Torreya dapanshanica (Taxaceae), a new species of gymnosperm from Zhejiang, East China

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Abstract

Torreya dapanshanica X.F.Jin, Yi-F.Lu & Zi L.Chen, a new species endemic to central Zhejiang, East China, is described and illustrated. This new species is most similar to T. jiulongshanensis (Z.Y.Li, Z.C.Tang & N.Kang) C.C.Pan, J.L.Liu & X.F.Jin, but differs in having leaves with an acuminate apex (vs. leaves with an acute apex), broadly ovoid-globose or globose seeds (vs. obovoid to narrowly obovoid seeds), slightly emarginate at the apex and obtuse-rounded at the base (vs. both acute at the apex and base), testa with irregular shallow grooves (vs. testa smooth or sometimes slightly concave). The diagnostic characters are critically compared and an IUCN assessment for the risk to the new species is estimated.

Keywords

Gymnosperm, new species, Torreya dapanshanica, Zhejiang
Introduction

Torreya Arn. (Taxaceae), containing eight species, is distributed in E Asia and SE to W America (Yang et al. 2017). The genus is represented by five species native to China together with Torreya nucifera, a cultivated species. Torreya grandis is both widely distributed and cultivated in East China (Cheng et al. 1978; Fu et al. 1999; Teng et al. 2017).

Female gametophyte tissue of seeds in cultivated Torreya grandis can be produced as edible ‘nuts’ and are called ‘Xiāngfěi’ in Chinese, which are available for sale in the markets in Zhejiang Province. In Zhejiang, as Ching reported in Hu (1927), people in Shengxian [Shen Hsien in the Wade-Giles Romanization system of writing Chinese], Kuaiji [Kwei-che], and Zhuji [Chu-che Hsien] have long since been meeting to sell nuts, although the region is very rugged, making traveling and transportation very difficult at that time. The ‘Xiāngfěi,’ fried seeds of the cultivated varieties viz. T. grandis ‘Merrillii’, produced from Fengqiao in Zhuji County are the most famous now for their large seeds, high yield, and good quality (Teng et al. 2017).

The species Torreya grandis is widely cultivated in the central to southwestern regions of Zhejiang, and some cultivars had long been recognized (Hu 1927). Chun (1925) described a long-leaved species, T. jackii, which was collected by Ching from Xianju, Zhejiang. Hu (1927) conducted a taxonomic study on Chinese Torreya, and recognized three native species, placing Torreya fargesii and T. jackii, which have deeply ruminated megagametophyte (female gametophyte tissue) in the sect. Ruminatae, while T. grandis with slightly ruminated megagametophyte was placed in sect. Nuciferae. Based on the variable size and shape of seeds of T. grandis, Hu recognized and described four varieties and one form from Fengqiao, Zhuji County; these infraspecific taxa were later recognized as cultivated varieties of T. grandis (Zhang 1993). Cheng et al. (1975) described Torreya yunnanensis as a new species from NW Yunnan, which was later classified as a variety, T. fargesii var. yunnanensis, by Kang (Kang and Tang 1995). Another new species, Torreya parvifolia described from S Sichuan, is similar to T. yunnanensis but differs in having shorter leaves and smaller seeds (Yi et al. 2006). Kang and Tang (1995) reviewed the taxonomy of the genus Torreya, and described a new variety, T. grandis var. jiulongshanensis, from Suichang County of SW Zhejiang. This variety has longer leaves and deeply ruminated megagametophyte, and was recently treated as an independent species (Teng et al. 2017). Torreya jiulongshanensis is at variance with the broader species concepts of Torreya grandis by Farjon (2010) and Eckenwalder (2009). These authors consider it as a variety or synonym of Torreya grandis.

During preparation of the new version of the “Flora of Zhejiang”, while developing a plan to protect the extremely small population of Torreya jiulongshanensis, an unusual Torreya was collected from Pan’an in central Zhejiang, which is similar to T. jiulongshanensis, but differs in having larger seeds, relatively longer leaves and acuminate apex (Teng et al. 2017). A precise morphological comparison of leaves and seeds revealed this taxon as a distinct new species, which we name and describe below.
Results

Torreya dapanshanica X.F. Jin, Y.F. Lu & Zi L. Chen, sp. nov. urn:lsid:ipni.org:names:77295798-1 Figs 1, 2

Latin diagnosis. Species nova haec T. jiulongshanensi (Z.Y. Li et al.) C.C. Pan et al. affinis est, sed a qua foliis apice acuminatis, basi cuneatis, seminibus late ovoideo-globosis vel globosis, basi obtusis, testis irregulariter et vadose canaliculatis differt.

Type. China. Zhejiang: Pan’an, Mount Dapanshan, Huaxi, on slope under forest, 28°58'37.41"N, 120°30'00.01"E, alt. 420 m, 22 August 2017, Xiao-Feng Jin 4036B (holotype: ZM; isotypes: HTC, PE, ZJFC, ZM).

Trees evergreen, 5–8 m tall, with trunk to 25 cm d.b.h., dioecious; bark gray-brown, irregularly vertically fissured; branches glabrous, slightly shiny, with young branches green and biennial ones yellow-green or green. Leaves decussate, base coiled and 2-ranked; blade linear, (1.9–)3–5(–6.9) cm long, 2.7–3.2 mm wide, upper part slightly falcate, apex acuminate and spiculate, base cuneate, adaxially dark green, shining, with mid-rib slightly concave, 2 grooves from base to near apex, abaxially green, with mid-rib slightly raised, 2 stomatal bands brown, each nearly equal to mid-rib in width, marginal band ca. 2× as wide as stomatal band; petioles short, ca. 1 mm long, yellow-brown. Pollen cones solitary, axillary, ovoid-globose, 9–12 mm long, 7–9 mm wide, base shortly pedunculate; peduncles 3–3.5 mm long; bracts 5 or 6-pairs, decussate, abaxially ridged, lowermost 2 pairs smaller, green, papery, others yellow-green, thinly papery; microsporophylls 42–56, spiral in 6–8 whorls, triangular-ovate, membranous, 2–2.5 mm long, apex praemorse with 9 minute teeth, each with 4 pollen sacs abaxially; pollen sac yellow, ellipsoid, 1.2–1.5 mm long, ca. 0.8 mm wide, longitudinally divided. Seed-bearing structures borne in pairs in leaf axils, sessile, 6–7 mm long, each with 2 pairs of decussate bracts and 1 lateral bract; bracts sub-leathery, abaxially ridged. Aril succulent, base with persistent bracts; seed (including aril) obovoid, 3.5–4 cm long, 2–2.5 cm in diam., apex slightly convex with a mucro, seed (excluding aril) broadly ovoid-globose or globose, apex slightly emarginate, base obtuse-rounded; testa ligneous, stiff, with irregular shallow grooves; female gametophyte tissue deeply ruminate.

Distribution and habitat. This new species is known only from Mount Dapanshan of Pan’an County, central Zhejiang. It grows at a single location on a forested slope by a stream margin at an elevation of 420–485 m.

Phenology. Pollen cones observed from late early July to early the following April; ovules from mid-November to late the following April. Seeds mature from September to October.

Etymology. The specific epithet ‘dapanshanica’ refers to the type locality of the new species.

Conservation status. Critically Endangered (CR) [B2ab(ii)D] (International Union for Conservation of Nature, IUCN 2019). The new species is only known from the
Figure 1. *Torreya dapanshanica* sp. nov. A branch with seeds B leaf (abaxial surface) C branch with pollen cones D microsporophyll/stamen (abaxial surface with four pollen sacs) E microsporophyll/stamen (adaxial surface) F branch with ovules G ovule (showing macrosporophyll and bracts) H seeds without aril I cross section of seed (showing deeply ruminate megagametophyte) (drawn by Xiao-Feng Jin; based on Xiao-Feng Jin 4036B, ZM).
type locality, Mount Dapanshan in Pan’an County, and occupies less than 1 km² with about six mature individuals and two seedlings. Moreover, the habitat destruction and seed harvesting by local people still exist. This species is considered as Critically Endangered (CR) according to classification methods used by the IUCN Red List Categories and Criteria (IUCN 2019) based on the current survey.

**Specimen examined.** Zhejiang: Pan’an, Mount Dapanshan, Huaxi, in forest by stream, 28°58’37.41"N, 120°30’00.01"E, alt. 470 m, 24 November 2012, Xiao-Feng Jin & Ying-Ying Zhou 2938 (ZJFC, ZM), alt. 479 m, 24 November 2012, Xiao-Feng Jin & Ying-Ying Zhou 2940 (ZM); the same locality, on slope by stream,
Comparison. Teng et al. (2017) analyzed the leaf variation of all wild species of Torreya from Zhejiang, and found the leaves of T. grandis var. jiulongshanensis were different from those of T. grandis and T. jackii. Consequently, var. jiulongshanensis was treated as an independent species and combined as T. jiulongshanensis. Within some populations identified as T. jiulongshanensis, Teng et al. (2017) mentioned that the leaves from the population in Pan’an were different from the others. Herein, we compared the leaf apex, and found that those from Pan’an (T. dapanshanica) are acuminate, whereas those from Suichang (T. jiulongshanensis) are acute (Fig. 3).

Seed morphology of Torreya dapanshanica is also different from T. jiulongshanensis (Fig. 4). The seeds of Torreya dapanshanica are broadly ovoid-globose or globose, 25.52±3.52 mm × 15.62±3.67 mm, apex slightly emarginate, base obtuse-rounded, testa with irregular shallow grooves. Torreya jiulongshanensis has seeds that are obovoid to narrowly ovoid, 22.56±3.28 mm × 10.29±2.23 mm, both apex and base acute, testa smooth or sometimes slightly concave.

A key to all known species of Torreya from China is shown below.
Key to the species of *Torreya* from China

1. Female gametophyte tissue slightly ruminate ........................................... *T. grandis*
   – Female gametophyte tissue deeply ruminate ........................................... 2
2. Inner wall of seed coat smooth; female gametophyte tissue without grooves.
   ................................................................................................................ 3
   – Inner wall of seed coat with 2 opposite longitudinal ridges; female gametophyte tissue with 2 conspicuous longitudinal grooves .................................. 6
3. Leaves 1.2–3 cm long, usually straight ........................................... *T. fargesii*
   – Leaves 2.5–7 cm long, slightly to strongly falcate ................................... 4
4. Leaves 2.5–5 cm long, stomatal bands brown; arils green-brown or brown, not powdery ............................................................... 5
   – Leaves 3.5–7 cm long, stomatal bands silvery gray; arils white powdery ....
     ........................................................................................................ 6
5. Leaf apex acute; seeds obovoid or narrowly obovoid, base acuminate; testa usually smooth ............................................................. *T. jiulongshanensis*
   – Leaf apex acuminate; seeds broadly ovoid-globose or globose, base obtuse; testa with irregular and shallow grooves ..................................... *T. dapanshanica*
6. Leaves 2–3.6 cm long; testa smooth ........................................... *T. yunnanensis*
   – Leaves 1.2–2 cm long; testa with irregular and shallow grooves ..............
     ........................................................................................................ *T. parvifolia*

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References

Cheng WC, Fu LK, Cheng CY (1975) Cymnospermae Sinicae. Zhiwu Fenlei Xuebao 13(4): 56–89. https://doi.org/10.1016/0002-8703(75)90099-X

Cheng WC, Fu LK, Chu CD (1978) Torreya. In: Cheng WC, Fu LK (Eds) Flora Reipublicae Popularis Sinicae (Vol. 7). Science Press, Beijing, 457–467.

Chun WY (1925) Two new trees from Chekiang. Journal of the Arnold Arboretum 6(3): 144–145. https://doi.org/10.5962/bhl.part.24130

Eckenwalder JE (2009) Conifers of the World: the Complete Reference. Timber Press.

Farjon A (2010) A Handbook of the World’s Conifers. E J Brill. https://doi.org/10.1163/9789047430629

Fu LG, Li N, Mill RR (1999) Taxaceae. In: Wu ZY, Raven PH (Eds) Flora of China (Vol. 4). Science Press, Beijing and Missouri Botanical Garden Press, St-Louis, 89–96.

Hu HH (1927) Synoptical study of Chinese Torreyas, with supplemental notes on the distribution and habitat. Contributions from the Biological Laboratory of the Science Society of China 3(5): 1–37.

IUCN (2019) Guidelines for using the IUCN Red List Categories and Criteria. Version 14. Prepared by the Standards and Petitions Subcommittee. https://www.iucnredlist.org/resources/redlistguidelines [accessed on 15 March 2021]

Kang N, Tang ZX (1995) Studies on the taxonomy of the genus Torreya. Bulletin of Botanical Research 15(3): 349–362.

Teng TY, Pan CC, Liu JL, Chen ZL, Xie WY, Jin XF (2017) Leaf variation of Torreya plants in Zhejiang and its taxonomic implications. Journal of Hangzhou Normal University (Natural Science Edition) 16(1): 9–12+. http://doi.org/10.3969/j.issn.1674-232X.2017.01.003

Yang Y, Wang ZH, Xu XT (2017) Taxonomy and Distribution of Global Gymnosperms. Shanghai Scientific and Technical Publishers, Shanghai, 1073–1079.

Yi TP, Yang L, Long TL (2006) Torreya parvifolia, a new species of the Taxaceae from Sichuan, China. Bulletin of Botanical Research 26(5): 513–515. http://doi.org/10.7525/j.issn.1673-5102.2006.05.001

Zhang SY (1993) Torreya. In: Zhang CF, Zhang SY (Eds) Flora of Zhejiang (Vol. 1). Zhejiang Science and Technology Publishing House, Hangzhou, 389–391.