



Nomenclatural novelties in *Wikstroemia* (Thymelaeaceae) of Zhejiang, China

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ABSTRACT: *Wikstroemia zhejiangensis* (Thymelaeaceae: Thymelaeoideae), a new endemic species from Zhejiang, China, is described and illustrated. *Wikstroemia gaomushanensis* is a new combination based on *Daphne gaomushanensis*. Owing to the four stamens alternating with the calyx lobes, and cup-like disk scales, these two species do not fit into an existing section. Therefore, a new section of *Wikstroemia*, sect. *Zhejiangenses*, is identified. Notes on the distribution, ecology, conservation status, and pollen micromorphology of *Wikstroemia zhejiangensis* and *W. gaomushanensis* are provided.

KEY WORDS: China, *Daphne*, new combination, new section, new species, taxonomy, *Wikstroemia zhejiangensis*, Zhejiang.

INTRODUCTION

The family Thymelaeaceae contains more than 500 species and is mainly distributed in both temperate and tropical regions (Bank *et al.*, 2002). Molecular studies have provided insights into the placement of the family in the Malvales s.l. (Alverson *et al.*, 1998; Fay *et al.*, 1998; Bayer *et al.*, 1999; Soltis *et al.*, 2000). Based on morphology, Thymelaeaceae has been divided into four subfamilies, i.e. Thymelaeoideae, Aquilarioideae, Gonystyloideae and Gilgiodaphnoideae (Heywood, 1993), which Takhtajan (1997) recognized them as four separate families including Thymelaeaceae, Aquilariaceae, Gonystylaceae and Phaleriaceae.

The subfamily Thymelaeoideae contains more than 20 genera and most of the species occur in tropical regions (Bank *et al.*, 2002). *Daphne* L., containing ca. 70 species, is mostly distributed in temperate region, whereas the related genus *Wikstroemia* Endl. occurs from Australasia to S China (Bank *et al.*, 2002; Wang *et al.*, 2009). *Wikstroemia* differs from *Daphne* by having a hypogynal disk that is distinct scales (*vs.* annular and oblique or cup-shaped), inflorescences racemose, paniculate, or spicate, less often capitate (*vs.* capitate or fascicled, rarely spicate or racemose), leaves opposite or alternate (*vs.* usually alternate, rarely opposite) (Wang *et al.*, 2009). The structure of hypogynal disk was widely used in the taxonomy of *Wikstroemia* and *Daphne* (Tsai, 1956; Huang, 1985; Huang and Chang, 1999; Wang *et al.*, 2009), but overlapping still exists between them (Zhang *et al.*, 2016). Numerical taxonomy of the genera *Daphne* and *Wikstroemia*, as well as the characters of leaf epidermis, showed the existence of overlapping of hypogynal disk and

fruit (Zhang *et al.*, 2015; Zhang *et al.*, 2016).

In China, taxonomic studies on Thymelaeaceae were mainly focused on the description of new species (Chien and Cheng, 1931; Tsai, 1956; Chang, 1985, 1986; Huang, 1985; Zhang and Shao, 1990; Liu and Lian, 1996; Qi and Wang, 2004; Chen *et al.*, 2018). One hundred and fifteen species in nine genera have been recorded in China, with the center of diversity located in S and SW China (Wang *et al.*, 2009). During preparation of a new edition of the *Flora of Zhejiang*, we conducted field work in Zhejiang Province in eastern China, during which, a new species of *Wikstroemia* was discovered and is herein described. Based on stamen number and the shape of the disk scales, we propose a new section for this species and for *Wikstroemia gaomushanensis* (Zi L. Chen, P. Wang & Y.F. Lu) Y.F. Lu & X.F. Jin, which we transfer from *Daphne*.

MATERIAL AND METHODS

Since 2014, we collected over 200 specimens of *Wikstroemia* and *Daphne* from Zhejiang Province for the preparation of the treatment of the family for a new edition of the *Flora of Zhejiang*. We also examined the specimens in HHBG, HTC, HZU, NAS, PE, ZJFC and ZM, and all specimens of *Wikstroemia* and *Daphne* were checked and compared. By comparing the morphological characters, we confirmed that almost all species of *Wikstroemia* from China have eight stamens; those of *W. zhejiangensis*, described here, and *W. gaomushanensis* have four stamens, without evidence of degeneration from a higher number, making these two species easily distinguishable from others.

Pollen grains were directly gathered from specimens



Fig. 1. Morphology of *Wikstroemia zhejiangensis* (A–D) and *W. gaomushanensis* (E–H). A, E. flowering shoot (scales bar 1 cm); B, F. inflorescence (scales bar 5 mm); C, G. opened calyx (showing four stamens and pistil) (scales bar 5 mm); D, H. fruit (scales bar 5 mm).

and mounted on stubs using double-sided adhesive tape, and directly coated with a layer of gold. The coated pollen grains and seeds were observed and photographed under a scanning electron microscope (Hitachi SU8010, Tokyo, Japan). Twenty pollen grains of each species were measured using a light microscopy. Pollen terminology mainly follows Beyers and Marais (1998) and Herber (2002).

TAXONOMIC TREATMENT

Wikstroemia sect. *Zhejiangenses* Y.F. Lu, Z.H. Chen & X.F. Jin, *sect. nov.*

Type species: Wikstroemia zhejiangensis Y.F. Lu, Z.H. Chen & X.F. Jin

Stamens 4, alternate the calyx lobes and inserted on the lower part of the tube; disk scales cup-like.

Two species, both in Zhejiang Province, eastern China.

Key to two species in the section

- 1a. Inflorescence (5–)9–26-flowered; leaf blade adaxially glabrous, abaxially sparsely pilose; ovaries glabrous, styles inconspicuous; disk scales entire, rarely praemorse at apex, undivided *W. zhejiangensis*
- 1b. Inflorescence 3–6-flowered; leaf blade adaxially sparse pilose, abaxially densely pilose; ovaries pilose at apex, styles conspicuous; disk scale deeply cleft on one side *W. gaomushanensis*

Wikstroemia zhejiangensis Y.F. Lu, Z.H. Chen & X.F. Jin, *sp. nov.*

浙江菟花 Figs. 1A–D, 2A–F & 3A, B

Type: CHINA. Zhejiang Province: Jingning Shezu Autonomous County, Dayanghu, in thickets under forest, alt. 850 m, 8 April 2021, X.F. Jin & Y.F. Lu 4630 (holotype ZM; isotypes HTC, ZM).

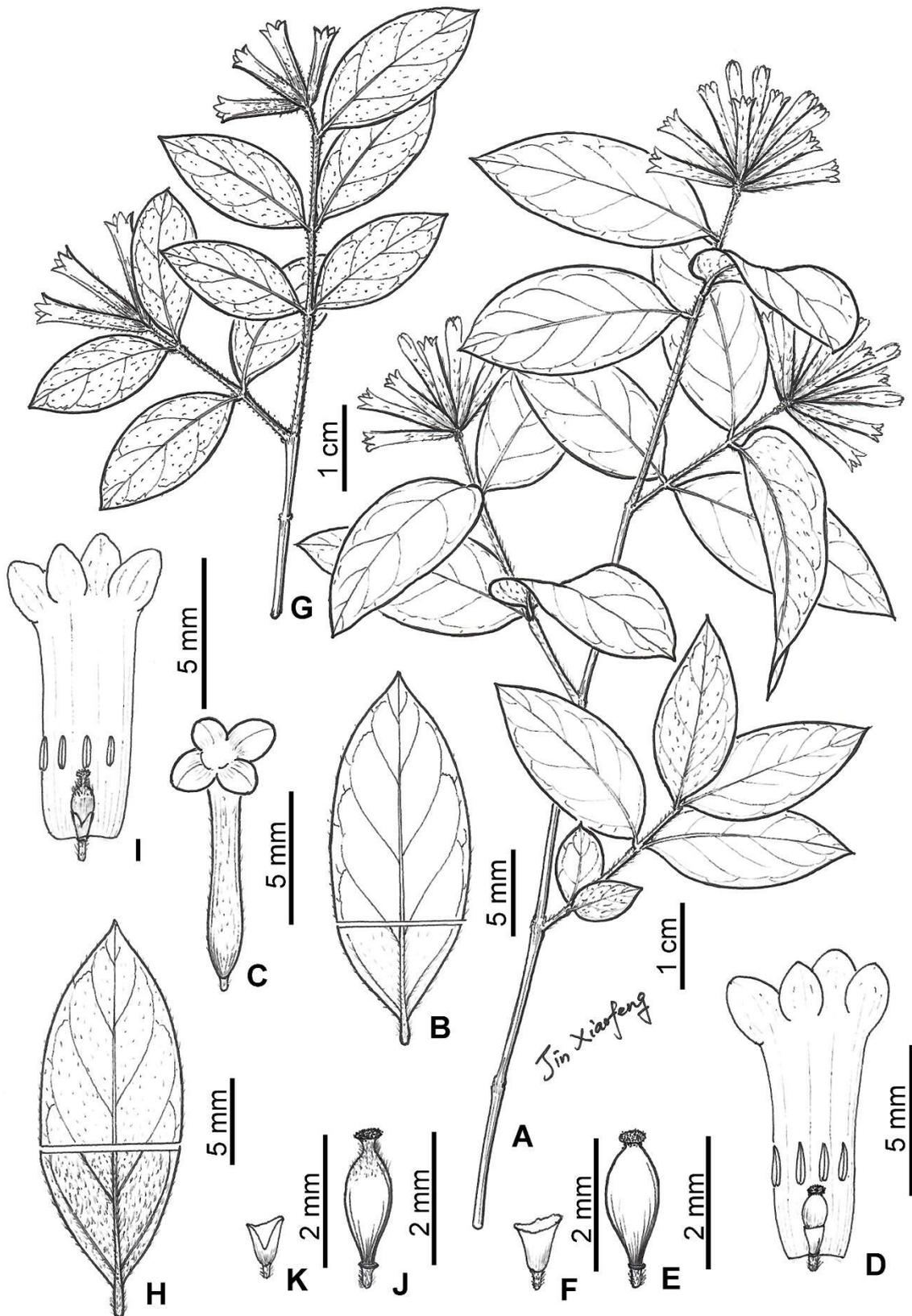


Fig. 2. *Wikstroemia zhejiangensis* (A–F) and *W. gaomushanensis* (G–K). A. flowering shoot; B. leaf (showing indumentum); C. flower; D. opened calyx; E. ovary and stigma; F. disk scale; G. flowering shoot; H. leaf (showing indumentum); I. opened calyx; J. ovary and stigma; K. disk scale. A–F from X.F. Jin & Y.F. Lu 4630 (ZM) and G–K from Z.L. Chen & P. Wang 2017050601 (HTC). Drawn by Xiaofeng Jin.



Diagnosis: Species nova *Wikstroemia gaomushanensis* (Zi L. Chen, P. Wang & Y.F. Lu) Y.F. Lu & X. F. Jin affinis est, sed a qua racemis subcapitatis (5–)6–26-floris, ovariis glabris, stylis inconspicuis, discis integris raro apice praemorsis non divisis, laminis supra glabris subtus sparse pilosis differt.

Description: Shrubs, deciduous, 0.2–0.8 m tall, branched or unbranched. Stems purplish brown, glabrous, slightly longitudinal ribbed; young shoots slender, yellow or yellowish green, densely white sericeous-pilose. Leaves opposite, sometimes alternate; petiole 1–2 mm long, sericeous-pilose; blade chartaceous or thick chartaceous, ovate, ovate-elliptic, elliptic-lanceolate or oblong-lanceolate, (1–)2–4(–6) cm long, (0.5–)0.7–1.7(–2.2) cm wide, base broadly cuneate or cuneate, apex acute, rarely obtuse, entire, adaxially green, glabrous, abaxially pale green and purple, sparsely sericeous-pilose; lateral veins 4–6 pairs. Inflorescences terminal or on short lateral branches, densely short-racemose, (5–)6–26-flowered; peduncles 0.7–1.3 cm long, white sericeous-pilose; pedicels very short, less than 1 mm long. Calyx pale purplish red or pinkish purple, tubular, 9–12 mm long, outside white sericeous-pilose, 4-lobed; lobes broadly ovate, 2–2.5 mm long, 1.5–2 mm wide, apex obtuse. Stamens 4, inserted at lower part of tube; filaments very short, ca. 0.5 mm long; anthers triangular-oblong, yellow, ca. 1.2 mm long. Ovary obovoid, ca. 2 mm long, glabrous, base short-stipitate; style very short, inconspicuous; stigma capitate. Disk scales cup-like, ca. 1 mm long, entire, rarely praemorse at apex. Drupe ovoid, 4–5 mm long, pale yellow-brown, enclosed in persistent calyx. Fl. Apr.–May, fr. May–Jun.

Distribution: Endemic to Zhejiang Province, East China; currently known only from central to southern Zhejiang in Jingning, Pingyang, Rui'an, Xianju and Yueqing counties (Fig. 4).

Habitat: By streams, roadsides, in thickets or at forest margins at 335–850 m a.s.l.

Conservation status: Data Deficient (IUCN 2012). Recent data on the population size and individual numbers, or impact from deforestation, are unavailable.

Palynology: Micromorphology of the pollen grains of *Wikstroemia zhejiangensis* is shown in Fig. 3 (A–B). All were stenopalynous and spherical, with sexine not tectate, suptratectal sub-units and germinal apertures present. The size of the pollen grains of the new species was $19.62 \pm 1.53 \mu\text{m}$ in diam.

Notes: The new species has the leaves opposite, sometimes alternate, which are easily observed. Leaf arrangement is important for taxonomy, but it is various in some species of *Wikstroemia*. In Zhejiang, *Wikstroemia pilosa*, *W. alba* and *W. monnula* have both opposite and alternate leaves.

Additional specimens examined: CHINA. Zhejiang Province: Jingning Shezu Autonomous County, Yanxi, Jiaoxikou, by stream at forest margin, alt. 335 m, 22 March 2020, Z. H. Chen et al. JN20032203 (HTC, ZM); Pingyang County, Aojiang, Mount Jiandao,

in thickets, alt. 600 m, 13 April 2020, Z. H. Chen, L. Chen et al. Lin PY20041301, PY20041302 (ZM), Shunxi, Zhiyingdong, 18 April 2020, F. Lin 2020001 (HTC); Rui'an County, Hongshuang Forestry Farm, Mount Huayan, at forest margin, alt. 350 m, 14 April 2020, Z. H. Chen et al. Lin RA20041401, RA20041402 (ZM); Xianju County, Danzhu, from Shangjing to Huangtan, roadside, 2 May 2019, Z. H. Chen et al. XJ19050209 (ZM); Yueqing County, Longxi, Longxi Village, on cliff, alt. 556 m, 18 April 2021, Z. H. Chen et al. YQ20141802 (HTC).

Wikstroemia gaomushanensis (Zi L. Chen, P. Wang & Y.F. Lu) Y.F. Lu & X.F. Jin, *comb. nov.*

高姥山堇花 Figs. 1E–H, 2G–K & 3C, D

Basionym: *Daphne gaomushanensis* Zi L. Chen, P. Wang & Y.F. Lu, J. Hangzhou Norm. Univ. (Nat. Sci. Ed.) 17(1): 5. 2018.

Type: China, Zhejiang Province, Pan'an County, Gao'er, Mount Gaomu, 6 May 2017, Z.L. Chen & P. Wang 2017050601 (holotype: HTC, isotypes: HTC, ZM).

Description: Shrubs, deciduous, 0.4–1 m tall, branched or unbranched. Stems pale purple-brown, glabrous, slightly longitudinal ribbed; young shoots slender, yellow, densely white sericeous-pilose. Leaves alternate or opposite; petioles 1–2.5 mm long, sericeous-pilose; blade chartaceous, oblong-lanceolate, elliptic, ovate or broadly ovate, 0.5–4 cm long, 0.3–1.8 cm wide, base cuneate or rounded, apex acute or acuminate, entire, adaxially green, densely sericeous-pilose when young, soon sparsely sericeous-pilose, abaxially densely sericeous-pilose; lateral veins 4 or 5 pairs;. Inflorescences terminal or on short lateral branches, densely short-racemose, 3–6-flowered; peduncles 3–7 mm long, white sericeous-pilose; pedicels very short, less than 1 mm long. Calyx pale purplish red, tubular, 7–12 mm long, outside white sericeous-pilose, 4-lobed; lobes ovate or long-ovate, 4–5 mm long, 1.8–2.5 mm wide, apex obtuse. Stamens 4, inserted at lower part of tube; filaments very short, ca. 0.5 mm long; anthers oblong-ellipsoid, yellow, ca. 1 mm long. Ovary obovoid, ca. 2 mm long, apex white pilose; style short, ca. 0.7 mm long; stigma capitate. Disk scales cup-like, ca. 0.8 mm long, divided on one lateral side. Drupe ovoid or broadly ovoid, 4–5 mm long, pale yellow-brown, enclosed in persistent calyx. Fl. Apr.–May, fr. Jun.

Distribution: Endemic to Zhejiang Province, East China; currently known only from the type locality (Mount Gaomu) and the adjacent area, Anwen Town (Fig. 4).

Habitat: Roadsides, on slopes and in thickets at 300–1000 m a.s.l.

Conservation status: Data Deficient (IUCN 2012). Recent data on the population size and individual numbers, or impact from deforestation, are unavailable.

Palynology: Micromorphology of the pollen grains of *Wikstroemia gaomushanensis* is shown in Fig. 3 (C–D). The shape and sexine of this species are similar to those of *W. zhejiangensis* but slightly smaller ($18.09 \pm 1.02 \mu\text{m}$ in diam.).

The pollen grains of four additional species with one purple-flowered form of *Wikstroemia* and two species of *Daphne* showed continuous variation in size and sexine. The sexine of those species was stenopalynous, with sexine tectate (Fig. 3: E–L), suptratectal sub-units present (with the exception of G and K), and germinal apertures absent.

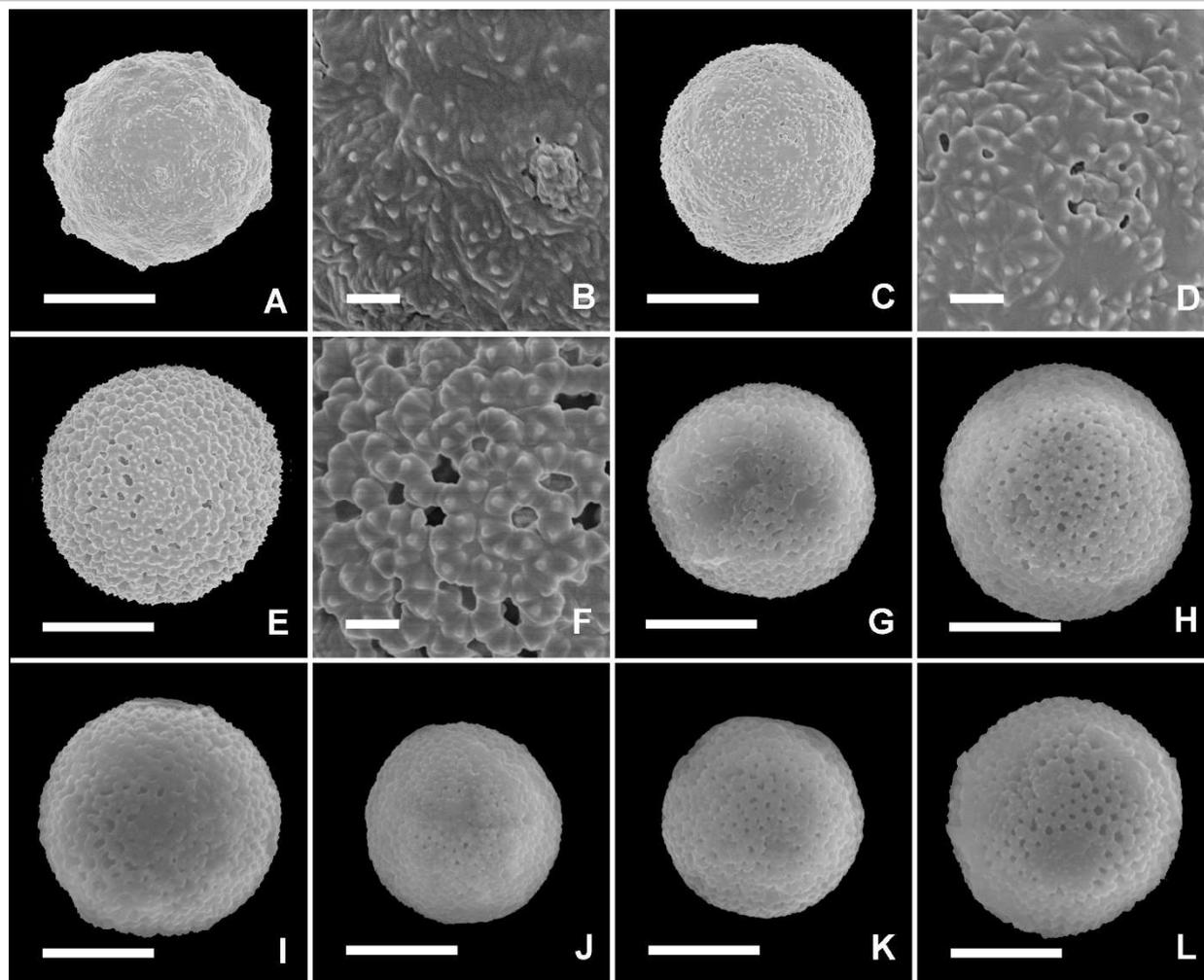


Fig. 3. Pollen micromorphology of *Wikstroemia zhejiangensis* (A, B), *W. gaomushanensis* (C, D) and five taxa of *Wikstroemia* and two species of *Daphne* from Zhejiang. A, C, E, G–L. pollen grains (scale bar 10 µm); B, D, F. sexine sculpture (scale bar 1 µm). A, B. from Z. H. Chen et al. JN20032203 (HTC); C, D. from Z.L. Chen & P. Wang 2017050601 (HTC); E, F. *W. indica* from anonymous 821 (HHBG); G. *W. monnula* from HBG Exped. 5698 (HHBG); H. *W. glabra* from anonymous 226 (HHBG); I. *W. glabra* f. *purpurea* from Y. Y. Ho 226 (HHBG); J. *W. pilosa* from L. Hong 45 (HHBG); K. *D. genkwa* from Y. Y. Ho 1213 (HHBG); L. *D. kiusiana* var. *atrocaulis* from S. Y. Chang 1859 (HHBG).

Notes: The micromorphology of the pollen grains doesn't show significantly different between *Wikstroemia gaomushanensis* and *W. zhejiangensis*.

Additional specimens examined: CHINA. Zhejiang Province: Pan'an County, Gao'er, Mount Gaomu, roadside on slope, alt. 1000 m, 2 June 2017, Z. L. Chen et P. Wang 2017060201, 2017060202 (HTC), 25 June 2018, X. F. Jin 4227 (HTC), Anwen, in thickets, alt. 300 m, 29 April 2013, X. F. Jin et W. W. Yang s. n. (HTC), 16 April 2017, Z. H. Chen s. n. (HTC).

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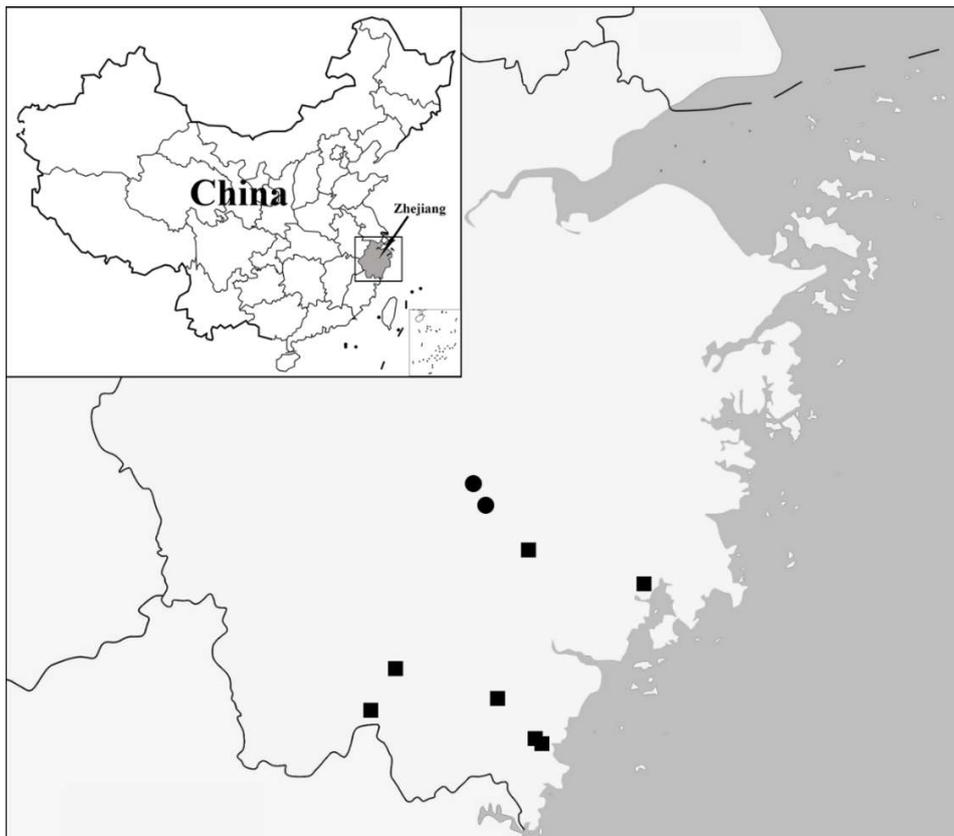


Fig. 4. Known distribution of *Wikstroemia zhejiangensis* (■) and *W. gaomushanensis* (●) in China. The spatial data for the map was downloaded and modified from the China map by the Ministry of Natural Resources of the People's Republic of China (Map source: <http://bzdt.ch.mnr.gov.cn>)