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Research

Taxonomic notes on *Ilex* sect. *Ilex* (Aquifoliaceae) from China I: revision of four species

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A taxonomic revision of four species of *Ilex* from China is presented. *Ilex dabieshanensis* is accepted as the nothospecies *I.* × *dabieshanensis*. Six new synonyms are proposed: *I. huoshanensis* is reduced to a synonym of *I.* × *dabieshanensis* from *I. centrochinensis*, *I. urceolatus* to *I. hylonoma* var. *glabra*, *I. kunmingensis* var. *capitata* and *I. macrostigma* to *I. kunmingensis* var. *kunmingensis*, and *I. dasyclada* and *I. tetramera* var. *glabra* to *I. tetramera* var. *tetramera*. A nomenclatural account, description, phenology, distribution and habitat, taxonomic notes and specimens cited is provided for each species.

Keywords: China, field investigation, hybridization, *Ilex*, morphology, taxonomic revision

Introduction

Ilex L. is the sole genus of Aquifoliaceae (Powell et al. 2000, Chen et al. 2008, Loizeau et al. 2016). It is the largest genus of dioecious woody plants and contains more than 500 species throughout the tropical and subtropical to temperate regions of the world (Cuénoud et al. 2000). China is one of the diversity centers of *Ilex* and accommodates about 200 species distributed in the regions south of the Qinling Mountains and the Huai River. According to 'Flora of China' (FOC; Chen et al. 2008), three subgenera are recognized within *Ilex* based on their phenology (evergreen or deciduous), type of inflorescence and number of pyrenes, viz. *I.* subgen. *Byronia* (Endl.) Loes., *I.* subgen. *Prinos* (L.) A. Gray and *I.* subgen. *Ilex*. Being the largest subgenus, *I.* subgen. *Ilex* is further divided into five sections: *I.* sect. *Lauroilex* S. Y. Hu, *I.* sect. *Lioprinus* (Loes.) S. Y. Hu, *I.* sect. *Paltoria* (Ruiz and Pavon) Maxim., *I.* sect. *Ilex* and *I.* sect. *Pseudoaquifolium* S. Y. Hu. Although most of the subgenera and sections have been suggested to be polyphyletic in recent molecular phylogenetic studies (Cuénoud et al. 2000, Manen et al. 2002, 2010), *I.* sect. *Ilex* may be monophyletic. Morphologically, *I.* sect. *Ilex* is well defined by its fasciculate inflorescences and stony or woody endocarps with striations, grooves, and/or pits (Hu 1949a, Chen and Feng 1999).

The number of known *Ilex* species in China has increased rapidly during the past 40 years (as elaborated in Hong 2015a), as well as that of *I.* sect. *Ilex*. In Hu's (1949b, 1950, 1951) serial publications on *Ilex* from China, 50 species of *I.* sect.

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Ilex were recognised, while in FOC (Chen et al. 2008), the number soared to 89. Most of the new species were published during the 1980s by Li (18 species; 1981, 1985) and Tseng (15 species; 1981, 1984). Furthermore, four new species regarded as members of *I.* sect. *Ilex*, viz *I. urceolatus* C. B. Shang, K. S. Tang & D. Q. Du (Shang et al. 2010), *I. chuguangii* M. M. Lin (Lin et al. 2013), *I. jingxiensis* Y. F. Huang & M. X. Lai (Huang et al. 2014), and *I. sanqingshanensis* W. B. Liao, Q. Fan & S. Shi (Shi et al. 2015), have been reported from China since the publication of FOC in 2008. However, some of the species are closely similar in morphology, sharing similar habitats and contiguous or overlapping distribution ranges (Hong 2015a). Given these reasons, several taxonomic studies (Hong 2015a, b) of *Ilex* in China have been carried out. In Hong's (2015a, b) study on *Ilex* for the 'Flora of Pan-Himalaya' Project, 14 species and 12 varieties were reduced to synonyms and one species was treated as a subspecies. Among these revised taxa, nine species and five varieties belong to *I.* sect. *Ilex*. Despite the advances achieved in the taxonomy of Chinese *Ilex*, *I.* sect. *Ilex* remains taxonomically problematic (particularly for species from the non-Pan-Himalayan area) due to the following reasons: 1) some species endemic to China are still only known from the type specimens, resulting in incomplete descriptions or doubtful synonyms; 2) the erection of some species or varieties has been based on a few quantitative characters (especially the density of indumentum), which are too variable for species delimitation; 3) previous taxonomic studies have been based mainly on examination of herbarium specimens and the lack of field investigations have often caused misjudgements of the character variation and a neglect of hybridization among species. To resolve these issues in *I.* sect. *Ilex*, more specimen examination, field investigation and collection, as well as evidence from morphological and molecular phylogenetic studies, should be combined.

We have been working on the taxonomy of *Ilex* in China since 2014, and *I.* sect. *Ilex* is our major focus. Here, we clarify the identities of four species of *I.* sect. *Ilex* from China based on substantial specimen examination, field investigation and literature collation.

Material and methods

Specimens of *Ilex* from 24 herbaria, including A, AU, CSFI, CSH, E, GXMG, HHBG, HIB, HITBC, IBK, IBSC, JIU, K, KUN, LBG, MO, NAS, NY, P, PE, SM, SZ, SYS and WUK and our own collections were examined. Meanwhile, the relevant literature, especially the protologues of all published names, was reviewed and collated.

According to Hu (1949a), the diagnostic characters of Chinese *Ilex* taxa, are mainly habit, branchlets, leaves, inflorescences, flowers and pyrenes. All these characters were used for species circumscription in the present study, as did Chen et al. (2008) in FOC and Hong (2015b) in Flora of Pan-Himalaya. The taxonomic treatment included accepted names, synonyms, types, morphological descriptions, distribution, habitat, phenology, taxonomic notes and specimens examined. The distribution range of the species was compiled from the distribution records of relevant specimens and images of living plants in the database of the Chinese Field Herbarium (CFH; <http://www.cfh.ac.cn>). Type specimens, photographs of plants taken in the wild (Fig. 1–4), and distribution maps (Fig. 5) are shown for each species.

Taxonomic treatment

1. *Ilex* × *dabieshanensis* K. Yao & M. P. Deng (1987, p. 324, pl. 1) (Fig. 1A–B, D–F)

Type: China. Anhui: Huoshan County, Dahuaping, 200 m a.s.l., 14 Oct 1982, M. P. Deng & H. T. Wei 81415 (holotype: NAS-00071082!; isotype: unseen).

Taxonomic synonym: *Ilex huoshanensis* Y. H. He (2002, p. 380, pl. 381; Fig. 1D–E).

Type: China. Anhui: Huoshan County, Manshui River, 580 m a.s.l., 14 May 1998, B. M. Li 98002 (holotype: PE-00057118!, isotype: KUN-1253504!).

Description

Evergreen tree, 5–10 m tall. Young branchlets longitudinally ridged. Terminal buds ovoid–conical to ovoid–globular, 3–5 mm long, acuminate at apex. Petiole 5–10 mm, adaxially slightly sulcate or flat. Leaf blade abaxially yellowish green, adaxially dark green, shiny, usually ovate, ovate–oblong, obovate–oblong or elliptic, 5–12 × 2–5 cm, leathery, with both surfaces glabrous, subrounded or cuneate at base, with slightly revolute margin and 4–10 (−16) pairs of unequal-sized teeth terminating with 1–2 mm long spines; midvein prominent abaxially, flat or slightly impressed adaxially; lateral veins 5–10 pairs, anastomosing near margin, reticulate veins obscure on both surfaces; male inflorescences: 1-flowered cymes, pseudopaniculate, 1.5–3.5 cm long, with rachises 3–8 mm; pedicels 8–10 mm, glabrous or sparsely pubescent; flowers 4-merous, yellowish green; calyx subpatelliform, with suborbicular, ca 1 mm long, ciliate lobes; petals obovate, 2–4 (6) × 1.5–3.0 mm, basally slightly connate; stamens 2–3; anthers oblong; rudimentary ovary ovoid. Female inflorescences: 1-flowered cymes, pseudoracemose, 1–3 cm long, with rachises 3–5 mm, glabrous or sparsely pubescent; pedicels 8–20 mm; calyx lobes suborbicular, ca 1 mm long, ciliate; petals elliptic, 3–5 × 1.5–2.0 mm; rudimentary stamens shorter than petals; ovary ovoid. Fruit red at maturity, globose or subglobose, 6–8 mm in diam.; persistent stigma discoid, 4-lobed; pyrenes 4, ovoid–ellipsoidal, 4–6 × 3–4 mm in diam., abaxially palmately or longitudinally striate and sulcate, endocarp bony.

Figure 1. Type specimens and morphology of *Ilex*×*dabieshanensis* (including its synonym) and *I. centrochinensis*. (A) holotype of *I.*×*dabieshanensis* (NAS-00071082); (B) paratype of *I.*×*dabieshanensis* (NAS-00071441); (C) isotype of *I. centrochinensis* (P-03274050); (D) holotype of *I. huoshanensis* (PE-00057118); (E) paratype of *I. huoshanensis* (KUN-1253505); (F) leaves of *I.*×*dabieshanensis*; (G) leaves of *I. centrochinensis*. (F–G) photographed by Y. Yang.

Phenology

Flowering from March to May, fruits ripening from September to November.

Distribution and habitat

China (Anhui, Henan, Hubei; Fig. 5), where it grows in forests or at the margin of forests, streamsides and roadsides at 200–600 m a.s.l.

Similar species

Ilex dabieshanensis was published by Yao and Deng (1987) based on specimens collected from Dahuaping, Huoshan County in South Dabie Mountains of Central China (Fig. 1A–B), and it has so far only been found in the Dabie Mountains. The intermedial leaf blades (5–12×2–5 cm; margin with 4–8 unequal-sized spinose teeth per side) and inflorescences (rachises 3–8 mm long in male inflorescences, 3–5 mm long in female inflorescences/infructescences) of *I.*×*dabieshanensis*, in comparison to those of *I. cornuta* Lindl. & Paxt. (leaf blades 4–9×2–4 cm, margin with 1 or 2 spines per side; rachises absent in male/female inflorescences) and *I. latifolia* Thunb. (leaf blades 8–19 (−28)×4.5–7.5 (−9.0) cm, margin sparsely serrate; rachises 10–20 mm long in male inflorescences, 10–20 mm long in female inflorescences/infructescences), suggest its hybrid origin (Shi et al. 2016). In the wild, *I.*×*dabieshanensis* is usually accompanied with its putative parents, i.e. *I. cornuta* and *I. latifolia*, which are also distributed in the Dabie Mountains. Furthermore, the hybrid origin and status of *I.*×*dabieshanensis* is clearly shown by molecular data in the recent study by Shi et al. (2016). Thus, *I. dabieshanensis* should be treated as *I.*×*dabieshanensis*.

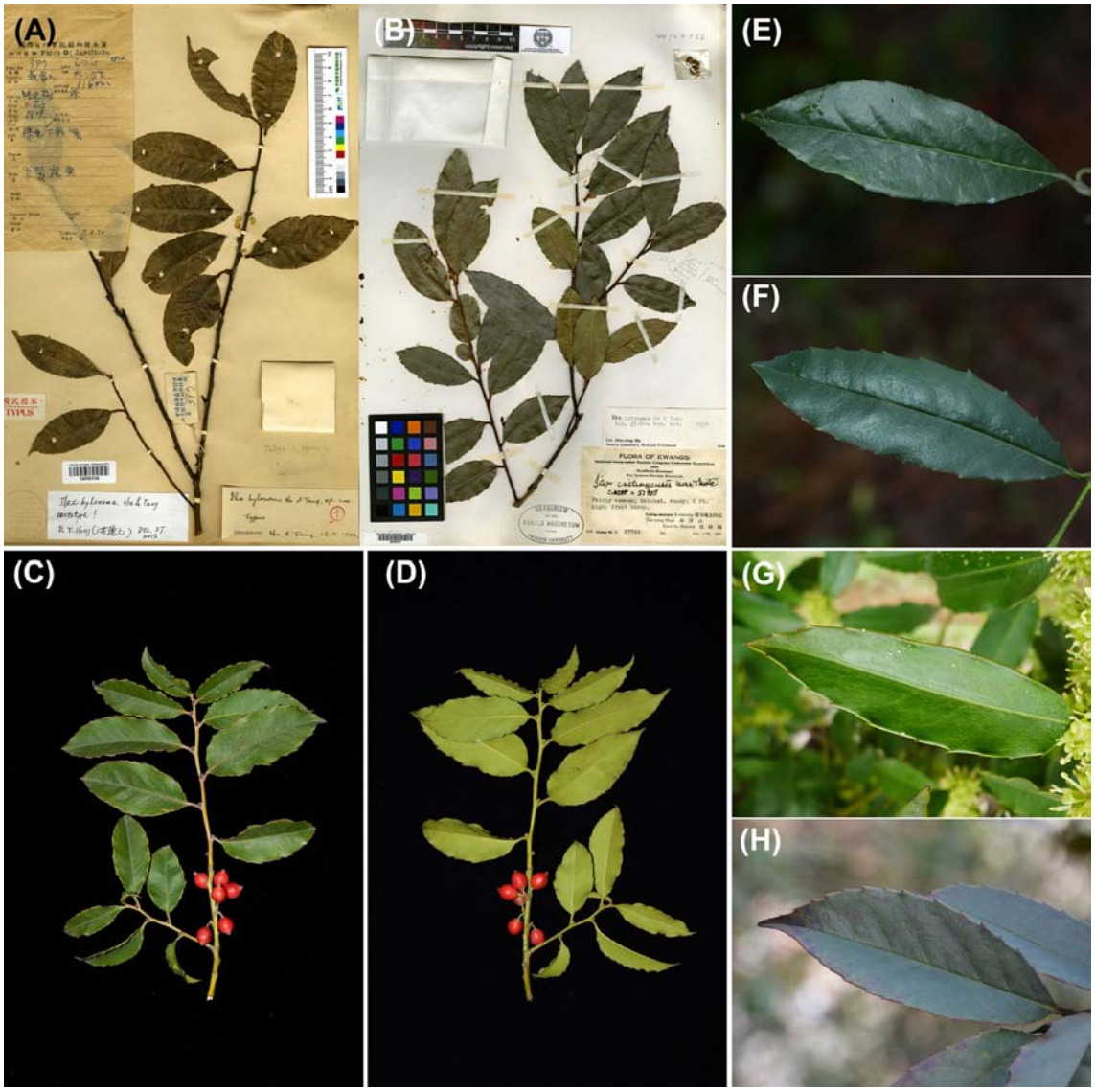

Figure 2. Type specimens and morphology of *I. hylonoma* var. *hylonoma* and *I. hylonoma* var. *glabra* (including its synonym). (A) Lectotype of *I. hylonoma* var. *hylonoma* (PE-02050334); (B) holotype of *I. hylonoma* var. *glabra* (A-00046745); (C–D) fruiting branch of *I. urceolatus*; (E) leaf of *I. hylonoma* var. *hylonoma*; (F–H) leaves of *I. hylonoma* var. *glabra*. (C–F, H) photographed by Y. Yang; (G) photographed by L. Jiang.

Ilex huoshanensis was published by He (2002) and its type specimen (Fig. 1D–E) was collected from Huoshan. In FOC (Chen et al. 2008), *I. huoshanensis* was treated as a synonym of *I. centrochinensis* S. Y. Hu (Fig. 1C, G), which may due to He's (2002) comment in the protologue that *I. huoshanensis* is very close to *I. centrochinensis*. However, based on the literature collated and specimens checked, we concluded that *I. huoshanensis* seems to be a separate species that differs from *I. centrochinensis* in its leaf margin which is unequal-sized spinose with spines 1–2 mm long (versus equal-sized spinose with spines 2–6 mm long in *I. centrochinensis*), female inflorescences pseudopaniculate with pedicels 8–20 mm long (versus solitary or fasciculate with pedicels ca 2 mm long in *I. centrochinensis*), and pyrenes palmately or longitudinally striate and sulcate abaxially (versus longitudinally 1-ridged abaxially, rugose and pitted throughout in *I. centrochinensis*). However, it shares all these diagnostic characters with *I.* × *dabieshanensis*. Therefore, we treat *I. huoshanensis* as a synonym of *I.* × *dabieshanensis*. A detailed morphological comparisons between *I.* × *dabieshanensis* and *I. centrochinensis* is provided in Table 1.

Additional specimens of* I. × dabieshanensis *examined

China. Anhui: Huoshan County, Dahuaping to Tongjiachong, 200 m a.s.l., 31 Mar 1982, M. P. Deng 81299 (NAS); Huoshan County, Manshui River, 580 m a.s.l., 2 Oct 1998, Y. H. He 98146 (KUN). Henan: Xin County, Liankang-shan National Nature Reserve, 20 May 2014, X. M. Gao (pictures

Figure 3. Type specimens and morphology of *Ilex kunmingensis* (including its synonym) and *I. corallina*. (A) holotype of *I. kunmingensis* (KUN-1207655); (B) holotype of *I. kunmingensis* var. *capitata* (KUN-1207661); (C) isotype of *I. macrostigma* (KUN-1207670); (D) isotype of *I. corallina* (NY-01546421); (E–G) morphology of *I. kunmingensis* (E = branch; F = fruits; G = pyrenes); (H–J) morphology of *I. corallina* (H = fruits; I = pyrenes; J = branch). (E–G) photographed by K. W. Xu; (H–J) photographed by F. Zhao.

in CFH, photographed by Xian-Ming Gao). Hubei: Luotian County, 476 m a.s.l., 19 May 2015, B. Chen CB09140 (CSH). Yunnan: Kunming City, Kunming Botanical Garden (cultivated), 7 Jan 2018, Y. Yang OYY 00055 (KUN).

Specimens of* I. centrochinensis *examined

China. Hubei: Yichang (Ichang), Sept 1886, A. Henry 1084 (isotype; P); Xingshan County, 720 m a.s.l., 6 Dec 1957, H. C. Li 1890 (HIB, PE); Wufeng Tujia Autonomous County, 960 m a.s.l., F. S. Peng 4953 (HIB); Badong County, Shennongjia, Niudong-wan, 300 m a.s.l., 1 Aug 1957, K. H. Fu and C. S. Chang 1196 (NAS, PE); Jianshi County, 5 Sep 1934, H. C. Chow 1523 (PE); Fang County, Luoxi, 1000 m a.s.l., 24 Sep 1958, K. J. Liu 0372 (PE). Chongqing: Wushan County, Longdong River, 200 m a.s.l., 12 Aug 1964, H. F. Chou and H. I. Su 109720 (IBSC, PE, SZ); Fengjie County, Xinhe Town, 800 m a.s.l., 28 Jun 1958, H. F. Chou 26481 (HIB, IBSC, SZ); Wuxi County, Lanying Town, 1109 m a.s.l., 19 Oct 2017, Y. Yang and J. C. Peng OYY00050 (KUN).

2. *Ilex hylonoma* H. H. Hu & T. Tang (1940, p. 250) (Fig. 2)

Type: China. Sichuan: Mt Emei, 1160 m a.s.l., 24 Jun 1935, T. H. Tu 397 (lectotype: PE-02050334!, designated by D. Y. Hong; isolectotypes: IBSC-0001441!, NAS-00071457!, PE-02050335!, SZ-00003280!).

Key to varieties of *I. hylonoma*

Leaf blade usually thinly leathery; midvein puberulent ……var. *hylonoma*

Leaf blade leathery or thickly leathery; midvein glabrous ……var. *glabra*

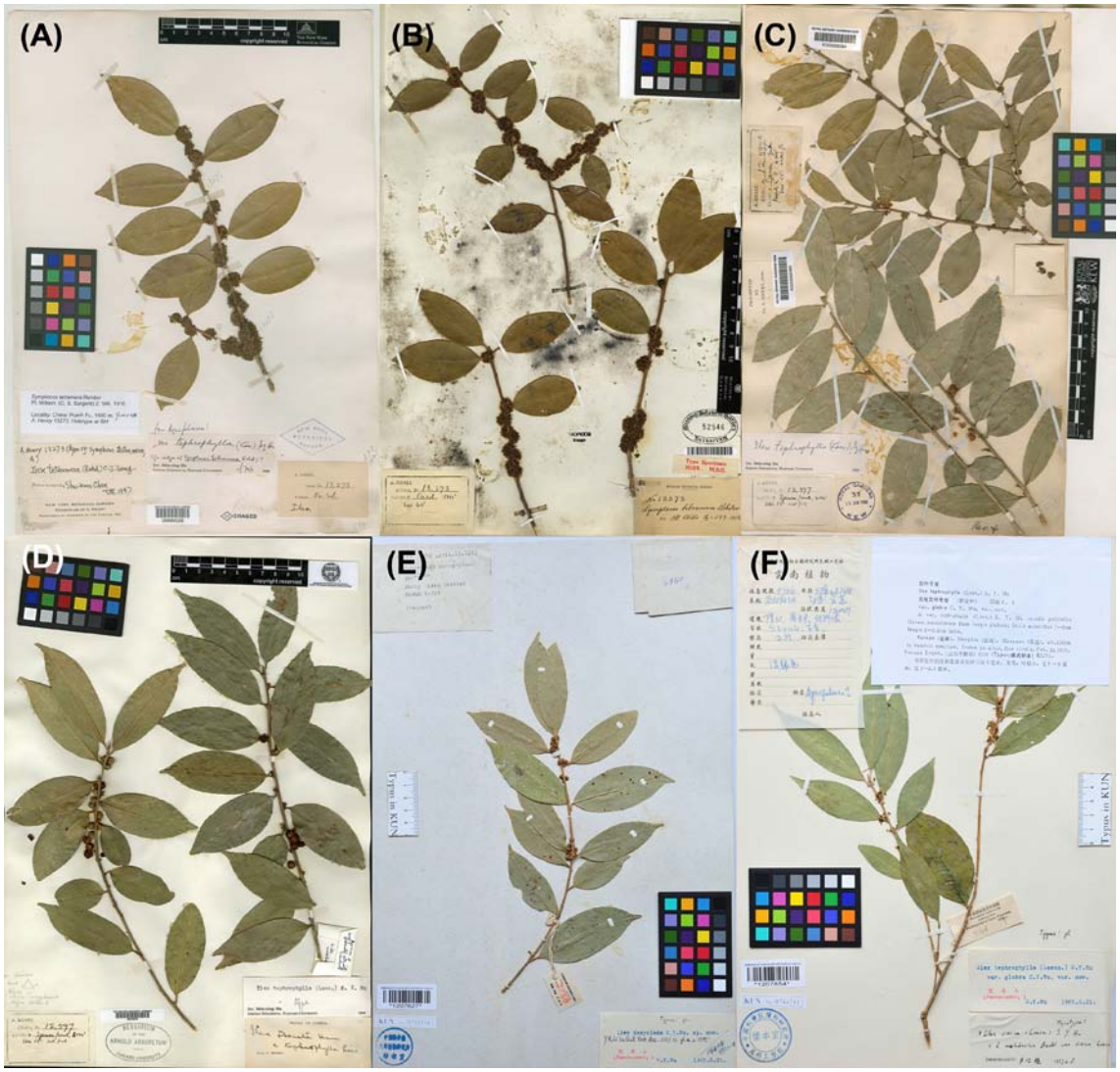

Figure 4. Type specimens of *Ilex tetramera* and its synonyms. (A–B) Isotypes of *I. tetramera* (A: NY-00888326; B: MO-391955); (C) isotype of *I. tephrophylla* and its flowering paratype (K-000669395); (D) holotype of *I. tephrophylla* (A-00049545); (E) holotype of *I. dasyclada* (KUN-1207627); (F) holotype of *I. tetramera* var. *glabra* (KUN-1207854).

2a. *Ilex hylonoma* var. *hylonoma*

Description

Evergreen tree up to 10 m tall. Branchlets glabrescent or glabrous. Terminal buds ovoid–conical to conical, glabrous or pubescent. Petiole 5–14 mm, pubescent or glabrous. Leaf blade abaxially greenish, adaxially yellowish-green to green, elliptic, oblong–elliptic, lanceolate, oblanceolate, or ovate–lanceolate, 6–13 × 2–4.5 cm, thinly leathery or leathery, at base obtuse or acute, rarely cuneate and margin coarsely and sharply serrate, or teeth ending in weak spines, at apex shortly acuminate; midvein adaxially impressed, puberulent, glabrescent, or glabrous; lateral veins 7–10 pairs, raised and prominent or obscure on both surfaces, anastomosing near margin; reticulate veinlets obscure abaxially, prominent adaxially,. Inflorescences: cymose, fasciculate, axillary on current or second year's branchlets. Male inflorescences: cymes of order 2, 3-flowered, sparsely pubescent; peduncles ca 1 mm; bracts deltoid, glabrous but ciliate; pedicel ca 3 mm; bracteoles 2, basal, ciliate; flowers 4-merous, yellowish; calyx ca 2 mm in diam., glabrous, with lobes broadly deltoid, ciliate, their apex obtuse; petals obovate–elliptic, 3.0–3.5 × 1.5–1.8 mm; stamens slightly longer than petals; anthers ovoid; rudimentary ovary subglobose. Female inflorescences: 1-cymes, few fascicled; pedicels ca 2 mm; calyx and petals similar to male flowers; ovary subglobose. Fruit 1–4 fascicled, red, subglobose to ellipsoid–subglobose, 0.8–1.2 (1.5) cm in diam., usually obtuse at apex, sometimes elongated and beaklike; persistent calyx explanate, ca 3 mm in diam.; persistent stigma prominent, thickly discoid; pyrenes 4, obovoid or oblong, 6–9 × 3–4 mm, abaxially irregularly rugose and pitted, with a median longitudinal ridge, endocarp bony.

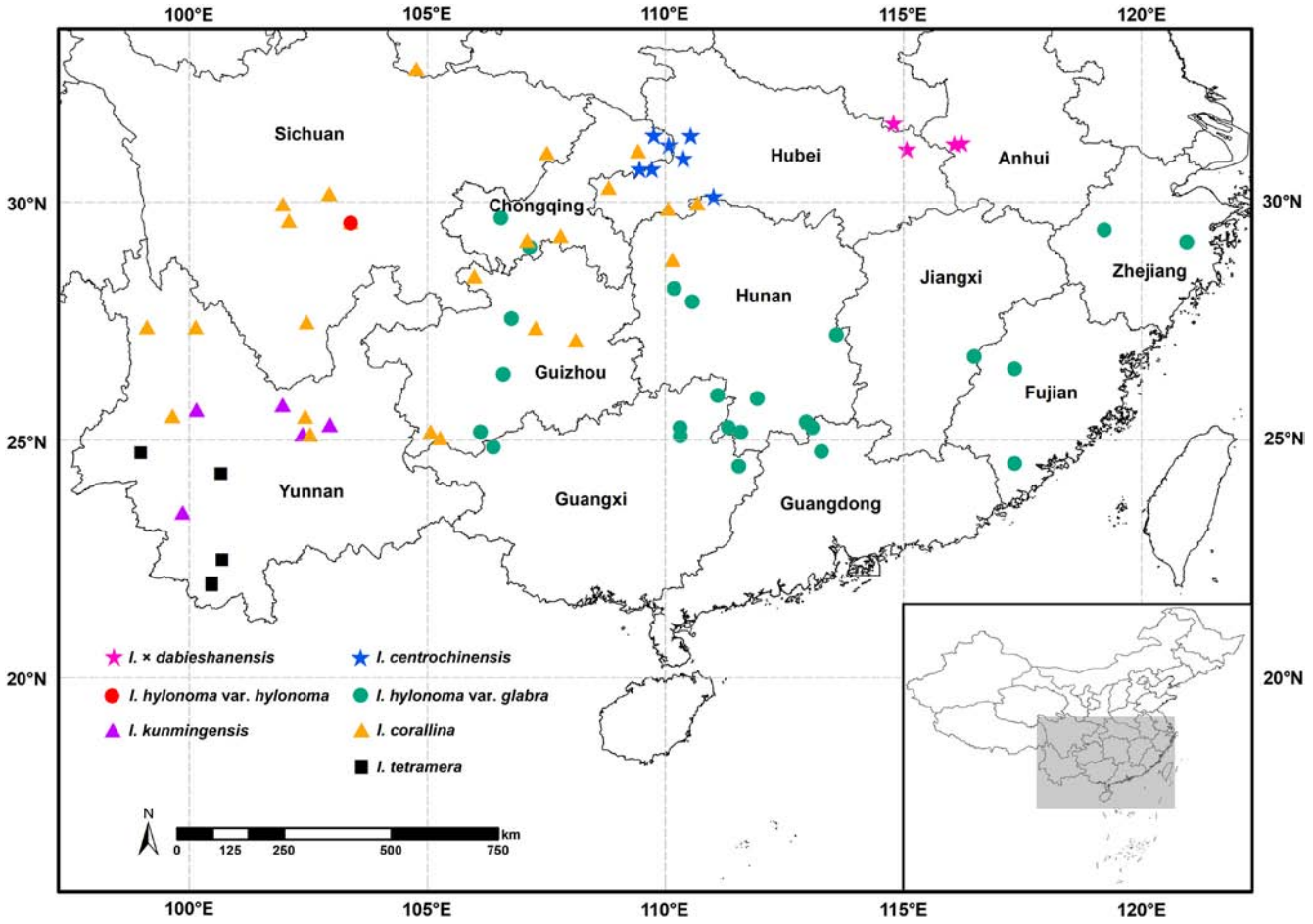

Figure 5. Distribution of *Ilex centrochinensis*, *I. corallina*, *I.* × *dabieshanensis*, *I. hylonoma* var. *hylonoma*, *I. hylonoma* var. *glabra*, *I. kunmingensis* and *I. tetramera* in China based on specimen records and our observations in the field.

Phenology

Flowering from March to May, fruiting from September to December.

Distribution and habitat

China (Sichuan; Fig. 5), where it grows in forests or at the the margin of forests at 700–1800 m a.s.l.

Additional specimens of I. hylonoma var.* hylonoma *examined

China. Sichuan: Emeishan City, Mt Emei, Apr 1939, Z. S. Zheng 365 (KUN); Emeishan City, Mt Emei, 1780 m a.s.l., 8 May 1939, S. L. Sun 0149 (KUN); Emeishan City, Mt Emei, 13 Nov 1940 W. P. Fang 15296 (KUN, SZ); Emeishan City, Mt Emei, Guanxinpo, 1300 m a.s.l, 18 Oct 1957, G. H. Yang 57565 (HIB, KUN, SZ, PE); Emeishan City, Mt Emei, Hongchunping, 1108 m a.s.l., 13 Apr 2018, Y. Yang OYY00083 (KUN).

2b. *Ilex hylonoma* var. *glabra* S. Y. Hu (1949b, p. 351) (Fig. 2B–D, F–H)

Type: China. Guangxi: Kwei-lin District [the present Lin'gui District or Lingchuan County], Longmu-an and vicinity, Haiyang-shan, 8–12 Jul 1937, W. T. Tsang 27796 (holotype: A-00046745!, isotype: IBSC-0217541!).

Taxonomic synonym: *Ilex urceolatus* C. B. Shang, K. S. Tang & D. Q. Du (2010, p. 645, pl. 646), syn. nov.

Type: China. Hunan: Lianyuan City, Jinshi Town, Liping Village, Quanying-shan, 8 Nov 2009, D. Q. Du and K. S. Tang 2009118 (holotype: NF!; isotype: unseen).

Description

Ilex hylonoma var. *glabra* is very similar to the type variety but differs by its thicker leaf texture and glabrous midvein.

Phenology

Flowering from February to April, fruiting from September to January.

Distribution and habitat

China (Guangxi, Guangdong, Guizhou, Chongqing, Hunan, Jiangxi, Fujian, Zhejiang; Fig. 5), where it usually occurs in thickets or sparse forests at 90 –1300 m a.s.l.

Table 1. Morphological comparisons between *Ilex cornuta*, *I.×dabieshanensis*, *I. latifolia* and *I. centrochinensis*.

Character	*I. cornuta*	*I.×dabieshanensis*	*I. latifolia*	*I. centrochinensis*
Habit	Evergreen shrubs or small trees, (0.6–) 1–4 m tall	Evergreen trees, 5–10 m tall	Evergreen trees to 20 m tall	Evergreen shrubs, 1.5–3 m tall
Leaves	4–9×2–4 cm; margin with 1 or 2 spines per side, spines 2–5 mm long	5–12×2–5 cm; margin with 4–8 unequal-sized spinose teeth per side, spines 1–2 mm long	8–19 (–28)×4.5–7.5 (–9); margin sparsely serrate	4–9×1.5–2.8 cm; margin with 3–10 equal-sized spinose teeth, spines 2–6 mm long
Male inflorescences	Fasciculate; pedicels 5–6 mm long	Pseudopaniculate, rachises 3–8 mm long; pedicels 8–12 mm long	Pseudopaniculate, rachises 10–20 mm long; pedicels 6–10 mm long	Fasciculate; pedicels 1–2 mm long
Female inflorescences/ infructescences	Fasciculate; pedicels 7–15 mm	Pseudoracemose, rachises 3–5 mm long; pedicels 8–20 mm long	Pseudoracemose, rachises 10–20 mm long; pedicels 7–10 mm long	Solitary or few-fasciculate; pedicels ca 2 mm long
Pyrenes	4, rugose and rugose-pitted throughout, abaxially longitudinally 1-sulcate, endocarp bony	4, abaxially palmately or longitudinally striate and sulcate, endocarp bony	4, abaxially irregularly rugose, with distinct longitudinal ridges, endocarp bony	4, abaxially longitudinally 1-ridged, rugose and pitted throughout, endocarp stony

Similar species

The leaf blade of *I. hylonoma* var. *glabra* is usually leathery or even thicker (Fig. 2B, F–H), but is papery or thinly leathery in the type variety (Fig. 2A, E). Except for the difference in leaf texture, there is no notable difference between the type variety and the glabrous variety of *I. hylonoma*. Therefore, we follow the treatment of Hu (1949b) and recognize these taxa as varieties only.

In the protologue of *I. urceolatus*, Shang et al. (2010) commented that *I. urceolatus* (Fig. 2C–D) is similar to *I. hylonoma* but differed in its more sharply serrate leaf margin and larger fruits. However, according to our observation of specimens of *I. hylonoma*, its leaf margin is quite variable, ranging from sparsely serrate to densely serrate with weak spines. Meanwhile, no clear difference can be found in their fruit size which is 9–12×11–17 mm in *I. urceolatus* and 8–12 (–15) in diameter in *I. hylonoma*. Geographically, *I. urceolatus* is known to Lianyuan City of West Hunan Province, which is within the distribution range of *I. hylonoma*. Given its leathery leaf blade and glabrous midvein, we consider *I. urceolatus* as a synonym of *I. hylonoma* var. *glabra*.

Additional specimens of* I. hylonoma *var.* glabra *examined

China. Guangxi: Kwei-lin District (the present Lin'gui District or Lingchuan County), San-min village and vicinity, 5–23 Aug 1937, W. T. Tsang 27998 (SYS); Qixing District, Chuanshan Garden, 130 m a.s.l., 31 Dec 2015, Y. Yang JL00486 (KUN); Yanshan District, 15 Nov 1953, P. Y. Xu 10600 (IBK); Lin'gui District, 28 Apr 1983, B. S. Li and S. Z. Cheng 04365 (PE); Xin'an County, 5 Sep 1937, C. H. Chung 83691 (IBK); Quanzhou County, 21 Se 1961, J. F. Chao 604340 (IBK); Pinggui District, Huangtian Town, Zujie-shan, 23 Sep 1958, M. K. Li 401827 (IBK); Leye County, Huaping town, 1132 m a.s.l., 25 Apr 2013. B. Y. Huang et al. 451028130425107LY (GXMG). Guangdong: Lechang County, 100 m a.s.l., 27 Feb 1942, C. S. Chen 235 (IBK); Ruyuan County, 4 May 1934, S. B. Guo 80386 (IBK). Chongqing: Jiangbei District, Peijia-shan, 4 December 1952, C. He and C. C. Lin 14366 (SZ); Nanchuan District, Mt Jinfo, T. F. Wang 10888 (PE). Guizhou: Huaxi District, Dangwu, 1150 m a.s.l., 24 Oct 1956, Sichuan-Guizhou Expedition Team 2074 (PE); Bozhou District, Majiawan, 950 m a.s.l., 13 Sep 1956, Sichuan-Guizhou Expedition Team 1501 (PE); Wangmo County, 19 Sep 1936, S. W. Deng 90936 (IBK). Hunan: You County, wetland of Jiubu River, 89 m a.s.l., 22 Sep 2015, G. X. Chen et al. LXP-06-5371 (JIU); Taoyuan County, 500 m a.s.l., 28 Sep 1978, Q. Z. Lin 00412 (CSFI); Xupu County, 200 m a.s.l., 29 Sep 1981, H. S. Liao 16216 (CSFI); Jianghua County, 8 Sep 1958, C. J. Qi 3832 (CSFI); Jiangyong County, 350 m a.s.l., 22 Apr 1984, Y. T. Xiao 40560 (CSFI); Ningyuan County, Qingshuiqiao Town, 400 m a.s.l., 19 May 1978, Q. Z. Lin 0320 (CSFI); Yizhang County, 15 Sep 1942, P. H. Liang 83430 (IBK); Luxi County, Shangyunjie, 390 m a.s.l, 16 Apr 1982, K. W. Liu 30102 (CSFI). Jiangxi: Guangchang County, Jianfeng Town, Yuantou village, Wangfu-ling, 8 Oct 1958, C. M. Hu 5416 (IBSC, KUN, PE). Fujian: Nanjing County, R. C. Lin 726 (AU); Jiangle County, Longqi Mountain, Jiuyaodong, 670 m a.s.l., 17 Oct 1992, Longqi Mountain Expedition Team 3062 (PE). Zhejiang: Jiande City, 28 Jun 1958, Anonymous 29368 (HHBG, PE); Tiantai County, Baihukeng, 9 Nov 1964, Anonymous 111 (HHBG). Jiangsu: Suzhou City, Baitang Botany Garden (cultivated), 5 Jan 2018, Y. Yang OYY00054 (KUN).

3. *Ilex kunmingensis* H. W. Li ex Y. R. Li (1985, p. 19, pl. 6: 1) (Fig. 3A–C, E–G)

Type: China. Yunnan: Songming County, Guodong Town, 2100–2300 m a.s.l., 12 Oct 1953, P. Y. Chiu 50398 (holotype: KUN-1207655!; isotypes: KUN-1207656!, KUN-1207657!, KUN-1207658!, PE-01322488!, WUK-0193616!)

Taxonomic synonyms: *Ilex kunmingensis* H. W. Li ex Y. R. Li var. *capitata* Y. R. Li (1985, p. 19; Fig. 3B), syn. nov. **Type**: China. Yunnan: Shuangjiang Lahu, Va, Blang and Dai Autonomous County, Taiping, Tiechang, 2200–2500 m a.s.l., 11 Sep 1957, G. S. Sin 840 (holotype: KUN-1207661!; isotypes: IBSC-0212739!, LBG-00118019!, PE-01322489!).

– *Ilex macrostigma* C. Y. Wu ex Y. R. Li (1985, p. 20, pl. 6:2; Fig. 3C), syn. nov.

Type: China. Yunnan: Heqing County, Songgui Town, 29 Apr 1939, K. M. Feng 858 (holotype: KUN, unseen; isotypes: KUN-1207670!, KUN-1207671!).

Description

Evergreen shrub or small tree up to 4 m tall. Branchlets longitudinally angular and sulcate, glabrous. Terminal buds ovoid–conical, glabrous. Petiole 5–9 mm long, glabrous; leaf blade green turning olive or brownish gray when dry, obovate–oblong or obovate–lanceolate, rarely elliptic, 4.5–8.5 × 1.5–3.0 cm, papery or thinly leathery, with both surfaces glabrous, base cuneate or broadly cuneate at base, with margin sparsely serrulate, sometimes inconspicuous, abruptly acuminate or acuminate at apex; midvein impressed adaxially; lateral veins 6–9 pairs, raised abaxially, flattened and evident adaxially, forked and anastomosing near margin; reticulate veins evident abaxially. Flowers not known. Infructescences: 1-fruited cymes, fasciculate, axillary on precious year's branchlets; rachises ca 1 mm; fruiting pedicels 2–5 mm, glabrous or puberulent; bracteoles basal, ovate–deltoid, ciliate. Fruit globose, ca 5 mm in diam.; persistent calyx 4-lobed, with lobes ovate, ciliate; persistent stigma thickly discoid or capitate, slightly 4-lobed; pyrenes 4, ovoid, ca 2 mm long, ca 1.5 mm wide, abaxially smooth, sometimes inconspicuously striate and sulcate, endocarp leathery.

Phenology

Flowering in April (based on the collection K. M. Feng 858 with small young fruits), fruits ripening from October to November.

Distribution and habitat

China (Yunnan; Fig. 5), where it grows in bush woods at 2100–2500 m a.s.l.

Similar species

Based on the specimens (K. W. Xu JL00176 from Cangshan Mt, Y. J. Guo et al. 17CS14840 from Yuanmou County, and Y. Yang OYY00053 from Kunming) of *I. kunmingensis* var. *kunmingensis* with leaves 5–8 × 2.0–2.7 cm and fruiting pedicels 2–4 mm long, the slightly larger leaf size (5–8 × 2–3 cm) and longer fruiting pedicels (3.5–5.0 mm) of *I. kunmingensis* var. *capitata* (Fig. 3B) – as recorded in the protologue – are within the variation range of the type variety. Furthermore, all the examined specimens of *I. kunmingensis* show a continuous distribution on the Yunnan Plateau. Therefore, *I. kunmingensis* var. *capitata* is not recognized as different from *I. kunmingensis* var. *kunmingensis* here.

In Hong's (2015a, b) revision of Aquifoliaceae in Pan-Himalaya, *I. macrostigma* (Fig. 3C) was treated as conspecific with *I. corallina* Franch. (Fig. 3D, H–G) based on its leaf shape and fruit/pyrene size. However, we found that *I. macrostigma* is distinct from *I. corallina* in its papery or thinly leathery (versus leathery in *I. coralline*) leaves which are green when fresh and olive or brownish-gray when dry (versus dark green when fresh and brown or dark brown when dry in *I. coralline*), and ovoid and smooth (versus ellipsoidal–trigonous and palmately striate in *I. corallina*) pyrenes. However, it shares all these diagnostic characters with *I. kunmingensis*. Therefore, we reduce *I. macrostigma* to a synonym of *I. kunmingensis*. More morphological differences between *I. kunmingensis* and *I. corallina* are presented in Table 2.

Additional specimens of* I. kunmingensis *examined

China. Yunnan: Songming Couty, Guodong Town, 2380 m a.s.l., 22 Aug 1957, P. Y. Chiu 54881 (KUN, PE); Dali City, Cangshan Mountain, 27 Oct 2015, K. W. Xu JL00176 (KUN); Yuanmou County, Liangshan, 2390 m a.s.l., 18 Oct 2017, Y. J. Guo et al. 17CS14840 (KUN); Xishan District, Wujia-qing, 2238 m a.s.l., 6 Jan 2018, Y. Yang OYY00053 (KUN).

Specimens of* I. corallina *examined

China. Yunnan: Dali, 12 Feb 1885, M. I. Delavay 927 (E-00428551, holotype; A-00049441, K-000669397, NY-01546421, P-03272805 and PE- 01896211, isotype); Dali, Fengyi, Quxiaguan, 5 Feb 1941, T. N. Liou 018107 (IBSC, PE). Xianggelila (Zhongdian), Haba Mt, Haba, 2400 m a.s.l., 16 Oct 1955, K. M. Feng 21063 (KUN, PE, SZ); Weixi Lisu Autonomous County, Huanghe, 1600 m a.s.l., 3 Oct 1956, P. Y. Mao 00359 (KUN, SZ); Fuming County, 2200 m a.s.l., 20 May 1964, P. Y. Chiu 58857 (KUN);

Table 2. Morphological comparison between *Ilex kunmingensis* and *I. corallina*.

Character	*I. kunmingensis*	*I. corallina*
Habit	Evergreen shrubs or trees, up to 4 m tall	Evergreen shrubs or trees, 3–10 m tall
Leaves	5–11 × 2.0–3.5 cm; papery or thinly leathery; green when fresh, olive or brownish gray when dry; margin sparsely serrulate	4–10 (–13) × 1.5–3.0 (–5.0) cm; leathery; dark green when fresh, brown or dark brown when dry; margin crenate–serrate, sometimes spinose
Female inflorescences or infructescences	Cymes, rachises ca 1 mm long; pedicels 2–5 mm long	Cymes, rachises ca 1 mm long; pedicels 1–2 mm long
Fruits	Globose, ca 5 mm in diam.	Subglobose, 3–5 mm in diam.
Pyrenes	4; ovoid, ca 2 mm long, ca 1.5 mm wide; abaxially smooth, sometimes inconspicuously striate and sulcate, laterally smooth	4; ellipsoidal–trigonous, 2.0–2.5 (–5.0) mm long, 1.5 (–2.0) mm wide; abaxially palmately striate and sulcate, laterally striate or rugose

Wuding County, Puxi, 1800 m a.s.l., 26 Nov 1956, C. S. Hsin 78 (KUN). Sichuan: Emeishan City, Mt Emei, Mutigou, 1200 m a.s.l., 5 Aug 1956, Y. H. Tao 51300 (SZ); Da County, Zaolin, Bazhong Team 687 (SM); Luding County, Yinchang-gou, 1800 m a.s.l., 4 Apr 1981, X. H. Hu 25001 (CDBI); Beichuan County, 950 m a.s.l., 3 Aug 1984, C. L. Tang et al. 554 (CDBI); Lushan County, Qinglong-chang, 1150 m a.s.l., 14 Oct 1936, K. L. Chiu 4018 (SZ); Kangding County, Guzanhuang Village, 1500 m a.s.l., 20 Apr 1974, Y. T. Ren and Q. S. Chao 110803 (SZ); Muli Zang Autonomous County, Shuiluo Town, 2000–2110 m a.s.l., 24 Oct 1959, S. K. Wu 3508 (KUN); Puge County, Dacao-he, 1600 m a.s.l., 7 Aug 1976, Anonymous 14200 (PE). Gansu: Wen County, Fanjia-ba, Xichang-gou, 750 m a.s.l., 19 Oct 1958, Y. C. He 01342 (PE). Chongqing: Nanchuan District, Fengjing, 900 m a.s.l., 4 Apr 1957, K. F. Li 60316 (IBSC, KUN, PE, SZ); Fengjie County, Zhongjia, 750 m a.s.l., 3 Oct 1964, H. F. Chou and H. Y. Su 110707 (HIB, IBSC, KUN, NAS, PE, SZ); Wulong County, 650 m a.s.l., 16 Sep 1978, W. H. Wang 3730 (SZ). Guizhou: Shibing County, Zijing-guan, 13 Jul 1959, Qiannan Team 2763 (KUN, NAS, PE); Weng'an County, Zhuchang, 650 m a.s.l., 12 Sep 1959, Libo Team 1846 (PE); Xingyi City, Dingxiao Town, 1200 m a.s.l., 9 Jul 1960, C. S. Chang and Y. T. Chang 6838 (PE); Anlong County, Dewo, 19 May 1960, Guizhou Expedition Team 3519 (IBK); Chishui City, Yuanhou Town, 410 m a.s.l., 14 Sep 1959, Bijie Team 1349 (PE). Hubei: Enshi City, 850 m a.s.l., Nov 1958, H. C. Li 6099 (SZ); Hefeng County, 360 m a.s.l., June 1958, H. C. Li 6502 (SZ); Lichuan County, Jianzhu-xi, 13 Jun 1958, W. P. Lin 400 (PE). Hunan: Shimeng County, Nanping, Maozhu-he, 450 m a.s.l., 14 Jun 1987, Pinghu Mountan Expedition Team 0282 (PE); Yongshun County, Xiaoxi, 14 Jul 2008, D. G. Zhang 080714023 (JIU).

4. *Ilex tetramera* (Rehd.) C. J. Tseng (1981, p. 21) (Fig. 4)

Basionym: *Symplocos tetramera* Rehder (1916, p. 598; Fig. 4A–B).

Type: China. Yunnan: Ning'er (Puerh Fu), 1600 m a.s.l., A. Henry 13273 (holotype: unseen; isotypes: IBSC-0001537!, MO-391955!, NY-00888326!).

Taxonomic synonyms: *Ilex odorata* Ham. ex D. Don var. *tephrophylla* Loes. (1908, p. 186; Fig. 4C–D); **based on the same type**: *Ilex tephrophylla* (Loes.) S. Y. Hu (1950, p. 67). **Type**: China. Yunnan: Simao (Szemao), ca 1200 m (4000 ft.) a.s.l., A. Henry 12597 (holotype: A-00049545!, isotypes: K-000669395!, MO-260545!).

– *Ilex dasyclada* C. Y. Wu ex Y. R. Li (1985, p. 13, pl. 4:2; Fig. 4E) syn. nov.

Type: China. Yunnan: Jingdong County, Mengpian (Meengpiann), 1600 m a.s.l., 19/20 Apr 1940, M. K. Li 3350 (holotype: KUN-1207627!, isotype: KUN-1207626!).

– *Ilex tephrophylla* var. *glabra* C. Y. Wu ex Y. R. Li (1985, p. 12; Fig. 4F), **based on the same type**: *Ilex tetramera* var. *glabra* (C. Y. Wu ex Y. R. Li) T. R. Dudley (1988, p. 28), syn. nov.

Type: China. Yunnan: Menghai County, Manyuan, 1300 m a.s.l., 24 Feb 1957, Yunnan Exped. 5126 (holotype: KUN-1207854!, isotype: KUN-0548872!).

Description

Evergreen shrub or tree, (1.5–) 3.0–12.0 m tall. Young branchlets longitudinally angular and sulcate, usually glabrous and rarely puberulent near the apex; older branchlets fissured. Terminal buds narrowly conical, usually glabrous. Petiole 3–8 mm, usually glabrous. Leaf blade oblong–elliptic to oblong–lanceolate, 5–11 × 2.0–3.5 cm, thickly papery or subleathery, adaxially dark to olive green while abaxially lighter, with both surfaces glabrous, obtuse to rounded at base, margin slightly recurved, inconspicuously crenulate with black teeth, apex acuminate to caudate–acuminate, with 5–15 mm long acumen; midvein impressed adaxially; lateral veins 6–8 pairs, abaxially prominent, slightly raised or flat, adaxially flat, furcate and anastomosing near margin. Male inflorescences: cymes of order 2, fasciculate, axillary on first to second year's branchlets; peduncles very short, ca 0.5 mm; bracts basal, ovate, ciliate; pedicels 1–5 mm, puberulent or glabrous; flowers yellow-white, 4-merous; calyx patelliform, ca 2 mm in diam., 4-lobed, with deltoid ciliate lobes,; corolla 5–6 mm in diam., petals obovate–oblong, ca 2.0 × 1.5 mm, basally slightly connate, rounded at apex; stamens longer than petals; anthers ovoid; rudimentary ovary subglobose, abruptly acute at apex, minutely lobed. Female flowers not known. Infructescences: 1-fruited cymes, pseudoracemose or fasciculate; rachis 3–9 mm, glabrous or puberulent; fruiting pedicels 1–4 mm, puberulent or glabrous; bracteoles 2, basal, ovate, ciliate. Fruit red, globose, 5–6 mm; persistent calyx explanate, ca 1.5 mm in diam., 4-lobed; persistent stigma navel-like, ca 1 mm in diam., minutely lobed; pyrenes 4, oblong, ca 4 mm long and wide, abaxially convex, palmately striate and sulcate, laterally irregularly longitudinally striate and deeply sulcate; endocarp stony.

Phenology

Flowering from February to April, fruiting in October (probably to December).

Distribution and habitat

China (Yunnan; Fig. 5), where it grows in evergreen broad-leaved forests at 700–1600 m a.s.l.

Similar species

Ilex tephrophylla was erected by Hu (1950) based on *I. odorata* var. *tephrophylla* (Loesener 1908) (Fig. 4C–D), with *Symplocos tetramera* (Rehder 1916) (Fig. 4A–B) being treated as its synonym. According to the Article 11.4. of the International Code of Nomenclature for Algae, Fungi and Plants (McNeill et al. 2012), the correct name for an

infrageneric taxon should be a combination of the specific name that belongs to the earliest one of the legal names of the related taxa at the same rank, and the name of the genus or species in which it should be put. Consequently, the combination based on *S. tetramera* has priority over *I. odorata* var. *tephrophylla*. The correct name *I. tetramera* was put forward by Tseng (1981). Meanwhile, the glabrous variety of *I. tetramera* was recombined as *I. tetramera* var. *glabra* by Dudley (1988) based on *I. tephrophylla* var. *glabra* (Li 1985).

The density of the indumentum on buds, young branchlets, rachis and pedicels of *I. tetramera* varies greatly from densely puberulent to glabrous. Based on the protologue and specimens examined by us, both *I. dasyclada* (Li 1985) (Fig. 4E) and *I. tetramera* var. *glabra* (Dudley 1988) (Fig. 4F) differ from *I. tetramera* var. *tetramera* only in the density of the indumentum. Furthermore, their type localities are all in southwest Yunnan and at similar elevation and habitat. Thus, we do not treat *I. dasyclada* and *I. tetramera* var. *glabra* as as different from *I. tetramera* (s. s.).

Additional specimens of* I. tetramera *examined

China. Yunnan: Simao District, 2–12 Mar 1922, Rock F. G. 2740 (E); Longling County (Lung-ling Hsien), 1800 m a.sl., 13 Apr 1934, H. T. Tsai 55779 (IBSC, KUN, LBG, PE, SZ); Lancang Lahu Autonomous County, vicinity of county town, 8 Mar 1976, K. T. Tao 9094 (HITBC); Jinghong City, 760–930 m a.s.l., 13 Oct 1955, P. I. Mao 6652 (IBSC, KUN, LBG, WUK); Menghai County, Feb 1959, The Fourth Team of Ministry of Forestry s. n. (KUN).

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References

Chen, S. K. and Feng, Y. X. 1999. Aquifoliaceae. In: Chen, S. K. (ed), Flora Reipublicae Popularis Sinicae. Vol. 45. – Science Press, pp. 1–296.

Chen, S. K. et al. 2008. Aquifoliaceae. – In: Wu, C. Y. et al. (eds), Flora of China. Vol. 11. – Science Press; Miss. Bot. Gard. Press, pp. 359–438.

Cuénoud, P. et al. 2000. Molecular phylogeny and biogeography of the genus *Ilex* L. (Aquifoliaceae). – Ann. Bot. 85: 111–122.

Dudley, T. R. 1988. New taxa of *Ilex* from Guangxi and Yunnan provinces of the People's Republic of China. – Holly Soc. J. 6: 11–47.

He, Y. H. 2002. A new species of the genus *Ilex* from Anhui, China. – Acta Phytotax. Sin. 40: 380–382.

Hong, D. Y. 2015a. A taxonomical revision of *Ilex* (Aquifoliaceae) in the Pan-Himalaya and unraveling its distribution patterns. – Phytotaxa 230: 151–171.

Hong, D. Y. 2015b. Aquifoliaceae. – In: Hong, D. Y. (ed), Flora of Pan-Himalaya. Science Press; Cambridge Univ. Press, pp. 1–52.

Hu, S. Y. 1949a. The genus *Ilex* in China, I. – J. Arnold Arbor. 30: 233–344.

Hu, S. Y. 1949b. The genus *Ilex* in China, II. – J. Arnold Arbor. 30: 348–387.

Hu, S. Y. 1950. The genus *Ilex* in China, III. – J. Arnold Arbor. 31: 39–80.

Hu, S. Y. 1951. Notes on the flora of China, I. – J. Arnold Arbor. 32: 390–401.

Hu, H. H. and Tang, T. 1940. Notes on five new and several other known species of *Ilex* from China. – Bull. Fan. Mem. Inst. Biol. Bot. 9: 245–256.

Huang, Y. F. et al. 2014. *Ilex jingxiensis* sp. nov. (Aquifoliaceae) from a limestone area along the Sino-Vietnamese border region of China. – Nord. J. Bot. 32: 848–851.

Li, Y. R. 1981. Some new taxa of Aquifoliaceae and Celastraceae from Xizang. – Acta Bot. Yunnan. 3: 351–357.

Li, Y. R. 1985. New taxa of Aquifoliaceae from Yunnan. – Bull. Bot. Res. 5: 1–35.

Lin, Q. W. et al. 2013. A new species of *Ilex* from Fujian Province. – Bull. Bot. Res. 33: 257–259.

Loesener, L. E. T. 1908. Monographia aquifoliacearum II. – Nova Acta Acad. Caes. Leop.-Carol. German. Nat. Cur. 89: 1–314.

Loizeau, P. A. et al. 2016. Aquifoliaceae. – In: Kubitzki, K. (ed.), Flowering plants. Eudicots, the families and genera of vascular plants. – Springer, pp. 31–36.

Manen, J. F. et al. 2002. The complex history of the genus *Ilex* L. (Aquifoliaceae): evidence from the comparison of plastid and nuclear DNA sequences and from fossil data. – Plant Syst. Evol. 235: 79–98.

Manen, J. F. et al. 2010. The history of extant *Ilex* species (Aquifoliaceae): evidence of hybridization within a Miocene radiation. – Mol. Phylogenet. Evol. 57: 961–977.

McNeill, J. et al. 2012. International code of nomenclature for algae, fungi and plants (Melbourne code). – Koeltz Scientific Books.

Powell, M. et al. 2000. The mountain holly (*Nemopanthus mucronatus*: Aquifoliaceae) revisited with molecular data. – Kew Bull. 55: 341–347.

Rehder, A. 1916. Symplocaceae. – In: Sargent, C. S. (ed.), Plantae Wilsonianae: an enumeration of the woody plants collected in western China for the Arnold Arboretum of Harvard University during the years 1907, 1908 and 1910. Vol. 2. Cambridge Univ. Press, pp. 593–599.

Shang, Q. B. et al. 2010. A new species of *Ilex* form Hunan Province. – Bull. Bot. Res. 30: 645–647.

Shi, S. et al. 2015. *Ilex sanqingshanensis* sp. nov. (Aquifoliaceae) from Jiangxi Province, China. – Nord. J. Bot. 33: 662–667.

Shi, L. et al. 2016. Molecular evidence for the hybrid origin of *Ilex dabieshanensis* (Aquifoliaceae). – PLoS One 11: e0147825.

Tseng, C. J. 1981. Contributions to the Aquifoliaceae of China. – Bull. Bot. Res. 1: 1–44.

Tseng, C. J. 1984. New taxa of *Ilex* from Guangxi. – Acta Phytotax. Sin. 22: 413–416.

Yao, K. and Deng, M. B. 1987. A new species of *Ilex* (Aquifoliaceae) from Anhui. – Acta Phytotax. Sin. 25: 324–325.