New Data on Chinese Goniothalamus (Annonaceae) Plants: Postprint

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Abstract

Annonaceae is the most evolutionarily advanced and species-rich family in the basal angiosperm order Magnoliales. Current phylogenetic studies divide Annonaceae into four subfamilies: Anaxagoreoideae, Ambavioideae, Annonoideae, and Malmeoideae, comprising 107 genera and over 2,400 species, with approximately 21 genera and 110 species native to China. Annonaceae is pantropically distributed and represents a dominant group in tropical flora. Yingjiang County in Yunnan Province, China, is located on the westernmost border of Yunnan, adjacent to northeastern Myanmar and in proximity to eastern Assam, India. Its flora occupies a transitional zone between the tropical biota of Southeast Asia (Indo-Malaysian region) and the subtropical-temperate biota of East Asia, characterized as a typical northern margin of the tropics. This region is of great importance in phytogeography and biogeography, serving as a key and hotspot area for biodiversity conservation. The tropical rainforest in this region represents a marginal type of the tropical rainforests of Assam, India, and northern Myanmar that have spread eastward and northward, constituting the latitudinal and altitudinal distributional limits of Southeast Asian tropical rainforests. This paper reports two newly recorded Chinese species of the genus *Goniothalamus* (Annonaceae) collected from Yingjiang County, Yunnan Province, China, and introduced and preserved at Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, namely *Goniothalamus sesquipedalis* (Colebr. ex Wall.) Hook. f. & Thomson and *G. peduncularis* King & Prain. The *Flora of China* treats *Goniothalamus lii* X. L. Hou & Y. M. Shui as a synonym of *G. yunnanensis* W. T. Wang. Based on observations of living plants, herbarium specimens, and literature research, this paper clarifies the taxonomic status of *G. lii* and treats it as a synonym of *G. peduncularis*. *Goniothalamus sesquipedalis* was previously recorded from India, Bangladesh, and Myanmar, while *G. peduncularis* is only known from Myanmar. This paper provides supplementary descriptions and color plates for both species to facilitate identification. Voucher

specimens are deposited in the herbarium of Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences (HITBC). The discovery of these two new records of *Goniothalamus* enriches our understanding of Annonaceae diversity in China and provides additional evidence that the tropical flora of Yunnan, China, belongs to the tropical Asian (Indo-Malaysian) floristic region and its relationship with the floras of northern Myanmar and northeastern India.

Full Text

New Data on *Goniothalamus* (Annonaceae) from China

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Abstract

Annonaceae represents the most derived and species-rich family within the basal angiosperm order Magnoliales. Current phylogenetic studies recognize four subfamilies (Anaxagoreoideae, Ambavioideae, Annonoideae, and Malmeoideae), encompassing 107 genera and over 2,400 species, with approximately 21 genera and 110 species native to China. This pantropical family constitutes a dominant component of tropical floras. Yingjiang County in western Yunnan, China, borders northeastern Myanmar and lies near eastern Assam, India, positioning its flora at a critical transition zone between the Southeast Asian (Indo-Malaysian) tropical biota and the East Asian subtropical-temperate biota. This region exhibits typical characteristics of the tropical northern margin and represents a biodiversity hotspot of exceptional phytogeographic and biogeographic significance. The local tropical rainforest represents an eastern and northern distributional limit of the rainforests of Assam (India) and northern Myanmar, marking the latitudinal and altitudinal extremes for Southeast Asian tropical rainforests.

We report two new records for the Chinese flora, *Goniothalamus sesquipedalis*

(Colebr. ex Wall.) Hook. f. & Thomson and *G. peduncularis* King & Prain, collected from Yingjiang, Yunnan, and conserved at Xishuangbanna Tropical Botanical Garden. Additionally, we clarify the taxonomic status of *G. lii* X.L. Hou & Y.M. Shui, which was treated as a synonym of *G. yunnanensis* W.T. Wang in *Flora of China*. Based on observations of living plants, examination of type specimens, and literature review, we propose *G. lii* as a new synonym of *G. peduncularis*. *Goniothalamus sesquipedalis* was previously known from India, Bangladesh, and Myanmar, while *G. peduncularis* was reported only from Myanmar. We provide updated descriptions and illustrations based on herbarium specimens and living collections. Voucher specimens are deposited in the Herbarium of Xishuangbanna Tropical Botanical Garden (HITBC). These discoveries enrich our understanding of Annonaceae diversity in China and provide additional evidence for Yunnan's tropical flora as part of the tropical Asian (Indo-Malaysian) floristic region and its close relationship with the floras of northern Myanmar and northeastern India.

Keywords: *Goniothalamus*, Annonaceae, new record, Yingjiang County, taxonomy

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Introduction

Goniothalamus (Blume) Hook.f. & Thomson, comprising over 130 species of trees and shrubs, is one of the largest palaeotropical genera in the Annonaceae, distributed primarily from India and Sri Lanka to tropical Australia and the South Pacific Islands (Saunders & Chalermglin, 2008; Nakkuntod et al., 2009; Turner, 2014; Thomas et al., 2017). In China, 11 species are currently recognized (Li & Gilbert, 2011).

During monitoring of Annonaceae living collections at Xishuangbanna Tropical Botanical Garden (XTBG), Chinese Academy of Sciences from 2018 to 2021, we observed two *Goniothalamus* species with both flowering and fruiting material. These species were introduced to XTBG in 1997 and 2002. After detailed examination of morphological characters, relevant literature, and herbarium specimens, we identified them as *Goniothalamus sesquipedalis* (Colebr. ex Wall.) Hook. f. & Thomson and *G. peduncularis* King & Prain, respectively. *Goniothalamus sesquipedalis* was previously known from India, Bangladesh, and Myanmar (Turner, 2015, 2018), while *G. peduncularis* was reported only from Myanmar (Turner, 2015, 2018). Both species therefore represent new records for the Chinese flora, for which we provide updated descriptions and illustrations herein.

Taxonomic Treatment

***Goniothalamus sesquipedalis* (Colebr. ex Wall.) Hook. f. & Thomson Plate I; Plate III: A**

Guatteria sesquipedalis Colebr. ex Wall. in Wallich, Pl. Asiat. Rar. 3: 42, t. 266, 1832.
Type: Wallich, Pl. Asiat. Rar. 3: t. 266, 1832 (lectotype, designated by Turner, Nordic J. Bot. 33: 270, 2015).

Description: Shrubs to 2 m tall. Young branches glabrous. Leaf laminas oblong, 22–47 cm long, 5.7–10.5 cm wide, length/width ratio 3.4–7.2, apex acuminate to caudate, base cuneate, sometimes attenuate, coriaceous, glabrous abaxially and adaxially; midrib glabrous and strongly prominent abaxially, glabrous and impressed adaxially; secondary veins 16–22 pairs, interarching 5–10 mm from recurved margin, impressed adaxially, raised abaxially; tertiary veins reticulate, distinct; petioles 1.3–2 cm long, 2.5–5 mm in diameter, glabrous. Flowers greenish-yellow, solitary, axillary or extra-axillary, often on the main trunk (cauliflory) and on older branches (ramiflory); flowering pedicels 3–5 mm long; pedicel bracts 2–6, 2–4 × 1.5–3 mm. Sepals 3, 5–11 mm long, 5–7 mm wide, basally connate, apex acute to obtuse, ovate, puberulent abaxially, sparsely puberulent adaxially, greenish-yellow. Outer petals 3, 25–28 mm long, 6–8 mm wide, length/width ratio 3.1–4.6, lanceolate, puberulent abaxially and adaxially, greenish-yellow. Inner petals 3, shortly clawed and free in lower part, cohering and forming an ovate-caudate cone at apex, 15–18 mm long, 5–6.5 mm wide, length/width ratio 2.5–3, ovate-lanceolate, puberulous abaxially and adaxially, sometimes shortly lanate abaxially and adaxially in upper part, yellowish green, base obtuse to a 4.5–5 mm claw. Stamens 70–80 per flower, 2–2.2 mm long, 0.8–0.9 mm wide; connectives apiculate. Carpels ca. 12 per flower, ovary 2.5–3 mm long, light green, white pubescent; stigma and style 2–2.2 mm long, puberulous. Immature fruits green, mature fruits orange-red; fruiting pedicels 7–8.5 mm long, 2.5–3 mm in diameter. Monocarps one-seeded, fresh monocarps 21–24 mm long, 10–12 mm wide, length/width ratio 2–2.2, dry monocarps 16–18.8 mm long, 6.9–7.4 mm wide, length/width ratio 2.2–2.7, ovoid to ellipsoid-ovoid, base rounded, apex attenuate, sparsely puberulous, glossy, pericarp medium-thick, ca. 2 mm thick, stipes 2–3 mm long, ca. 3 mm in diameter. Seeds 13–14 mm long, 6.5–7 mm wide, ovoid, testa slightly with latitudinal stripes, dark brown to blackish brown, aril yellowish brown, endosperm ruminations lamellate.

Distribution: China (Yunnan) (new record); India (Sikkim, Assam, Nagaland, Manipur, Meghalaya) (Grierson, 1984; Karthikeyan et al., 2009); Bangladesh (Khanam & Rahman, 2002); Myanmar (Kress et al., 2003; Kang et al., 2017).

Additional specimens examined:
China. Yunnan: Yingjiang County, Xima Township, Nabangba, 24°44 N, 97°33 E, 400 m, 5 November 1974, Tao Guoda 013190 (specimen no. 001927 [barcode HITBC0040552!], specimen no. 001928 [barcode HITBC0040553!]); same location, April 1979, s. coll. (specimen no. 066463

[barcode HITBC0040554!]); Yingjiang County, Xima Township, 24°45 N, 97°42 E, 260 m, 3 December 1981, Tao Guoda 12774 (specimen no. 001929 [barcode HITBC0040551!]); Yingjiang County, Nabangba, Tongbiguan Natural Reserve, 10 October 2011, Zhou Shishun 11197 (HITBC 0040504); Yingjiang County, Labang, voucher from cultivated plant at Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, 21 July 2019, Yang Bin, XTBG0077 (HITBC); 15 February 2020, Yang Bin, XTBG0079 (HITBC); 9 May 2020, Yang Bin & Xiao Chunfen, XTBG0114 (HITBC); 24 May 2021, Yang Bin, XTBG0243 (HITBC).

Notes: Specimens of *Goniothalamus sesquipedalis* deposited in the Herbarium of Xishuangbanna Tropical Botanical Garden (HITBC specimen nos. 001927, 001928, 001929, 066463) were previously misidentified as *Goniothalamus multiovulatus* Ast, a species native to Vietnam (Turner, 2018). *Goniothalamus multiovulatus* can be differentiated from *G. sesquipedalis* by having 4.5–5.5 cm long, 2–2.5 cm wide, cylindrical monocarps with 2–4 hairy seeds per monocarp (Ast, 1938). Hou (2003) misidentified these specimens (HITBC specimen nos. 001927, 001928, 001929) as *Goniothalamus macrophyllus* (Bl.) Hook. f. & Thomson, which is distributed in Malaysia, Singapore, Indonesia, and Thailand (Saunders, 2002; Saunders & Chalermglin, 2008; Turner, 2018). *Goniothalamus macrophyllus* differs from *G. sesquipedalis* by having leaves with a distinctive and diagnostically important 'granular' appearance abaxially due to immersion of tertiary and lower-order veins (Saunders, 2002; Saunders & Chalermglin, 2008). *Goniothalamus sesquipedalis* differs from *G. macrophyllus* in several important respects: the leaves of *G. sesquipedalis* have secondary venation very prominent adaxially and forming an intramarginal vein, with tertiary venation prominent and reticulate, whereas *G. macrophyllus* has secondary venation ± plane to impressed adaxially and not forming an intramarginal vein, with tertiary venation inconspicuous (Saunders, 2002). *Goniothalamus sesquipedalis* can also be distinguished from *G. macrophyllus* by having 3–5 mm (vs. 5–11.5 mm) long flowering pedicels; lanceolate, greenish-yellow (vs. ovate, orange-pink) outer petals when mature; and ovate-lanceolate (vs. ovate), 15–18 mm (vs. 7–15 mm) long inner petals (Saunders, 2002; Saunders & Chalermglin, 2008).

***Goniothalamus peduncularis* King & Prain Plate II; Plate III: B**

Goniothalamus lii X.L. Hou & Y.M. Shui, Acta Bot. Yunnan., 25(3): 258, 2003. **Syn. nov.**

Type: Burma, Upper Burma, Kachin Hills, Sima Road, 1000 feet, 1897, Shaik Mokim s.n. (lectotype CAL [CAL000004500], designated by Turner, Gard. Bull. Singapore 70 (1): 523, 2018; isolectotype K [K000380823], Plate III: B).

Type of *G. lii*: China. Yunnan: Yingjiang County, Xima Township, Nabangba, 300 m, 7 November 1974, Tao Guoda 013254 (holotype KUN1263140, Plate III: C; isotype HITBC [specimen no. 001921, barcode 0040594!]).

Description: Shrubs to 4 m tall. Young branches glabrous. Leaf laminas oblong, elliptic-oblong to oblanceolate-oblong, 15–23 cm long, 4.4–7 cm wide, apex acuminate, base cuneate, thinly papery, glabrous abaxially and adaxially; midrib raised abaxially, impressed adaxially; secondary veins 10–16 pairs, interarching 3–7 mm from recurved margin, impressed adaxially, raised abaxially; tertiary veins reticulate, raised abaxially, inconspicuous adaxially; petioles 8–13 mm long, with shallow furrows adaxially, glabrous, black when dry. Inflorescence often solitary, sometimes 2-flowered, axillary, often on the main trunk (cauliflory) and rarely on older branches (ramiflory); peduncle degenerate, 1–2 mm long; flowering pedicels 9–15 mm long; pedicel bracts 2–4, 1–2 mm long, ca. 1 mm wide. Sepals 3, ovate, 5–7 mm long, 3–6 mm wide, basally connate, apex acute to obtuse, sparsely puberulent abaxially, conspicuously puberulent along margin, puberulent adaxially, yellowish-green. Outer petals 3, 25–37 mm long, 12–16 mm wide when fresh, 24–34 mm long, 9–12 mm wide when dry, ovate to ovate-lanceolate, puberulent abaxially and adaxially, often yellowish-green, grey-white when mature. Inner petals 3, shortly clawed and free in lower part, cohering and forming an ovate-attenuate to ovate-acuminate cone at apex, 13–15 mm long, 5–6 mm wide when fresh, 12–14 mm long, 4–5 mm wide when dry, ovate-lanceolate to oblong-lanceolate, puberulous abaxially and adaxially, densely so in upper part, greenish yellow, base obtuse to a 2–3 mm claw, apex attenuate to acuminate. Stamens ca. 100 per flower, 2.5 mm long; connectives slightly apiculate, sometimes hemispherical when dry, yellowish brown pubescent. Carpels 20–30 per flower, ovary ca. 2 mm long, greenish-yellow, white pubescent; stigma and style 2–3 mm long. Immature fruits green, mature fruits deep blackish blue; fruiting pedicels 1.2–1.5(–4.8) cm long. Monocarps 4–25, 1–2-seeded per monocarp, fresh monocarps 17–25 mm long, 8–9 mm wide, ellipsoid to ellipsoid-oblong, base rounded, apex rounded with a small tip, subglabrous to sparsely puberulent, pericarp ca. 1 mm thick when fresh, stipes 5–12 mm long. Seeds 10–13 mm long, 6.5–8 mm wide, ellipsoid, testa with white puberulous hairs outside, yellowish brown when immature, endosperm ruminations lamellate.

Distribution: China (Yunnan: Yingjiang, Cangyuan, Menghai) (new record); Myanmar (Kress et al., 2003; Turner, 2015, 2018).

Additional specimens examined:
China. Yunnan: Yingjiang County, Xima Township, Nabangba, 300 m, 10 December 1978, Tao Guoda 17895 (specimen no. 002077 [barcode HITBC0040544!]); Menghai County, Mengman Township, 995 m, 22°9 25.23 N, 100°5 34.29 E, 28 June 2021, Zhou Shishun 19431 (HITBC); 909 m, 22°10 50.79 N, 100°4 32.98 E, 29 June 2021, Zhou Shishun 19474 (HITBC); Cangyuan County, Banhong Township, Fabaomangkuhe, 700 m, 30 May 1974, Li Yanhui 11770 (specimen no. 001923 [barcode HITBC0040547!], specimen no. 001925 [barcode HITBC0040545!]); 780–800 m, 2 June 1974, Li Yanhui 11873 (specimen no. 001926 [barcode HITBC0040546!], Plate III: C1); Banlao Township, Shangbanlao, 900 m, 21 May 1975, Li Yanhui 20975 (specimen no. 001922 [barcode HITBC0040548!]); Yingjiang County, Longmen,

voucher from cultivated plant at Xishuangbanna Tropical Botanical Garden, 21 April 2021, Xiao Wenqiang, C400663 (HITBC0031632!); 6 May 2019, Sheng Caiyu, C400846 (HITBC0031129!); 26 May 2020, Yang Bin & Xiao Chunfen, XTBG0128 (HITBC).

Notes: *Goniothalamus lii* X.L. Hou & Y.M. Shui was characterized by oblong or oblong-lanceolate leaf blades with (10–)13–21 pairs of lateral veins, pedicels 9–13 mm long, sepals ca. 5 × 4 mm, outer petals 2.5 × 1.3 cm, and stamens with hemispherical connectives sometimes bearing dense brownish puberulence (Hou & Shui, 2003). All these characters are consistent with *G. peduncularis*. Moreover, examination of relevant type materials of *G. lii* and observations on living plants of *G. peduncularis* introduced from Yingjiang County reveal that both species share linear styles and ellipsoid monocarps. Therefore, we consider *G. lii* conspecific with *G. peduncularis* and propose it as a synonym of the latter.

In *Flora of China*, Li & Gilbert (2011) synonymized *G. lii* with *G. yunnanensis* W.T. Wang (Plate III: D) (Wu & Wang, 1957) without further explanation. We disagree with this treatment. As Hou & Shui (2003) noted in the protologue of *G. lii*, it is morphologically similar to *G. yunnanensis* but clearly differs in having 10–21 (vs. 7–9) pairs of lateral veins and pedicels 9–13 mm (vs. ca. 4 mm) long. Furthermore, based on our observations of living plants, the distinction between these species is obvious in many additional characters. *Goniothalamus lii* (here treated as *G. peduncularis*) has grey-white outer petals when mature (Plate II: d3), linear styles (Plate II: d7), monocarp stipes 5–12 mm long (Plate II: E, F, G), and monocarps deep blackish blue when mature (Plate II: F). In contrast, *G. yunnanensis* has reddish-brown outer petals when mature, stick-shaped styles (Jiang & Li, 1979), very short monocarp stipes (<2 mm), and monocarps orange-red to dark red when mature.

Plates

Plate I. *Goniothalamus sesquipedalis* (Colebr. ex Wall.) Hook. f. & Thomson
A. Plant; B. Flowering branch (front view); C. Flowering branch (back view); D. Flower; E. Dissection of a flower (e1. Sepals; e2. Outer petals; e3. Inner petals; e4. Stamens and carpels; e5. Stamen; e6. Carpel); F. Immature fruits; G. Mature fruit; H. Longitudinal section of monocarps; I. Seeds. Photographed by Yang Bin at XTBG.

Plate II. *Goniothalamus peduncularis* King & Prain
A–B. Flowering branches; C. Flowers; D. Dissection of a flower (d1. Pedicel; d2. Sepals; d3. Outer petals; d4. Inner petals; d5. Stamens and carpels after petal removal; d6. Stamen; d7. Carpel); E. Immature fruits; F. Mature fruit; G. Monocarps; H. Seeds. Photos A–E, G–H by Yang Bin at XTBG; F by Wang Liyan at Yingjiang.

Plate III. Type specimens and voucher specimens of four *Goniothalamus*

species
A. Isotype of *Goniothalamus sesquipedalis* (Colebr. ex Wall.) Hook. f. & Thomson; B. Isotype of *G. pedunculari*s King & Prain; C. Holotype of *G. lii* X.L. Hou & Y.M. Shui [C1. Flower voucher specimen (HITBC0040546)]; D. Isotype of *G. yunnanensis* W.T. Wang.

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Note: Figure translations are in progress. See original paper for figures.