

TAXACEAE

红豆杉科 hong dou shan ke

Fu Liguó (傅立国 Fu Li-kuo)¹, Li Nan (李楠)²; Robert R. Mill³

Trees or shrubs evergreen, dioecious or rarely monoecious. Leaves spirally arranged or decussate, linear or lanceolate, abaxial surface with 1 stomatal band on each side of prominent or inconspicuous midvein, resin canal present or absent. Pollen cones solitary in leaf or bract axils, or aggregated into spikelike complexes apically on branches; microsporophylls numerous; pollen sacs 3–9, radially arranged or on outer side of microsporophyll and then with distinct adaxial and abaxial surfaces; pollen nonsaccate. Seed-bearing structures solitary or paired in axils of leaves or bracts, pedunculate or sessile, with several overlapping or decussate bracts at base; ovule solitary, borne at apex of floral axis, erect. Seed sessile or pedunculate, drupelike or nutlike, partially enclosed in a succulent, saccate or cupular aril, or completely enclosed within aril; female gametophyte tissue abundant. Cotyledons 2. Germination epigeal, hypogeal in *Torreya*.

Five genera and 21 species; mainly N hemisphere (except *Austrotaxus* R. H. Compton: New Caledonia); four genera (one endemic) and 11 species (five endemic, one introduced) in China.

Cheng Wan-chün, Fu Li-kuo & Chu Cheng-de. 1978. Taxaceae. In: Cheng Wan-chün & Fu Li-kuo, eds., Fl. Reipubl. Popularis Sin. 7: 437–467.

- 1a. Leaves with midvein \pm inconspicuous adaxially; pollen sacs borne on outer side of microsporophylls, with distinct adaxial and abaxial surfaces; seed-bearing structures paired in leaf axils, sessile; seed completely enclosed within aril 4. *Torreya*
- 1b. Leaves with midvein prominent adaxially; axillary; pollen sacs various; seed-bearing structures solitary in axils of leaves or bracts, shortly pedunculate or subsessile; seed surrounded by a cupular or saccate aril, but with distal part exposed.
- 2a. Leaves decussate, with resin canal; pollen cones arranged in terminal (very rarely lateral) spikes; seed-bearing structures long pedunculate; aril saccate, almost completely enclosing seed except for extreme apex 3. *Amentotaxus*
- 2b. Leaves spirally arranged, sessile, without resin canal; pollen cones solitary in leaf axils, not forming spikes; seed-bearing structures shortly pedunculate or subsessile; aril cupular, enclosing only proximal part of seed.
- 3a. Branchlets irregularly alternate; abaxial stomatal bands of leaves pale yellow or pale grayish green; aril of seed red when ripe 1. *Taxus*
- 3b. Branchlets subopposite or subwhorled; abaxial stomatal bands of leaves white powdery; aril of seed white when ripe 2. *Pseudotaxus*

1. TAXUS Linnaeus, Sp. Pl. 2: 1040. 1753.

红豆杉属 hong dou shan shu

Trees or shrubs evergreen, dioecious; branchlets irregularly alternate, basal part with few or several persistent or early deciduous bud scales; winter bud scales overlapping, with prominent or indistinct, longitudinal adaxial ridges. Leaves 2-ranked, spirally arranged, sessile, or shortly petiolate in *Taxus cuspidata*, linear, straight or falcate, decurrent, adaxial surface with raised midvein, abaxial surface with 2 pale gray, grayish blue, or pale yellow stomatal bands, resin canal absent. Reproductive structures axillary, solitary. Pollen cones pedicellate, globose, with overlapping bracts at base; microsporophylls 6–14, shield-shaped, each with 4–9 radially arranged pollen sacs. Seed-bearing structures subsessile, with several overlapping bracts, 2 or 3 distal pairs of which are decussate. Aril red or orange when ripe, succulent. Seed nutlike, ripening in 1st year, enclosed within cupular aril but with apex exposed; hilum prominent. Cotyledons 2. Germination epigeal. $2n = 24$.

About nine species: mainly N hemisphere; three species in China.

Taxus sumatrana (Miquel) de Laubenfels (*T. celebica* (Warburg) H. L. Li), from Indonesia (Sulawesi and Sumatra) and the Philippines, has been recorded from China (e.g., Fl. Taiwan, ed. 2). Such records are based on a broad concept of that species, including the taxa treated in this account as *T. wallichiana* var. *chinensis* and *T. wallichiana* var. *mairei* (but excluding the type of *T. wallichiana*). The total number of distinct species of *Taxus* occurring in Asia is quite controversial and in need of further study.

The papillae and other characters of the abaxial leaf surface are best observed in fresh, young leaves. The papillae are minute and are best seen using a microscope or a lens of $\times 25$ magnification or greater.

¹ Herbarium, Institute of Botany, Chinese Academy of Sciences, 20 Nanxincun, Xiangshan, Beijing 100093, People's Republic of China.

² Herbarium, Shenzhen Fairy Lake Botanical Garden, Liantang, Shenzhen, Guangdong 518004, People's Republic of China.

³ Herbarium, Royal Botanic Garden Edinburgh, 20a Inverleith Row, Edinburgh EH3 5LR, Scotland, United Kingdom.

- 1a. Leafy branchlets ± flat in living state; leaves linear to lanceolate, gradually tapered distally, usually falcate, apex gradually acuminate or abruptly tapered and indistinctly mucronate; winter bud scales early deciduous or some persistent at base of branchlets 2. *T. wallichiana*
- 1b. Leafy branchlets “V”-shaped in cross section in living state; leaves linear, almost equally wide throughout length, straight or slightly falcate, apex shortly mucronate to cuspidate; winter bud scales persistent at base of branchlets.
- 2a. Leaves usually straight, midvein densely and evenly papillate abaxially, base usually symmetric; seed columnar-oblong, ± equally wide throughout length, obtusely ridged on 2 sides distally; hilum elliptic 1. *T. fuana*
- 2b. Leaves slightly falcate, midvein not papillate abaxially, base ± asymmetric; seed ovoid or trigonous-ovoid, distal part with 3 or 4 or more obtuse ridges; hilum usually triangular or quadrangular 3. *T. cuspidata*

1. *Taxus fuana* Nan Li & R. R. Mill, Novon 7: 263. 1997.

密叶红豆杉 mi ye hong dou shan

Trees or large shrubs to 12 m tall; trunk to 3.5 m d.b.h.; winter buds ovoid, scales persistent at base of branchlets, ridged adaxially, abruptly acute at apex. Leafy branchlets “V”-shaped in cross section in living state, 3–6 × 3.5–6 cm in outline. Leaves borne at 60–90° to branchlet axis; petiole 1–1.5 mm; blade bright green adaxially, linear, almost equally wide throughout length, usually straight, 1.2–3(–3.5) cm × 1.5–2.5 mm, ± thick, midvein and stomatal bands both densely and evenly papillate abaxially, midvein ca. 0.2 mm wide abaxially, stomatal bands pale yellow, 0.6–0.7 mm wide, marginal bands 0.1–0.2 mm wide, base cuneate or shortly attenuate, usually symmetric, margin revolute (especially when dry), apex cuspidate, mucro 0.5–1 mm. Pollen cones ovoid, 6–8 mm; cone axis extended above apical bracts as a short stalk ca. 1 mm; bracts 2-ranked, proximal ones imbricate, small, distal ones pale green and semitransparent, much larger; microsporophylls pinkish brown. Seed-bearing structures axillary, sessile. Aril red when ripe. Seed columnar-oblong, ± equally wide throughout length, slightly bilaterally flattened, ca. 6.5–7 × 4.5–5 mm, obtusely ridged on 2 sides distally, apex sharply mucronate; hilum elliptic. Pollination Apr, seed maturity Sep–Nov.

Mixed forests and *Pinus* forests, usually in shade; 2500–3100 (–3400) m (descending to 1800 m in other parts of range of species). SW Xizang (Jilong Xian) [N India, Kashmir, Nepal, Pakistan].

An endangered species in China. In FRPS, two species of *Taxus* were recognized from SW China: the plants restricted to SW Xizang were identified as *T. wallichiana*, while those from SW Sichuan, SE Xizang, and W Yunnan were recognized as *T. yunnanensis*. However, Nan Li & L. K. Fu (Novon 7: 263–264. 1997) noted that critical study of types and authentic material revealed *T. yunnanensis* to be a synonym of *T. wallichiana*, and the plants identified in FRPS as *T. wallichiana* to be a new species, *T. fuana*.

2. *Taxus wallichiana* Zuccarini, Abh. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. 3: 803. 1843.

须弥红豆杉 xu mi hong dou shan

Trees or shrubs to 30 m tall; trunk to 1.3 m d.b.h.; bark variably colored, grayish brownish, reddish, or purplish, peeling off in strips or cracking and falling off as thin

scales; winter bud scales early deciduous or some persistent at base of branchlets, triangular-ovate, with or without longitudinal ridges abaxially. Leafy branchlets ± flat in living state, 3–9 × 1.5–6 cm in outline. Leaves borne at (50–)60–90° to branchlet axis, subsessile or with petiole to 1 mm; blade dark green and glossy adaxially, paler abaxially, linear to lanceolate, gradually tapered distally, usually falcate, (0.9–)1.5–3.5(–4.7) cm × (1.5–)2–4(–5) mm, midvein slightly elevated adaxially, 0.1–0.2 mm wide, densely and evenly papillate abaxially, or with papillae scattered on midvein or in 1–several lateral rows adjacent to stomatal band, or midvein not papillate, stomatal bands pale yellowish, 0.6–0.9 mm wide, densely and evenly papillate, marginal bands 0.1–0.4 mm wide, base cuneate or attenuate, asymmetric, margin flat to revolute, apex gradually acuminate or abruptly tapered and indistinctly mucronate, mucro 0.1–0.5 mm. Pollen cones scattered along 2nd year branchlet axis, ± sessile or shortly pedunculate (peduncle ca. 0.5 mm), pale yellowish, ovoid, 5–6 × ca. 3 mm; bracts usually 6, broadly ovate, pale green; microsporophylls 8–14, each with (4 or) 5 or 6(–8) pollen sacs. Seed-bearing structures borne toward distal end of branchlet axis. Aril red or orange when ripe, often ± translucent. Seed ovoid or obovoid, occasionally columnar-oblong, sometimes slightly flattened, 5–8 × 3.5–5 mm, usually with obtuse ridges (sometimes trigonous and 3-ridged); apex with small mucro; hilum elliptic to suborbicular or rounded-trigonous. Pollination Sep–Apr, seed maturity Aug–Dec. Broad-leaved, coniferous, and mixed forests, thickets, deforested rocks, open slopes; 100–3500 m. S Anhui, Fujian, S Gansu, N Guangdong, N Guangxi, Guizhou, W Henan, W Hubei, Hunan, Jiangxi, S Shaanxi, Sichuan, Taiwan, SE Xizang, Yunnan, Zhejiang [Bhutan, N India, ?Laos, Myanmar, Sikkim, Vietnam].

Can be used within its native range for afforestation. The wood is an excellent building material, and is also used in making vehicles, agricultural implements, furniture, and stationery. A compound recently isolated from the leaves may prove promising as an antitumor agent.

- 1a. Leaves linear to lanceolate, thin and soft 2a. var. *wallichiana*
- 1b. Leaves linear, thick textured.

- 2a. Leaves straight to distally falcate, usually 1.5–2.2 cm × ca. 3 mm, midvein of same color as stomatal band, densely and evenly papillate, margin flat in living state 2b. var. *chinensis*
- 2b. Leaves usually falcate, 2–3.5 cm × 2.5–4 mm, midvein of different color to stomatal band, not papillate, or with papillae scattered on midvein or in 1–several lateral rows adjacent to stomatal band, margin revolute 2c. var. *mairei*

2a. *Taxus wallichiana* var. *wallichiana*

须弥红豆杉(原变种) xu mi hong dou shan (yuan bian zhong)

Taxus baccata Linnaeus subsp. *wallichiana* (Zuccarini) Pilger; *T. wallichiana* var. *yunnanensis* (W. C. Cheng & L. K. Fu) C. T. Kuan; *T. yunnanensis* W. C. Cheng & L. K. Fu.

Leaves linear to lanceolate, thin and soft.

Broad-leaved and mixed forests, often among bamboos, frequently by streams; 2000–3500 m. SW Sichuan, SE Xizang, W Yunnan [Bhutan, N India, N Myanmar, Sikkim, S Vietnam].

2b. *Taxus wallichiana* var. *chinensis* (Pilger) Florin, Acta Hort. Berg. 14(8): 355. 1948.

红豆杉 hong dou shan

Taxus baccata subsp. *cuspidata* (Siebold & Zuccarini) Pilger var. *chinensis* Pilger in Engler, Pflanzenr. IV. 5 (Heft 18): 112. 1903; *T. baccata* var. *sinensis* A. Henry; *T. chinensis* (Pilger) Rehder; *T. cuspidata* Siebold & Zuccarini var. *chinensis* (Pilger) C. K. Schneider. Leaves linear, straight to distally falcate, usually 1.5–2.2 cm × ca. 3 mm, thick textured, midvein of same color as stomatal band, densely and evenly papillate, margin flat in living state.

Forests, often among bamboos, frequently by streams; 1100–2500(–2700) m. S Anhui (Huang Shan), Fujian, S Gansu, N Guangxi, SE and W Guizhou, W Hubei, NE Hunan, S Shaanxi, Sichuan, E Yunnan, Zhejiang; cultivated in Jiangxi (Lu Shan) [N Vietnam].

2c. *Taxus wallichiana* var. *mairei* (Lemée & H. Léveillé) L. K. Fu & Nan Li, Novon 7: 263. 1997.

南方红豆杉 nan fang hong dou shan

Tsuga mairei Lemée & H. Léveillé, Monde Pl. 2(16): 20. 1914; *Taxus chinensis* (Pilger) Rehder var. *mairei* (Lemée & H. Léveillé) W. C. Cheng & L. K. Fu; *T. mairei* (Lemée & H. Léveillé) S. Y. Hu ex T. S. Liu; *T. speciosa* Florin.

2. PSEUDOTAXUS W. C. Cheng, Res. Notes Forest. Inst. Nat. Centr. Univ. Nanking, Dendrol. Ser., 1: 1. 1947.

白豆杉属 bai dou shan shu

Nothotaxus Florin.

Leaves linear, usually falcate and 2–3.5 cm × 2.5–4 mm, thick, midvein of different color to stomatal band, not papillate, or with papillae scattered on midvein or in 1–several lateral rows adjacent to stomatal band, margin revolute.

Coniferous and mixed forests, thickets, deforested rocks, open slopes; 100–3500 m (but usually at lower elevations than var. *chinensis*, especially in the E, typically below 1200 m, ascending to over 3000 m in Sichuan and Yunnan). S Anhui, Fujian, S Gansu, N Guangdong, N Guangxi, Guizhou, W Henan, W Hubei, Hunan, Jiangxi, S Shaanxi, Sichuan, Taiwan, E Yunnan, Zhejiang [N India, ?Laos, Myanmar, Vietnam].

3. *Taxus cuspidata* Siebold & Zuccarini, Abh. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. 4(3): 232. 1846.

东北红豆杉 dong bei hong dou shan

Taxus baccata Linnaeus subsp. *cuspidata* (Siebold & Zuccarini) Pilger; *T. baccata* subsp. *cuspidata* var. *latifolia* Pilger; *T. baccata* var. *microcarpa* Trautvetter; *T. caespitosa* Nakai; *T. cuspidata* var. *latifolia* (Pilger) Nakai; *T. cuspidata* var. *microcarpa* (Trautvetter) Kolesnikov.

Trees to 20 m tall; trunk to 1–1.5 m d.b.h.; bark reddish brown, with shallow fissures; winter bud scales persistent at base of branchlets, overlapping, ridged dorsally, tapered apically. Leafy branchlets “V”-shaped in cross section in living state. Leaves borne at 75–95° to branchlet axis, subsessile; blade dark green and glossy adaxially, linear, almost equally wide throughout length, slightly falcate, 1–2.5(–4) cm × 2.5–3 mm, midvein not papillate abaxially, stomatal bands tawny yellow, 0.6–0.7 mm wide, at least 2 × as wide as marginal bands, marginal bands ca. 0.2 mm wide, base cuneate, ± asymmetric, margin revolute, apex usually shortly mucronate, mucro 0.1–0.3 mm. Pollen cones ovoid or subglobose, ca. 3.5 mm; peduncle 0.5–1 mm; microsporophylls 9–14, each with 5–8 pollen sacs. Aril purplish red when ripe, lustrous. Seed ovoid or trigonous-ovoid, ca. 6 × 4–4.5 mm, distally with 3 or 4 or more obtuse ridges, apex with small, obtuse mucro; hilum usually triangular or quadrangular. Pollination spring, seed maturity autumn.

Acid soils in cold, humid places; 500–1000 m. Heilongjiang, E Jilin, Liaoning, Shaanxi [Japan, Korea, E Russia (Kurile Islands, Primorye, Sakhalin)].

Only var. *cuspidata*, described here, occurs in China; var. *nana* Rehder occurs in Japan.

The wood used in building construction, furniture manufacture, and as a carving material. The heartwood yields a red dye, oil is extracted from the seeds, and a compound used to treat diabetes is extracted from the wood, bark, leaves, and roots.

Shrubs evergreen, dioecious; branches usually whorled; branchlets subopposite or subwhorled, base with persistent bud scales; winter bud scales overlapping, ridged adaxially. Leaves spirally arranged, distichous; petiole very short or leaves sessile; blade linear, basally twisted, straight or slightly falcate, midvein raised both adaxially and abaxially, abaxial stomatal bands 2, white, resin canal absent, base obtuse, decurrent, apex mucronate. Reproductive structures axillary, solitary, sessile. Pollen cones globose, with 4 pairs of decussate basal bracts; microsporophylls 6–12, shieldlike, decussate; pollen sacs 4–6, radially arranged. Seed-bearing structures with 7 pairs of decussate basal bracts in 4 series each of 3 or 4 bracts. Ovule erect, sessile. Aril white when ripe, cupular, succulent. Seed ripening in 1st year, nutlike, ovoid, slightly flattened, enclosed within aril except for distal, exposed part, apex with a small mucro. Cotyledons 2. Germination epigeal. $2n = 24^*$.

• One species: China.

1. *Pseudotaxus chienii* (W. C. Cheng) W. C. Cheng, Res. Notes Forest. Inst. Nat. Centr. Univ. Nanking, Dendrol. Ser., 1: 1. 1947.

白豆杉 *bai dou shan*

Taxus chienii W. C. Cheng, Contr. Biol. Lab. Chin. Assoc. Advancem. Sci., Sect. Bot., 9(3): 240. 1934;

Nothotaxus chienii (W. C. Cheng) Florin; ?*Pseudotaxus liana* Silba.

Shrubs to 4 m tall; bark grayish brown, peeling off in strips. Leafy branchlets ovate or elliptic in outline, 2.2–5 × 1.2–3.2 cm, axis green or yellow-green in 1st year, dark green in 2nd year, terete, sometimes with nodular projections. Leaves borne at 40–45° to axis when young but at 50–90° on mature trees; petiole absent or less than 1 mm; blade bright green adaxially in 1st year, subsequently abruptly turning very dark green, linear, straight or slightly falcate, 1–2.6 cm × 2–4.5 mm, not leathery, midvein ca. 0.4 mm wide, stomatal bands ca. 0.5–1.1 mm wide, broader than or about as wide as marginal bands, of ca. 9 rows on young plants but of 13–19 rows on adult plants, marginal bands 0.2–0.3

mm wide, base obtuse and ± asymmetric, margin revolute, apex obtuse, mucronate, mucro pale whitish green, hooked, 0.4–0.7 mm. Aril campanulate, 5–7 mm. Seed ovoid, 5–8 × 4–5 mm, slightly flattened distally. Pollination late Mar–May, seed maturity Oct.

• Evergreen and deciduous broad-leaved forests. N Guangdong, N Guangxi, NW and S Hunan, SW Jiangxi, S Zhejiang; also cultivated in Zhejiang (Hangzhou Shi, etc.) as an ornamental.

A rare species. The wood is used as a carving material and for making utensils.

Pseudotaxus liana was described from Guangxi and at the same time recorded from Hunan and Jiangxi. In the protologue (Silba, Phytologia 81: 327. 1996, as “*liana*”), it was said to differ from *P. chienii* in its broadly ovate or ovate-oblong leaves, 1.3–2.8 cm × 3.5–5.5 mm, which are thick and leathery; it was also compared with two species in the Podocarpaceae: *Podocarpus brassii* Pilger, from Indonesia (Irian Jaya) and Papua New Guinea, and *Prumnopitys harmsiana* (Pilger) de Laubenfels, from South America. Further study is needed to ascertain whether it is distinct from *Pseudotaxus chienii* and, if so, to settle its generic, and possibly also familial, placement. If it is distinct, then some of the records of *P. chienii* may in fact belong to the new species.

3. AMENTOTAXUS Pilger, Bot. Jahrb. Syst. 54: 41. 1916.

穗花杉属 *sui hua shan shu*

Shrubs or small trees dioecious; branchlets opposite, base with bud scales not persistent; winter buds tetragonal-ovate, acute, glossy, scales, decussate, in 3–5 whorles of 4, ridged adaxially. Leaves decussate, but brought into a single plane by twisting of petioles; blade straight or slightly falcate, usually more than 5 mm wide, adaxial surface mottled when fresh, rarely smooth, rugose or ± so when dry, resin canal present below sheath of vascular bundle, sclereids present, rarely absent, base decurrent, margin slightly downcurved. Pollen cones aggregated into (1 or)2–6(–10) long, slender, compound racemes or spikes arising from bract axil near apex of branches; individual cones opposite, sessile or subsessile, ellipsoid or subglobose; microsporophylls numerous, ± shield-shaped; pollen sacs 3–8, arranged radially, or adaxially and abaxially. Seed-bearing structures compressed-tetragonal or flattened abaxially, basal part with 6–10 pairs of decussate bracts arranged in 4 rows each of 3–5 bracts; ovule 1, sessile, erect. Seed ripening in 1st year, long pedunculate, ellipsoid or obovoid-ellipsoid, enclosed except for apex in a saclike aril which is bright red or reddish yellow when ripe; bracts persistent at base.

Five or six species: China, Vietnam; three species (one endemic) in China.

Amentotaxus has been placed in its own tribe (Amentotaxae W. C. Cheng & C. D. Chu) or family, Amentotaxaceae. Although Page (in Kubitzki, Fam. Gen. Vasc. Pl. 1: 299–302. 1990) included it in the Cephalotaxaceae, molecular data indicate very strongly that it is the sister genus of *Torreya*, which is similar in the size and shape of its seed and in usually having bilaterally symmetric clusters of pollen sacs.

Amentotaxus assamica D. K. Ferguson (Kew Bull. 40: 115. 1985) was described from SE Xizang, in temperate rainforests on steep, north-facing slopes, associated with species of *Magnolia*, *Quercus*, *Rhododendron*, etc. It is apparently similar to *A. argotaenia*, but differs in having leaves without sclereids, the adaxial surface smooth or with only longitudinal striations (due to shrinkage) when dry. Further collections are needed to establish whether it is truly distinct from *A. argotaenia*.

1a. Stomatal bands on abaxial leaf surface 2/3 to 1.5 × as wide as green marginal bands 3. *A. argotaenia*

1b. Stomatal bands on abaxial leaf surface 2 × as wide as green marginal bands.

- 2a. Leaves linear, linear-lanceolate, or linear-elliptic, 8–15 mm wide, usually straight, apex tapered or obtuse, abaxial stomatal bands pale brown or pale yellowish white; pollen cone racemes 4 or more, 10–15 cm; seed ellipsoid, 2.2–3 cm 1. *A. yunnanensis*
- 2b. Leaves lanceolate or linear-lanceolate, 5–10 mm wide, usually slightly falcate, tapered distally, apex long acuminate, stomatal bands white; pollen cone racemes usually 2–4, less than 5 cm; seed usually obovoid-ellipsoid, 2–2.5 cm 2. *A. formosana*

1. *Amentotaxus yunnanensis* H. L. Li, J. Arnold Arbor. 33: 197. 1952.

云南穗花杉 *yun nan sui hua shan*

Amentotaxus argotaenia (Hance) Pilger var. *yunnanensis* (H. L. Li) P. C. Keng.

Trees to 15 m tall; trunk to 25 cm d.b.h.; main branches spreading to form a broad, ovoid crown. Leafy branchlets ascending, broadly oblong-ovate in outline, ca. 8 × 12 cm, axis green in 1st year, thereafter light yellow to light yellowish brown, ridged. Leaves borne at ca. 60° to branchlet axis, subsessile, linear, linear-lanceolate, or linear-elliptic, usually straight, sometimes slightly falcate distally, 3.5–10(–15) × 0.8–1.5 cm, thick and leathery, midvein prominently raised adaxially, 1–2 mm wide abaxially, stomatal bands brown or pale yellowish white when dry, 3–4 mm wide, at least 2 × as wide as marginal bands, very dense, in ca. 40 rows, marginal bands 1.5–2 mm wide, base broadly cuneate or obtuse, margin slightly downcurved, apex obtuse on basal 1–3 leaves of each branchlet, tapered on others. Pollen-cone racemes borne 4–6 together, 10–15 cm; bracts 16–20 in 4 rows of 4(or 5), keeled, distal bract 8–9 × 4–5 mm; pollen sacs (4–)6 or 7(or 8). Aril reddish purple when ripe, slightly white powdery, 2.2–3 × 1.4–1.5 cm. Seed ellipsoid, shortly beaked at apex; peduncle ca. 1.5 cm, relatively thick, flattened proximally but quadrangular distally. Pollination Apr, seed maturity Oct.

Forming small patches of pure forest on limestone mountains; 1000–1600 m. SW Guizhou (Xingyi Xian), SE Yunnan [N Vietnam].

An endangered species in China. The wood is used in house building, in making furniture and agricultural implements, and as a carving material; the species is also cultivated as an ornamental tree.

2. *Amentotaxus formosana* H. L. Li, J. Arnold Arbor. 33: 196. 1952.

台湾穗花杉 *tai wan sui hua shan*

Amentotaxus yunnanensis H. L. Li var. *formosana* (H. L. Li) Silba.

Trees to 10 m tall; trunk to 3 cm d.b.h.; main branches few. Leafy branchlets broadly ovate-rectangular in outline, (2.5–)7–12 × 14–18 cm, axis green in 1st and 2nd years, becoming brown striped in 3rd year, quadrangular or subterete. Leaves borne at 55–70° to branchlet axis, subsessile; petiole (if present) thick, to 1 mm; blade dark green adaxially, lanceolate or linear-lanceolate, usually slightly but distinctly falcate, 5–8.5

cm × 5–10 mm, leathery, midvein 1–1.5 mm wide abaxially, with a narrow, green band ca. 0.5 mm wide on either side, stomatal bands white, ca. 2 mm wide, very dense (ca. 30 rows), ca. 2 × as wide as marginal bands, marginal bands 0.6–1.6 mm wide, base broadly cuneate or obtuse, margin revolute, apex long acuminate. Pollen-cone racemes borne (1–)3 or 4(or 5) together, ca. 3 cm; cones in 7–9 pairs, close together, subsessile (peduncle less than 1 mm), subglobose; bracts usually 7(–11) in 2–4 rows, keeled distal ones ca. 15 × 5 mm; microsporophylls ca. 10, 1.5–2 cm, recurved at maturity, each with 5–8 pollen sacs. Aril reddish yellow when ripe. Seed finally reddish purple, obovoid-ellipsoid, 2–2.5 × 0.9–1.1 cm, apex mucronulate; peduncle 1.5–2 cm, recurved at maturity; 2 rows of basal scales persistent. Pollination Feb, seed maturity Dec.

• Scattered in damp, shady places in tropical rainforests and broad-leaved subtropical forests, ravines, cliffs; 500–1300 m. SE Taiwan.

The wood is used for making furniture, farm implements, utensils, and handicrafts; the species is also cultivated as an ornamental tree.

3. *Amentotaxus argotaenia* (Hance) Pilger, Bot. Jahrb. Syst. 54: 41. 1916.

穗花杉 *sui hua shan*

Shrubs or small trees to 7 m. Leafy branchlets ascending or suberect, broadly rectangular to oblong-elliptic in outline, 4.5–8 × 8–15 cm, axis green in 1st year, greenish yellow to yellowish red in 2nd and 3rd years, quadrangular or subterete in cross section. Leaves borne at 45–95° to branchlet axis, subsessile or petiole to 3 mm, dark green adaxially, linear or linear-lanceolate, falcate or ± straight, 2–11 cm × 5–11 mm, leathery, with sclereids, mottled adaxially when fresh, rugose with transverse striations at ca. 90° to midvein when dry, midvein raised adaxially, scarcely so abaxially, 1–1.2 mm wide with a very narrow, indistinct green band 0.15–0.2 mm wide on either side, whole midvein band 1.2–2 mm wide, stomatal bands white, 1–2 mm wide, narrower than marginal bands, of 15–25 rows, marginal bands 1.4–3 mm wide, base cuneate to attenuate, asymmetric, margin flat or very narrowly revolute, apex dark, callose, rounded to sharply triangular, obtuse on basal 1–4 (often more) leaves of each branchlet, often acuminate on others. Pollen-cone racemes borne (1 or)2–4(–10) together, 1.5–6.5 cm; cones in ca. 12 pairs, ovoid, ca. 3.5 × 2.5–3.2 mm; bracts ca. 6 at base of otherwise naked peduncle, distal bract ca. 2.5 × 2 mm, keeled; microsporophylls 6–8,

peltate, each with (2 or)3(–5) pollen sacs. Seed-bearing structures with peduncle to ca. $2/3 \times$ length of subtending leaf. Aril bright red when ripe. Seed finally red, narrowly obovoid-ellipsoid, $1.9\text{--}2.6 \times 1\text{--}1.3$ cm, with small, mucronulate apex; peduncle 1.1–1.4 cm, compressed-quadrangular, dilated below bracts, naked. Pollination Apr, seed maturity Oct. $2n = 24$.

Limestone mountains, forests, ravines, shady and damp stream banks; 300–1100 m. Fujian, S Gansu, Guangdong, Guangxi, Guizhou, W Hubei, Hunan, Jiangsu, NW Jiangxi, C and SE Sichuan, Taiwan, SE Xizang, S Zhejiang [N Vietnam].

A vulnerable species in China.

H. L. Li (J. Arnold. Arbor. 33: 195. 1952) separated plants from W Hubei and Sichuan as *Amentotaxus cathayensis*, on the basis of leaf shape and length, and the stomatal bands being narrower (15–20 rows of stomata), instead of broader (22–25 rows in *A. argotaenia*), than the marginal bands. *Amentotaxus cathayensis* has not usually been accepted because these characters are not constant, although the stomatal band character did usually separate the two taxa in the sample examined by the authors. They can also be differentiated by presence (*A. cathayensis*) or absence (*A. argotaenia*) of a distinct petiole 1–3 mm. More research is needed to settle the status of *A. cathayensis*, which is here included provisionally in the synonymy of var. *argotaenia*.

- 1a. Leaves 3–11 cm \times 6–11 mm; pollen cone racemes borne (1 or)2–4 together, 5–6.5 cm; seed-bearing structures with peduncle up $1/3 \times$ length of subtending leaf 3a. var. *argotaenia*
- 1b. Leaves 2–3.7 cm \times 5–7 mm; pollen cone racemes borne up to 10 together, 1.5–5.5 cm; seed-bearing structures with peduncle

ca.

$2/3 \times$ length of subtending leaf ... 3b. var. *brevifolia*

3a. Amentotaxus argotaenia var. *argotaenia*

穗花杉(原变种) sui hua shan (yuan bian zhong)
Podocarpus argotaenia Hance, J. Bot. 21: 357. 1883;
Amentotaxus argotaenia var. *cathayensis* (H. L. Li) P.
C. Keng; *A. cathayensis* H. L. Li; *Cephalotaxus argotaenia* (Hance) Pilger; *Podocarpus insignis* Hemsley.

Leaves 3–11 cm \times 6–11 mm. Pollen-cone racemes borne (1 or)2–4 together, 5–6.5 cm. Seed-bearing structures with peduncle to $1/3 \times$ length of subtending leaf.

Forests, ravines, shady and damp stream banks; 300–1100 m. Fujian, S Gansu, Guangdong, Guangxi, Guizhou, W Hubei, Hunan, Jiangsu, NW Jiangxi, C and SE Sichuan, Taiwan, SE Xizang, ?Zhejiang [N Vietnam].

3b. Amentotaxus argotaenia var. *brevifolia* K. M. Lan & F. H. Zhang, Acta Phytotax. Sin. 22: 492. 1984.

短叶穗花杉 duan ye sui hua shan

Leaves 2–3.7 cm \times 5–7 mm. Pollen-cone racemes borne up to 10 together, 1.5–5.5 cm. Seed-bearing structures with peduncle ca. $2/3 \times$ length of subtending leaf.

- Limestone mountains; ca. 900 m. S Guizhou.

4. TORREYA Arnott, Ann. Nat. Hist. 1: 130. 1838, nom. cons.

榧树属 fei shu shu

Trees evergreen, dioecious (occasionally monoecious); branches whorled; branchlets subopposite or subwhorled, base with bud scales not persistent; winter buds with several pairs of decussate bud scales. Leaves decussate or subopposite, 2-ranked, linear or linear-lanceolate, basally twisted, leathery, adaxial surface slightly convex with midvein \pm indistinct, abaxial surface with 2 stomatal bands, resin canal present on abaxial side of vascular bundle, base decurrent, apex sharply acuminate. Pollen cones axillary, solitary, shortly pedunculate, ellipsoid or shortly columnar; microsporophylls in 4–8 whorls each of 4 microsporophylls; pollen sacs (3 or)4, marginal, pendulous. Seed-bearing structures borne in pairs in leaf axils, sessile, each with 2 pairs of decussate bracts and 1 lateral bract; ovule 1, erect. Aril succulent, base of aril with persistent bracts. Seed ripening in autumn of 2nd year, drupelike, completely enclosed within aril; female gametophyte tissue ruminant or not. Cotyledons 2. Germination hypogeal. $2n = 22$.

Six species: China, Japan; SE and W United States; four species (three endemic, one introduced) in China.

- 1a. Leaves borne at 20–60° to branchlet axis, 3.5–9 cm, stomatal bands silvery gray initially, later turning brown 4. *T. jackii*
- 1b. Leaves usually borne at 60–90° to branchlet axis, (0.7–)1.1–3.6(–4) cm, stomatal bands brown even when young.
 - 2a. Leaves with 2 longitudinal grooves adaxially, midvein distinctly narrower than marginal bands 3. *T. fargesii*
 - 2b. Leaves without 2 longitudinal grooves adaxially, midvein about as wide as marginal bands.
 - 3a. Leaves (0.7–)1.1–2.5(–4.5) cm, base obtuse or broadly rounded, apex cuspidate; axis of 2nd- or 3rd-year branchlets yellowish green, light brownish yellow or pale brown 2. *T. grandis*
 - 3b. Leaves 2–3 cm, base slightly rounded or cuneate, apex very long acuminate; axis of 2nd- or 3rd-year branchlets green or reddish brown 1. *T. nucifera*

1. Torreya nucifera (Linnaeus) Siebold & Zuccarini, Abh. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. 4(3): 234. 1846.

日本榧树 ri ben fei shu

Taxus nucifera Linnaeus, Sp. Pl. 2: 1040. 1753.

Trees to 25 m tall; trunk to 90 cm d.b.h.; bark grayish brown or light brownish red, smooth when young, fissured and peeling off in thin strips. Axis of leafy branchlets green and glabrous in 1st year, green or reddish brown and lustrous in 2nd or 3rd year. Leaves 2-ranked, linear, straight or slightly curved, 2–3 cm × 2.2–3 mm, rigid, pale green adaxially, stomatal bands 2, pale yellow, narrow, impressed, base slightly rounded or cuneate, abruptly narrowed into a short petiole, apex very long acuminate, spinose. Seed dark green when young, purplish brown at maturity, ellipsoid-obovoid or obovoid, 2.5–3.2 × 1.3–1.7 cm. Pollination Apr–May, seed maturity Oct.

Cultivated as a slow-growing, ornamental tree. Jiangsu, Jiangxi, Shandong, Shanghai, Zhejiang [native to Japan].

2. *Torreya grandis* Fortune ex Lindley, Gard. Chron. 1857: 788. 1857.

榿树 fei shu

Trees to 25 m tall; trunk to 0.5(–2) m d.b.h.; bark light yellowish gray, dark gray, or grayish brown, with irregular vertical fissures. Leafy branchlets oblong-obovate in outline, 4–7 × 2.5–4 cm, axis green and glabrous in 1st year, thereafter yellowish green, light brownish yellow or pale brown. Leaves borne at (50–)60–90° to branchlet axis; petiole 0.5–1 mm; blade bright green and glossy adaxially, linear-lanceolate, usually straight, (0.7–)1.1–2.5(–4.5) cm × 2–3.5 mm, with no conspicuous grooves, midvein indistinct adaxially, (0.2–)0.5–0.7 mm wide abaxially, stomatal bands (0.2–)0.3–0.4 mm wide, marginal bands 0.5–0.7 mm wide, base obtuse or broadly rounded, ± symmetric, margin flat or very narrowly revolute, apex symmetrically or slightly asymmetrically tapered, cuspidate, cusp 0.3–1 mm. Pollen cones columnar, ca. 8 mm; bracts conspicuously ridged. Aril pale purplish brown and white powdery when ripe, apex obtuse-rounded or rounded and cuspidate. Seed ellipsoid to ovoid, elongate-ellipsoid, obovoid, or obovoid-conical, 2–4.5 × 1.2–2.5 cm; female gametophyte tissue slightly wrinkled, not ruminant. Pollination Apr, seed maturity Sep–Nov of 2nd year.

• Mountains, open valleys, often by streams, on yellow, red, and dark soils; 200–1400 m. S Anhui, N Fujian, NE Guizhou, W Hunan, S Jiangsu, N Jiangxi, Zhejiang.

The wood is used in constructing buildings, bridges, and furniture. The seed, known as “xiangfei,” is edible and also yields an edible oil; the essential oil “torreya oil” is extracted from the aril. Numerous variants have been recognized at the rank of variety, form, or cultivar (cf. S. Y. Hu, *Taiwania* 10: 23–25. 1964). *Torreya grandis* var. *sargentii* Hu appears very distinct, leaf blade: midvein very narrow, ca. 0.2 mm wide, with green belt on either side ca. 0.3 mm wide, stomatal bands very narrow, 0.2–0.25 mm wide; seed strongly obovoid, 40–45 × 18–20 mm); however, very few specimens have

been seen, so the distinctions are probably not genuine; it is included here in the synonymy of var. *grandis*.

- 1a. Leaf blade (0.7–)1.1–2.5 cm; aril of seed ellipsoid to ovoid or elongate-ellipsoid, apex obtuse-rounded 2a. var. *grandis*
- 1b. Leaf blade 2.5–4.5 cm; aril of seed obovoid-conical, apex rounded, cuspidate 2b. var. *jiulongshanensis*

2a. *Torreya grandis* var. *grandis*

榿树(原变种) fei shu (yuan bian zhong)

Caryotaxus grandis (Fortune ex Lindley) Henkel & W. Hochstetter; *Torreya grandis* var. *chingii* Hu; *T. grandis* var. *dielsii* Hu; *T. grandis* f. *major* Hu; *T. grandis* var. *merrillii* Hu; *T. grandis* f. *non-apiculata* Hu; *T. grandis* var. *sargentii* Hu; *T. nucifera* (Linnaeus) Siebold & Zuccarini var. *grandis* (Fortune ex Lindley) Pilger; *Tumion grande* (Fortune ex Lindley) Greene.

Leaf blade (0.7–)1.1–2.5 cm. Aril of seed ellipsoid to ovoid or elongate-ellipsoid, apex obtuse-rounded.

• Mountains, open valleys; 200–1400 m. S Anhui, N Fujian, NE Guizhou (Songtao), W Hunan, S Jiangsu, N Jiangxi, Zhejiang.

2b. *Torreya grandis* var. *jiulongshanensis* Z. Y. Li & al., Bull. Bot. Res., Harbin 15: 356. 1995.

九龙山榿树 jiu long shan fei shu

Leaf blade 2.5–4.5 cm. Aril of seed obovoid-conical, apex rounded, cuspidate.

• Mountains; ca. 800 m. S Zhejiang (Suichang Xian).

3. *Torreya fargesii* Franchet, J. Bot. (Morot) 13: 264. 1899.

巴山榿树 ba shan fei shu

Trees or shrubs to 20 m tall; trunk to 1 m d.b.h.; bark dark gray, pale brown, or grayish brown, irregularly vertically fissured, sometimes flaking. Leafy branchlets oblong to elliptic-oblong in outline, 5–13 × 3–7.5 cm, axis green in 1st year, thereafter yellowish. Leaves borne at 55–80° to branchlet axis; petiole 0.5–1 mm; blade shining green adaxially, linear to linear-lanceolate, straight or distally falcate, 1.2–3.6(–4) cm × 2–4 mm, with 2 longitudinal grooves, midvein indistinct adaxially, 0.3–0.6 mm wide abaxially, stomatal bands light brown, (0.15–)0.2–0.3 mm wide, marginal bands 0.5–1.2 mm wide, base broadly cuneate, ± asymmetric, margin flat or very narrowly revolute, apex usually shortly and symmetrically tapered, cuspidate, cusp 0.3–1 mm. Pollen cones pale yellow, ovoid, ca. 5–6 × 4.5–5 mm; bracts in 4–12 pairs in 4 rows, longitudinally ridged. Aril pale green or slightly white powdery, with small apical mucro. Seed ovoid to globose or broadly ellipsoid, 1.5–2.5 cm in diam.; inner wall of seed coat smooth or with 2 opposite longitudinal ridges; female gametophyte tissue conspicuously and deeply ruminant

internally. Pollination Apr–May, seed maturity Sep–Oct of 2nd year.

• Coniferous, mixed, and broad-leaved forests; 1000–3400 m. ?S Anhui, W Hubei, NW Hunan, Jiangxi, S Shaanxi, Sichuan, NW Yunnan.

Suitable for afforestation and reforestation. The high quality timber is used in constructing houses, bridges, and furniture, and making implements and utensils; an oil is extracted from the seed.

1a. Leaves ± straight, usually shortly and symmetrically tapered at apex, grooves on adaxial surface usually not extending beyond middle of blade, marginal bands 0.5–0.9(–1.1) mm wide 3a. var. *fargesii*

1b. Leaves often strongly falcate, gradually tapered toward apex from about middle, grooves on adaxial surface extending beyond middle of blade, marginal bands (0.7–)0.9–1.2 mm wide 3b. var. *yunnanensis*

3a. *Torreya fargesii* var. *fargesii*

巴山榧树(原变种) ba shan fei shu (yuan bian zhong)
Torreya grandis Fortune ex Lindley var. *fargesii* (Franchet) Silba; *Tumion fargesii* (Franchet) Skeels.

Leaves ± straight, usually shortly and symmetrically tapered at apex, grooves on adaxial surface usually not extending beyond middle of blade, marginal bands 0.5–0.9(–1.1) mm wide.

• Scattered in coniferous and broad-leaved forests; 1000–1800 m. ?S Anhui, W Hubei, NW Hunan, Jiangxi, S Shaanxi, Sichuan.

The record from S Anhui is based on *R. C. Ching 3036* (E, K) from Huang Shan, a locality outside the main distribution area of *Torreya fargesii*. This specimen was cited under *T. grandis* by S. Y. Hu (Taiwania 10: 24. 1964), but is provisionally and tentatively placed under *T. fargesii* here. However, it differs strikingly from the latter species in several features, and clearly deserves further investigation; the specimens seen are sterile and more material from the area would be required before a decision could be made as to their taxonomic status.

3b. *Torreya fargesii* var. *yunnanensis* (W. C. Cheng & L. K. Fu) N. Kang, Bull. Bot. Res., Harbin 15: 353. 1995.

云南榧 yun nan fei

Torreya yunnanensis W. C. Cheng & L. K. Fu in W. C. Cheng & al., Acta Phytotax. Sin. 13(4): 87. 1975; *T. grandis* var. *yunnanensis* (W. C. Cheng & L. K. Fu) Silba.

Leaves often strongly falcate, gradually tapered toward apex from about middle, grooves on adaxial surface extending beyond middle of blade, marginal bands (0.7–)0.9–1.2 mm wide.

• Coniferous and mixed forests in warm temperate zones, locally a common forest tree; 1500–3400 m. NW Yunnan (Gongshan Drungzu Nuzu Zizhixian, Lijiang Naxizu Zizhixian, Weixi Xian, Zhongdian Xian).

A vulnerable plant.

4. *Torreya jackii* Chun, J. Arnold Arbor. 6: 144. 1925.

长叶榧树 chang ye fei shu

Trees to 12 m tall; trunk to 20 cm d.b.h.; bark gray or dark gray, falling off in thick flakes exposing pale brown cortex. Leafy branchlets horizontal or pendulous, rhombic-elliptic, ± flabellate or broadly obovate in outline, 7–9 × 5–10 cm, axis green turning greenish brown in 1st year, thereafter reddish brown and glossy. Leaves borne at 20–60° to branchlet axis, adjacent leaves (especially distal ones), with blades twisted through ca. 90° so that their surfaces nest within each other; petiole 1–2 mm, twisted; blade deep shining green adaxially, linear to linear-lanceolate, very gradually tapered from proximal 1/3 into apex, distally ± falcate, (2.5–)3–7(–9) cm × (2.5–)3–3.8(–4) mm, leathery, with 2 raised ridges extending from base to near apex, midvein extremely indistinct adaxially, strongly raised abaxially with a flat band on either side, whole midvein band ca. 1.2 mm wide, stomatal bands with silver-gray powder initially but finally brown, 0.1–0.2 mm wide, ca. 12 rows, marginal bands 0.5–0.7 mm wide, base cuneate, slightly asymmetric, strongly twisted, margin thickened abaxially and slightly downcurved but not revolute, apex cuspidate, cusp slender, tapered, 1–1.5 mm, often breaking off. Aril white powdery, with small mucro. Seed obovoid, 2–3 × ca. 1.2 cm; female gametophyte tissue deeply ruminant within. Seed maturity autumn.

• Woods; 400–1000 m. N Fujian, NE Jiangxi, S Zhejiang.

A vulnerable species. *Torreya jackii* is unlike the other Chinese members of the genus and is remarkably similar to *Cephalotaxus fortunei*, from which it can be distinguished by its sessile seed-bearing structures and by the peculiar, strongly twisted leaf arrangement.

The wood is very fragrant, and is used to make agricultural implements, utensils, and handicrafts. The leaves are also very aromatic when bruised or burned, giving off a fragrance like sandalwood oil.

