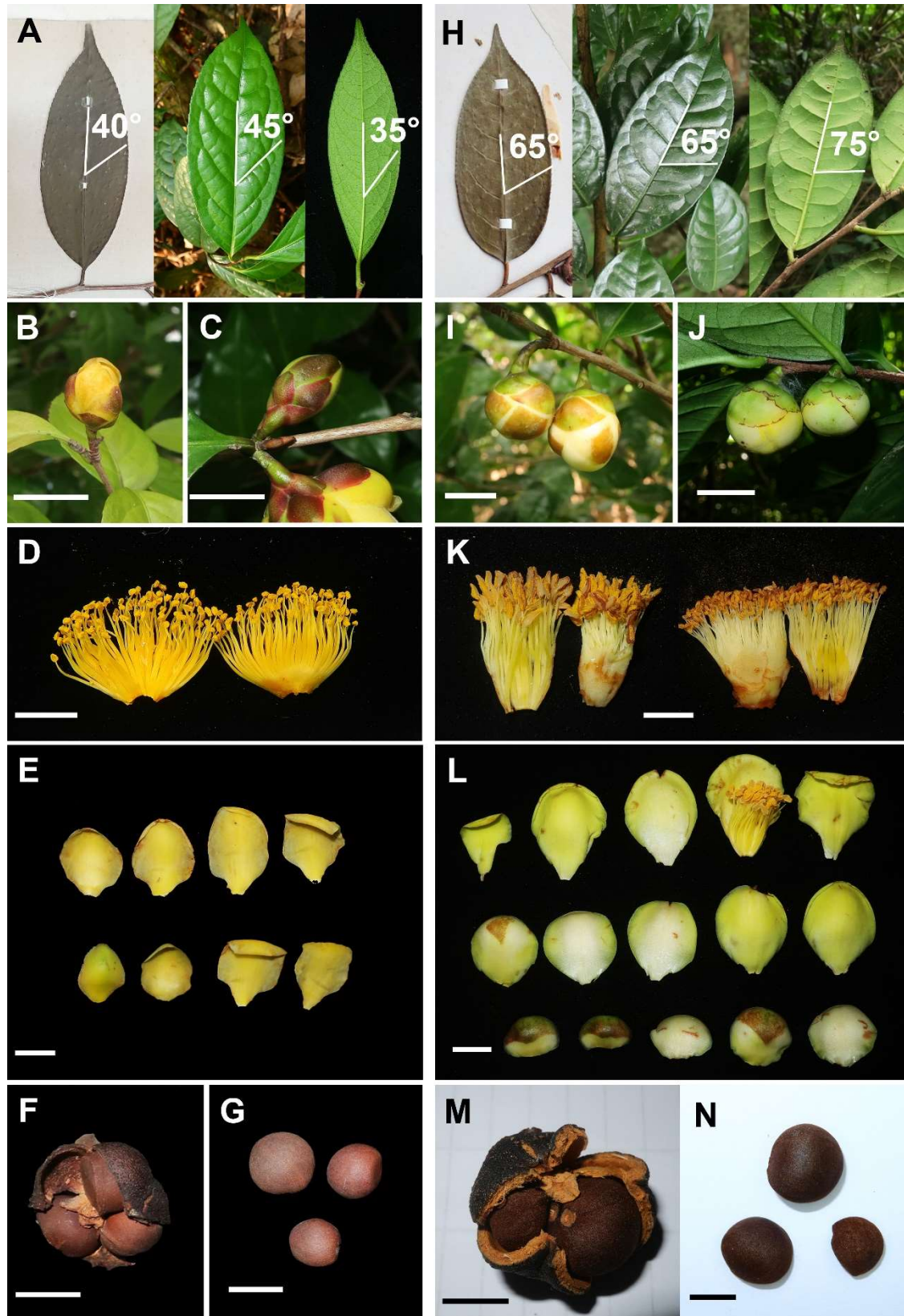
Characters	<i>C. wumingensis</i>	<i>C. flavida</i> var. <i>patens</i>	<i>C. flavida</i>	<i>C. pingguoensis</i> var. <i>terminalis</i>
<b>Young branches</b>				
Vestiture	greyish yellow	greyish brown	greyish brown	greyish yellow
<b>Leaf</b>				
Texture	thinly leathery	leathery to thick leathery	thinly leathery to leathery	thinly leathery
Size (cm)	7–11×2.5–5	7.5–17×3–6.2	7.0–18×3–6.2	5.0–7.5(–10)×1.5–3.5
Petiole	5–10 mm long, glabrous	7–12 mm long, glabrous	3–8 mm long, glabrous	5–10 mm long, glabrous
Blade vestiture	both surfaces glabrous	both surfaces glabrous	both surfaces glabrous	both surfaces glabrous
Blade base	broadly cuneate to subrounded	broadly cuneate to subrounded	cuneate to obtuse	cuneate to obtuse
Blade margins	serrulate	serrulate	serrulate	serrulate
Blade venation	secondary veins 5–8, angle between the midvein and secondary veins 35°–45°, reticulate veins abaxially slightly raised	secondary veins 7–9, angle between the midvein and secondary veins 65°–70°, reticulate veins abaxially slightly raised	secondary veins 7–9, angle between the midvein and secondary veins 45°–70°, reticulate veins abaxially slightly raised	secondary veins 3–5, angle between the midvein and secondary veins ca. 40°, reticulate veins both surfaces invisible
<b>Flower</b>				
	axillary or terminal, solitary or paired	axillary or terminal, solitary	axillary, solitary	Subterminal, solitary
Flower bud shape & size	Ovate to long-ovate, 10–11 × 7–8 mm	Globose, 1.4–1.5 cm in diam.	Ovate	Ovate, ca. 1.0 cm in diam.
Flower diam. (cm)	2–5	4–6	3.5–6	3.5–4.5
bracteoles	4–6, inside white puberulent	5–6, inside white puberulent	5–6, inside white puberulent	5–6, glabrous or outside farinose puberulent
Sepals	5–8, ovate to long-ovate, inside white puberulent,	6, semiorbicular to ovate, inside white puberulent,	5, semiorbicular to ovate, inside white puberulent	5, suborbicular, outside farinose puberulent
Petals	7–9, yellow or pale yellow	10–14, yellow	10–14, pale yellow, with red or purple streaks or spots	7–8, pale yellow
Petal size (cm)	1.3–2.5×1.0–1.5	1.3–3.5×1.2–2.0	1.5–2.8×1.3–2.0	1.0–2.0×1.0–1.5
<b>Androecium</b>				
Stamen No.	ca. 150	ca. 250	ca. 300	ca. 130
Stamen vestiture	glabrous	glabrous	glabrous	glabrous
Outer filaments	connate for basal quarter (3–5 mm long)	connate for basal quarter (8–10 mm long)	connate for basal quarter (2–3 mm long)	connate for basal quarter (ca. 1 mm long)
pollen shape	prolate	subspheroidal	subspheroidal <sup>#</sup>	subspheroidal <sup>#</sup>
pollen size (µm)	35–40 × 23–30	29.5–32 × 28–33	29.4–36.8×27–33.4 <sup>#</sup>	27.7–34.6×26.3–34.7 <sup>#</sup>
<b>Gynoecium</b>				
Ovary locule	3(–4)-loculed	2–5-loculed*	(2 or)3-loculed	3-loculed
Ovary vestiture	glabrous	glabrous	glabrous	glabrous
Style number	3–4	3–4	2–3	3
Style vestiture	glabrous	glabrous	glabrous	glabrous
<b>Capsule</b>				
Diameter (cm)	1.2–2.5	2.5–3.5*	2.5–3.5*	1.5–3*
Pericarp	0.7–1.3 mm thick <sup>&amp;</sup>	1.5–2.5 mm thick <sup>&amp;</sup>	0.5–1.5 mm thick <sup>&amp;</sup>	1.0–1.5 mm thick*

\* referenced from Ming and Bartholomew (2007); # referenced from Qin *et al.* (2023); & referenced from Ye and Xue (2013).

*flavida* var. *patens* (including *C. longgangensis* var. *patens*, *C. multipetala*, and *C. quinqueloculosa*) formed a separate, well-supported clade, distinct from *C. wumingensis*, in the phylogenies based on nuclear and chloroplast sequence datasets. *Camellia wumingensis* and *C. pingguoensis* var. *terminalis* (J.Y.Liang & Z.M.Su) T.L.Ming & W.J.Zhang were grouped in the same clade based on nuclear sequence data, but were separated based on the small single-copy region of the chloroplast genome. In morphology, *C. wumingensis* and *C. pingguoensis* var. *terminalis* are easily differentiated; the latter taxon has

smaller leaves, reticulate veins both surfaces invisible, all flowers are subterminal and solitary, and the sepal abaxial surface is farinose-puberulent, for example (**Table 1**).

In conclusion, *C. wumingensis* is distinct from *C. flavida* var. *patens* in morphological and pollen traits, and the two taxa are phylogenetically distinct based on nuclear and chloroplast sequence data (Wei *et al.*, 2022). The concept that *C. wumingensis* was a synonym of *C. flavida* var. *patens* is not supported. Thus, *C. wumingensis* was a neglected species that is formally described and illustrated below.



**Fig. 2.** Morphological comparison of *Camellia wumingensis* (A–G) and *C. flavida* var. *patens* (H–N). A, H: Leaves with angle between midvein and secondary veins indicated. B, C, I, J: Flower buds; D, K: Stamens; E, L: Petals. F, M: Capsule. G, N: Seeds. Scale bar = 1 cm.



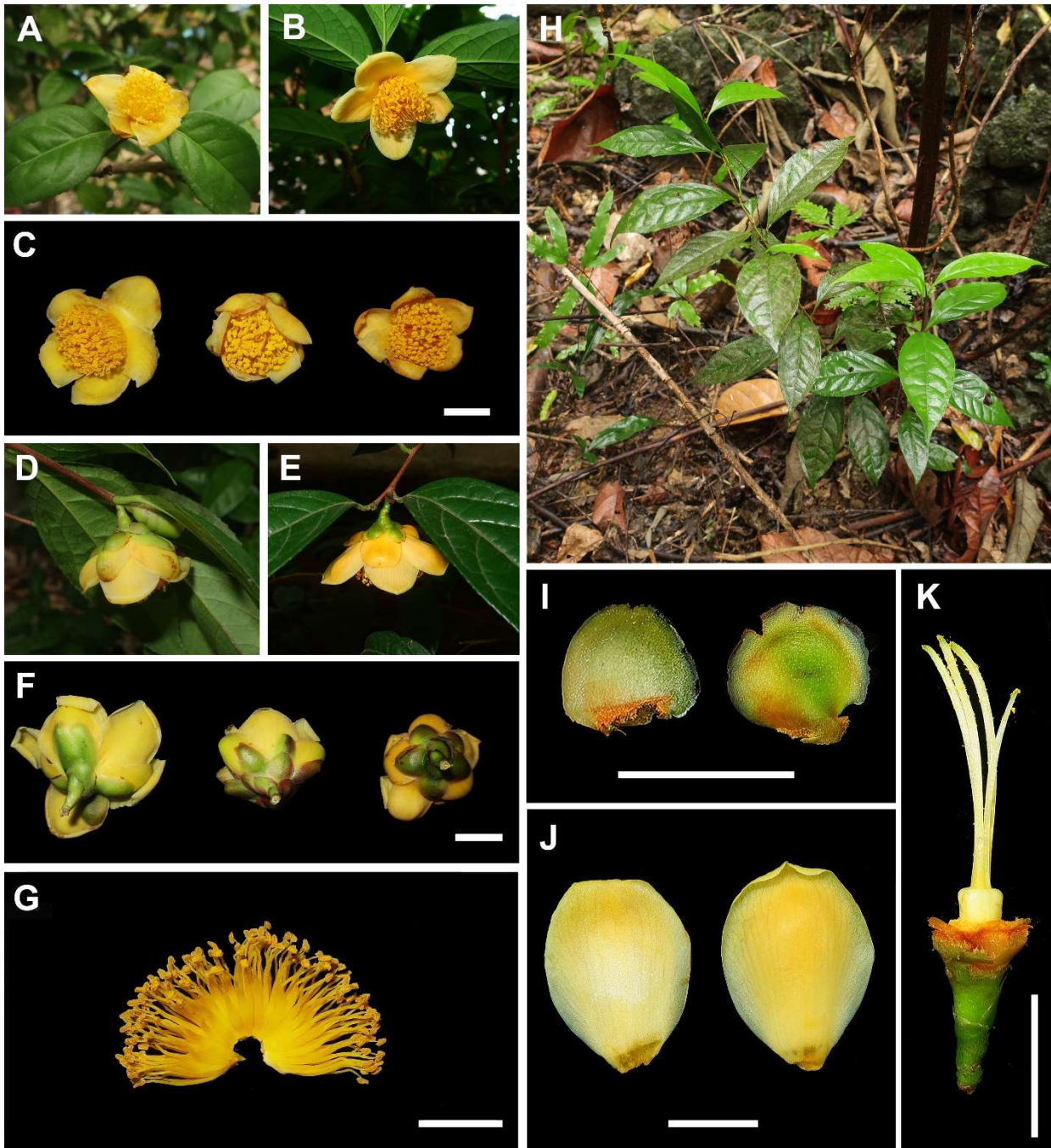


Fig. 3. *Camellia wumingensis* S.Ye Liang & C.R.Fu ex Hai L.Chen. **A, B, D, E**: Flowering branches. **C**: Face view of flower. **F**: Back view of flower. **G**: Androecium. **H**: Habit. **I**: Front and back view of sepals. **J**: Front and back view of petals. **K**: Gynoecium. Scale bar = 1 cm.

## TAXONOMIC TREATMENT

*Camellia wumingensis* S.Ye Liang & C.R.Fu ex Hai L.Chen, *sp. nov.*

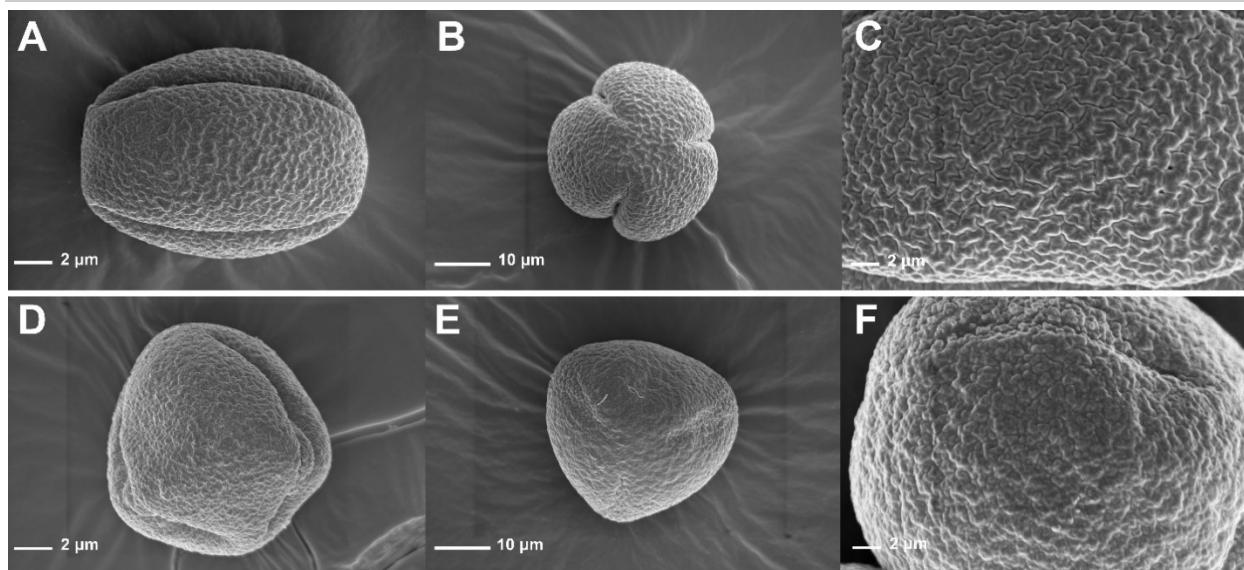
**Figs. 2A–G, 3, 4A–C**

— *Camellia wumingensis* S.Y. Liang & C.R.Fu in Guangxi Forest Sci. Tech. 1990(1): 9, f. 3 1990, *Camellia* 15, f. 7. 1993, nom. nud. T.L.Ming, Monogr. *Camellia*, 102, 2000, pro syn.

**Type:** CHINA. Guangxi, Nanning City, Wuming

District, Luoxu Town, 23°15' N, 107°52' E, 264 m, 20 February 2023, *Hailing Chen, Jinqun Huang & Junbin Liu JHC503* (holotype, IBK, IBK00451431; isotypes, IBK, IBK00451432–IBK00451434).

**Diagnosis:** *Camellia wumingensis* is morphologically similar to *C. flavida* var. *patens* in having petiole adaxially grooved, flowers axillary or terminal, ovary glabrous, capsule oblate, and seeds brown, but differs by its leaves thinly leathery, 7–11 × 2.5–5 cm (vs. leathery



**Fig. 4.** Pollen morphology of *Camellia wumingensis* (A–C) and *C. flavida* var. *patens* (D–F). **A, D:** Equatorial view. **B, E:** Polar view. **C, F:** Exine surface.

to thick leathery, 7.5–17 × 3–6.2 cm), secondary veins 5–8, the angle of the midvein and secondary veins relatively narrow, 35°–45° (vs. 7–9, 60°–75°), flower bud ovate to long-ovate, 10–11 × 7–8 mm (vs. globose, 1.4–1.5 cm in diam.), androecium ca. 150 stamens (vs. ca. 250), outer filaments basally connate only 3–5 mm long (vs. 8–10 mm long), and petals 7–9 (vs. 10–14).

**Description:** Shrub, 1–3 m tall, evergreen. **Branches** greyish brown to greyish yellow; young branches greyish yellow; current-year branchlets purplish red, glabrous; terminal buds glabrous, green. **Leaves** simple, alternate; petiole 5–10 mm long, 1–1.5 mm in diam., green, glabrous, adaxially grooved; leaf blade elliptic to long-elliptic, 7–11 × 2.5–5 cm, thinly leathery, adaxially green, abaxially pale green, brown glandular punctate, both surfaces glabrous, base broadly cuneate to subrounded, apex acuminate to shortly caudate, margin serrulate; midvein abaxially elevated and adaxially impressed, secondary veins 5–8 on each side of midvein, abaxially raised and adaxially slightly impressed, reticulate veins abaxially slightly raised and adaxially invisible. **Flower** buds ovate to long-ovate, 10–11 × 7–8 mm, glabrous; flowers axillary or terminal, solitary or paired, open flowers evenly circular, yellow or pale yellow, 2–5 cm in diam.; pedicel distinct, 5 mm long, 1.5–3 mm in diam.; **bracteoles** 4–6, semiorbicular, green, unequal, 0.4–0.6 × 0.1–0.25 mm, outside glabrous, inside white puberulent, margin ciliate. **Sepals** 5–8, ovate to long-ovate, green to yellowish green, 4–10 × 5–7 mm, outside glabrous, inside white puberulent, base truncate, apex rounded, margin ciliate. **Petals** 7–9, yellow or pale yellow, elliptic, broadly ovate to obovate, 1.3–2.5 × 1.0–1.5 cm, inner petals united with outermost filaments 3–5 mm at the base. **Androecium** ca. 150 stamens, in 2 circles, yellow; filaments 1.2–1.8 cm long, glabrous, outer

filament 0.7 mm in diam., whorl basally connate for 3–5 mm, inner filament 1 mm in diam., distinct; anthers yellow, 1.2–1.8 mm long; pollen prolate, 35–40 × 23–30 μm. **Gynoecium** 1.7–3.0 cm long; ovary superior, 3(–4)-loculed, subglobose or cylindrical, 1.9–2.1 mm long, 1.5–2.0 mm in diam., glabrous; styles 3–4, 1.5–1.8 cm long, 0.5 mm in diam., free or basally connate for 7–9 mm, glabrous; stigma yellow, indistinct. **Capsule** oblate, 1.2–2.5 cm in diam., 3(–4)-loculed with 1 or 2 seeds per locule; pericarp 0.7–1.3 mm thick. **Seeds** brown, globose or hemispherical, ca. 1 cm in diameter.

**Phenology:** Flowering from November to the following January. Fruiting from January to October, mature fruits were observed from September to October.

**Distribution, habitat, and conservation status:** *Camellia wumingensis* is only known from Wuming District, Guangxi, China. Four subpopulations have been located in evergreen broad-leaved forests on limestone hills. Although the four subpopulations are located within a protected area, they are threatened owing to the high commercial value of the species. Presently, less than 100 individuals in the wild are known with few adult trees. The area of occupancy (AOO) and extent of occurrence (EOO) are 16 km<sup>2</sup> and 29.669 km<sup>2</sup>, respectively (both calculated with GeoCAT; Bachman *et al.*, 2011). According to the currently available data and the IUCN Red List Categories and Criteria guidelines (IUCN, 2022), assessment of *C. wumingensis* as Critically Endangered (CR) based on the criteria C2a(i) is recommended (IUCN, 2022). Therefore, strategies to preserve the wild populations of this species is a focus of our ongoing research.

**Etymology:** The species epithet is derived from the name of the type locality Wuming District, Nanning City, Guangxi, China. Sheng Ye firstly provided the name



'*Camellia wumingensis* S. Y. Liang & C. R. Fu' on the herbarium label in the 1980s. At present, this name is still widely used in many fields, though it was invalidly published. Hence we propose to retain original epithet.

**Vernacular name:** 武鸣金花茶 (wǔ míng jīn huā chá) in Chinese.

**Additional specimens examined (paratypes):** CHINA. Guangxi: Nanning City, Wuming District, 6 October 1980, *T.Z. Ching, C.R. Fu 8001006* (GXFI), 11 November 1980, *Wei 8001195* (GXFI), 18 November 1981, *S.Ye Liang 8109323* (GXFI, SYS), 3 December 1981, *S.Ye Liang 8101203* (GXFI), 3 January 1982, *T.Z. Ching 8209361*; Wuming District, Ningwu Town, Liangxin Village, 16 October 2013, *Quanqing Ye, Yongbin Lu, Guoqing Peng, Q.Q. Ye 1302* (IBK), 26 December 2019, *Yanchi Lai, Hewen Zheng LYC&ZHW20191226* (IBK), *Hailing Chen, Shichang Dai JHC164* (IBK); Wuming District, Ningwu Town, Xinfu Village, 21 February 2023, *Hailing Chen, Jinquan Huang, Junbin Liu JHC502* (IBK).

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