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PINACEAE

松科 song ke

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Trees or rarely shrubs, evergreen or deciduous, monoecious. Branchlets often dimorphic: long branchlets with clearly spirally arranged, sometimes scalelike leaves; short branchlets often reduced to slow growing lateral spurs bearing dense clusters of leaves at apex. Leaves solitary or in bundles of (1 or)2–5(–8) when basally subtended by a leaf sheath; leaf blade linear or needlelike, not decurrent. Cones unisexual. Pollen cones solitary or clustered, with numerous spirally arranged microsporophylls; microsporophyll with 2 microsporangia; pollen usually 2-saccate (nonsaccate in *Cedrus, Larix, Pseudotsuga,* and most species of *Tsuga*). Seed cones erect or pendulous, maturing in 1st, 2nd, or occasionally 3rd year, dehiscent or occasionally indehiscent, with many spirally arranged ovulate scales and bracts; ovulate scales usually smaller than bracts at pollination, with 2 upright ovules adaxially, free or only basally adnate with bracts, maturing into seed scales. Seed scales appressed, woody or leathery, variable in shape and size, with 2 seeds adaxially, persistent or deciduous after cone maturity. Bracts free or adnate basally with seed scales, well developed or rudimentary, exserted or included. Seeds terminally winged (except in some species of *Pinus*). Cotyledons 2–18. Germination hypogeal or epigeal. 2*n* = 24* (almost always).

Ten or eleven genera and ca. 235 species: N hemisphere; ten genera (two endemic) and 108 species (43 endemic, 24 introduced) in China. Species of the Pinaceae are among the most valuable and commercially important plants in the world. Most species are trees, and are often excellent sources of lumber, wood products, and resins; many are cultivated for afforestation and as ornamentals.

Cheng Wan-chün, Fu Li-kuo, Law Yu-wu, Fu Shu-hsia, Wang Wen-tsai, Chu Cheng-de, Chao Chi-son & Chen Chia-jui. 1978. Pinaceae. *In:* Cheng Wan-chün & Fu Li-kuo, eds., Fl. Reipubl. Popularis Sin. 7: 32–281.

1a. Leaves evergreen, needlelike, 2–5(–7) per bundle, terminal on very short branchlets, base enclosed by sheath; seed cones maturing in 2nd or 3rd year; seed scales woody, thickened, apex differentiated into apophysis and umbo ..... 1. *Pinus*

1b. Leaves evergreen or deciduous, linear or needlelike, spirally arranged or in a cluster at apex of short branchlets, not in bundles; seed cones maturing in 1st year (except in *Cedrus*); seed scales thin, woody or leathery, without apophysis and umbo.

2a. Lateral short branchlets present, very clearly defined, with dense bundles of many leaves.

3a. Leaves evergreen, needlelike, usually triangular or ± quadrangular in cross section, stiff; seed cones maturing in 2nd(or 3rd) year ..... 10. *Cedrus*

3b. Leaves deciduous, linear-needlelike or narrowly oblanceolate-linear, flattened, flexible; seed cones maturing in 1st year.

4a. Pollen cones solitary; seed scales thin, ± leathery, persistent after maturity; leaves ca. 1.8 mm wide ..... 3. *Larix*

4b. Pollen cones clustered; seed scales thick, woody, shed after maturity; leaves 1.5–4 mm wide 7. *Pseudolarix*

2b. Lateral short branchlets absent, or poorly defined (in *Cathaya*), with leaves all solitary, never in bundles (though in *Cathaya* partly so dense as to appear bundled).

5a. Branchlets opposite, with orbicular leaf scars; seed cones erect; seed scales deciduous at maturity, with cone rachis persistent ..... 9. *Abies*

5b. Branchlets irregularly alternate, leaf scars often elliptic or on peglike projections (pulvini); seed cones usually pendulous or erect; seed scales persistent at maturity.

6a. Seed cones axillary, initially erect, finally pendulous; leaves partly densely clustered ..... 4. *Cathaya*

6b. Seed cones terminal on branchlets; leaves evenly distributed along branchlets.

7a. Seed cones erect; pollen cones terminally clustered on branchlets; seed and wing as long as seed scale ..... 8. *Keteleeria*

7b. Seed cones usually pendulous, occasionally erect; pollen cones solitary in leaf axils; seed and wing shorter than seed scale.

8a. Leaves not borne on peglike projections, leaving slightly raised, elliptic scars, grooved adaxially; bracts distinctly exserted, 3-lobed at apex ..... 5. *Pseudotsuga*

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8b. Leaves borne on persistent, peglike projections (pulvinus), flattened or ± rhombic in cross
section; bracts rudimentary, included.
9a. Leaves sessile, quadrangular, subflattened, or flattened in cross section; seed cones usually more than 4 cm (sometimes less than 4 cm in *Picea purpurea*) ..... 2. *Picea*
9b. Leaves petiolate, flattened, rarely subquadrangular in cross section; seed cones usually 1.5–3.5 cm (to ca. 6 cm in *Tsuga longibracteata*) ..... 6. *Tsuga*

1. PINUS Linnaeus, Sp. Pl. 2: 1000. 1753.

松属 song shu

Trees or rarely shrubs, evergreen, with regularly whorled branches; branchlets strongly dimorphic: long branchlets bearing scalelike leaves and spreading leaf bundles; short branchlets bearing leaves in bundles of 2–5(–7); winter buds large, with numerous scales. Leaves needlelike, slender or stout, straight or twisted, triangular, flabellate-triangular, or semiorbicular in cross section, stomatal lines several, on 1, 2, or all surfaces, vascular bundles 1 or 2, resin canals 2–10 or more, marginal or median, rarely internal, base enclosed by persistent or deciduous, membranous sheath. Pollen cones usually borne in spikelike clusters at base of 1st-year branchlets, sessile, cylindric or ovoid; pollen 2-saccate. Seed cones pedunculate or subsessile, erect or pendulous, cylindric or ovoid, maturing in 2nd or 3rd year. Seed scales spirally arranged, woody, exposed apex thickened and ridged (the apophysis), with a prominent protuberance (umbo), usually terminating in a spine or prickle, persistent. Bracts minute. Seeds variable in color, shape, and size, winged or not; wing adnate or articulated to seed. Cotyledons 3–18. Germination epigeal. $2n = 24$*.

About 110 species: N Africa, Asia, Europe, North America; 39 species (seven endemic, 16 introduced) in China.

1a. Needles with basal sheath deciduous and basal scalelike leaves not decurrent, cross section with 1 vascular bundle; umbo terminal or dorsal.
2a. Umbo dorsal; needles 3–5 per bundle.
3a. Needles 4 or 5 per bundle; bark dark brown, flaking ..... 25. *P. squamata*
3b. Needles 3 per bundle; bark white, irregularly flaking.
4a. Seed cones 12–20 cm; seeds cylindric, ca. 2.5 cm ..... 26. *P. gerardiana*
4b. Seed cones 5–7 cm; seeds ovoid, ca. 1 cm ..... 27. *P. bungeana*
2b. Umbo terminal; needles (2–)5 per bundle.
5a. Seeds wingless or only shortly winged.
6a. Seed cones dehiscent at maturity; branchlets glabrous.
7a. Seeds wingless or ridged along abaxial margin; seed coat thick; apophyses not or slightly reflexed
at margin ..... 31. *P. armandii*
7b. Seeds with a rudimentary wing 2–7 mm; seed coat thin; apophyses obviously reflexed at margin
..... 32. *P. fenzeliana*
6b. Seed cones indehiscent or imperfectly dehiscent; branchlets densely pubescent.
8a. Needles slender, 4–8 cm × 0.5–1 mm; resin canals 2, marginal; shrubs ..... 28. *P. pumila*
8b. Needles stout, 7–12 cm × 1–1.5 mm; resin canals 3, median; trees.
9a. First-year branchlets with red-brown hairs; needles with 6–8 blue-gray stomatal lines along
each abaxial surface; seed cones 9–14 cm; seed scales acuminate at apex, recurved 29. *P. koraiensis*
9b. First-year branchlets with yellow-brown hairs; needles with 3–5 gray-white stomatal lines
along each abaxial surface; seed cones 5–8 cm; seed scales rounded at apex, incurved 30. *P. sibirica*
5b. Seeds long winged.
10a. Needles 7–20 cm; seed cones cylindric to narrowly cylindric, 7–25 cm.
11a. Needles not pendulous, 6–14 cm; seed cones 7–20 cm ..... 38. *P. strobus*
11b. Needles pendulous, (6–)11–24 cm; seed cones 10–30 cm.
12a. Needles dark green adaxially; 1st-year branchlets green with faint bloom, glabrous;
abaxial resin canal of needles always median ..... 34. *P. wallichiana*

12b. Needles grass green adaxially, conspicuously whitish bloomed on 2 abaxial surfaces;
1st-year branchlets conspicuously whitish bloomed, glandular pubescent; 1(or 2) abaxial
resin canal(s) of needles always asymmetrically placed ..... 33. *P. bhutanica*

10b. Needles less than 8 cm; seed cones ovoid, ovoid-ellipsoid, or ellipsoid-cylindric, usually less than 10 cm.

13a. Needles less than 1 mm in diam.; seed cones sessile or shortly pedunculate.

14a. Branchlets densely pubescent; seed cones sessile; seeds as long as broad wing; needles
3.5–5.5 cm ..... 39. *P. parviflora*

14b. Branchlets glabrous or puberulent; seed cones shortly pedunculate; seeds ca. 1/2 as
long as narrow wing; needles 4–8 cm ..... 35. *P. morrisonicola*

13b. Needles 1–1.5 mm in diam.; seed cones distinctly pedunculate.

15a. Branchlets densely pubescent; resin canals 3, median ..... 36. *P. wangii*

15b. Branchlets glabrous, rarely puberulent; resin canals 2, marginal, sometimes also 1 median ..... 37. *P. kwangtungensis*

1b. Needles with basal sheath persistent and basal scalelike leaves decurrent, cross section with 2 vascular bundles; umbo dorsal.

16a. Wing adnate to seed; needles 3 per bundle; apophyses distinctly protruded, with transverse ridges and
spiny umbo ..... 1. *P. roxburghii*

16b. Wing articulated to seed; needles 2–5 per bundle; apophyses and umbo of different types.

17a. Needles (2 or)3(–5) per bundle.

18a. Trunk and branches usually with adventitious sprouts; needles mostly to 20 cm.

19a. Needles 2(or 3) per bundle, ca. 1 mm in diam.; winter buds 0.5–0.7(–1) cm in diam.; bark
plates with evident resin pockets; adaxial surface of seed scales lacking contrasting border distally ..... 11. *P. echinata*

19b. Needles 3(–5) per bundle, 1–1.5(–2) mm in diam.; winter buds 1–1.5(–2) cm in diam.; bark plates without evident resin pockets; adaxial surface of seed scales with dark red-brown
border distally.

20a. Needles (12–)15–21 cm, slightly twisted; branchlets initially orange or yellow-orange, often glaucous; seed cones late dehiscent after maturity ..... 12. *P. serotina*

20b. Needles 5–10(–15) cm, twisted; branchlets initially orange-brown, not glaucous; seed cones dehiscent at maturity ..... 13. *P. rigida*

18b. Trunk and branches usually without adventitious sprouts; needles mostly 15–45 cm.

21a. Needles slender, 10–30 cm × 0.7–1.2 mm (except *P. yunnanensis* var. *pygmaea* with stout needles 5–13 cm).

22a. Umbo blunt or shortly mucronate in apical part of cone; needles 2(or 3) per bundle,
12–20 cm, slightly twisted ..... 2. *P. massoniana*

22b. Umbo shortly mucronate; needles (2 or)3 per bundle, 10–30 cm, not twisted.

23a. Needles slender and pliant, less than 1 mm in diam.; resin canals marginal; apophyses ± pyramidal, distinctly cross keeled ..... 3. *P. kesiya*

23b. Needles relatively stout and stiff (slender and pliant in plants growing in dry,
hot valleys), 1–1.2 mm in diam.; resin canals marginal and median; apophyses swollen, usually not pyramidal, not or slightly cross keeled 4. *P. yunnanensis*

21b. Needles ± stout, 12–45 cm × 1.5–2 mm.

24a. Winter buds 3–4 cm, silvery white; seed cones 15–25 cm ..... 14. *P. palustris*

24b. Winter buds to 2 cm, reddish, chestnut, orange, or silvery brown; seed cones usually
5–15 cm.

25a. Seed cones pedunculate.
26a. Seed cones (7–)9–18(–20) cm, all deciduous; umbo central, depressed-pyramidal, with a stout, short prickle; needles 2 or 3 per bundle ..... 15. *P. elliottii*
26b. Seed cones 5–10(–12) cm, often a few basal cones persistent; umbo slightly projecting, ending in a straight, minute prickle; needles (2 or)3(–5) per bundle ..... 16. *P. caribaea*
25b. Seed cones sessile or subsessile.
27a. Branchlets ca. 1 cm in diam.; terminal bud lanceolate-cylindric, mostly less than 1 cm wide, slightly resinous; seed cones mostly dull yellow-brown, narrowly ovoid when open ..... 17. *P. taeda*
27b. Branchlets 1–2 cm in diam.; terminal bud ovoid, ca. 1 cm wide, very resinous; seed cones mostly reddish brown, broadly ovoid when open ..... 18. *P. ponderosa*

17b. Needles 2(or 3) per bundle.
28a. Needles mostly 20–30 cm or more.
29a. Umbo blunt or with sunken, short mucro.
30a. Needle with 2 resin canals; seed cones red-brown at maturity ..... 6. *P. latteri*
30b. Needle with up to 9 resin canals; seed cones pale brown at maturity .... 19. *P. tropicalis*
29b. Umbo ± spiny or pointed at apex.
31a. Seed cones borne on stalks to 3 cm, chocolate brown; apophyses lustrous 15. *P. elliottii*
31b. Seed cones sessile or subsessile, brown, yellow-, or red-brown; apophyses rarely lustrous.
32a. Branchlets ca. 1 cm in diam.; terminal bud lanceolate-cylindric, usually less than 1 cm wide, slightly resinous; seed cones usually dull yellow-brown, narrowly ovoid when open ..... 17. *P. taeda*
32b. Branchlets 1–2 cm in diam.; terminal bud ovoid, ca. 1 cm wide, very resinous; seed cones usually reddish brown, broadly ovoid when open .....18. *P. ponderosa*
28b. Needles mostly less than 20 cm.
33a. Seed cones 9–18 cm ..... 20. *P. pinaster*
33b. Seed cones usually not more than 8 cm.
34a. Needles slender and pliant, ca. 1 mm in diam.; apophyses relatively thin, flat or slightly raised.
35a. Trunk and branches usually with adventitious sprouts; umbo with a stout, sharp prickle ..... 11. *P. echinata*
35b. Trunk and branches usually without adventitious sprouts; umbo flat or blunt.
36a. Needles 12–20 cm, slightly twisted ..... 2. *P. massoniana*
36b. Needles 5–12 cm, straight ..... 7. *P. densiflora*
34b. Needles stout, 1–2 mm in diam.; apophyses ± swollen or pyramidal.
37a. Needles shorter, longest ones not more than 8 cm, strongly twisted.
38a. Seed cones strongly asymmetric, curved forward on branches; needles 2–5 cm ..... 23. *P. banksiana*
38b. Seed cones symmetric or nearly so; needles usually longer.
39a. Bark on distal sections of trunk orange, plated; needles blue-, gray-, or yellow-green, stomatal lines conspicuous; branchlets initially dull green or orange-brown, not glaucous; adaxial surface of seed scales lacking contrasting border distally ..... 10. *P. sylvestris*

39b. Bark on distal sections of trunk reddish, scaly; needles deep to pale yellow-green, stomatal lines inconspicuous; branchlets initially red or purple tinged, often glaucous; adaxial surface of seed scales with strong purple-red or -brown border distally ..... 24. *P. virginiana*

37b. Needles (5–)9–16 cm, straight or rarely slightly twisted.

40a. Seed cones deciduous..

41a. Winter buds silvery white, cylindric-ellipsoid or cylindric 21. *P. thunbergii*

41b. Winter buds brown, ovoid or oblong-ovoid ..... 22. *P. nigra*

40b. Seed cones persistent.

42a. Needle with resin canals median, rarely also marginal; needles 4.5–17 cm; seed cones 3–6 cm ..... 8. *P. taiwanensis*

42b. Needle with resin canals marginal, occasionally 1 or 2 median; needles 6–15 cm; seed cones 2.5–9 cm.

43a. Bark initially reddish brown, becoming dark grayish brown; 1st-year branchlets shiny yellowish brown; needle sheaths initially 0.5–1 cm; resin canals 3 or 4; pollen cones 1–1.8 cm; seed cones shiny chocolate brown at maturity ..... 5. *P. densata*

43b. Bark dull grayish brown or dark gray; 1st-year branchlets light grayish brown, light brown, or yellowish brown; needle sheaths initially 1–2 cm; resin canals 5–9; pollen cones 0.5–0.9 cm; seed cones yellowish brown to brown at maturity 9. *P. tabuliformis*

1. Pinus roxburghii Sargent, Silva N. Amer. 11: 9. 1897.

须弥长叶松 xu mi chang ye song

Trees to 55 m tall; trunk to over 1 m d.b.h.; bark dark red-brown, thick, deeply and longitudinally fissured, scaly; winter buds brown, small, ovoid, not resinous. Needles 3 per bundle, slender, flabellate-triangular in cross section, 20–30 cm × ca. 1.5 mm, resin canals 2, median, base with persistent sheath 2–3 cm. Seed cones shortly pedunculate, ovoid, 10–20 × 6–9 cm. Seed scales oblong, thick, stiff; apophyses strongly swollen, conspicuously transversely ridged; umbo triangular, protruding. Seeds 8–12 mm; wing ca. 2.5 cm. Seed maturity Oct–Nov.

Mountains; 2100–2200 m. S Xizang [Bhutan, N India, Kashmir, Nepal, Pakistan, Sikkim].

A rare plant in China. The timber is used for construction, furniture, etc., and the trunk as a source of resin.

2. Pinus massoniana Lambert, Descr. Pinus 1: 17. 1803.

马尾松 ma wei song

Trees to 45 m tall; trunk to 1.5 m d.b.h.; bark red-brown toward apex of trunk, gray- or red-brown toward base, irregularly scaly and flaking; crown broadly pyramidal or umbrellalike; branchlets usually growing twice per year, yellowish brown, occasionally glaucous; winter buds brown, ovoid-cylindric or cylindric. Needles 2(or 3) per bundle, slightly twisted, 12–20 cm, stomatal lines present on all surfaces, resin canals 4–8, marginal, base with persistent sheath. Seed cones pendulous, shortly pedunculate, green, turning chestnut brown at maturity, ovoid, conical-ovoid, or ovoid-cylindric, 2.5–7 × 2.5–5 cm. Seed scales suboblong-obovoid or subsquare; apophyses rhombic, slightly swollen or flat, slightly transversely ridged; umbo flattened, slightly sunken, blunt or shortly mucronate in apical part of cone. Seeds narrowly ovoid, 4–6 mm; wing 1.6–2.1 cm. Pollination Apr–May, seed maturity Oct–Dec of 2nd year.

• Plains, hills, mountains; near sea level to 2000 m. Anhui, Fujian, Guangdong, Guangxi, Guizhou, Hainan, W Henan, Hubei, Hunan, S Jiangsu, Jiangxi, SE Shaanxi, Sichuan, Taiwan, E Yunnan, Zhejiang.

An important tree for afforestation in S China. The timber is used for construction, railway sleepers, mine timber, furniture, wood pulp, etc., and the trunk as a source of resin and tannin, and for cultivating fungi.

1a. Umbo spiny ..... 2c. var. *shaxianensis*

1b. Umbo usually flattened or obtuse.

2a. Seed cones ovoid or conical-ovoid; bark gray-brown toward base of trunk, irregularly scaly and flaking 2a. var. *massoniana*

2b. Seed cones ovoid-cylindric; bark red-brown, irregularly flaking 2b. var. *hainanensis*

2a. Pinus massoniana var. **massoniana**

马尾松(原变种) ma wei song (yuan bian zhong)

Pinus argyi Lemée & H. Léveillé; *P. argyi* var. *longevaginans* H. Léveillé; *P. canaliculata* Miquel; *P. cavaleriei* Lemée & H. Léveillé; *P. crassicorticea* Y. C. Zhong & K. X. Huang; *P. nepalensis* J. Forbes (1839), not Chambray (1845); *P. sinensis* D. Don (1828), not Mayr (1894) nor (Beissner) Voss (1913).

Bark gray-brown toward base of trunk, irregularly scaly and flaking. Branches of 1st order spreading horizontally or ascending. Needles slender, 12–20 cm,

pliant. Seed cones ovoid or conical-ovoid, 4–7 × 2.5–4 cm.

• Plains, hills, mountains; near sea level to 2000 m. Anhui, Fujian, Guangdong, Guangxi, Guizhou, W Henan, Hubei, Hunan, S Jiangsu, Jiangxi, SE Shaanxi, Sichuan, Taiwan, E Yunnan, Zhejiang.

2b. Pinus massoniana var. **hainanensis** W. C. Cheng & L. K. Fu in W. C. Cheng & al., Acta Phytotax. Sin. 13(4): 85. 1975.

雅加松 ya jia song

Bark red-brown toward base of trunk, irregularly flaking. Branches of 1st order spreading horizontally; branchlets ascending. Needles slender, 12–20 cm, pliant. Seed cones ovoid-cylindric, 4–7 × 2.5–5 cm.

• Hills. Hainan.

An endangered plant.

2c. Pinus massoniana var. **shaxianensis** D. X. Zhou, Bull. Bot. Res., Harbin 11(3): 41. 1991.

沙黄松 sha huang song

Trunk straight; bark red-brown, flaking. Winter buds red-brown, slightly covered with bloom. Seed cones ovoid-ellipsoid, 5–9 × 2–3 cm. Seed scales obovate-cuneate; apophyses slightly swollen; umbo spiny. Seeds black-brown, almost obovate, ca. 9 mm; wing 2.5–3 cm.

• C Fujian (Sha Xian).

3. Pinus kesiya Royle ex Gordon, Gard. Mag. & Reg. Rural Domest. Improv. 16: 8. 1840.

卡西松 ka xi song

Pinus insularis Endlicher var. *khasyana* (Griffith) Silba; *P. insularis* var. *langbianensis* (A. Chevalier) Silba; *P. kesiya* var. *langbianensis* (A. Chevalier) Gaussen ex Bui; *P. langbianensis* A. Chevalier.

Trees to 30 m tall; trunk to 60 cm d.b.h.; bark brown, irregularly flaking; crown broadly domed; branchlets yellowish brown, shiny, aging to orange-brown, initially covered with scale bases (which are shed in 2nd or 3rd year), producing 2 or more nodes each year; winter buds red-brown, conical, slightly resinous. Needles 3 per bundle, slender, triangular in cross section, 10–22 cm × 0.7–1 mm, pliant, resin canals 3–6, marginal, base with persistent sheath 1–2 cm. Seed cones usually solitary or paired, ovoid, 5–6 × ca. 3.5 cm, persistent for many years. Seed scales narrowly suboblong, 2.5–3 × 1–1.5 cm; apophyses ± pyramidal, obviously transversely ridged; umbo small, ellipsoid, slightly protruded into a tiny recurved spine. Seeds black-brown, slightly appressed, ellipsoid, 5–6 × 3–4 mm.

Plateaus; 700–1200 m. SE Xizang, Yunnan [NE India, Laos, Myanmar, Philippines, Thailand, Vietnam].

4. Pinus yunnanensis Franchet, J. Bot. (Morot) 13: 253. 1899.

云南松 yun nan song

Trees or rarely shrubs; bark brown-gray, longitudinally fissured, scaly; branchlets reddish brown, thick, glabrous; winter buds red-brown, ovoid, large, not resinous. Needles (2 or)3 per bundle, flabellate-triangular or semiorbicular in cross section, 7–30 cm × 1–1.2 mm, stomatal lines present on all surfaces, resin canals 4 or 5, median and marginal, base with persistent sheath. Seed cones shortly pedunculate, green, maturing to brown or chestnut brown, conical-ovoid, 5–11 cm, dehiscent or indehiscent at maturity. Seed scales oblong-ellipsoid, ca. 3 × 1.5 cm; apophyses usually swollen, cross keeled, rarely recurved; umbo slightly sunken or slightly protruded, ending in a minute prickle. Seeds brown, slightly appressed, nearly ovoid or obovoid, 4–5 mm; wing 1.2–1.4 cm. Pollination Apr–May, seed maturity Oct.

• Mountains, river basins, dry and sunny slopes; 400–3100 m. Guangxi, Guizhou, SW Sichuan, SE Xizang, Yunnan.

The timber is used for construction, railway sleepers, boards, furniture, and wood pulp. The trunk can be used as a source of resin, the roots for cultivating fungi, and the bark for producing tannin.

1a. Shrubs; seed cones indehiscent at maturity; needles 7–13 cm ..... 4c. var. *pygmaea*
1b. Trees; seed cones dehiscent at maturity; needles to 30 cm.
  2a. Needles not or slightly pendulous, ca. 1.2 mm in diam. ..... 4a. var. *yunnanensis*
  2b. Needles pendulous, less than 1 mm in diam. ..... 4b. var. *tenuifolia*

4a. Pinus yunnanensis var. **yunnanensis**

云南松(原变种) yun nan song (yuan bian zhong)

Pinus insularis Endlicher var. *yunnanensis* (Franchet) Silba; *P. sinensis* D. Don var. *yunnanensis* (Franchet) Shaw; *P. tabuliformis* Carrière var. *yunnanensis* (Franchet) Dallimore & A. B. Jackson.

Trees to 30 m. Needles not or slightly pendulous, 10–30 cm × ca. 1.2 mm. Seed cones dehiscent at maturity.

• Mountains, river basins; 600–3100 m. Guangxi, Guizhou, SE Xizang, Yunnan.

4b. Pinus yunnanensis var. **tenuifolia** W. C. Cheng & Y. W. Law in W. C. Cheng & al., Acta Phytotax. Sin. 13(4): 85. 1975.

细叶云南松 xi ye yun nan song

Pinus insularis var. *tenuifolia* (W. C. Cheng & Y. W. Law) Silba.

Trees to 30 m. Needles pendulous, 20–30 cm × less than 1 mm. Seed cones dehiscent at maturity.

• River basins; 400–1200 m. Guangxi, Guizhou.

4c. Pinus yunnanensis var. **pygmaea** (Hsüeh) Hsüeh in W. C. Cheng & L. K. Fu, Fl. Reipubl. Popularis Sin. 7: 258. 1978.

地盘松 di pan song

Pinus densata Masters var. *pygmaea* Hsüeh in W. C. Cheng & al., Acta Phytotax. Sin. 13(4): 85. 1975; *P. tabuliformis* var. *pygmaea* (Hsüeh) Silba.

Shrubs to 2 m, branched from base. Needles 7–13 cm, stiff, resin canals 2, marginal or 1 median. Seed cones clustered, 4–5 cm, persistent, indehiscent at maturity.

• High mountains, dry and sunny slopes; 2200–3100 m. SW Sichuan, Yunnan.

5. Pinus densata Masters, J. Linn. Soc., Bot. 37: 416. 1906.
高山松 gao shan song
Pinus prominens Masters; *P. sinensis* D. Don var. *densata* (Masters) Shaw; *P. tabuliformis* Carrière var. *densata* (Masters) Rehder; *P. wilsonii* Shaw (1911), not Roezl (1857).

Trees to 30 m tall; trunk to 1.3 m d.b.h.; bark reddish brown, scaly and plated when young, finally dark grayish brown, forming irregular, square, thick plates; crown ovoid-conical, broadly ovoid in old trees; branches spreading; 1st-year branchlets shiny yellowish brown, stout; 2nd- and 3rd-year branchlets reddish brown; winter buds dull brown, ovoid-conical, ca. 15 × 6 mm, slightly resinous, scales white fringed at margin, acuminate at apex. Needles persisting for 3 years, usually 2(or 3) per bundle, straight, slightly twisted, 8–14 cm × 1–1.5 mm, stomatal lines present on all surfaces, resin canals 3 or 4, marginal, occasionally 1 or 2 median, base with persistent sheath initially 5–10 mm, margin finely serrulate, apex acute. Pollen cones yellowish brown, cylindric, 10–18 × 3–4.5 mm. Seed cones solitary or in pairs, pendulous, sessile or very shortly pedunculate, shiny chocolate brown at maturity, narrowly ovoid before opening, ovoid or broadly ovoid when open, 4–6 × 4–7 cm, persistent. Seed scales with apophyses prominent, rhombic, 4–7 mm thick, sharply transversely keeled; umbo dorsal, with a short prickle. Seeds light grayish brown, ellipsoid-ovoid, 4–6 mm; wing 1.5–2 cm. Pollination May, seed maturity Oct of 2nd year.

• Open forests in high mountains, forming pure stands or (below 3000 m) mixed with *Pinus armandii* and *P. yunnanensis;* 2600–3500 (–4200) m. S Qinghai, W Sichuan, SE Xizang, Yunnan.

Morphologically intermediate between *Pinus yunnanensis* of lower elevations and *P. tabuliformis* of more northerly latitudes. Molecular evidence supports the hypothesis that *P. densata* originated as a Tertiary natural hybrid involving the former two species and a third, unknown species.

Can be used for afforestation in the alpine zones of W Sichuan and E Xizang.

6. Pinus latteri Mason, J. Asiat. Soc. Bengal 18: 74. 1849.
南亚松 nan ya song

Pinus ikedae Yamamoto; *P. merkusii* Junghuhn & de Vriese subsp. *latteri* (Mason) D. Z. Li; *P. merkusii* var. *latteri* (Mason) Silba; *P. merkusii* var. *tonkinensis* (A. Chevalier) Gaussen ex Bui; *P. tonkinensis* A. Chevalier.
Trees to 30 m tall; trunk to 2 m d.b.h.; bark gray-brown, thick, scaly; crown globose or umbrellalike; branchlets dark brown, glabrous; winter buds brown, cylindric. Needles 2 per bundle, semiorbicular in cross section, 15–27 cm × ca. 1.5 mm, stomatal lines present on all surfaces, resin canals 2, median, base with persistent sheath 1–2 cm. Seed cones pedunculate (peduncle ca. 1 cm), green, turning red-brown at maturity, conical or ovoid-cylindric, 5–10 cm. Seed scales oblong, ca. 3 × 1.2–1.5 cm; apophyses subrhombic or pentagonal-rhombic, slightly swollen, shiny, slightly recurved toward apex, flat toward base, obviously radially ridged; umbo usually slightly sunken. Seeds gray-brown, slightly appressed, ellipsoid-ovoid, 5–8 × ca. 4 mm; wing 1.7–2 cm. Pollination May–Apr, seed maturity Oct of 2nd year.
Hills, terraces; below 1200 m. SW Guangdong, S Guangxi, Hainan [Cambodia, Laos, SE Myanmar, Thailand, Vietnam].
The timber is used for construction, bridge building, and making poles and instruments. The trunk can be used as a source of resin, the bark for tannin, and the needles for turpentine.

7. Pinus densiflora Siebold & Zuccarini, Fl. Jap. 2: 22. 1842.
赤松 chi song
Trees to 30 m tall; trunk to 1.5 m d.b.h.; bark orange-red, red-brown, or brown-yellow, flaking and scaly; crown umbrellalike; 1st-year branchlets pale yellow or red-yellow, slightly glaucous, glabrous, white powdery or not; vegetative buds dark red-brown, oblong-ovoid, slightly resinous; scales slightly reflexed at apex. Needles 2 per bundle, twisted or not, semiorbicular in cross section, 5–15 cm × ca. 1 mm, vascular bundles 2, resin canals 3–9, marginal, margin inflexed or not. Seed cones erect or pendulous, shortly pedunculate, dark yellow-brown or brownish yellow, ovoid or ovoid-conical, 3–5.5 × 2.5–4.5 cm, dehiscent at maturity. Seed scales usually thin; apophyses usually appressed, broadly rhombic, flat or recurved at apex, rarely pyramidal and slightly ridged; umbo flat or slightly protruding into a minute spine. Seeds obovoid-ellipsoid or ovoid, 3–7 × ca. 3 mm; wing 1–2 cm × 5–7 mm. Pollination Apr–Jun, seed maturity Sep–Oct of 2nd year.
Coastal regions to mountains, lakesides, rocky hillsides; near sea level to 900 m. E and S Heilongjiang, NE Jiangsu, SE Jilin, Liaoning, E and N Shandong [Japan, Korea, E Russia].
The timber is used for construction, poles, and furniture; the trunk can be used as a source of resin.

1a. First-year branchlets not white powdery; needles not or only slightly twisted, 13–15 cm, margin usually inflexed 7c. var. *zhangwuensis*
1b. First-year branchlets white powdery; needles twisted, 5–12 cm, margin usually not inflexed.
  2a. Seed cones erect; apophyses flat ..... 7a. var. *densiflora*
  2b. Seed cones pendulous; apophyses ± pyramidal, apex recurved in apophyses toward base of cones ..... 7b. var. *ussuriensis*

7a. Pinus densiflora var. **densiflora**

赤松(原变种) chi song (yuan bian zhong)

Pinus densiflora var. *brevifolia* Liou & Q. L. Wang; *P. densiflora* var. *funebris* (Komarov) Liou & Q. L. Wang ex Silba; *P. densiflora* f. *liaotungensis* (Liou & Q. L. Wang) Kitagawa; *P. densiflora* var. *liaotungensis* Liou & Q. L. Wang; *P. funebris* Komarov; *P. scopifera* Miquel.

Bark orange-red or red-brown. First-year branchlets white powdery. Needles twisted, 5–12 cm, resin canals 4–6, margin usually not inflexed. Seed cones erect. Apophyses usually flat. Seeds obovoid-ellipsoid or ovoid, 3–7 mm; wing 1.5–2 cm. Pollination Apr, seed maturity Sep–Oct of 2nd year.

Coastal regions to mountains; near sea level to 900 m. E Heilongjiang, NE Jiangsu, SE Jilin, C and S Liaoning, E and N Shandong [Japan, Korea, E Russia].

7b. Pinus densiflora var. **ussuriensis** Liou & Q. L. Wang in Liou, Ill. Fl. Lign. Pl. N. E. China 98, 548. 1958.

兴凯赤松 xing kai chi song

Pinus densiflora f. *ussuriensis* (Liou & Q. L. Wang) Kitagawa; *P. takahasii* Nakai.

Trees to 20 m tall; bark red-brown or yellow-brown. First-year branchlets white powdery. Needles twisted, 5–12 cm, resin canals 8, margin usually not inflexed. Seed cones pendulous. Apophyses ± pyramidal, obviously ridged, apex recurved in apophyses toward base of cones. Seeds pale brown with black spots, slightly appressed, obovoid, 3–5 mm; wing 1–1.2 cm. Pollination May–Jun, seed maturity Sep–Oct of 2nd year.

Lakesides, rocky hillsides. S Heilongjiang [E Russia].

7c. Pinus densiflora var. **zhangwuensis** S. J. Zhang & al., Bull. Bot. Res., Harbin 15: 338. 1995.

彰武赤松 zhang wu chi song

First-year branchlets not white powdery. Needles not or only slightly twisted, 13–15 cm, resin canals 3–9, margin usually inflexed. Seed cones pendulous when immature. Seeds 5–7 mm; wing ca. 1.5 cm.

- About 230 m. N Liaoning (N of Zhangwu).

8. Pinus taiwanensis Hayata, J. Coll. Sci. Imp. Univ. Tokyo 30(1): 307. 1911.

台湾松 tai wan song

Pinus brevispica Hayata; *P. hwangshanensis* W. Y. Hsia; *P. luchuensis* Mayr subsp. *hwangshanensis* (W. Y. Hsia) D. Z. Li; *P. luchuensis* var. *hwangshanensis* (W. Y. Hsia) C. L. Wu; *P. luchuensis* subsp. *taiwanensis* (Hayata) D. Z. Li; *P. taiwanensis* var. *damingshanensis* W. C. Cheng & L. K. Fu.

Trees to 50 m tall; trunk straight or ± tortuous, to 1 m d.b.h.; bark dark gray or grayish brown; crown broadly ovoid, finally umbrellalike; branches spreading or spreading-ascending; 1st-year branchlets brown to yellowish brown, slender; winter buds pinkish brown or reddish brown, cylindric, ovoid-ellipsoid, or ovoid, 1–1.5 cm × 5–6 mm, ± resinous, scales white or long white fringed at margin. Needles 2 per bundle, not or slightly twisted, 4.5–17 cm × 0.6–1 mm, resin canals 2–7(or 8), median, rarely also marginal, base with sheath 0.5–1.4 cm, margin serrulate, with 26–57 teeth per cm in middle part of needle. Pollen cones reddish brown or yellowish brown, 1–2 cm × 3–4 mm. Seed cones light brown to chocolate brown, lustrous, narrowly ovoid or ovoid conical before opening, 3–6 × (2.5–)3–5 cm (closed), persistent. Seed scales ca. 1.8 × 0.8–1 cm, apophyses at middle of closed cones shield- or lozenge-shaped or pentagonal, with 2 or 3 distinct, ± straight or concave proximal edges and a distal end with either 2 distinct, straight or curved edges or a single, rounded margin; umbos depressed or flat, with a minute but distinct and persistent, mucronate prickle, or with a tiny, deciduous prickle, or unarmed. Seeds ellipsoid or ovoid, compressed, 5–6 × 2.6–3.4 mm (excluding wing); wing 1–1.4 cm × 5–6 mm. Pollination Apr–May, seed maturity Oct of 2nd year.

- Mixed warm-temperate and montane forests, open areas and sunny ridges on sandy, acidic mountains, co-dominant with species of Fagaceae; 600–3400 m. Anhui, Fujian, C Guangxi, Guizhou, S Henan, Hubei, Hunan, Jiangsu, Jiangxi, Taiwan, SE Yunnan, Zhejiang.

An important timber tree in Taiwan, *Pinus taiwanensis* is very close to *P. luchuensis*, from Japan (Ryukyu Islands). *Pinus taiwanensis* var. *damingshanensis*, described from C Guangxi (Shanglin: Daming Shan) and also recorded from Guizhou, is here included in synonymy. It has both marginal and median resin canals in the needles, but this character was considered unreliable by D. Z. Li (Edinburgh J. Bot. 54: 343. 1997). R. R. Mill prefers to treat all material from the Chinese mainland as a separate species, *P. hwangshanensis*, which differs from typical *P. taiwanensis* (from Taiwan) as follows: needle sheaths 0.5–1 cm (not 1–1.4 cm); middle part of margin with (37–)43–57 teeth per cm (not 26–35(–39)); pollen cones reddish brown (not yellowish brown); umbo of seed scales depressed, with a minute but distinct and persistent, mucronate prickle (not flat, with a tiny, deciduous prickle or unarmed).

9. Pinus tabuliformis Carrière, Traité Gén. Conif., ed. 2, 1: 510. 1867.

油松 you song

Trees to 25 m tall; trunk to over 1 m d.b.h.; bark grayish brown or dark gray, scaly; crown flat topped; 1st-year branchlets light grayish brown, light brown, or yellowish brown, thick, glabrous; winter buds oblong, slightly resinous. Needles 2(or 3) per bundle, dark green, semiorbicular in cross section, 6–15 cm × 1–1.5 mm, resin canals 5–9, marginal, rarely 1 or 2 median, base with persistent sheath initially 1–2 cm. Pollen cones 5–9 mm. Seed cones shortly pedunculate, initially green, turning yellowish brown to brown at maturity, ovoid to ovoid-globose, 2.5–9 × 4–9 cm, usually persistent for a few years. Seed scales suboblong-obovate, 1.6–2 × ca. 1.4 cm; apophyses swollen, broadly or irregularly rhombic, ridged or not, cross keeled; umbo protruding into a spine. Seeds pale brown, mottled, ovoid or narrowly so, 6–8 × 4–5 mm

(1.5–1.8 cm including wing). Pollination Apr–May, seed maturity Oct of 2nd year.

Hills, mountains; 100–2600 m. Gansu, Hebei, Henan, W Hubei, Hunan, S Jilin, Liaoning, Nei Mongol, Ningxia, Qinghai, Shaanxi, Shandong, Shanxi, Sichuan [Korea].

The timber is used for construction, poles, mine timber, ship building, and furniture. The trunk can be used as a source of resin, the bark for tannin, and the needles for medicine.

1a. Seed cones ovoid-globose, 2.5–5 cm; apophyses slightly swollen; needles slender, 7–12 cm × ca. 1 mm, pliant; 1st-year branchlets usually glaucous ..... 9d. var. *henryi*

1b. Seed cones ovoid, 4–9 cm; apophyses obviously swollen; needles stout, 6–15 cm × 1.2–1.5 mm, stiff; 1st-year branchlets not glaucous or glaucous only when very young.

2a. Trunk monopodial only toward base, branched in middle part; crown flabellate ..... 9c. var. *umbraculifera*

2b. Trunk monopodial; crown conical when young, flat topped at maturity.

3a. Bark gray or brown-gray toward base of trunk, red-brown toward apex, pale brown inside 9a. var. *tabuliformis*

3b. Bark dark gray ..... 9b. var. *mukdensis*

9a. Pinus tabuliformis var. **tabuliformis**

油松(原变种) you song (yuan bian zhong)

Pinus densiflora Siebold & Zuccarini var. *tabuliformis* (Carrière) Masters; *P. leucosperma* Maximowicz; *P. sinensis* Mayr (1894), not D. Don (1828) nor (Beissner) Voss (1913); *P. tabuliformis* var. *bracteata* Takenouchi; *P. tabuliformis* f. *jeholensis* Liou & Q. L. Wang; *P. tabuliformis* f. *purpurea* Liou & Q. L. Wang; *P. tabuliformis* var. *tokunagai* (Nakai) Takenouchi; *P. taihangshanensis* Hu & Yao; *P. tokunagai* Nakai.

Trunk monopodial; bark gray or brown-gray toward base of trunk, red-brown toward apex, pale brown inside; crown conical when young, flat topped at maturity; 1st-year branchlets brownish yellow, not glaucous or glaucous only when very young. Needles stout, 10–15 cm × ca. 1.5 mm, stiff. Seed cones 4–9 × 4–9 cm. Apophyses swollen, obviously ridged.

• Hills, mountains; 100–2600 m. Gansu, Hebei, Henan, S Jilin, Liaoning, Nei Mongol, Ningxia, Qinghai, Shaanxi, Shandong, Shanxi, Sichuan.

9b. Pinus tabuliformis var. **mukdensis** (Uyeki ex Nakai) Uyeki, J. Chôsen Nat. Hist. Soc. 3: 45. 1925.

黑皮油松 hei pi you song

Pinus mukdensis Uyeki ex Nakai, Bot. Mag. (Tokyo) 33: 195. 1919.

Trunk monopodial; bark dark gray, longitudinally or irregularly fissured; crown conical when young, flat topped at maturity; 1st-year branchlets brownish yellow, not glaucous or glaucous only when very young. Needles stout, 10–15 cm × ca. 0.5 mm, stiff. Seed cones 4–9 × 4–9 cm. Apophyses swollen, obviously ridged.

Hills, mountains. NE Hebei (Chengde Shi), ?Jilin, C Liaoning (Shenyang Shi) [Korea].

9c. Pinus tabuliformis var. **umbraculifera** Liou & Q. L. Wang in Liou, Ill. Fl. Lign. Pl. N. E. China 97, 548. 1958.

扫帚油松 sao zhou you song

Trunk monopodial only toward base, branched from middle part; crown flabellate; branches of 1st order inclined-ascending; 1st-year branchlets brownish yellow, not glaucous or glaucous only when very young. Needles stout, 6–15 cm × ca. 1.5 mm, stiff. Seed cones 4–9 × 4–9 cm. Apophyses swollen, obviously ridged.

• Hills. Hebei, C Liaoning (Anshan Shi).

9d. Pinus tabuliformis var. **henryi** (Masters) C. T. Kuan, Fl. Sichuan. 2: 113. 1983.

巴山松 ba shan song

Pinus henryi Masters in F. B. Forbes & Hemsley, J. Linn. Soc., Bot. 26: 550. 1902; *Pinus massoniana* Lambert var. *henryi* (Masters) C. L. Wu; *P. massoniana* var. *wulingensis* C. J. Qi & Q. Z. Lin.

Trunk monopodial; bark gray or brown-gray toward base of trunk, red-brown toward apex, pale brown inside; crown conical when young, flat topped at maturity; 1st-year branchlets red-brown, usually glaucous. Needles 7–12 cm × ca. 1 mm, slightly stiff. Seed cones ovoid-globose, 2.5–5 cm. Apophyses slightly swollen.

• Mountains; 1100–2000 m. W Hubei, Hunan, S Shaanxi, NE Sichuan.

10. Pinus sylvestris Linnaeus, Sp. Pl. 2: 1000. 1753.

欧洲赤松 ou zhou chi song

Trees to 40 m tall; bark red-brown, flaking; branchlets dark gray-brown; winter buds red-brown or pale to yellowish brown, ovoid to oblong-ovoid, resinous. Needles 2 per bundle, blue-green, semiorbicular in cross section, (0.5–)3–14 cm × 1–2 mm, stiff, stomatal lines present on all surfaces, vascular bundles 2, resin canals 6–8, marginal, base usually twisted, with persistent sheath. Seed cones dull yellow-brown at maturity, conical-ovoid, 3–6 cm. Apophyses broadly rhombic, flat or shortly pyramidal; umbo small, blunt or mucronate.

Mountains, river basins, dry rocky slopes; 400–1600 m. Heilongjiang, Jilin, N Nei Mongol; cultivated in Beijing Shi, Liaoning (Gai Xian) [Kazakstan, N Mongolia, Russia; SW Asia, Europe].

The timber is used for construction, railway sleepers, ship building, and making poles and furniture. The trunk can be used as a source of resin, and the bark for tannin.

1a. Winter buds brown or pale yellowish brown; needles 4–12 cm ..... 10c. var. *mongolica*

1b. Winter buds red-brown; needles (0.5–)3–8 cm.
2a. Needles stout, (0.5–)3–7 cm × ca. 2 mm; winter buds oblong-ovoid 10a. var. *sylvestris*
2b. Needles slender, 5–8 cm × 1–1.5 mm; winter buds ovoid ..... 10b. var. *sylvestriformis*

10a. Pinus sylvestris var. **sylvestris**

欧洲赤松(原变种) ou zhou chi song (yuan bian zhong)

Winter buds red-brown, oblong-ovoid. Needles stout, (0.5–)3–7 cm × ca. 2 mm.

Mountains, dry rocky slopes; 400–800(–900) m. Heilongjiang, Jilin, NE Nei Mongol; cultivated in Beijing Shi, Liaoning (Gai Xian) [Kazakstan, ?Mongolia, Russia; SW Asia, Europe].

10b. Pinus sylvestris var. **sylvestriformis** (Takenouchi) W. C. Cheng & C. D. Chu in W. C. Cheng & L. K. Fu, Fl. Reipubl. Popularis Sin. 7: 246. 1978.

长白松 chang bai song

Pinus densiflora Siebold & Zuccarini f. *sylvestriformis* Takenouchi, J. Jap. Forest. Soc. 24: 120. 1942; *P. densiflora* var. *sylvestriformis* (Takenouchi) Q. L. Wang.

Winter buds red-brown, ovoid. Needles slender, 5–8 cm × 1–1.5 mm.

- Mountains, river basins; 800–1600 m. SE Jilin.

A vulnerable plant.

10c. Pinus sylvestris var. **mongolica** Litvinov, Sched. Herb. Fl. Ross. 5: 160. 1905.

樟子松 zhang zi song

Pinus sylvestris var. *manguiensis* S. Y. Li & Adair; *P. yamazutai* Uyeki.

Winter buds brown or pale yellowish brown. Needles 4–12 cm × 0.5–2 mm.

Sandy mountains; 400–900 m. NW Heilongjiang, N Nei Mongol (N Da Hinggan Ling) [N Mongolia, E Russia].

A vulnerable plant in China.

11. Pinus echinata Miller, Gard. Dict., ed. 8, *Pinus* no. 12. 1768.

萌芽松 meng ya song

Trees to 40 m tall; trunk to 1.2 m d.b.h. in native range, usually with adventitious sprouts; bark red-brown, plates scaly with evident resin pockets; crown rounded-conical; 2nd-year branchlets greenish brown or red-brown, aging red-brown or gray, slender, to 5 mm in diam., roughened and cracking below leafy portion; winter buds red-brown, ovoid or cylindric, resinous. Needles 2 (or 3) per bundle, gray- or yellow-green, straight, slightly twisted, (5–)7–11(–13) cm × ca. 1 mm, stomatal lines present on all surfaces, base with persistent sheath 0.5–1(–1.5) cm. Seed cones solitary or clustered, subsessile or shortly pedunculate (peduncle to 1 cm), red-brown, aging gray, ovoid-conical when open, 4–7 cm, maturing in 2 years. Seed scales lacking contrasting dark border adaxially distally; umbo with an elongated or stout and short, sharp prickle. Seeds gray or nearly black, ellipsoid, ca. 6 mm; wing 1.2–1.6 cm.

Cultivated. Fujian (Minhou Xian), Jiangsu (Nanjing Shi), Zhejiang (Fuyang Xian) [native to SE United States].

This tree is very fast growing and is highly valued as a source of timber and wood pulp. It is also a promising species for afforestation.

12. Pinus serotina Michaux, Fl. Bor.-Amer. 2: 205. 1803.

晚松 wan song

Pinus rigida Miller var. *serotina* (Michaux) Loudon ex Hoopes.

Trees to 21 m tall; trunk to 0.6 m d.b.h. in native range, usually with adventitious sprouts; bark red-brown, irregularly furrowed into oblong, flat, scaly plates; crown often rounded or flat; branchlets orange- or yellow-brown, often glaucous, stout; winter buds red-brown, ovoid or narrowly ovoid, 1–1.5 (–2) cm. Needles tufted at branchlet tips, 3 (or 5 in adventitious or disturbed growth) per bundle, slightly twisted, (12–)15–21 cm × 0.3–1.5(–2) mm, stomatal lines present on all surfaces, fine, base with persistent sheath 1–2 cm, margin serrulate, Seed cones whorled, sessile or pedunculate (when peduncles to 1 cm), pale red-brown or creamy brown, broadly ovoid or globose when open, 5–8 cm, maturing in 2 years, late dehiscent. Seed scales with dark red-brown border adaxially distally; apophyses rhombic, low cross keeled; umbo with a short, weak prickle, sometimes unarmed. Seeds pale brown, mottled darker or nearly black, somewhat compressed, ellipsoid, 5–6 mm, apex oblique; wing to 2 cm.

Cultivated. Jiangsu, Jiangxi, Zhejiang [native to SE United States].

13. Pinus rigida Miller, Gard. Dict., ed. 8, *Pinus* no. 10. 1768.

刚松 gang song

Trees to 30 m tall; trunk straight or crooked, to 0.9 m d.b.h. in native range, usually with adventitious sprouts; bark red-brown, with deeply and irregularly oblong, flat, scaly ridges; crown rounded or irregular; 2nd-year branchlets orange-brown, aging darker brown, stout, mostly more than 5 mm wide, rough; winter buds red-brown, ovoid or ovoid-cylindric, resinous, scales fringed at margin. Needles 3(–5) per bundle, deep or pale yellow-green, twisted, 5–10(–15) cm × 1–1.5(–2) mm, stomatal lines present on all surfaces, base with persistent sheath 0.9–1.2 cm. Seed cones often clustered, sessile or shortly pedunculate, dull brown or pale red-brown, conical or ovoid before opening, broadly ovoid with flat or slightly convex base when open, 3–9 cm, maturing in 2 years, dehiscent. Seed scales with dark red-brown border adaxially distally; apophyses rhombic, slightly raised, strongly cross keeled; umbo low pyramidal, with a slender, reflexed prickle. Seeds dark brown, mottled darker or nearly

black, broadly obliquely obovoid-deltoid, 4–6 mm; wing 1.5–2 cm.

Cultivated. Fujian, Jiangsu (Nanjing Shi), Jiangxi (Lu Shan), Liaoning, Shandong (Qingdao Shi) [native to SE Canada, E United States].

14. Pinus palustris Miller, Gard. Dict., ed. 8, *Pinus* no. 14. 1768.

长叶松 chang ye song

Pinus australis F. Michaux; *P. longifolia* Salisbury.

Trees to 45 m tall; trunk to 1.2 m d.b.h. in native range; bark orange-brown, with coarse, oblong, scaly plates; crown rounded; branches spreading-descending, upcurved at tips; branchlets orange-brown, aging darker brown, stout, rough; winter buds silvery white, ovoid, 3–4 cm, scales fringed at margin. Needles spreading-recurved, (2 or)3 per bundle, yellow-green, slightly twisted, 20–45 cm × ca. 1.5 mm, stomatal lines present on all surfaces, base with persistent sheath 2–2.5(–3) cm, margin finely serrulate. Seed cones solitary or paired toward branchlets tips, sessile or rarely shortly pedunculate, dark brown, ovoid-cylindric when open, 15–25 cm, maturing in 2 years, then quickly shedding seeds and falling. Apophyses dull, nearly rhombic, slightly thickened and raised, strongly cross keeled; umbo broadly triangular, with a short, stiff, reflexed prickle. Seeds pale brown, mottled darker, truncate-obovoid, ca. 1 cm; wing 3–4 cm.

Cultivated. Fujian, Jiangsu, Jiangxi (Lu Shan), Shandong (Qingdao Shi), Zhejiang [native to SE United States].

15. Pinus elliottii Engelmann, Trans. Acad. Sci. St. Louis 4: 186. 1880.

湿地松 shi di song

Trees to 30 m tall; trunk to 0.8 m d.b.h. in native range; bark orange- or purple-brown, furrowed into irregularly oblong, large, papery, scaly plates; crown conical, becoming rounded or flat topped; branchlets orange-brown, aging darker brown, stout, roughly scaly, producing 3 or 4 nodes each year; winter buds silvery brown, cylindric, scales fringed at margin. Needles 2 or 3 per bundle, slightly twisted, yellow- or blue-green, 15–20 (–24) cm × 0.2–1.5 mm, stomatal lines present on all surfaces, base with persistent sheath 1–2 cm, margin finely serrulate. Seed cones solitary or paired, pedunculate (peduncle to 3 cm), pale brown, ovoid or ovoid-cylindric when open, (7–)9–18(–20) cm, maturing in 2 years, then falling the year after seeds shed. Apophyses lustrous, slightly raised, strongly cross keeled; umbo depressed-pyramidal, with a short, stout prickle. Seeds dark brown, ellipsoid, 6–7 mm, apex oblique; wing to 2 cm.

Cultivated. Anhui (Jing Xian), Fujian (Minhou Xian), Guangdong, Guangxi, Hubei (Wuhan Shi), Hunan, Jiangsu, Jiangxi (Ji'an Xian), Taiwan, Yunnan (Kunming Shi), Zhejiang [native to SE United States].

16. Pinus caribaea Morelet, Rev. Hort. Côte d'Or 1: 107. 1851.

加勒比松 jia le bi song

Trees to 40 m tall; trunk to 1 m d.b.h. in native range; bark gray or pale reddish brown, fissured and shed in large, flat, wide plates; crown ovoid or irregularly shaped; branchlets initially green and glaucous, aging orange-brown, producing a few short nodes each year; winter buds cylindric, scales white fringed at margin. Needles (2 or)3 per bundle, usually 4 or 5 per bundle on young trees, dull green or pale yellow-green, 15–30 cm × ca. 1.5 mm, stomatal lines present on all surfaces, resin canals (2 or)3 or 4(–8), internal, base with persistent sheath 1–1.5 cm, margin serrulate. Seed cones almost terminal, ovoid-cylindric, 5–10(–12) × 3–6 cm, often leaving a few basal scales. Seed scales reflexed or spreading; apophyses lustrous, tan or reddish brown, swollen, cross keeled; umbo slightly projecting, ending in a straight, minute prickle. Seeds usually narrowly mottled gray or light brown, rhombic-ovoid, 6–7 mm; wing dull gray, 2–2.5 cm, usually remaining attached.

Cultivated. Fujian, Guangdong, Guangxi, Jiangsu, Jiangxi [native to Caribbean region, Central America].

17. Pinus taeda Linnaeus, Sp. Pl. 2: 1000. 1753.

火炬松 huo ju song

Trees to 45 m tall; trunk to 1.6 m d.b.h. in native range; bark red-brown, forming square or irregularly oblong, scaly plates; crown broadly conical or rounded; branchlets orangish or yellow-brown, aging darker brown, ca. 1 cm in diam., rough; winter buds pale red-brown, conical-cylindric, slightly resinous, scales white fringed at margin. Needles ascending or spreading, dark yellow-green, slightly twisted, (10–)12–18(–23) cm × 1–2 mm, pliant, stomatal lines present on all surfaces, base with persistent sheath 1–2.5 cm, margin finely serrulate. Seed cones nearly terminal, solitary or in small clusters, sessile or subsessile, mostly dull yellow-brown, narrowly ovoid when open, 6–12 cm, maturing in 2 years, then soon shedding seeds. Seed scales without dark border adaxially distally; apophyses dull, rhombic, slightly thickened, variously raised but more so toward base of cone, strongly cross keeled; umbo strongly pyramidal, recurved, tapering to a stoutly based, sharp prickle. Seeds red-brown, obdeltoid, 5–6 mm; wing to 2 cm.

Cultivated. Anhui, Fujian, Guangdong (Guangzhou Shi), Guangxi, Henan, Hubei (Wuhan Shi), Hunan, Jiangsu (Nanjing Shi), Jiangxi (Lu Shan), Taiwan, Zhejiang [native to SE United States].

18. Pinus ponderosa Douglas ex C. Lawson, Agric. Man. 354. 1836.

西黄松 xi huang song

Trees to 70 m tall; trunk to 2.5 m d.b.h. in native range; bark yellow- to red-brown, deeply and irregularly furrowed into broadly oblong, scaly plates; crown broadly conical to rounded; branchlets orange-brown,

aging darker, stout, rough; winter buds red-brown, ovoid, very resinous, scales white fringed at margin. Needles tufted at apex of branchlets, spreading to erect, (2 or)3(–5) per bundle, deep yellow-green, slightly twisted, 7–25(–30) cm × (1–)1.2–2 mm, pliant, stomatal lines present on all surfaces, base with persistent sheath 1.5–3 cm, margin serrulate. Seed cones solitary or rarely paired, sessile or subsessile, mostly reddish brown, broadly ovoid when open, symmetric or asymmetric, 5–15 cm, maturing in 2 years, then soon shedding seeds, leaving rosettes of scales on branchlets. Apophyses dull or lustrous, thickened, variously raised, cross keeled; umbo usually pyramidal or truncate, rarely depressed or with a reflexed prickle. Seeds brown or yellow-brown, often mottled darker, ellipsoid-obovoid, 3–9 mm; wing 1.5–2.5 cm.

Cultivated. Henan (Jigong Shan), Jiangsu (Nanjing Shi), Jiangxi (Lu Shan), Liaoning [native to W North America].

This species is economically important and is grown for its fine timber.

19. Pinus tropicalis Morelet, Rev. Hort. Côte d'Or 1: 106. 1851.

热带松 re dai song

Trees to 20 m tall; trunk to 1.8 m d.b.h. in native range; bark grayish red, irregularly furrowed into large, oblong plates; crown broadly rounded; branchlets orange-brown initially, aging gray-brown or gray, stout, rough; winter buds stout, scales reflexed. Needles very erect, 2(or 3) per bundle, stiff, 10–30 cm × ca. 1 mm, resin canals 2–9, large, touching both endodermis and hypodermis and forming a septum, margin serrulate. Seed cones erect or spreading, shortly pedunculate, pale brown, ovoid-conical, 5–8 cm. Apophyses orange-brown, pyramidal, cross ridged; umbo not spinose.

Cultivated. Guangdong (Zhanjiang Shi) [native to W Cuba].

20. Pinus pinaster Aiton, Hort. Kew. 3: 367. 1789.

海岸松 hai an song

Trees to 30 m in native range; bark brown, deeply and irregularly longitudinally furrowed; branches sometimes pendulous, forming a pyramidal crown; branchlets pale reddish brown, producing 1–few nodes each year; winter buds brown, oblong, resinous. Needles 2 per bundle, bright green, usually twisted, 10–20 cm × ca. 2 mm, stiff, resin canals 6, median. Seed cones clustered, shortly pedunculate, conical- or ellipsoid-ovoid, symmetric or asymmetric, 9–18 cm. Apophyses brown, lustrous, conspicuously pyramidal; umbo slightly projecting and pungent.

Cultivated. Jiangsu, Jiangxi (Lu Shan) [native to N Africa, S Europe].

21. Pinus thunbergii Parlatore in A. de Candolle, Prodr. 16(2): 388. 1868.

黑松 hei song

Pinus thunbergiana Franco.

Trees to 30 m tall; trunk to 2 m d.b.h. in native range; bark dull gray when young, aging gray-black, rough and thick, scaly and decidous; crown broadly conical or umbrellalike; 1st-year branchlets pale brown-yellow, glabrous; winter buds silvery white, cylindric-ellipsoid or cylindric, scales fringed at margin. Needles 2 per bundle, dull green, shiny, 6–12 cm × 0.5–2 mm, rigid, stomatal lines present on all surfaces, resin canals 6–11, median, base with persistent sheath, margin serrulate. Seed cones solitary or 2 or 3 together, shortly pedunculate, brown, conical-ovoid or ovoid, 4–6 × 3–4 cm, deciduous. Seed scales ovate-elliptic; apophyses slightly swollen, obviously cross keeled; umbo slightly concave, apex blunt. Seeds obovoid-ellipsoid, 5–7 × 2–3.5 mm; wing gray-brown, 1–1.1 cm. Pollination Apr–May, seed maturity Oct of 2nd year.

Cultivated in cities, used for afforestation on mountain slopes; to 1400 m. Beijing Shi, Hubei (Wuhan Shi, Yingshan Xian), Jiangsu (Nanjing Shi), Jiangxi, Liaoning, Shandong, Yunnan (Kunming Shi), Zhejiang [native to Japan, Korea].

22. Pinus nigra J. F. Arnold, Reise Mariazell 8. 1785.

欧洲黑松 ou zhou hei song

Trees to 50 m in native range; bark gray or dark brown; branchlets pale brown or orange-brown, glabrous; winter buds ovoid or cylindric-ovoid, slightly resinous. Needles 2 per bundle, pale or dark green, straight or curved, 4–19 cm × 1–2 mm, somewhat rigid, resin canals 3–17, median, base with persistent sheath. Seed cones subsessile, yellowish or pale brown, shiny, 3–8 × 2–4 cm, deciduous. Apophyses slightly or obtusely keeled; umbo mucronate.

Widely cultivated. Beijing Shi, Hubei (Wuhan Shi), Jiangsu (Nanjing Shi), Jiangxi (Lu Shan), Liaoning, Shandong, Zhejiang [native to NW Africa, SW Asia, S Europe].

23. Pinus banksiana Lambert, Descr. Pinus 1: 7. 1803.

北美短叶松 bei mei duan ye song

Trees to 25 m tall; trunk straight or crooked, to 0.6 m d.b.h. in native range; bark orange- or red-brown, scaly; crown irregularly rounded or flat topped; branchlets orange-red or red-brown, aging gray-brown, slender, rough; winter buds red-brown, ovoid, resinous. Needles 2 per bundle, yellow-green, twisted, 2–5 cm × 1–1.5(–2) mm, stomatal lines present on all surfaces, fine, base with semipersistent sheath 3–6 mm, margin finely serrulate. Seed cones upcurved, nearly sessile or shortly pedunculate, tan to pale brown or greenish yellow, ovoid when open, asymmetric, 3–5.5 cm, maturing in 2 years, then soon shedding seeds or often long serotinous and shedding seeds only with age or after fire. Apophyses mostly depressed but increasingly mamillate toward outer part, basal of cone; umbo depressed, sunken centrally, small, unarmed or with a small, reflexed apicula. Seeds brown or nearly black, compressed obovoid, oblique, 4–5 mm; wing 1–1.2 cm.

Cultivated. Beijing Shi, Heilongjiang (Harbin Shi), Henan (Jigong Shan), Jiangsu (Nanjing Shi), Jiangxi (Lu Shan), Liaoning, Shandong [native to N North America].

24. Pinus virginiana Miller, Gard. Dict., ed. 8, *Pinus* no. 9. 1768.

矮松 ai song

Trees to 20 m tall; trunk to 0.5 m d.b.h. in native range; bark gray-brown, with irregular, scaly, plated ridges, reddish and scaly toward apex of trunk; crown irregularly rounded or flattened; branchlets red or purple tinged, often glaucous, aging red-brown or gray, slender, rough; winter buds red-brown, ovoid or cylindric, resinous or not, scales white fringed at margin. Needles 2 per bundle, deep to pale yellow-green, strongly twisted, 2–8 cm × 1–1.5 mm, stomatal lines present on all surfaces, inconspicuous, base with persistent sheath 4–10 mm, margin serrulate. Seed cones subsessile or shortly pedunculate (peduncle to 1 cm), dull red-brown, ovoid when open, symmetric, 3–7(–8) cm, maturing in 2 years, then soon shedding seeds. Seed scales with strong purple-red or purple-brown border adaxially distally, rigid; apophyses slightly elongated and thickened; umbo low pyramidal, with a slender, stiff prickle. Seeds pale brown, mottled darker, compressed obovoid, 4–7 mm, apex oblique; wing to 2 cm, narrow.

Cultivated. Jiangsu (Nanjing Shi), Jiangxi (Lu Shan) [native to E United States].

25. Pinus squamata X. W. Li, Acta Bot. Yunnan. 14: 259. 1992.

巧家五针松 qiao jia wu zhen song

Trees; bark gray-green, aging dark brown, flaking, smooth when young, inner bark pale; branchlets red-brown, densely yellow- or gray-brown pubescent or glabrous; winter buds red-brown, ovoid, resinous, scales triangular-lanceolate. Needles 4 or 5 per bundle, 9–17 cm × ca. 0.8 mm, stomatal lines present on all surfaces, vascular bundle 1, resin canals 3–5, marginal, base with sheath shed, margin serrulate. Seed cones pedunculate (peduncle 1.5–2 cm), conical-ovoid, ca. 9 × 6 cm, dehiscent at maturity. Seed scales oblong-elliptic, ca. 2.7 × 1.8 cm; apophyses swollen, obviously transversely ridged; umbo dorsal, sunken, not spiny. Seeds black, longitudinally striate, oblong or obovate; wing ca. 1.6 cm, black striate, articulate. Pollination Apr–May, seed maturity Sep–Oct of 2nd year.

- NE Yunnan (Qiaojia Xian).

A highly endangered species known only from a population of little more than 20 trees.

26. Pinus gerardiana Wallich ex D. Don in Lambert, Descr. Pinus, ed. 8°, 2: p. s.n. inter 144 & 145. 1832.

须弥白皮松 xu mi bai pi song

Trees; bark white, fissured into irregular, thin plates; 1st-year branchlets pale green-yellow, glabrous, with projected leaf scars. Needles 3 per bundle, triangular-flabellate in cross section, 6–10 cm, stiff, vascular bundle 1, resin canals 5–7, marginal, base with sheath shed. Seed cones shortly pedunculate, almost brown at maturity, oblong or ovoid, 12–20 × 9–11 cm. Seed scales 4–5 cm; apophyses broad, swollen, ± recurved, obviously ridged; umbo dorsal, apex obtuse. Seeds cylindric, ca. 2.5 cm; wing rudimentary, usually adhering to adjacent scale.

Mountains; ca. 2700 m. S Xizang [E Afghanistan, N India, Kashmir, N Pakistan].

27. Pinus bungeana Zuccarini ex Endlicher, Syn. Conif. 166. 1847.

白皮松 bai pi song

Trees to 30 m tall; trunk monopodial or forked near base, to 3 m d.b.h.; bark irregularly flaking, inner bark pale, exfoliating in irregular, thin, scaly patches; crown broadly pyramidal or umbrellalike; 1st-year branchlets gray-green, glabrous; winter buds red-brown, ovoid, not resinous. Needles 3 per bundle, triangular-flabellate in cross section, 5–10 cm × 0.5–2 mm, stiff, vascular bundle 1, resin canals 6 or 7, marginal, rarely 1 or 2 median, base with sheath shed. Seed cones solitary, shortly pedunculate or subsessile, usually pale green, yellowish brown at maturity, ovoid or conical-ovoid, 5–7 × 4–6 cm. Seed scales broadly oblong-cuneate, apex thickened; apophyses subrhombic, obviously transversely ridged; umbo dorsal, triangular, protruding, usually terminating in a recurved spine. Seeds gray-brown, subobovoid, ca. 10 × 5–6 mm; wing loosely attached, ca. 5 mm. Pollination Apr–May, seed maturity Oct–Nov of 2nd year.

- Mountains, hills; 500–1800 m. S Gansu, W Henan, W Hubei (Badong Xian), S Shaanxi, Shandong, Shanxi, N Sichuan.

28. Pinus pumila (Pallas) Regel in Kuester & al., Index Sem. Hort. Bot. Imp. Petrop. 1858: 23. 1859.

偃松 yan song

Pinus cembra Linnaeus var. *pumila* Pallas, Fl. Ross. 1(1): 5. 1784; *P. cembra* var. *pygmaea* Loudon.

Shrubs to 6 m tall, usually with creeping branches to 10 m; bark gray-brown, flaking; branchlets initially brown, dark red-brown in 2nd or 3rd year, densely pubescent; winter buds red-brown, conical-ovoid, slightly resinous. Needles 5 per bundle, trapeziform in cross section, 4–6(–8.3) cm × ca. 1 mm, stiff, vascular bundle 1, resin canals (1 or)2, marginal, base with sheath shed. Seed cones erect, maturing to pale purple- or red-brown, conical-ovoid or ovoid, 3–4.5 × 2.5–3 cm, indehiscent or imperfectly dehiscent at maturity. Seed scales broadly subrhombic or rhombic-obovate; apophyses broadly triangular, thick, swollen, margin slightly recurved; umbo purple-black, distinct, ending in a slightly recurved protuberance. Seeds dark brown, triangular-obovoid, 7–10 × 5–7 mm, wingless, abaxial margin ridged.

Mountains; 1000–2300 m. Heilongjiang, Jilin, Nei Mongol [Japan, Korea, N Mongolia, E Russia].

29. Pinus koraiensis Siebold & Zuccarini, Fl. Jap. 2: 28. 1842.

红松 hong song

Apinus koraiensis (Siebold & Zuccarini) Moldenke; *Pinus mandschurica* Ruprecht; *P. prokoraiensis* Y. T. Zhao & al.; *Strobus koraiensis* (Siebold & Zuccarini) Moldenke.

Trees to 50 m tall; trunk to 1 m d.b.h.; bark gray-brown or gray, fissured longitudinally into irregularly oblong plates, inner bark red-brown; branchlets densely red-brown, occasionally yellow pubescent; winter buds reddish brown, oblong-ovoid, slightly resinous. Needles 5 per bundle, dark green, straight, almost triangular in cross section, 6–12 cm, stomatal lines 6–8 along each abaxial surface, blue-gray, vascular bundle 1, resin canals 3, median, base with sheath shed, margin serrulate. Seed cones solitary or several clustered near apex of 1st-year branchlets, erect, pedunculate (peduncle 1–1.5 cm), conical-ovoid or ovoid-oblong, 9–14 × 6–8 cm, indehiscent or slightly dehiscent at maturity, with seeds exposed but not shed. Seed scales reflexed at apex. Seeds triangular-obovoid, 1.2–1.6 cm, wingless.

Mountains; 200–1800 m. Heilongjiang, Jilin [Japan, Korea, E Russia].

The timber is used for construction, bridge building, vehicles, furniture, and wood pulp. The seeds are edible, medicinal, and used as a source of soap and lubricating oil. Turpentine is obtained from the timber and roots, and the bark yields tannin.

30. Pinus sibirica Du Tour in Déterville, Nouv. Dict. Hist. Nat. 18: 18. 1803.

鲜卑五针松 xian bei wu zhen song

Pinus cembra Linnaeus subsp. *sibirica* (Du Tour) Krylov; *P. cembra* var. *sibirica* (Du Tour) G. Don; *P. hingganensis* H. J. Zhang; *P. sibirica* var. *hingganensis* (H. J. Zhang) Silba.

Trees to 35 m tall; trunk to 1.8 m d.b.h.; bark pale brown or gray-brown; branchlets yellow or brownish yellow, thick, densely pale yellow pubescent; winter buds red-brown, conical. Needles 5 per bundle, slightly curved, almost triangular in cross section, 6–11 cm × 0.5–1.7 mm, stiff, stomatal lines 3–5 along each abaxial surface, gray-white, vascular bundle 1, resin canals 3, median, base with sheath shed, margin serrulate. Seed cones erect, conical-ovoid, 5–8 × 3–5.5 cm, indehiscent or slightly dehiscent at maturity. Seed scales widely cuneate proximally, thickened distally; apophyses purple-brown, broadly rhombic or broadly triangular-semiorbicular, densely pilose; umbo yellow-brown, obvious. Seeds yellow-brown, obovoid, ca. 10 × 5–6 mm, slightly ridged, wingless. Pollination Apr, seed maturity Sep–Oct of 2nd year.

Mountains, river basins; 800–2400 m. Heilongjiang (Tuqiang), Nei Mongol, Xinjiang [Kazakstan, Mongolia, E Russia].

A vulnerable species in China. Plants named as *Pinus hingganensis* represent the E limits of *P. sibirica;* they are considerably disjunct from the main distribution center, and grow at lower elevations (800–1300 m), but are nevertheless indistinguishable from *P. sibirica*.

The timber is used for construction and furniture.

31. Pinus armandii Franchet, Nouv. Arch. Mus. Hist. Nat., sér. 2, 7: 95. 1884.

华山松 hua shan song

Trees to 35 m tall; trunk to 1 m d.b.h.; bark gray, fissured into square plates or shed; crown conical or cylindric-pyramidal; branchlets green, gray-green, or -brown, glaucous, turning brown when dry, glabrous; winter buds almost cylindric, slightly resinous. Needles 5(–7) per bundle, triangular in cross section, 8–15 cm × 1–1.5 mm, vascular bundle 1, resin canals 3(–7), median or 2 marginal. Pollen cones erect or drooping, slender or stout, cylindric or ovoid-ellipsoid. Seed cones pedunculate (peduncle 2–3 cm), green, maturing yellow or brown-yellow, conical-cylindric, dehiscent at maturity, shedding seeds. Seed scales rhombic-obovate, 3–4 × 2.5–3 cm; apophyses rhombic or triangular, not ridged, apex obtuse-rounded or acuminate, not recurved or slightly recurved; umbo not obvious. Seeds yellow-brown, dark brown, or black, obovoid, 1–1.5 cm × 6–10 mm, wingless or abaxial margin ridged, rarely shortly winged. Pollination Apr–May, seed maturity Sep–Oct of 2nd year.

Mountains, river basins; 1000–3300 m. S Gansu, C and NW Guizhou, Hainan, SW Henan, W Hubei, S Shaanxi, S Shanxi, Sichuan, C Taiwan, SE Xizang, Yunnan [N Myanmar].

The timber is used for construction, railway sleepers, furniture, and wood fiber.

1a. Pollen cones erect, stout, ovoid-ellipsoid; branchlets green or gray-green, drying brown; apophyses yellow or brown-yellow when mature, rhombic, not recurved distally or recurved only at umbo ..... 31a. var. *armandii*

1b. Pollen cones drooping, slender, cylindric; branchlets gray-brown; apophyses brown or reddish brown when mature, triangular, usually slightly recurved distally 31b. var. *mastersiana*

31a. Pinus armandii var. **armandii**

华山松(原变种) hua shan song (yuan bian zhong)

Pinus excelsa Wallich ex D. Don var. *chinensis* Patschke; *P. levis* Lemée & H. Léveillé; *P. scipioniformis* Masters.

Branchlets green or gray-green, drying brown. Pollen cones erect, stout, ovoid-ellipsoid. Apophyses yellow or brown-yellow when mature, rhombic, not recurved distally or recurved only at umbo.

Mountains, river basins; 1000–3300 m. S Gansu, C and NW Guizhou, Hainan, SW Henan, W Hubei, S Shaanxi, S Shanxi, Sichuan, SE Xizang, Yunnan [N Myanmar].

31b. Pinus armandii var. **mastersiana** (Hayata) Hayata, J. Coll. Sci. Imp. Univ. Tokyo 25(19): 217. 1908.

台湾果松 tai wan guo song

Pinus mastersiana Hayata, Gard. Chron., ser. 3, 43: 194. 1908.

Branchlets gray-brown. Pollen cones drooping, slender, cylindric. Apophyses brown or reddish brown when mature, triangular, usually slightly recurved distally.

• Mountains, on well-drained, acidic soils; 1800–3300 m. C Taiwan.

32. Pinus fenzeliana Handel-Mazzetti, Oesterr. Bot. Z. 80: 337. 1931.

海南五针松 hai nan wu zhen song

Trees to 50 m tall; trunk to 1 m d.b.h.; bark dark brown or gray-brown, flaking; 1st-year branchlets pale brown (drying dark red-brown), rarely glaucous, slender, glabrous, longitudinally furrowed; winter buds cylindric-conical or ovoid, slightly resinous. Needles 5 per bundle, slender, triangular in cross section, 5–18 cm × 0.5–0.7 cm, flexible, vascular bundle 1, resin canals 3, 2 marginal and 1 median. Seed cones solitary or 2–4 clustered at base of branchlets, pedunculate (peduncle 1–2 cm), green, maturing to yellow-brown, narrowly ovoid, ellipsoid-ovoid, or cylindric-ellipsoid, 6–14 × 3–6 cm, usually resinous, dehiscent. Seed scales almost cuneate or oblong-obovoid, 2–2.5 × 1.5–2 cm at middle of cone; apophyses broadly subrhombic, distal margin obviously reflexed, apex thickened. Seeds chestnut or pale brown, obovoid-ellipsoid, 0.8–1.5 cm × 5–8 mm; seed coat thin; wing rudimentary, 2–4(–7) mm or much shorter. Pollination Apr, seed maturity Oct–Nov of 2nd year.

Mountains, usually scattered on ridges, rocks, or cliffs; 900–1600 m. SW Anhui, Guangxi, C and N Guizhou, Hainan, SE Henan, E Hubei, SE Sichuan [Vietnam].

The timber is used for construction and producing turpentine.

1a. Needles 10–18 cm; seed cones narrowly ovoid or ovoid-ellipsoid, 6–9 cm; seeds chestnut brown, wing 2–4(–7) mm 32a. var. *fenzeliana*
1b. Needles 5–14 cm; seed cones cylindric-ellipsoid, ca. 14 cm; seeds pale brown, wing very short, woody ... 32b. var. *dabeshanensis*

32a. Pinus fenzeliana var. **fenzeliana**

海南五针松(原变种) hai nan wu zhen song (yuan bian zhong)

Pinus parviflora Siebold & Zuccarini var. *fenzeliana* (Handel-Mazzetti) C. L. Wu.

Needles 10–18 cm. Seed cones narrowly ovoid or ovoid-ellipsoid, 6–9 cm. Seeds chestnut brown; wing 2–4(–7) mm.

Mountains, usually scattered on ridges and rocks; 1000–1600 m. Guangxi, C and N Guizhou, Hainan, SE Sichuan (Wulong Xian) [Vietnam].

32b. Pinus fenzeliana var. **dabeshanensis** (W. C. Cheng & Y. W. Law) L. K. Fu & Nan Li, Novon 7: 262. 1997.

大别五针松 da bie wu zhen song

Pinus dabeshanensis W. C. Cheng & Y. W. Law in W. C. Cheng & al., Acta Phytotax. Sin. 13(4): 85. 1975; *P. armandii* Franchet var. *dabeshanensis* (W. C. Cheng & Y. W. Law) Silba.

Needles 5–14 cm. Seed cones cylindric-ellipsoid, ca. 14 cm. Seeds pale brown; wing very short, woody.

• Mountains, sometimes on cliffs or rocks; 900–1400 m. SW Anhui (Jinzhai Xian, Yuexi), SE Henan (Shangcheng Xian), E Hubei (Luotian Xian, Yingshan Xian).

An endangered plant.

33. Pinus bhutanica Grierson & al., Notes Roy. Bot. Gard. Edinburgh 38: 299. 1980.

不丹松 bu dan song

Trees to 25 m or more; crown moderately open, not twiggy; branches spreading, drooping, sinuous; 1st-year branchlets conspicuously whitish bloomed, glandular pubescent; 2nd-year branchlets with thin, pale gray-green bark. Needles shed in 2nd year, 5 per bundle, pendulous, very slender, curved, triangular in cross section, 15–24 cm, adaxial surface grass green with no stomata, 2 abaxial surfaces conspicuously whitish bloomed, each with 4–7 stomatal lines, resin canals 3(or 4), adaxial 2 marginal or submarginal, abaxial 1(or 2) marginal or submarginal and always asymmetrically placed. Seed cones pedunculate (peduncle (1–) 4.5–6 cm), elongate-cylindric, 12–20 × 3–4 cm (5–7 cm wide when open). Seed scales rather elongate, thinly woody, base cuneate; apophyses rhombic, 1–1.5 × 1.5–2.5 cm, keeled, apex subacute. Seeds brown, obovoid, compressed, 6–8 × 4–5 mm; wing persistent, ca. 2 × 0.7–1 cm.

SE Xizang [Bhutan].

34. Pinus wallichiana A. B. Jackson, Bull. Misc. Inform. Kew 1938: 85. 1938.

乔松 qiao song

Pinus excelsa Wallich ex D. Don (1828), not Lamarck (1778); *P. griffithii* M'Clelland (1854), not (J. D. Hooker) Parlatore (1868); *P. nepalensis* Chambray (1845), not J. Forbes (1839).

Trees to 70 m tall; trunk to 1 m or more d.b.h.; bark dark gray-brown, minutely scaly and flaking; crown broadly pyramidal; 1st-year branchlets green (drying red-brown), shiny, faintly whitish bloomed, glabrous; winter buds red-brown, cylindric-obovoid or cylindric-conical, slightly resinous. Needles 5 per bundle, pendulous, slender, triangular in cross section, (6–)11–18(–20) cm × ca. 1 mm, soft, adaxial surface dark green, vascular bundle 1, resin canals 3, adaxial 2 marginal, abaxial 1 always median. Seed cones pendulous, pedunculate (peduncle 2.5–4 cm), cylindric, straight or curved, 10–30 × 3–4 cm (5–9 cm wide when open), resinous. Seed scales cuneate-obovate, 3–5 × 2–3 cm at middle of cone; apophyses shiny, often glaucous, rhombic, slightly thickened; umbo dark brown, slightly projecting, apex obtuse, obviously incurved. Seeds

brown or black-brown, ellipsoid-obovoid, 3–9 × 4–5 mm; wing 1–3 cm × 8–9 mm. Pollination Apr–May, seed maturity autumn of 2nd year.

Mountains, temperate rainforests; 1600–3300 m. S Xizang, NW Yunnan [Afghanistan, Bhutan, N India, Kashmir, Myanmar, Nepal, Pakistan, Sikkim].

Pinus wallichiana var. *parva* K. C. Sahni (Indian J. Forest. 12(1): 40. 1989) was described from SE Xizang, where it apparently grows in temperate rainforests with species of *Rhododendron* at ca. 3000 m. It is an insufficiently understood taxon, known only from the type, which was not seen by the authors. It is said to differ from typical *P. wallichiana* as follows: needles mostly less than 11 cm; seed cones straight (not curved), smaller (ca. 10 cm); seeds smaller (ca. 3 mm); wing shorter (ca. 10 mm).

The timber is used for construction, furniture, and for producing turpentine.

35. Pinus morrisonicola Hayata, Gard. Chron., ser. 3, 43: 194. 1908.

台湾五针松 tai wan wu zhen song

Pinus formosana Hayata; *P. parviflora* Siebold & Zuccarini var. *morrisonicola* (Hayata) C. L. Wu; *P. uyematsui* Hayata.

Trees to 30 m tall; trunk to 1.2 m d.b.h.; bark dark gray, flaking; crown conical; 1st-year branchlets red-brown, initially yellowish pubescent, glabrescent; winter buds pale brown, ovoid, not resinous. Needles 5 per bundle, triangular in cross section, 4–9 cm × 0.6–1 mm, vascular bundle 1, resin canals 2, marginal, base with sheath shed. Seed cones 3 or 4 clustered at base of branchlets, pedunculate (peduncle 0.5–1 cm), conical-ellipsoid or ovoid-ellipsoid, 7–11 × 5–7 cm, resinous, dehiscent. Seed scales cuneate-elliptic, 3–3.5 × 1.5–2 cm; apophyses brown, shiny, broadly rhombic, middle portion thickened, apex recurved. Seeds ellipsoid-ovoid or narrowly ovoid, 8–10 × 5–6 mm; wing pale brown, 1.5–2 cm × 5–8 mm.

- Mountain slopes, ridges; 300–2300 m. Taiwan.

The timber is used for construction, bridge building, and making poles and furniture.

36. Pinus wangii Hu & W. C. Cheng, Bull. Fan Mem. Inst. Biol., n.s., 1: 191. 1948.

毛枝五针松 mao zhi wu zhen song

Trees to 20 m tall; trunk to 60 cm d.b.h. branchlets slender, dark red-brown, turning dark gray-brown, initially densely brown pubescent, glabrous in 2nd or 3rd year; winter buds brown, not resinous. Needles 5 per bundle, thick, slightly incurved, triangular in cross section, 2.5–6 cm × 1–1.5 mm, stiff, vascular bundle 1, resin canals 3, median, base with sheath shed. Seed cones solitary or 2 or 3 clustered at base of branchlets, pedunculate (peduncle 1.5–2 cm), yellowish brown, brown, or dark gray-brown at maturity, oblong-ellipsoid or cylindric-ovoid, 4.5–9 × 2–4.5 cm. Seed scales subobovate, 2–3 × 1.5–2 cm; apophyses transversely rhombic, margin thin, slightly incurved, rarely slightly recurved on middle or basal seed scales; umbo sunken, not swollen. Seeds pale brown, ellipsoid-ovoid, 8–10 × ca. 6 mm; wing ca. 16 × 7 mm.

Scattered in evergreen broad-leaved forests on limestone hillsides, where only fragmented populations remain on inaccessible cliffs; 500–1800 m. SE Yunnan (Malipo Xian, Xichou Xian) [?Vietnam].

An endangered species in China. The Vietnamese plants may represent a different taxon, perhaps better placed within *Pinus dalatensis* Ferré, which is endemic to Vietnam.

The timber is used for construction, bridge building, and making poles and furniture.

37. Pinus kwangtungensis Chun & Tsiang, Sunyatsenia 7: 113. 1948.

华南五针松 hua nan wu zhen song

Trees to 30 m tall; trunk to 1.5 m d.b.h.; bark brown, scaly; 1st-year branchlets pale brown; old branchlets grayish brown or yellow-brown, glabrous, rarely puberulent; winter buds black-brown, slightly resinous. Needles 2–5 per bundle, triangular in cross section, 3.5–7 cm × 1–1.5 mm, vascular bundle 1, resin canals 2, marginal, sometimes also 1 median, base with sheath shed. Seed cones usually solitary, pedunculate (peduncle 0.7–2 cm), reddish brown at maturity, cylindric-oblong or cylindric-ovoid, 3–9(–17) × 1.5–7 cm, slightly resinous. Seed scales cuneate-obovate, 2.5–3.5 × 1.5–2.3 cm; apophyses rhombic, apex thin, straight or slightly incurved. Seeds ellipsoid or obovoid, 0.8–1.2 cm, together with wing subequal to seed scales. Pollination Apr–May, seed maturity Oct of 2nd year.

Hills, slopes, mountain ridges, summits; 500–1600 m. N Guangdong, SW Guangxi, S Guizhou, Hainan, S Hunan [Vietnam].

A vulnerable species in China. It has often been confused, and even united, with *Pinus fenzeliana* (to which the records from Hainan might belong); however, the two species are not considered here to be conspecific.

1a. Needles usually 5 per bundle, with white stomatal bands abaxially; seed cones 5–9(–17) × 3–7 cm ..... 37a. var. *kwuangtungensis*
1b. Needles 2 or 3(–5) per bundle, with inconspicuous stomatal bands abaxially; seed cones 3–4 × 1.5–2 cm ..... 37b. var. *varifolia*

37a. Pinus kwangtungensis var. **kwangtungensis**

华南五针松(原变种) hua nan wu zhen song (yuan bian zhong)

Pinus wangii Hu & W. C. Cheng var. *kwangtungensis* (Chun & Tsiang) Silba.

Needles usually 5 per bundle, with white stomatal bands abaxially. Seed cones 5–9(–17) × 3–7 cm.

Hills, slopes, mountain ridges; 700–1600 m. N Guangdong, S Guizhou, Hainan, S Hunan [Vietnam].

37b. Pinus kwangtungensis var. **varifolia** Nan Li & Y. C. Zhong, Novon 7: 262. 1997.

变叶华南五针松 bian ye hua nan wu zhen song

Needles 2 or 3(–5) per bundle, with inconspicuous stomatal bands abaxially. Seed cones 3–4 × 1.5–2 cm.

Summits of limestone mountains; ca. 500 m. SW Guangxi (Longlin Gezu Zizhixian, Tiandeng Xian) [Vietnam].

Perhaps not a distinct taxon; the lower number of leaves per bundle may be the result of poor growth.

38. Pinus strobus Linnaeus, Sp. Pl. 2: 1001. 1753.

北美乔松 bei mei qiao song

Trees to 65 m tall; trunk to 1.8 m d.b.h.; bark gray-brown, deeply furrowed, with irregularly oblong, long, scaly plates; crown conical, becoming rounded or flattened on top; winter buds light red-brown, ovoid-cylindric, slightly resinous. Needles 5 per bundle, not pendulous, deep green to blue-green, slightly twisted, 6–14 cm × 0.7–1 mm, pliant, stomatal lines present on all surfaces, base with early shed sheath 1–1.5 cm, margin finely serrulate. Seed cones clustered, pedunculate (peduncle 2–3 cm), gray-brown or pale brown with purple or gray tints, cylindric, ellipsoid, or lanceolate-cylindric when open, 7–20 cm, maturing in 2 years, then soon shedding seeds and falling. Apophyses slightly raised, apex resinous; umbo terminal. Seeds red-brown, black mottled, broadly and obliquely obovoid, compressed, 5–6 mm; wing pale brown, 1.8–2.5 cm.

Cultivated. Beijing Shi, Jiangsu (Nanjing Shi), Jiangxi (Lu Shan), Liaoning [native to E Canada, Guatemala, S Mexico, E United States].

39. Pinus parviflora Siebold & Zuccarini, Fl. Jap. 2: 27. 1842.

日本五针松 ri ben wu zhen song

Trees to 25 m tall; trunk to 1 m d.b.h.; bark pale gray, aging dull gray, smooth when young, furrowed with age into scaly plates; crown conical; 1st-year branchlets initially green, aging yellow-brown, densely pale yellow pubescent; winter buds ovoid, not resinous. Needles 5 per bundle, slightly curved, triangular in cross section, 3.5–5.5 cm × 0.7–0.9 mm, stomatal lines present along abaxial surfaces, white, vascular bundle 1, base with sheath shed. Seed cones subsessile, ovoid or ovoid-ellipsoid, 4–7.5 × 3.5–4.5 cm. Seed scales obovate-rhombic or oblong-obovate, 2–3 × 1.8–2 cm; apophyses pale brown or dull gray-brown, almost rhombic; umbo terminal, sunken, margin recurved distally. Seeds nearly brown, mottled with black, irregularly obovoid, 8–10 × ca. 7 mm; wing ca. 1 cm.

Widely cultivated in cities in the Chang Jiang basin and Shandong [native to Japan].

Commonly used as a garden tree or for bonsai.

2. PICEA A. Dietrich, Fl. Berlin 2: 794. 1824.

云杉属 yun shan shu

Fu Liguo (傅立国 Fu Li-kuo), Li Nan (李楠); Thomas S. Elias[4]

Trees evergreen; trunk monopodial, straight; branches nearly whorled; branchlets ridged and grooved, with each leaf borne on a persistent, peglike base (pulvinus); short branchlets absent; winter buds ovoid, conical, or subglobose, resinous or not, scales on terminal buds recurved or not, persistent at base of branchlets. Leaves spirally arranged, spreading radially, or directed forward on upper side of branchlets and spreading on lower side, each inserted on a petiolelike pulvinus, linear, straight or curved, quadrangular, broadly rhombic, or flattened in cross section, stomatal lines adaxial or on each surface, vascular bundle 1, resin canals 2, sometimes small and discontinuous. Pollen cones solitary in leaf axils, rarely terminal, ellipsoid or cylindric; pollen 2-saccate. Seed cones solitary, pendulous at maturity, ovoid-cylindric or cylindric, rarely ovoid, maturing in 1st year. Seed scales thinly woody, leathery, or papery, with margin entire, denticulate, or undulate toward apex, persistent. Bracts included, small. Seeds obovoid or ovoid; wing long, membranous. Cotyledons 4–9(–15). Germination epigeal. 2*n* = 24*.

About 35 species: Asia, Europe, North America; 18 species (seven endemic, two introduced) in China.

1a. Leaves flattened or subflattened (broadly rhombic in cross section), adaxial surface much paler, stomatal lines
mostly or only present on adaxial surface.
2a. Seed scales closely arranged before maturity, rigid, ± thinly woody.
3a. Leaves 1.5–3.5 cm; seeds 1.6–2 cm including wing ..... 14. *P. spinulosa*
3b. Leaves 1–2.3(–2.5) cm; seeds 1.2–1.6 cm including wing.
4a. Leaves directed forward and closely appressed on upper side of branchlets, spreading and almost pectinately arranged on lower side, not parallel sided; seed scales at middle of cones obovate-
oblong or rhombic, distal margin usually recurved, sometimes elongate ..... 15. *P. brachytyla*

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4b. Leaves directed forward (but not appressed) on upper side of branchlets, slightly directed forward
on lower side, parallel sided for most of length; seed scales at middle of cones obovate, convex,
distal margin ± incurved, rounded ..... 16. *P. farreri*

2b. Seed scales loosely arranged before maturity, thin, flexible, ± leathery or papery.

5a. Leaves subflattened, ± broadly rhombic in cross section; seed cones usually (4–)7–15 × 2.5–5 cm ..... 11. *P. likiangensis*

5b. Leaves flattened; seed cones usually 2.5–6 × 1.5–3 cm.

6a. Seed cones violet or black-purple at maturity; leaves 0.7–1.2 cm ..... 12. *P. purpurea*

6b. Seed cones brown or yellowish brown at maturity; leaves 1–2 cm ..... 13. *P. jezoensis*

1b. Leaves quadrangular in cross section, equifacial or subequifacial, all surfaces similar in color, stomatal lines
present and almost equal in number on each surface.

7a. Bud scales at base of branchlets appressed; 1st-year branchlets glabrous.

8a. Leaves 3.5–5.5 cm; seed cones 12–18 cm ..... 8. *P. smithiana*

8b. Leaves 0.8–2.5 cm; seed cones, 5–14 cm.

9a. Seed cones 8–14 × 3–6.5 cm; leaves 1.5–2.5 cm.

10a. Winter buds purplish brown, not glossy, to 5 mm; branchlets gray or pale yellow with a little
brown; seed scales rhombic-obovate, 2.7–3 cm wide ..... 7. *P. neoveitchii*

10b. Winter buds reddish brown or dull brown, glossy, 8–10 mm; branchlets yellowish brown; seed scales broadly cuneate-obovate or semiorbicular, 1.5–2.5 cm wide ..... 18. *P. torano*

9b. Seed cones 5–8 × 2.5–5 cm; leaves 0.8–1.8 cm.

11a. First-year branchlets pale gray or yellowish gray; seed cones 2.5–4 cm ..... 9. *P. wilsonii*

11b. First-year branchlets yellowish brown or brown; seed cones 5–7 cm ..... 10. *P. morrisonicola*

7b. Buds scales at base of branchlets ± reflexed (opening in *P. schrenkiana*); 1st-year branchlets ± pubescent,
rarely glabrous.

12a. Branchlets densely glandular hairy ..... 1. *P. obovata*

12b. Branchlets ± pubescent, without glandular hairs, rarely glabrous.

13a. Branchlets pale yellow or yellow, pendulous; bud scales not reflexed at base of branchlets 2. *P. schrenkiana*

13b. Branchlets darker, rarely pendulous; bud scales ± reflexed at base of branchlets.

14a. Leaves yellow-green, slender, ca. 1.5–1.8 mm wide.

15a. Seed cones 10–15(–18.5) cm ..... 17. *P. abies*

15b. Seed cones 5–8 cm ..... 3. *P. koraiensis*

14b. Leaves ± glaucous green, stout, ca. 2–2.5 mm wide.

16a. Leaf apex acute or pungent ..... 4. *P. asperata*

16b. Leaf apex obtuse, mucronate, or subacute, upcurved.

17a. Seed cones green, margin red toward apex before maturity; branchlets reddish,
± glaucous ..... 5. *P. crassifolia*

17b. Seed cones green before maturity; branchlets yellow-brown or brown in 2nd
year, not glaucous ..... 6. *P. meyeri*

1. Picea obovata Ledebour, Fl. Altaic. 4: 201. 1833.

鲜卑云杉 xian bei yun shan

Picea abies (Linnaeus) H. Karsten subsp. *obovata* (Ledebour) Hultén; *P. abies* var. *obovata* (Ledebour) Lindquist; *P. excelsa* (Lamarck) Link var. *obovata* (Ledebour) Blytt; *P. vulgaris* Link var. *altaica* Teplouchov.

Trees to 40 m tall; trunk to 1 m d.b.h.; bark dark gray, irregularly flaking; crown pyramidal; branchlets yellow or pale brown-yellow, turning gray or dull gray, initially with dense glandular hairs, later puberulent; winter buds pale brown-yellow, conical, resinous, scales slightly recurved at base of branchlets. Leaves directed forward on upper side of branchlets, spreading on lower side, quadrangular-linear, ± curved, quadrangular or broadly rhombic in cross section, 1.3–2.3 cm × ca. 2 mm, stomatal lines 5–7 along each surface adaxially and 4 or 5 along each surface abaxially, apex acute. Seed cones purple or dark purple, rarely green

when young, maturing brown, ovoid-cylindric or cylindric, 5–11 × 2–3 cm. Seed scales at middle of cones cuneate-obovate, convex, 1.8–2.1 × 1.5–1.8 cm, exposed part nearly smooth, sometimes slightly striate, distal margin entire, rounded, or truncate-rounded. Seeds dark brown, triangular-obovoid, ca. 5 mm; wing obovate-oblong, 9–11 mm. Pollination May, seed maturity Sep–Oct.

Mountains, slopes, river basins, valleys; 1200–1800 m. Xinjiang [Kazakstan, Mongolia, Russia].

A vulnerable species in China. The timber is used for construction, carving, poles, and wood pulp; tannin is extracted from the bark.

2. Picea schrenkiana Fischer & C. A. Meyer, Bull. Acad. Imp. Sci. Saint-Pétersbourg 10: 253. 1842.

雪岭云杉 xue ling yun shan

Picea morinda Link subsp. *tianschanica* (Ruprecht) Berezin; *P. obovata* Ledebour var. *schrenkiana* (Fischer & C. A. Meyer) Carrière; *P. schrenkiana* subsp. *tianschanica* (Ruprecht) Bykov; *P. schrenkiana* var. *tianschanica* (Ruprecht) W. C. Cheng & S. H. Fu; *P. tianschanica* Ruprecht.

Trees to 60 m tall; trunk to 2 m d.b.h.; bark dull brown, thickly flaking; crown cylindric or narrowly pyramidal; branchlets pendulous, yellowish gray or yellow in 1st and 2nd years, finally dark gray, glabrous or pubescent; winter buds brownish yellow, conical-ovoid, slightly resinous, scales slightly opening at base of branchlets. Leaves spreading radially, directed forward, quadrangular-linear, straight or somewhat curved, broadly rhombic in cross section, 2–3.5 cm × ca. 1.5 mm, stomatal lines 5–8 along each surface adaxially, 4–6 along each surface abaxially, apex acute. Seed cones purple or green, maturing purplish or dull brown, ellipsoid-cylindric or cylindric, 6–11.3 × 2.5–3.5 cm. Seed scales triangular-obovate, 1.2–2 × (1–)1.3–1.8 cm, apex rounded. Seeds obliquely ovoid, 3–4 mm; wing obovate, 1.2–1.3 cm. Pollination May–Jun, seed maturity Sep–Oct.

Mountains, N-facing slopes, cool ravines; 1200–3500 m. Xinjiang [Kazakstan, Kyrgyzstan].

The timber is used for construction, aircraft, machines, poles, and wood pulp, and tannin is extracted from the bark. The species is also cultivated for afforestation and as an ornamental.

3. Picea koraiensis Nakai, Bot. Mag. (Tokyo) 33: 195. 1919.

红皮云杉 hong pi yun shan

Picea intercedens Nakai; *P. intercedens* var. *glabra* Uyeki; *P. koraiensis* var. *intercedens* (Nakai) Y. L. Chou; *P. koyamae* Shiras var. *koraiensis* (Nakai) Liou & Q. L. Wang; *P. tonaiensis* Nakai.

Trees to 30 m tall; trunk to 80 cm d.b.h.; bark gray- or red-brown, rarely gray, flaking; crown pyramidal; branchlets initially yellow, yellowish brown, or reddish brown, turning yellowish, reddish, or gray-brown in 2nd or 3rd year, slender, glabrous or pubescent; winter buds reddish brown, conical-ovoid, slightly resinous, scales ± recurved at apex. Leaves directed forward on upper side of branchlets, spreading on lower side, quadrangular-linear, straight or curved, broadly quadrangular in cross section, green, 1.2–2.2 cm × 1.5–1.8 mm, stomatal lines 2–4 along each surface, apex acute. Seed cones green, maturing yellowish brown or brown, ovoid-cylindric, 5–8 × 2.5–3.5 cm. Seed scales at middle of cones obovate or obovate-oblong, 1.5–1.9 × 1.2–1.5 cm, exposed part of abaxial surface glossy, distal margin entire, rounded or obtuse. Seeds dark gray, obovoid, ca. 4 mm; wing pale brown, narrowly obovate-oblong, 0.9–1.2 cm. Pollination May–Jun, seed maturity Sep–Oct.

Mountain slopes, along streams; 400–1800 m. Heilongjiang, Jilin, Liaoning [Korea, E Russia].

Only var. *koraiensis*, described here, occurs in China; var. *pungsanensis* (Uyeki ex Nakai) Farjon (*P. pungsanensis* Uyeki ex Nakai) is endemic to N Korea and differs in having the distal margin of the seed scales erose-denticulate and obtuse or truncate.

The timber is used for construction, furniture, carving, poles, ships, and wood pulp. Resin is extracted from the trunk, and tannin from the bark and cones. The species is also cultivated for afforestation and as an ornamental.

4. Picea asperata Masters, J. Linn. Soc., Bot. 37: 419. 1906.

云杉 yun shan

Trees to 45 m tall; trunk to 1 m d.b.h.; bark grayish brown, furrowed into irregular, rough, scaly plates; branchlets initially brownish yellow or reddish brown, turning brown or brownish gray in 2nd or 3rd year, pubescent or glabrous; winter buds conical or ovoid-conical, resinous, scales appressed or slightly recurved in apical buds, ± recurved at base of branchlets, keeled. Leaf cushions glaucous, rigid. Leaves directed forward or ascending on upper side of branchlets, parted and spreading laterally on lower side, glaucous or not, linear, slightly curved, ± quadrangular-rhombic in cross section, 1–2 cm × 1–2 mm, stomatal lines 4–8 along each surface, apex acute or slightly pungent. Seed cones green, maturing pale brown or reddish brown, cylindric-oblong or cylindric, 5–16 × 2.5–3.5 cm, apex obtuse. Seed scales at middle of cones obovate, ca. 2 × 1.5 cm, margin entire or denticulate, apex rarely 2-lobed. Seeds obovoid, ca. 4 mm; wing pale brown, obovate-oblong, ca. 1.1 cm. Pollination Apr–May, seed maturity Sep–Oct.

• Mountains, river basins; 2400–3600 m. E and S Gansu, N Ningxia, Qinghai, SW Shaanxi, Sichuan, ?SE Xizang.

The timber is used for construction, aircraft, railway sleepers, furniture, and wood fiber. The trunk is used for producing resin, and the roots, branches, and leaves for producing aromatic oils.

1a. Seed scales 2-lobed at apex ..... 4c. var. *heterolepis*
1b. Seed scales entire or rarely slightly denticulate.
2a. Leaves not glaucous, slender, apex acute or obtuse-acute; branchlets not glaucous, pubescent or glabrous 4a. var. *asperata*
2b. Leaves glaucous, stout, apex somewhat pungent; branchlets glaucous and glabrous ..... 4b. var. *aurantiaca*

4a. Picea asperata var. **asperata**

云杉(原变种) yun shan (yuan bian zhong)

Picea asperata var. *ponderosa* Rehder & E. H. Wilson; *P. gemmata* Rehder & E. H. Wilson; *P. ponderosa* (Rehder & E. H. Wilson) Lacassagne; *P. retroflexa* Masters.

First-year branchlets red- or yellow-brown, not glaucous, glabrous or slightly pubescent. Leaves not glaucous, slender, apex acute or subacute. Seed scales entire, rarely slightly denticulate.

• Mountains, river basins; 2400–3600 m. E and S Gansu, N Ningxia (Helan Shan), Qinghai, SW Shaanxi, Sichuan.

4b. Picea asperata var. **aurantiaca** (Masters) Boom, Ned. Dendrol., ed. 10, 96. 1978.

白皮云杉 bai pi yun shan

Picea aurantiaca Masters, J. Linn. Soc., Bot. 37: 420. 1906.

Branchlets glaucous, glabrous. Leaves glaucous, stout, apex somewhat pungent. Seed scales entire, rarely slightly denticulate.

• Mountains; 2600–3600 m. W Sichuan (Kangding Xian), ?SE Xizang.

An endangered plant.

4c. Picea asperata var. **heterolepis** (Rehder & E. H. Wilson) Rehder, Man. Cult. Trees, ed. 2, 24. 1940.

裂鳞云杉 lie lin yun shan

Picea heterolepis Rehder & E. H. Wilson in Sargent, Pl. Wilson. 2: 24. 1914; *P. asperata* var. *notabilis* Rehder & E. H. Wilson; *P. notabilis* (Rehder & E. H. Wilson) Lacassagne.

Seed scales 2-lobed at apex.

• Mountains. W Sichuan (Guan Xian).

5. Picea crassifolia Komarov, Bot. Mater. Gerb. Glavn. Bot. Sada RSFSR 4: 177. 1923.

青海云杉 qing hai yun shan

Trees to 25 m tall; trunk to 60 cm d.b.h. branchlets initially greenish yellow, turning pink or brownish yellow, rarely turning yellow in 2nd year or on drying, usually glaucous, pubescent or glabrous; winter buds conical, usually not resinous, scales usually reflexed, obviously keeled on dorsal sides at base of branchlets. Leaves spreading nearly radially, or ascending on upper side of branchlets, curved laterally on lower side, stout, broadly quadrangular in cross section, 1.2–3.5 cm × 2–3 mm, stomatal lines 5–7 along each surface adaxially and 4–6 along each surface abaxially, apex obtuse or mucronate. Seed cones cylindric, 7–11 × 2–3.5 cm. Seed scales at middle of cones obovate, slightly incurved, ca. 1.8 × 1.5 cm, margin entire or slightly undulate, apex rounded. Seeds obliquely obovoid, ca. 3.5 mm; wing obovate, ca. 9 mm. Pollination Apr–May, seed maturity Sep–Oct.

• Mountains; 1600–3800 m. Gansu, Nei Mongol (Daqing Shan), Ningxia, NE Qinghai (Qilian Shan, around Qinghai Hu).

The uses of the timber are similar to those of *Picea asperata*.

6. Picea meyeri Rehder & E. H. Wilson in Sargent, Pl. Wilson. 2: 28. 1914.

白璟 bai qian

Picea meyeri var. *mongolica* H. Q. Wu; *P. meyeri* f. *pyramidalis* (H. W. Jen & C. G. Bai) L. K. Fu & Nan Li; *P. meyeri* var. *pyramidalis* H. W. Gen & C. G. Bai; *P. mongolica* (H. Q. Wu) W. D. Xu.

Trees to 30 m tall; trunk to 60 cm d.b.h.; bark gray-brown, irregularly flaking; crown conical; branchlets yellow-brown, pubescent or glabrous; winter buds brown, conical or ovoid-conical, slightly resinous, scales recurved. Leaves spreading radially, ascending on upper side of branchlets, spreading and curved upward on lower side, quadrangular-linear, slightly curved, 1.3–3 cm × ca. 2 mm, stomatal lines present on all surfaces, apex obtuse or subacute. Seed cones green, maturing brown-yellow, oblong-cylindric, 6–9 × 2.5–3.5 cm. Seed scales obovate, ca. 1.6 × 1.2 cm, striate on exposed part abaxially, base broadly cuneate or nearly orbicular, apex rounded or triangular-obtuse. Seeds obovoid, ca. 3.5 mm; wing pale brown, oblanceolate, ca. 1 cm. Pollination Apr, seed maturity Sep–Oct.

• Mountains; 1600–2700 m. ?S Gansu, Hebei, Nei Mongol, Shaanxi, Shanxi.

The timber is used for construction, poles, bridge building, furiture, and wood pulp. The species is also cultivated for afforestation and as an ornamental.

7. Picea neoveitchii Masters, Gard. Chron., ser. 3, 33: 116. 1903.

大果青璟 da guo qing qian

Trees to 15 m tall; trunk to 50 cm d.b.h.; bark gray, scaly, flaking; crown broadly conical; branchlets initially pale yellow or with a little brown, turning gray or yellow-gray in 2nd and 3rd years, finally gray or dark gray, stout, glabrous; winter buds globose, slightly resinous, scales purplish brown, appressed at base and apex of branchlets. Leaves spreading radially, curved and directed forward on upper side of branchlets, spreading and ascending on lower side, quadrangular-

linear, longitudinally rhombic in cross section, 1.5–2.5 cm × ca. 2 mm, stomatal lines 4–7 along each surface, apex acute. Seed cones green, maturing pale brown or brown, rarely yellow-green, oblong- or ovoid-cylindric, 8–14 × 5–6.5 cm. Seed scales at middle of cones rhombic-ovate, ca. 2.7 × 2.7–3 cm, distal margin thinner, denticulate or almost entire, apex broadly rounded or obtuse. Seeds obovoid, 5–6 × ca. 3.5 mm; wing obovate, ca. 1 cm. Pollination May, seed maturity Sep–Oct.

• Scattered on mountain slopes and in river basins, or on rocky talus; 1300–2000 m. S Gansu, SW Henan (Neixiang Xian), W Hubei, S Shaanxi, NE Shanxi (Wutai Shan), Sichuan.

An endangered species much in need of protection. The timber is used for construction, poles, furniture, and wood pulp.

8. Picea smithiana (Wallich) Boissier, Fl. Orient. 5: 700. 1884.

长叶云杉 chang ye yun shan

Pinus smithiana Wallich, Pl. Asiat. Rar. 3: 24. 1832; *Picea khutrow* (Royle ex Turra) Carrière; *P. morinda* Link; *Pinus khutrow* Royle ex Turra.

Trees to 60 m tall; trunk to 2 m d.b.h.; bark pale brown, breaking into irregular plates; crown conical; branchlets pendulous, pale brown or pale gray when young, glabrous; winter buds reddish brown, conical or ovoid, scales slightly open, rarely appressed at base of branchlets. Leaves spreading radially, directed obliquely forward, quadrangular-linear, slender, curved, quadrangular or subquadrangular in cross section, 3.3–5.5 cm × 1.3–1.8 mm, stomatal lines 2–5 along each surface, apex acute or acuminate. Seed cones green, maturing brown, lustrous, cylindric or fusiform-cylindric, 10–18 × 4.5–5 cm. Seed scales broadly obovate, thick, ca. 3 × 2.4 cm, rigid, base cuneate, apex entire, broadly triangular-obtuse. Seeds dark brown, ca. 5 mm; wing ovoid-oblong, 1–1.5 cm, apex pointed.

Alpine lithosols; 2300–3600 m. S Xizang [Afghanistan, N India, Kashmir, Nepal, Pakistan].

A rare species in China. The timber is used for construction, furniture, and wood pulp. The species is also cultivated for afforestation and as an ornamental.

9. Picea wilsonii Masters, Gard. Chron., ser. 3, 33: 133. 1903.

青㮈 qing qian

Picea mastersii Mayr; *P. watsoniana* Masters; *P. wilsonii* var. *shanxiensis* Silba; *P. wilsonii* var. *watsoniana* (Masters) Silba.

Trees to 50 m tall; trunk to 1.3 m d.b.h.; bark gray, irregularly flaking; crown pyramidal; branchlets yellowish green or yellowish gray, turning pale gray or brownish gray, glabrous, rarely initially puberulent; winter buds yellowish brown or brown, ovoid, not resinous, scales appressed at base of branchlets. Leaves directed forward on upper side of branchlets, spreading on lower side, quadrangular-linear, straight or slightly curved, broadly quadrangular in cross section, 0.8–1.3 cm × 1.2–1.7 mm, stomatal lines 4 or 5 along each surface, apex acuminate. Seed cones green, maturing yellow-brown or pale brown, ovoid-oblong, 5–8 × 2.5–4 cm. Seed scales at middle of cones obovate, 1.4–1.7 × 1–1.4 cm, exposed part not obviously striate, nearly smooth, base cuneate, apex rounded, acute, or truncate. Seeds obovoid, 3–4 mm; wing pale brown, oblanceolate, 8–11 mm. Pollination Apr, seed maturity Oct.

• Mountains, river basins; 1400–2800 m. Gansu, Hebei, Hubei, Nei Mongol, Qinghai, Shaanxi, Shanxi, Sichuan.

The timber is used for construction, poles, furniture, and wood pulp. The species is also cultivated for afforestation and as an ornamental.

10. Picea morrisonicola Hayata, J. Coll. Sci. Imp. Univ. Tokyo 25(19): 220. 1908.

台湾云杉 tai wan yun shan

Trees to 50 m tall; trunk to 1.5 m d.b.h.; bark grayish brown, scaly, flaking; branchlets initially brown or yellowish brown, turning grayish brown in 2nd year, glabrous; winter buds ovoid, rarely conical-ovoid, scales appressed at base of branchlets. Leaves densely arranged, directed forward on upper side of branchlets, spreading on lower side, linear, straight or slightly curved, broadly rhombic in cross section, 0.8–1.4 cm × ca. 1 mm, stomatal lines 5 along each surface adaxially and 2 or 3 along each surface abaxially, apex acute. Seed cones red or purplish green, maturing brown, rarely with a little purple, oblong- or ovoid-cylindric, 5–7 × 2.5–3 cm. Seed scales somewhat closely arranged, those at middle of cones obovate, ca. 1.5 × 1.2 cm, base broadly cuneate or slightly rounded, apex broadly rounded. Seeds nearly obovoid, ca. 3–4 mm; wing yellowish or orange-brown, obovate-oblong, 6–7 mm. Pollination Apr, seed maturity Oct.

• Mountains; 2500–3000 m. Taiwan.

The timber is used for construction, vehicles, furniture, and wood pulp.

11. Picea likiangensis (Franchet) E. Pritzel, Bot. Jahrb. Syst. 29: 217. 1900.

丽江云杉 li jiang yun shan

Trees to 50 m tall; trunk to 2.5 m d.b.h.; bark dull gray or brown-gray, breaking into thick, irregular plates; crown pyramidal; branchlets initially pale yellow or brownish yellow, finally gray or gray-yellow, often sparsely pubescent, rarely with glandular hairs; winter buds brown, conical, ovoid, or globose, resinous, scales not reflexed, or slightly opening at base of branchlets. Leaves directed forward on upper side of branchlets, spreading on lower side, linear, straight or slightly curved, ± broadly rhombic in cross section or subflattened, 0.6–1.5 cm × 1–1.5 mm, stomatal lines 4–7 along each surface adaxially, 0–4 along each surface abaxially, apex acute or obtuse. Seed cones reddish brown or purple, maturing brown, reddish brown, purplish brown, or dark purple, ovoid-oblong or ovoid-cylindric, 4–12 × 1.7–3.5 cm. Seed scales at middle of cones rhombic-ovate, 1.5–2.6 × 1–1.7 cm, base cuneate, margin denticulate or undulate, apical part narrowed into a triangular or obtusely triangular point. Seeds

gray-brown, subovoid, 0.7–1.4 cm including wing; wing pale brown, lustrous, usually with purplish spots, obovate-oblong. Pollination Apr–May, seed maturity Sep–Oct.

Mountains, ravines, river basins; 2500–4100 m. S Qinghai, S and W Sichuan, E Xizang, NW Yunnan [Bhutan].

The timber is used for construction, machines, poles, furniture, and wood pulp. The bark is used for producing tannin, the trunk for resin, and the leaves for aromatic oils.

1a. Leaves with stomatal lines usually restricted to adaxial surface, rarely with 1 or 2 incomplete stomatal lines along each surface abaxially; 1st-year branchlets usually with glandular hairs ..... 11e. var. *linzhiensis*

1b. Leaves usually with 2–4 complete stomatal lines along each surface abaxially, rarely stomatal lines absent abaxially; 1st-year branchlets pubescent.

2a. Seed cones 7–12 cm; 1st-year branchlets usually slender, sparsely pubescent ..... 11a. var. *likiangensis*

2b. Seed cones 4–9 cm; 1st-year branchlets usually stout, densely pubescent.

3a. Seed cones red-brown or black-purple before maturity; 1st-year branchlets usually with short nodes ..... 11b. var. *rubescens*

3b. Seed cones green-yellow or yellow, or with green seed scales tinged red-brown or reddish purple on distal margin before maturity; 1st-year branchlets with long nodes.

4a. Seed cones green-yellow or yellow before maturity 11c. var. *hirtella*

4b. Seed cones with green seed scales tinged red-brown or eeddish purple on distal margin before maturity 11d. var. *montigena*

11a. Picea likiangensis var. **likiangensis**

丽江云杉(原变种) li jiang yun shan (yuan bian zhong)

Abies likiangensis Franchet, J. Bot. (Morot) 13: 257. 1899; *Picea yunnanensis* Lacassagne.

First-year branchlets usually slender, with nodes of normal length, sparsely pubescent. Leaves usually with 2–4 stomatal lines along each surface abaxially. Seed cones red-brown or black-purple, maturing brown to reddish or blackish, 7–12 cm.

Mountains, river basins; 2500–3800 m. SW Sichuan, SE Xizang, NW Yunnan [Bhutan].

11b. Picea likiangensis var. **rubescens** Rehder & E. H. Wilson in Sargent, Pl. Wilson. 2: 31. 1914.

川西云杉 chuan xi yun shan

Picea balfouriana Rehder & E. H. Wilson; *P. balfouriana* f. *bicolor* S. Chen; *P. likiangensis* var. *balfouriana* (Rehder & E. H. Wilson) Slavin; *P. purpurea* Masters var. *balfouriana* (Rehder & E. H. Wilson) Silba; *P. sikangensis* W. C. Cheng.

First-year branchlets stout, with short nodes, densely pubescent. Leaves usually with 3 or 4 stomatal lines along each surface abaxially. Seed cones red-brown or black-purple, maturing brown to reddish or black-brown, 4–9 cm.

- Mountains; 3000–4100 m. S Qinghai, S Sichuan, E Xizang.

This variety produces fine quality timber.

11c. Picea likiangensis var. **hirtella** (Rehder & E. H. Wilson) W. C. Cheng in Chen, Taxon. Chin. Trees 40. 1937.

黄果云杉 huang guo yun shan

Picea hirtella Rehder & E. H. Wilson in Sargent, Pl. Wilson. 2: 32. 1914; *P. balfouriana* var. *hirtella* (Rehder & E. H. Wilson) W. C. Cheng; *P. purpurea* var. *hirtella* (Rehder & E. H. Wilson) Silba.

First-year branchlets usually stout, with nodes of normal length, densely pubescent. Leaves usually with 3 or 4 stomatal lines along each surface abaxially. Seed cones green-yellow or yellow before maturity, pale brown-yellow at maturity, 4–9 cm.

- Mountains; 3000–4000 m. W Sichuan, SE Xizang.

11d. Picea likiangensis var. **montigena** (Masters) W. C. Cheng in Chen, Taxon. Chin. Trees 40. 1937.

康定云杉 kang ding yun shan

Picea montigena Masters, Gard. Chron., ser. 3, 39: 146. 1906.

First-year branchlets usually stout, with nodes of normal length, densely pubescent. Leaves usually with 1–4 stomatal lines along each surface abaxially. Seed scales green, tinged red-brown or reddish purple on distal margin before maturity, 4–9 cm.

- Mountains; above 3300 m. W Sichuan.

11e. Picea likiangensis var. **linzhiensis** W. C. Cheng & L. K. Fu in W. C. Cheng & al., Acta Phytotax. Sin. 13(4): 83. 1975.

林芝云杉 lin zhi yun shan

First-year branchlets with nodes of normal length, usually glandular hairy. Leaves usually with stomatal lines along adaxial surface, apex acute or obtuse. Seed scales pale violet or red-brown, or green tinged pale reddish purple on distal margin before maturity, 5–10 cm.

- Mountains; 2900–3700 m. SW Sichuan, SE Xizang, NW Yunnan.

12. Picea purpurea Masters, J. Linn. Soc., Bot. 37: 418. 1906.

紫果云杉 zi guo yun shan

Picea likiangensis (Franchet) E. Pritzel var. *purpurea* (Masters) Dallimore & A. B. Jackson.

Trees to 50 m tall; trunk to 1 m d.b.h.; bark dark gray, scaly; crown pyramidal; branchlets initially yellow or pale brownish yellow, turning yellow-gray or gray in 2nd or 3rd year, densely pubescent; winter buds conical, resinous, scales not reflexed, or slightly opening at apex. Leaves spreading radially, or closely appressed forward on upper side of branchlets, ± spreading on lower side, linear, straight or slightly curved, broadly rhombic in cross section, ± dorsiventrally flattened, 7–12 × 1.5–1.8 mm, keeled on both sides, stomatal lines 4–6 along each surface adaxially, sometimes also 1 or 2 incomplete lines abaxially, apex obtuse-mucronate. Seed cones purplish black or reddish purple, cylindric-ovoid or ellipsoid, 2.5–4(–6) × 1.7–3 cm. Seed scales loosely arranged, rhombic-ovate, 1.3–1.6 × ca. 1.3 cm at middle of cones, ± papery, distal margin thinner, narrowed into a triangle, undulate, erose-denticulate. Seeds ca. 9 mm including brown, purple-spotted wing. Cotyledons 5–7, 1–1.3 cm. Pollination Apr, seed maturity Oct.

• Mountains; predominantly on N-facing slopes; 2600–3800 m. S Gansu, Qinghai, N Sichuan.

This species produces fine quality timber similar to that of *Picea likiangensis*.

13. Picea jezoensis (Siebold & Zuccarini) Carrière, Traité Gén. Conif. 255. 1855.

鱼鳞云杉 yu lin yun shan

Abies jezoensis Siebold & Zuccarini, Fl. Jap. 2: 19. 1842.

Trees to 50 m tall; trunk to 1.5 m d.b.h.; bark initially brown and smooth, aging blackish brown or dull purplish gray, rough, and scaly or fissured; crown pyramidal or broadly conical; branchlets initially pale yellow, later orange-yellow or yellowish brown, glossy, glabrous or sparsely pubescent; winter buds pale brown, ovoid-conical, not resinous, scales often slightly recurved or opening at base of branchlets. Leaves directed forward on upper side of branchlets, spreading on lower side, linear, slightly recurved, flattened, 1–2(–2.4) cm × 1.5–2 mm, stomatal lines in 2 white bands adaxially, apex acute or mucronate. Seed cones green, red- or purple-brown, maturing brown or yellowish brown, oblong-cylindric or narrowly ovoid, 3–7(–9) × 2–3.5 cm. Seed scales rhombic, rhombic-elliptic, or ovate-elliptic, broadest at middle, thin, ca. 12 × 7–8 mm at middle of cones, papery, margin irregularly denticulate, apex almost truncate or rounded. Seeds ovoid-cuneate, ca. 3 × 2 mm; wing 6–10 × 4–5 mm. Pollination May–Jun, seed maturity Sep–Oct.

Mountains, river basins; 300–1700(–1800) m. Heilongjiang, Jilin, Nei Mongol [Japan, Korea, E Russia].

The timber is used for construction, machines, poles, furniture, and wood pulp. The bark is used for producing tannin, the trunk for resin, and the leaves for aromatic oils.

Two varieties occur in China, while var. *jezoensis* occurs in Japan and E Russia.

1a. First-year branchlets brown or yellowish brown; seed cones 4–6(–9) × 2–2.6 cm; seed scales ovate-elliptic or rhombic-elliptic at middle of cones .. 13a. var. *microsperma*

1b. First-year branchlets yellow or pale yellow, rarely slightly brown; seed cones 3–4 × 2–2.2 cm; seed scales rhombic at middle of cones ..... 13b. var. *komarovii*

13a. Picea jezoensis var. **microsperma** (Lindley) W. C. Cheng & L. K. Fu, Fl. Reipubl. Popularis Sin. 7: 159. 1978.

兴安鱼鳞云杉 xing an yu lin yun shan

Abies microsperma Lindley, Gard. Chron. 1861: 22. 1861; *Picea ajanensis* Fischer ex Carrière; *P. jezoensis* var. *ajanensis* (Fischer ex Carrière) W. C. Cheng & L. K. Fu; *P. kamtchatkensis* Lacassagne; *P. manshurica* Nakai; *P. microsperma* (Lindley) Carrière.

First-year branchlets brown or yellowish brown, glabrous or slightly pubescent. Seed cones 4–6(–9) × 2–2.6 cm. Seed scales ovate- or rhombic-elliptic at middle of cones.

Mountains, river basins; 300–800 m. Heilongjiang, Jilin, Nei Mongol [Japan, E Russia].

13b. Picea jezoensis var. **komarovii** (V. N. Vassiljev) W. C. Cheng & L. K. Fu, Fl. Reipubl. Popularis Sin. 7: 161. 1978.

长白鱼鳞云杉 chang bai yu lin yun shan

Picea komarovii V. N. Vassiljev, Bot. Zhurn. (Moscow & Leningrad) 35: 504. 1950.

First-year branchlets yellow or pale yellow, rarely with a little brown, glabrous. Seed cones 3–4 × 2–2.2 cm. Seed scales rhombic at middle of cones.

Mountains; (600–)1000–1700(–1800) m. E and S Jilin [Korea, E Russia].

14. Picea spinulosa (Griffith) A. Henry, Gard. Chron., ser. 3, 39: 219. 1906.

须弥云杉 xu mi yun shan

Abies spinulosa Griffith, J. Trav. 259. 1847; *Picea morindoides* Rehder; *P. spinulosa* var. *yatungensis* Silba.

Trees to 60 m tall; bark rough, flaking, scaly; branchlets pendulous, initially brownish yellow, turning gray in 2nd year, slender, glabrous; winter buds brown, ovoid or conical-ovoid. Leaves directed forward on upper side of branchlets, spreading on lower side, linear, flattened or subflattened, broadly rhombic in cross section, 1.5–3.5 cm × 1.1–1.8 mm, slightly keeled on both surfaces, stomatal lines 5–7 in each of 2 white bands adaxially, occasionally 1–3 incomplete stomatal lines abaxially, apex acute or acuminate. Seed cones green, purple at margin of seed scales, maturing brown or dark brown, oblong-cylindric or cylindric, 9–11 × 3–4.5 cm. Seed scales closely arranged, obovate or obtrullate, thick, ca. 2 × 1.8 cm, exposed part smooth and glossy, not striate. Seeds dark brown, ca. 5 mm; wing pale brown, lustrous, obovate-oblong, 1.1–1.5 cm × ca. 5 mm.

Mountains; 2900–3600 m. S Xizang [Bhutan, Nepal, Sikkim].

The timber is used for construction, and the species is cultivated for afforestation.

15. Picea brachytyla (Franchet) E. Pritzel, Bot. Jahrb. Syst. 29: 216. 1900.

麦吊杉 mai diao shan

Trees to 30 m tall; trunk to 1 m d.b.h.; bark gray or grayish brown, longitudinally fissured into thick, square plates or irregularly flaking; crown conical-pyramidal; branchlets pendulous, initially pale yellow or brownish yellow, turning brownish yellow or brown in 2nd or 3rd year, finally gray; winter buds often ovoid or ovoid-conical, rarely conical at apex, scales appressed at base of branchlets. Leaves directed forward and closely appressed on upper side of branchlets, spreading and almost pectinately arranged on lower side, linear, not parallel sided, slightly curved or straight, flattened, 1–2.2(–2.5) cm × 1–1.5 mm, slightly keeled on both sides, stomatal lines 5–7 in each of 2 white or pale bands adaxially, apex acute or mucronate. Seed cones green, red- or purple-brown, maturing dull brown or brown tinged purplish, ovoid- or cylindric-oblong, 6–10(–12) × 3–4 cm. Seed scales at middle of cones obovate-oblong or rhombic, 1.4–2.2 × 1.1–1.3 cm, base cuneate, distal margin usually recurved, sometimes elongate. Seeds ca. 1.2 cm including wing. Pollination Apr–May, seed maturity Sep–Oct.

Mountain slopes, valleys, river basins; 1500–3800 m. S Gansu, W Henan, W Hubei, SE Shaanxi, Sichuan, SE Xizang, NW Yunnan [Bhutan, N Myanmar].

A vulnerable species in China. The timber is used for construction, aircraft, machines, and wood pulp. The species is also cultivated for afforestation.

1a. Seed cones green before maturity; leaves thin; bark grayish brown, longitudinally fissured into thick, square plates 15a. var. *brachytyla*
1b. Seed cones red- or purple-brown before maturity; leaves thick; bark pale gray or gray, irregularly flaking ... 15b. var. *complanata*

15a. Picea brachytyla var. **brachytyla**

麦吊杉(原变种) mai diao shan (yuan bian zhong)

Abies brachytyla Franchet, J. Bot. (Morot) 13: 258. 1899; *Picea ascendens* Patschke; *P. brachytyla* var. *latisquamea* Stapf; *P. brachytyla* var. *pachyclada* (Patschke) Silba; *P. brachytyla* var. *rhombisquamea* Stapf; *P. pachyclada* Patschke; *P. sargentiana* Rehder & E. H. Wilson.

Bark grayish brown, longitudinally fissured into thick, square plates. Leaves thin, stomatal lines in 2 white bands adaxially. Seed cones green before maturity.

• Mountain slopes, valleys, river basins; 1500–2900 m. S Gansu, W Henan, W Hubei, SE Shaanxi, Sichuan, SE Xizang, NW Yunnan.

15b. Picea brachytyla var. **complanata** (Masters) W. C. Cheng ex Rehder, Man. Cult. Trees, ed. 2, 30. 1940.

油麦吊杉 you mai diao shan

Picea complanata Masters, Gard. Chron., ser. 3, 39: 146. 1906; *P. likiangensis* (Franchet) E. Pritzel var. *linzhiensis* W. C. Cheng & L. K. Fu f. *bicolor* W. C. Cheng & L. K. Fu.

Bark pale gray or gray, irregularly flaking. Leaves thick, stomatal lines in 2 white or pale bands adaxially. Seed cones red- or purple-brown before maturity.

Mountains, river basins; 2000–3800 m. W Sichuan, SE Xizang, NW Yunnan [?Bhutan, N Myanmar].

16. Picea farreri C. N. Page & Rushforth, Notes Roy. Bot. Gard. Edinburgh 38: 130. 1980.

缅甸云杉 mian dian yun shan

Trees to 35 m tall; bark grayish, scaly; crown open, broadly conical; branches spreading or slightly descending, slender; branchlets steeply descending, ultimate ones strongly pendulous; 1st- and 2nd-year branchlets olive brown to pale orange-brown, initially pubescent, later glabrescent. Leaves directed forward (but not appressed) on upper side of branchlets, slightly directed forward on lower side, blue-green with slight bloom, (1.5–)1.8–2.3(–2.5) cm, flattened, parallel sided for most of length, covered with bright snow-white epicuticular wax adaxially, stomatal lines 5 or 6 in each of 2 bands adaxially, apex abruptly acute, somewhat pungent. Pollen cones conical-cylindric, 2–2.5 cm × ca. 3 mm. Seed cones sessile or very shortly pedunculate (peduncle ca. 0.5 cm), mid brown, ellipsoid-cylindric, (6–)7–9.5(–10) × 3–4 cm when open. Seed scales at middle of cones obovate, convex, 0.8–1.2 × 1–1.6 cm, distal margin ± incurved, rounded. Seeds ca. 1.6 × 0.5 cm including wing; wing pale brown, margin erose.

Small, pure stands in usually open forests in cool, wet limestone mountains with heavy monsoon rains (in Myanmar); 2400–2700 m. W Yunnan (Nu Jiang valley) [Myanmar (Fen-Shui-Ling valley)].

17. Picea abies (Linnaeus) H. Karsten, Deutsche Fl. 324. 1881.

欧洲云杉 ou zhou yun shan

Pinus abies Linnaeus, Sp. Pl. 2: 1002. 1753; *P. excelsa* Lamarck (1778), not Wallich ex D. Don (1828); *Picea excelsa* (Lamarck) Link.

Trees to 60 m tall; trunk to 6 m d.b.h. in native range; bark furrowed into small scales; branchlets usually pendulous, reddish brown or orange when young, glabrous or slightly pubescent; winter buds conical, scales reflexed, reddish brown. Leaves ascending or directed forward on upper side of branchlets, spreading on lower side, quadrangular-linear, straight or curved, 1.2–2.5 cm, stomatal lines along each surface. Seed cones brown when mature, cylindric, 10–15(–18.5) cm. Seed scales rhombic-obovate or -ovate, distal margin

denticulate, apex truncate or emarginate. Seeds ca. 4 mm; wing ca. 1.6 cm.

Cultivated. Beijing Shi, Jiangxi (Lu Shan), Shandong (Qingdao Shi) [native to Europe].

18. Picea torano (Siebold ex K. Koch) Koehne, Deut. Dendrol. 22. 1893.

日本云杉 ri ben yun shan

Abies torano Siebold ex K. Koch, Dendrologie 2(2): 233. 1873.

Trees to 40 m tall; trunk to 3 m d.b.h. in native range; bark pale gray, rough, flaking into tiny scales; branchlets pale yellow or pale brownish yellow, stout, glabrous; winter buds reddish or pale black-brown, glossy, ovoid or ovoid-oblong, 8–10 mm, scales closely appressed. Leaves spirally arranged or ascending on upper side of branchlets, curved on lower side, dull green, quadrangular-linear, stout, rhombic in cross section, 1.5–2 cm × 1.5–2 mm, obviously keeled, stomatal lines along each surface, apex acute. Seed cones pale yellow-green before maturity, reddish brown when mature, narrowly ovoid or cylindric-ellipsoid, 7.5–12.5 × ca. 3.5 cm. Seed scales suborbicular or obovate, margin slightly denticulate, apex rounded. Seeds 6–8 mm; wing to 1.4 cm.

Cultivated. Beijing Shi, Shandong (Qingdao Shi), Zhejiang (Hangzhou Shi) [native to Japan].

The name *Picea polita* Carrière, based on *Abies polita* Siebold & Zuccarini, has been used for this species. However, *A. polita* is an illegitimate renaming of *Pinus abies* Linnaeus (*Picea abies* (Linnaeus) H. Karsten), and therefore cannot be used in any sense.

3. LARIX Miller, Gard. Dict., Abr. ed. 4, 1: [744]. 1754.

落叶松属 luo ye song shu

Trees deciduous; branches irregularly whorled, spreading; branchlets strongly dimorphic: long branchlets with leaves present only in 1st year, older parts with leaves in dense tufts on lateral short branchlets developed from axillary buds. Leaves spirally arranged on long branchlets, in dense clusters of 15–50 or more on short branchlets, sessile, turning yellow and falling in autumn, linear-needlelike, flattened, longitudinally keeled adaxially, sometimes also slightly so abaxially, ca. 1.8 mm wide, flexible, stomatal lines abaxial or on each surface, vascular bundle 1, resin canals 2, usually marginal. Cones borne at apex of short branchlets, solitary. Pollen not saccate, with a narrow, equatorial ridge. Seed cones shortly pedunculate, usually erect, purplish, reddish, or rarely green, maturing in 1st year. Seed scales thin, ± leathery, opening to release seeds, persistent. Bracts included or exserted, ovate or lanceolate, midvein prominent abaxially, forming an apical cusp. Seeds small; wing persistent, relatively long, membranous. Cotyledons 6–8. Germination epigeal. 2*n* = 24*.

Fifteen species: boreal and temperate regions of Asia, Europe, and North America; 11 species (four endemic, two introduced) in China.

1a. Seed cones ovoid or narrowly ovoid; bracts included or slightly exserted, shorter than seed scales; branchlets not pendulous.
  2a. Seed scales triangular-ovate, ovate, or subrhombic, usually densely purplish brown hairy abaxially, apex rounded ..... 7. *L. sibirica*
  2b. Seed scales pentagonal- or quadrangular-ovate, glabrous, usually smooth and shining on exposed part abaxially, apex emarginate or ± truncate.
    3a. Seed scales ± recurved at margin distally; 1st-year branchlets glaucous ..... 11. *L. kaempferi*
    3b. Seed scales not recurved distally; 1st-year branchlets not glaucous.
      4a. Seed scales at middle of cones pentagonal-ovate, ± convex, longer than wide ..... 8. *L. gmelinii*
      4b. Seed scales at middle of cones suborbicular, subrectangular, or ± square, as long as or longer than wide.
        5a. First-year branchlets reddish brown or light brown, usually sparsely to densely pubescent; seed scales 16–40, broadly square-ovate or square-orbicular; tips of bracts not exposed .... 9. *L. olgensis*
        5b. First-year branchlets light yellow or yellowish gray, glabrous; seed scales 45–50, suborbicular; tips of bracts slightly exposed ..... 10. *L. decidua*
1b. Seed cones cylindric or ovoid-cylindric; bracts obviously exserted, longer than or rarely equal to seed scales; branchlets pendulous.
  6a. Bracts straight or slightly recurved at apex.
    7a. Seed cones stout; seed scales gray or yellow-gray, square-orbicular or oblong, longer than wide, apex rounded or square-orbicular ..... 5. *L. himalaica*

7b. Seed cones relatively slender; seed scales dark brown or dark gray, square-orbicular, obtriangular-orbicular, or subsquare, as wide as or wider than long, apex truncate, emarginate, or truncate-rounded 6. *L. potaninii*

6b. Bracts reflexed or recurved.

8a. Seed cones ellipsoid-cylindric, 2.5–4 cm; seed scales obtriangular- or reniform-orbicular, densely long hairy abaxially; short branchlets densely yellow hairy; leaves 1.2–3.5 cm, keeled on both sides 4. *L. mastersiana*

8b. Seed cones cylindric, 4.5–11 cm; seed scales obovate-quadrangular or suboblong, usually densely pubescent and tuberculate abaxially; short branchlets glabrous or subglabrous; leaves 2.5–5 cm; keeled only adaxially.

9a. Pollen cones ovoid, 6–8 mm; short branchlets wider than long ..... 3. *L. kongboensis*

9b. Pollen cones ovoid-conical or columnar, 10–22 mm; short branchlets as wide as long.

10a. Bracts obviously reflexed, obovate- or ovate-lanceolate, 5–7 mm at widest part; short branchlets slender, only bases of scales persistent ..... 1. *L. griffithii*

10b. Bracts obliquely spreading and recurved, lanceolate, 3.5–5.5 mm at widest part; short branchlets stout, scales persistent, revolute ..... 2. *L. speciosa*

1. Larix griffithii J. D. Hooker, Himal. J. 1: 255–256, 2: 44, 481. 1854.

藏红杉 zang hong shan

Larix griffithiana Carrière; *Pinus griffithiana* (Carrière) Voss; *P. griffithii* (J. D. Hooker) Parlatore (1868), not M’Clelland (1854).

Trees to over 20 m tall; trunk to 80 cm d.b.h.; bark gray-brown or dark brown, deeply fissured longitudinally; long branchlets initially reddish brown, light brown, or yellowish brown; short branchlets 6–8 mm in diam., nearly smooth, with remnants of bud scales and rings of revolute scales bases; winter buds ovoid-globose or globose, not resinous. Leaves 2.5–5.5 cm × 1–1.8 mm, keeled abaxially and toward base adaxially. Seed cones maturing brown or light brown, cylindric or cylindric-ellipsoid, 5–11 × 2.2–3 cm. Seed scales obovate-square, ± flat, 1.1–1.4 × 1.1–1.4 cm at middle of cones, pubescent toward base abaxially, margin denticulate toward apex, apex truncate or slightly emarginate. Bracts ovate- or obovate-lanceolate, longer than seed scales, 5–7 mm at widest part, obviously reflexed. Seeds grayish white, with irregular purplish spots, obliquely obovoid, ca. 10 mm including wing. Pollination Apr–May, seed maturity Oct.

Mountains; 3000–4100 m. S and E Xizang [Bhutan, Nepal, Sikkim].

The timber is used for construction, pit props, railway sleepers, and making furniture, and the bark yields tannins. The tree is also used for afforestation.

2. Larix speciosa W. C. Cheng & Y. W. Law in W. C. Cheng & al., Acta Phytotax. Sin. 13(4): 84. 1975.

怒江红杉 nu jiang hong shan

Larix griffithiana Carrière var. *speciosa* (W. C. Cheng & Y. W. Law) Silba; *L. griffithii* J. D. Hooker var. *speciosa* (W. C. Cheng & Y. W. Law) Farjon.

Trees to 25 m tall; bark dark red-brown, fissured, scaly; branchlets pendulous; long branchlets initially purplish brown or brown, occasionally glaucous, glabrous; short branchlets stout, 6–8 mm in diam., with several rings of revolute bud scales; winter buds red- or purple-brown, ovoid or conical. Leaves oblanceolate-linear, 2.5–5.5 cm × 1.5–2 mm, flat or keeled toward base adaxially, keeled abaxially, stomatal lines present on abaxial surface. Seed cones pedunculate (peduncle 5–7 mm), maturing red- or purple-brown, cylindric, 7–9 × 2–3 cm. Seed scales ca. 100, obovate-oblong or suboblong, 1.2–1.5 cm × 8–9 mm, densely pubescent and verruculose abaxially, base auriculate, apex truncate, emarginate. Bracts exserted, lanceolate, obliquely recurved, 3.5–4.5 mm at widest part, apex tapered. Seeds pale gray, with irregular yellow-brown spots, obliquely ovoid, ca. 5 mm; wing 5–7 mm. Pollination Apr–May, seed maturity Sep–Oct.

- Mountains; 2600–4000 m. SE Xizang, NW Yunnan.

3. Larix kongboensis R. R. Mill, Novon 9: 79. 1999.

贡布红杉 gong bu hong shan

Trees to 25 m tall; long branchlets light reddish brown in 2nd year, later turning light gray, glabrous; short branchlets broadly obconical, 2–4.5 × 4.5–6 mm; leaf cushions glabrous. Leaves linear-oblong, straight or slightly falcate, 0.9–2.2 cm × 0.6–1.1 mm when mature, keeled only adaxially and proximally. Pollen cones reddish, broadly conical, 6–8 × 5.5–6.5 mm. Seed cones maturing gray-brown, oblong-ellipsoid, 4.5–5 × 2.2–2.5 cm. Seed scales broadly obovate-reniform, ca. 8 × 10 mm at middle of cones, minutely whitish pubescent abaxially, apex broadly rounded, entire or shallowly retuse. Bracts exserted, lanceolate, exposed part ca. 8 × 5.5 mm, strongly reflexed, tapered gradually then finally more abruptly into a cusp, cusp 1.5–4 mm, upturned at apex. Seeds not seen. Pollination Apr, seed maturity late summer–autumn.

- Rocky slopes; 3200–3500 m. SE Xizang (Gongbo’gyamda).

4. Larix mastersiana Rehder & E. H. Wilson in Sargent, Pl. Wilson. 2: 19. 1914.

川红杉 chuan hong shan

Larix griffithii J. D. Hooker var. *mastersiana* (Rehder & E. H. Wilson) Silba.

Trees to 25 m tall; trunk to 0.8 m d.b.h.; bark grayish brown or dark brown, irregularly and longitudinally fissured; branchlets pendulous; long branchlets yellowish brown or brown, turning yellowish gray or dark gray, initially puberulent; short branchlets 3–4 mm in diam., densely brownish yellow pubescent; winter buds ovoid-orbicular. Leaves linear, 1.2–3.5 cm × ca. 1 mm, keeled on both sides. Seed cones brownish purple, maturing brown, cylindric-ellipsoid, 2.5–4 × 1.5–2 cm. Seed scales cordate or obovate-reniform, 0.8–1.1 × 1–1.3 cm at middle of cones, densely brown pubescent abaxially, apex emarginate. Bracts exserted, dark brown-purple, broadly lanceolate, obviously reflexed, 1.1–1.5 cm. Seeds light gray, obliquely obovoid, 7–9 mm including wing. Pollination Apr–May, seed maturity Oct.

• Mountains; 2300–3500 m. Sichuan.

An endangered species. The timber is used for construction, pit props, railway sleepers, and making furniture, and the bark yields tannins. The species is also used for afforestation.

5. Larix himalaica W. C. Cheng & L. K. Fu in W. C. Cheng & al., Acta Phytotax. Sin. 13(4): 84. 1975.

须弥红杉 xu mi hong shan

Larix potaninii Batalin var. *himalaica* (W. C. Cheng & L. K. Fu) Farjon & Silba.

Branchlets pendulous; long branchlets light yellow or brownish yellow, bright in 2nd year, finally yellowish gray; short branchlets 2–5 mm in diam., glabrous, with rings of reflexed bud scales; winter buds subglobose or conical-globose. Leaves linear, 1–2.5 cm × ca. 1 mm, flat or keeled toward base adaxially, keeled abaxially. Seed cones erect, purplish brown, maturing dark brown, cylindric, 2–6.5 × 2.8–3.2 cm, apex obtuse. Seed scales suborbicular or oblong-orbicular, 1.2–1.5 × 0.9–1.3 cm at middle of cones, longer than wide, densely pubescent abaxially, finally glabrous, apex rounded or broadly rounded. Bracts exserted, purplish or purplish brown, lanceolate-oblong, straight, slightly longer than or equaling seed scales, 1.4–1.7 cm, apex obtuse. Seeds obliquely triangular-ovoid, ca. 9 mm including wing.

River basins, valleys; 3000–3500 m. S Xizang [Nepal].

6. Larix potaninii Batalin, Trudy Imp. S.-Peterburgsk. Bot. Sada 13: 385. 1894.

红杉 hong shan

Trees to 50 m tall; trunk to 1 m d.b.h.; bark gray or gray-brown, rough, longitudinally fissured; crown conical; long branchlets reddish brown or purplish brown, rarely initially yellowish brown, finally dark gray; short branchlets 3–8 mm in diam., glabrous or densely yellowish brown hairy at apex; winter buds brown or dark brown, glossy, ovoid. Leaves 1.2–3.5 cm × 1–1.5 mm, keeled on both sides. Seed cones reddish or purplish, maturing purplish brown or light gray-brown, cylindric or ovoid-cylindric, 2.5–7.5 × 1.5–3.5 cm. Seed scales 35–90, slightly convex, 0.8–1.6 × 0.8–1.1 cm, as wide as or wider than long, ± strigose to pubescent and tuberculate abaxially, apex truncate or obtuse-rounded. Bracts often exserted, purplish brown, oblong-lanceolate, straight, apex acute or acuminate. Seeds light brown with irregular purplish spots, obliquely obovate, obliquely obovoid, 7–10 mm including wing. Pollination Apr–May, seed maturity Oct.

• Mountains, river basins; 2500–4300(–4600) m. S Gansu, S Shaanxi, Sichuan, SE Xizang, N Yunnan.

The timber is used for construction, pit props, railway sleepers, and making furniture, and the bark yields tannins. The species is also used for afforestation.

1a. First-year long branchlets grayish yellow, light yellow, or brownish yellow; seed scales ± strigose abaxially ..... 6c. var. *chinensis*
1b. First-year long branchlets red-brown, purplish brown, or yellowish brown; seed scales ± tuberculate and pubescent abaxially.
  2a. Seed cones 3–5 × 1.5–2.5 cm; seed scales 35–65, thin, 0.8–1.3 cm; short branchlets slender, densely hairy at apex ..... 6a. var. *potaninii*
  2b. Seed cones 5–7.5 × 2.5–3.5 cm; seed scales 75–90, thick, 1.4–1.6 cm; short branchlets stout, glabrous or subglabrous ..... 6b. var. *australis*

6a. Larix potaninii var. **potaninii**

红杉(原变种) hong shan (yuan bian zhong)

Larix griffithii Masters (1902), not J. D. Hooker (1854); *L. thibetica* Franchet.

First-year long branchlets red-brown, purplish brown, or yellowish brown. Short branchlets slender, densely hairy at apex. Seed cones 3–5 × 1.5–2.5 cm. Seed scales 35–65, thin, 0.8–1.3 cm, ± tuberculate and pubescent abaxially.

• Mountains, river basins; 2500–4000 m. S Gansu, Sichuan, N Yunnan.

6b. Larix potaninii var. **australis** A. Henry ex Handel-Mazzetti, Symb. Sin. 7: 14. 1929.

大果红杉 da guo hong shan

Larix potaninii var. *macrocarpa* Y. W. Law.

First-year long branchlets red-brown, purplish brown, or yellowish brown. Short branchlets stout, 4–8 mm in diam., glabrous or subglabrous. Seed cones 5–7.5 × 2.5–3.5 cm. Seed scales 75–90, thick, 1.4–1.6 cm, ± tuberculate and pubescent abaxially.

• Mountains; (2700–)3800–4300(–4600) m. SW Sichuan, SE Xizang, NW Yunnan.

6c. Larix potaninii var. **chinensis** L. K. Fu & Nan Li, Novon 7: 262. 1997.

秦岭红杉 qin ling hong shan

Larix chinensis Beissner (1896), not Miller (1768).

First-year long branchlets grayish yellow, light yellow, or brownish yellow. Short branchlets 3–4 mm in diam., densely yellow pubescent. Seed cones 2.5–5 × 1.5–2.8 cm. Seed scales 40–55, ± strigose abaxially.

• Mountains; 2600–3500 m. S Shaanxi.

A vulnerable plant. The name *Larix potaninii* var. *chinensis* was published as a new combination based on *L. chinensis* Beissner (Mitt. Deutsch. Dendrol. Ges. 5: 215. 1896). However, the latter is illegitimate, being a later homonym of *L. chinensis* Miller (1768), so *L. potaninii* var. *chinensis* is effectively a new name based on Beissner's type.

7. Larix sibirica Ledebour, Fl. Altaic. 4 : 204. 1833.

鲜卑落叶松 xian bei luo ye song

Larix decidua subsp. *sibirica* (Ledebour) Domin; *L. decidua* var. *sibirica* (Ledebour) Regel; *L. russica* (Endlicher) Sabine ex Trautvetter; *L. sukaczewii* Dylis; *Pinus larix* Linnaeus var. *russica* Endlicher.

Trees to 40 m tall; trunk to 80 cm d.b.h.; bark dark gray to dark brown, rough, longitudinally fissured; crown conical, branchlets not pendulous, yellow or yellowish gray, glossy, densely hairy when young, glabrescent; short branchlets densely grayish hairy at apex; winter buds subglobose. Leaves 2–4 cm, keeled abaxially, apex acute or obtuse. Seed cones purplish or reddish brown, rarely green, maturing pale brown or purplish brown, ovoid or narrowly so, 2.5–4.5 × 2–3.5 cm. Seed scales 25–40, ovate or narrowly rhombic-ovate, 1.5–2 × 1–1.8 cm, usually densely rusty brown pubescent abaxially, rarely subglabrous, apex obtuse. Bracts included, violet, oblong-lanceolate, 1/4–1/2 as long as seed scales, midvein elongated into a caudate cusp. Seeds light gray, obliquely obovoid, 1–1.5 cm including wing. Pollination May, seed maturity Sep–Oct.

Mountains, lowland taiga; 500–3500 m. Xinjiang [Mongolia, E Russia].

The timber is used for construction, bridge building, vehicles, poles, and making furniture, and the bark yields tannins. The species is also cultivated for afforestation and as an ornamental.

8. Larix gmelinii (Ruprecht) Kuzeneva, Trudy Bot. Muz. Rossiisk. Akad. Nauk 18: 41. 1920.

落叶松 luo ye song

Trees to 35 m tall; trunk to 90 cm d.b.h.; bark gray to dark gray, longitudinally fissured, scaly; crown ovoid-conical; branchlets initially yellowish brown, aging gray-brown or gray, slender, ca. 1 mm in diam., glabrous or pubescent; short branchlets 2–4 mm in diam., yellowish hairy at apex; winter buds subglobose, scales dark brown. Leaves 1.5–3 cm × 0.7–1 mm, keeled abaxially. Seed cones purplish red, maturing yellow-brown or purplish brown, ovoid or ovoid-oblong, 1.2–4 × 1–3 cm. Seed scales 14–45, pentagonal-ovate, 1–1.5 × 0.8–1.2 cm at middle of cone, glabrous and glossy abaxially, margin truncate or emarginate toward apex. Bracts ovate-lanceolate, 1/3–1/2 as long as seed scales, apex cuspidate. Seeds grayish with light brown spots, obliquely ovoid, ca. 10 mm including wing. Pollination May–Jun, seed maturity Sep.

Hills, mountains, rocky slopes, peatlands, swamps, lowland subarctic plains, river basins, valleys; 300–2800 m. Hebei, Heilongjiang, NW Henan, Jilin, Nei Mongol, Shanxi [Korea, Mongolia, E Russia].

The timber is used for construction, poles, vehicles, bridge building, and wood fiber. The trunk is used for producing resin, and the bark for tannins. The species is also cultivated for afforestation and as an ornamental.

1a. First-year long branchlets slender, ca. 1 mm in diam.; short branchlets 2–3 mm in diam.; seed cones 1.2–3 × 1–2 cm; seed scales 14–30, dehiscent at maturity ..... 8a. var. *gmelinii*

1b. First-year long branchlets stout, 1.4–2.5 mm in diam.; short branchlets 3–4 mm in diam.; seed cones 2–4 × 2–3 cm; seed scales 26–45, indehiscent or slightly dehiscent at maturity toward apical part of cone ..... 8b. var. *principis-rupprechtii*

8a. Larix gmelinii var. **gmelinii**

落叶松(原变种) luo ye song (yuan bian zhong)

Abies gmelinii Ruprecht, Beitr. Pflanzenk. Russ. Reiches 2: 56. 1845; *Larix dahurica* Turczaninow ex Trautvetter; *L. dahurica* f. *denticulata* Liou & Q. L. Wang; *L. dahurica* f. *glauca* Liou & Q. L. Wang; *L. dahurica* var. *heilingensis* (Y. C. Yang & Y. L. Chou) Kitagawa; *L. dahurica* f. *macrocarpa* Liou & Q. L. Wang; *L. gmelinii* f. *genhensis* (S. Y. Li & Adair) L. K. Fu & Nan Li; *L. gmelinii* var. *genhensis* S. Y. Li & Adair; *L. gmelinii* var. *hsinganica* Y. C. Yang & Y. L. Chou; *L. heilingensis* Y. C. Yang & Y. L. Chou; *L. komarovii* Kolesnikov; *L. middendorfii* Kolesnikov; *L. ochotensis* Kolesnikov.

First-year long branchlets slender, ca. 1 mm in diam. Short branchlets 2–3 mm in diam. Seed cones 1.2–3 × 1–2 cm. Seed scales 14–30, dehiscent at maturity.

Hills, mountains, peatlands, swamps, lowland subarctic plains, river basins, valleys; 300–1200 m. Heilongjiang, Jilin, Nei Mongol [Korea, Mongolia, E Russia].

8b. Larix gmelinii var. **principis-rupprechtii** (Mayr) Pilger in Engler & Prantl, Nat. Pflanzenfam., ed. 2, 13: 327. 1926.

华北落叶松 hua bei luo ye song

Larix principis-rupprechtii Mayr, Fremdländ. Wald-Parkbäume 309. 1906; *L. dahurica* Turczaninow ex Trautvetter var. *principis-rupprechtii* (Mayr) Rehder & E. H. Wilson; *L. gmelinii* f. *pendula* (D. S. Zhang & Y. M. Chen) L. K. Fu & Nan Li; *L. gmelinii* var. *wulingschanensis* (Liou & Q. L. Wang) Kitagawa; *L. principis-rupprechtii* var. *pendula* D. S. Zhang & Y. M. Chen; *L. wulingschanensis* Liou & Q. L. Wang.

First-year long branchlets stout, 1.4–2.5 mm in diam. Short branchlets 3–4 mm in diam. Seed cones 2–4 × 2–3 cm. Seed scales 26–45, indehiscent or slightly dehiscent at maturity toward apical part of cone.

• Mountains, usually on rocky slopes; 600–2800 m. Hebei, NW Henan, Shanxi.

9. Larix olgensis A. Henry, Gard. Chron., ser. 3, 57: 109. 1915.

黄花落叶松 huang hua luo ye song

Larix dahurica Turczaninow ex Trautvetter f. *multilepis* Liou & Q. L. Wang; *L. gmelinii* (Ruprecht) Kuzeneva var. *olgensis* (A. Henry) Ostenfeld & Syrach-Larsen; *L. olgensis* var. *changpaiensis* Y. C. Yang & Y. L. Chou f. *intermedia* (Takenouchi) Yang & Nie; *L. olgensis* var. *changpaiensis* f. *pubibasis* Yang & Nie; *L. olgensis* f. *viridis* (E. H. Wilson) Nakai.

Trees to 30 m tall; trunk to 1 m d.b.h.; bark gray to gray-brown, longitudinally fissured, flaking, scaly; crown pyramidal; long branchlets reddish or light brown, initially slightly shining, aging gray or dark gray, 1–1.2 mm in diam., pubescent or glabrous; short branchlets 2–3 mm in diam., densely brownish hairy at apex; winter buds purplish brown, ovoid or conical-ovoid. Leaves 1.5–2.5 cm × ca. 1 mm, keeled abaxially. Seed cones reddish purple or violet, maturing light brown and sometimes tinged with purple, ovoid-oblong. Seed scales 14–16, ovate-quadrangular or quadrangular-orbicular, usually slightly recurved distally when dry, 0.9–1.2 × ca. 1 cm, ± tuberculate, sometimes pubescent, rarely nearly glabrous abaxially, base slightly wider, apex truncate or emarginate, obtuse. Bracts included, dark purple-brown, oblong-ovate, 4–7 mm. Seeds light yellow or white, irregularly purple spotted, subobovoid, ca. 9 mm including wing. Pollination May, seed maturity Sep–Oct.

Mountains, moist slopes, swamps; 500–1800 m. Jilin, E Liaoning [Korea, E Russia].

The timber is used for construction, poles, vehicles, pit props, railway sleepers, and wood fiber. The trunk is used for producing resin and the bark for tannins. The species is also cultivated for afforestation and as an ornamental.

10. Larix decidua Miller, Gard. Dict., ed. 8, *Larix* no. 1. 1768.

欧洲落叶松 ou zhou luo ye song

Larix europaea Lamarck & de Candolle.

Trees to 50 m tall; trunk to 2 m d.b.h.; bark grayish brown, cracking into irregular plates; crown irregularly pyramidal; long branchlets light yellow or light grayish yellow, turning gray or blackish in 2nd or 3rd year, initially glabrous; short branchlets cylindric or subglobose, bearing rings of scale remnants; leaf cushions densely yellow pubescent. Leaves 2–3 cm × 0.5–1 mm, flat or occasionally slightly keeled adaxially, keeled abaxially. Seed cones dark red or purplish, becoming green with pink scale margins, ovoid or ovoid-oblong. Seed scales ovate or suborbicular, 0.8–1.5 × 0.7–1.3 cm, initially reddish pubescent near base abaxially, glabrescent, base narrowed, margin incurved distally, apex repand or shallowly emarginate. Bracts included, apex 3-lobed, cusp exposed, ca. 2.5 mm. Seeds dark brownish gray, ovoid-cuneate, ca. 4 × 2.5 mm; wing pale brown, ovate.

Cultivated. Jiangxi (Lu Shan), Liaoning (Xiongyuecheng) [native to Europe].

11. Larix kaempferi (Lambert) Carrière, Fl. Serres Jard. Eur. (Ghent) 11: 97. 1856.

日本落叶松 ri ben luo ye song

Pinus kaempferi Lambert, Descr. Pinus 2: [Pref.] v. 1824; *Larix leptolepis* (Siebold & Zuccarini) Gordon; *L. leptolepis* var. *louchanensis* Ferré & Augère.

Trees to 35(–40) m tall; trunk to 1.5 m d.b.h.; crown broadly pyramidal, dense; long branchlets light yellow or light reddish brown, glaucous, initially pale brownish pub–escent, turning glabrous and grayish brown or blackish brown in 2nd year; short branchlets bearing rings of scale remnants; leaf cushions sparsely pilose. Leaves linear-oblanceolate, 1–2.5 cm × 0.7–1.1 mm, inconspicuously keeled abaxially, apex obtuse. Seed cones terminal, violet, maturing orange-brown tinged with purple, finally gray-brown, ovoid-globose, 1.5–3.5 × 1.5–2.5 cm. Seed scales 30–40, suborbicular, 1–1.3 × 1–1.3 cm, glabrous, margin sometimes undulate, apex entire or emarginate, usually strongly recurved. Bracts included, ligulate, ca. 1/2 as long as seed scales. Seeds brownish white mottled with red, ovoid-cuneate, slightly flattened, ca. 4 × 3 mm; wing reddish yellow tinged with brown, ovate-oblong, ca. 8 × 4 mm.

Cultivated. Hebei, Heilongjiang, Henan, Jiangxi, Jilin, Liaoning, Shandong [Japan].

4. CATHAYA Chun & Kuang, Acta Bot. Sin. 10(3): 245. 1962.

银杉属 yin shan shu

Trees evergreen; trunk monopodial, columnar, straight; branchlets apparently dimorphic: long branchlets with alternate rapid and slow growths that result in sets of leaves alternating with denser tufts; false short (lateral) branchlets bearing solitary leaves so densely as to appear clustered. Leaves spirally arranged, radially spreading, linear-oblanceolate, slightly curved or straight, flattened, longitudinally grooved adaxially, stomatal bands 2, abaxial, white, separated by an elevated midvein, vascular bundle 1, resin canals 2, marginal, margin entire, apex rounded. Pollen cones 1–3 from axillary buds on branchlets. Pollen 2-saccate, with visible cap on pole. Seed cones axillary,

sessile, initially erect, finally pendulous, ovoid, maturing in 1st year, often persistent for many years. Seed scales suborbicular, woody, stiff, dehiscent at maturity, persistent. Bracts spatulate, apex tapering. Seeds obliquely ovoid; wing membranous. Cotyledons 3 or 4. Germination epigeal. 2*n* = 24*.

• One species: China.

The original description was by Chun & Kuang, Bot. Zhurn. (Moscow & Leningrad) 43: 464. 1958. However, the name was not validly published there because two species were described simultaneously and the type species was not indicated.

1. Cathaya argyrophylla Chun & Kuang, Acta Bot. Sin. 10(3): 246. 1962.
银杉 yin shan

Cathaya nanchuanensis Chun & Kuang; *Pseudotsuga argyrophylla* (Chun & Kuang) Greguss; *Tsuga argyrophylla* (Chun & Kuang) de Laubenfels & Silba.

Trees to 20 m tall; trunk to 40 cm d.b.h.; bark dark gray, irregularly flaking; branchlets yellow-brown, initially densely gray-yellow pubescent, aging dark yellow and glabrous; winter buds light yellow-brown, ovoid or ovoid-conical. Leaf cushions topped with pale, orbicular or subsquare leaf scars. Leaves dark green adaxially, 4–6 cm × 2.5–3 mm on long branchlets, nearly clustered into a whorl on short branchlets where usually not longer than 3 cm, puberulent, densely pubescent along grooves, margin slightly revolute. Seed cones green, dark brown when mature, ovoid or ellipsoid, 3–5 × 1.5–3 cm. Seed scales 13–16, suborbicular or compressed orbicular-ovate, 1.5–2.5 × 1–2.5 cm, densely pubescent on exposed part. Bracts 1/4–1/3 as long as seed scales. Seeds dark green mottled with light green, slightly appressed, obliquely ovoid, 5–6 × 3–4 mm; wing yellow-brown, obliquely ovate or elliptic-ovate, 1–1.5 cm × 4–6 mm.

• Mountains, usually on open slopes and ridges; 900–1900 m. NE Guangxi (Jinxiu Yaozu Zizhixian, Longsheng Gezu Zizhixian), N Guizhou (Daozhen Xian, Tongzi), S Hunan, SE Sichuan (Nanchuan Xian, Wulong Xian).

5. PSEUDOTSUGA Carrière, Traité Gén. Conif., ed. 2, 1: 256. 1867.

黄杉属 huang shan shu

Trees evergreen; trunk straight; branches irregularly vertical; branchlets with slightly raised, circular leaf scars; short branchlets absent; winter buds ovoid or fusiform, not resinous. Leaves spirally arranged, ± linear, flattened, longitudinally grooved adaxially, stomatal lines abaxial, in 2 white bands, separated by an elevated midvein, vascular bundle 1, resin canals 2, sublateral, marginal, base ± twisted. Pollen cones axillary, solitary, cylindric; pollen not saccate, globose. Seed cones developing from axillary buds near ends of 2nd-year branchlets, solitary, pedunculate, pendulous, purplish red or green, maturing in 1st year. Seed scales variously shaped, convex, woody, margin rounded toward apex, persistent. Bracts well developed, exserted or included, 3-lobed, straight or reflexed, with a cusp longer than lateral lobes. Seeds borne in a shallow, membranous cup covering 1 side of seed, adnate to wing; wing obliquely ovate, short, covering only a small portion of seed scale. Cotyledons 5–8(–12). Germination epigeal. 2*n* = 24 (26 in *P. menziesii*).

Six species: China, Japan, W North America; five species (three endemic, two introduced) in China.

1a. Leaf apex acute, acuminate, or obtuse; bracts appressed or reflexed.
  2a. Seed cones ca. 8 × 3.5–4 cm; seed scales about as long as or longer than wide ..... 5. *P. menziesii*
  2b. Seed cones 9–13(–18) × 4–6 cm; seed scales distinctly wider than long ..... 4. *P. macrocarpa*
1b. Leaf apex emarginate; bracts reflexed.
  3a. Leaves 2.8–5.5 cm × 1.3–1.8(–2) mm; seed scales at middle of cones suborbicular or rhombic-orbicular; cusp of bracts 6–12 mm; wing of seeds as long as seed scale ..... 1. *P. forrestii*
  3b. Leaves 0.7–2.5(–3) cm × 2–3.2 mm; seed scales at middle of cones flabellate, reniform, semiorbicular, or compressed orbicular-rhombic; cusp of bracts 2–5 mm; wing of seeds 1/2–4/5 as long as seed scale.
    4a. Leaves usually (1.3–)2–2.5(–3) cm × ca. 2 mm; seed scales at middle of cones semiorbicular, flabellate, or reniform ..... 2. *P. sinensis*
    4b. Leaves usually 0.7–1.5(–2) cm × 2–3.2 mm; seed scales at middle of cones broadly compressed orbicular-rhombic ..... 3. *P. brevifolia*

1. Pseudotsuga forrestii Craib, Notes Roy. Bot. Gard. Edinburgh 11: 189. 1919.

瀾沧黄杉 lan cang huang shan

Pseudotsuga sinensis Dode var. *forrestii* (Craib) Silba.

Trees to 40 m tall; trunk to 80 cm d.b.h.; bark dark brown-gray, rough, deeply fissured longitudinally; branchlets initially pale yellow or greenish yellow, becoming reddish brown when dry, light brown or brownish gray in 2nd or 3rd year, glabrous or pubescent. Leaves pectinately arranged, subsessile, linear, 2.8–5.5

cm × 1.3–1.8(–2) mm, base cuneate, apex emarginate. Seed cones ovoid, 5–8 × 4–5.5 cm. Seed scales at middle of cones suborbicular or rhombic-orbicular, (2.5–)2.7–3.5 × 3–3.6 (–4) cm, glabrous abaxially, base cuneate-orbicular. Bracts obviously longer than seed scales, reflexed, cusp lanceolate, 6–12 mm, lateral lobes narrowly triangular, ca. 3 mm. Seeds light brown, irregularly dark spotted, triangular-ovoid, slightly depressed, glabrous adaxially; wing obliquely ovate. Seed maturity Oct.

- Mountains; 2400–3300 m. Yunnan.

A vulnerable species. The timber is used for construction, bridge building, vehicles, and furniture. The species is also grown for afforestation.

2. Pseudotsuga sinensis Dode, Bull. Soc. Dendrol. France 23–24: 58. 1912.

黄杉 huang shan

Trees to 50 m tall; trunk to 1 m d.b.h.; bark gray or dark gray, irregularly and thickly scaly; branchlets initially pale yellow or yellowish gray, aging gray, usually glabrous or slightly pubescent on main branchlets and densely pubescent on lateral branchlets. Leaves pectinately arranged, linear, (1.3–)2–2.5(–3) cm × ca. 2 mm, stomatal bands abaxial, whitish or gray-green, base broadly cuneate, apex emarginate. Seed cones pale purple, glaucous, maturing purplish brown, ovoid to ellipsoid- or conical-ovoid, 3.5–8 × 2–4.5 cm. Seed scales at middle of cones semiorbicular, flabellate, or reniform, 2.5–3 × 3.2–4.5 (–5) cm, rusty brown pubescent abaxially, base broadly cuneate or almost truncate, concave at sides. Bracts reflexed, cusp narrowly triangular, ca. 3 mm, apex obtuse. Seeds irregularly brown spotted abaxially, triangular-ovoid, slightly depressed, densely rusty brown pubescent adaxially; wing obliquely ovate or semitrullate. Pollination Apr, seed maturity Oct–Nov.

- Hills, mountains, evergreen broad-leaved forests; 600–2800 (–3300) m. S Anhui, N Fujian, N Guizhou, W Hubei, NW Hunan, NE Jiangxi, S Shaanxi, SE Sichuan, Taiwan, C and NE Yunnan, Zhejiang.

A vulnerable species. The timber is used for construction, bridge building, furniture, and wood fiber.

1a. Leaves with whitish stomatal bands abaxially ..... 2a. var. *sinensis*
1b. Leaves with gray-green stomatal bands abaxially ..... 2b. var. *wilsoniana*

2a. Pseudotsuga sinensis var. **sinensis**

黄杉(原变种) huang shan (yuan bian zhong)

Pseudotsuga gaussenii Flous; *P. shaanxiensis* S. Z. Qu & K. Y. Wang; *P. sinensis* var. *gaussenii* (Flous) Silba; *P. xichangensis* C. T. Kuan & L. J. Zhou.

Leaves with whitish stomatal bands abaxially.

- Hills, mountains; 600–2800(–3300) m. S Anhui, N Fujian, N Guizhou, W Hubei, NW Hunan, NE Jiangxi, S Shaanxi, SE Sichuan, C and NE Yunnan, Zhejiang.

2b. Pseudotsuga sinensis var. **wilsoniana** (Hayata) L. K. Fu & Nan Li, Novon 7: 263. 1997.

台湾黄杉 tai wan huang shan

Pseudotsuga wilsoniana Hayata, Icon. Pl. Formos. 5: 204. 1915; *P. salvadori* Flous.

Leaves with gray-green stomatal bands abaxially.

- Mountains, mainly in evergreen broad-leaved forests; 800–1500 m. Taiwan.

This variety is isolated geographically from var. *sinensis* but is not markedly distinct morphologically.

3. Pseudotsuga brevifolia W. C. Cheng & L. K. Fu in W. C. Cheng & al., Acta Phytotax. Sin. 13(4): 83. 1975.

短叶黄杉 duan ye huang shan

Pseudotsuga sinensis Dode var. *brevifolia* (W. C. Cheng & L. K. Fu) Farjon & Silba.

Bark brown, scaly, longitudinally fissured. Branchlets reddish brown, initially densely pubescent, turning light brown or gray and glabrous or subglabrous in 2nd or 3rd year. Leaves spirally or irregularly pectinately arranged, linear, 0.7–1.5(–2) cm × 2–3.2 mm, apex emarginate. Seed cones ovoid-ellipsoid or ovoid, 3.7–6.5 × ca. 3.4 cm. Seed scales at middle of cones compressed orbicular-rhombic, 2.2–2.5 × ca. 3.3 cm, hard and woody, densely pubescent abaxially, base cuneate, not concave at sides. Bracts reflexed, cusp narrowly triangular, ca. 3 mm, lateral lobes triangular, margin erose. Seeds irregularly brown spotted, obliquely triangular-ovoid, ca. 2 cm including wing; wing reddish brown, lustrous, ca. 1 cm, pubescent on middle part adaxially.

- Scattered on S-facing slopes and mountain tops, on calcareous and rocky soils; ca. 1300 m. SW Guangxi, Guizhou.

A vulnerable species.

4. Pseudotsuga macrocarpa (Vasey) Mayr, Wald. Nordamer. 278. 1889.

大果黄杉 da guo huang shan

Abies macrocarpa Vasey, Gard. Monthly & Hort. 18: 21. 1876.

Trees to 25 m tall; trunk to 1.3 m d.b.h.; bark reddish brown, aging dark blackish gray, scaly, longitudinally fissured; branchlets pendulous, reddish brown or pale brown, aging gray-brown, slender, flexible, slightly pubescent; winter buds reddish brown, ovoid-conical or fusiform-conical, acute. Leaves 2.5–4 cm × ca. 2 mm, stomatal bands 2, abaxial, grayish white, base strongly twisted, apex acute. Seed cones greenish yellow when immature, ripening to dull brown, ovoid-cylindric, 9–13(–18) × 4–6 cm. Seed scales at middle of cones broadly cuneate-flabellate, thick, transversely convex, 2–2.5 × 3–3.5 cm, often resinous, puberulent when young, soon glabrous, faintly striate abaxially. Bracts exserted, not reflexed, lingulate, cusp longer than lateral

lobes. Seeds brown, ovoid-conical, 1–1.2 cm × ca. 6 mm; wing pale brown, obovate, 1–1.4 cm.

Cultivated. Jiangxi (Lu Shan) [native to W United States].

5. Pseudotsuga menziesii (Mirbel) Franco, Bol. Soc. Brot., ser. 2, 24: 74. 1950.

花旗松 hua qi song

Abies menziesii Mirbel, Mém. Mus. Hist. Nat. 13: 70. 1825; *Abies taxifolia* Lambert (1803), not Salisbury (1796); *Pinus douglasii* Sabine ex D. Don; *Pseudotsuga douglasii* (Sabine ex D. Don) Carrière; *P. taxifolia* (Lambert) Britton.

Trees to 100 m tall; trunk to 4 m d.b.h. in native range; bark dark gray-brown or blackish green, smooth, with resin blisters, aging rough and scaly with deep longitudinal fissures; branchlets initially light yellow, becoming red-brown when dry, slightly pubescent. Leaves dark green adaxially, linear, 1.5–3 cm × 1–2 mm, stomatal bands 2, abaxial, white, apex obtuse or acuminate. Seed cones brown, glossy, ellipsoid-ovoid, ca. 8 × 3.5–4 cm. Seed scales ± rhombic, 2–2.5 × 2–2.5 cm, as long as or longer than wide. Bracts exserted, longer than seed scales, cusp straight or reflexed, 6–10 mm, tapering at apex, lateral lobes wide and short, denticulate at margin.

Cultivated. Beijing Shi, Jiangxi (Lu Shan) [native to W Canada, Mexico, W United States].

6. TSUGA (Endlicher) Carrière, Traité Gén. Conif. 185. 1855.

铁杉属 tie shan shu

Pinus Linnaeus sect. *Tsuga* Endlicher, Syn. Conif. 83. 1847; *Nothotsuga* Hu ex C. N. Page.

Trees evergreen; branches irregularly whorled; branchlets with leaf cushions and persistent winter bud scales at base; winter buds ovoid or globose, not resinous. Leaves pectinately arranged, rarely radially spreading (emerging in false whorls on lateral branchlets), petiolate; petiole twisted at base; blade usually linear and flattened, stomatal lines abaxial, rarely on each surface, in 2 white bands, separated by an elevated midvein, vascular bundle 1, resin canal 1 below vascular bundle. Pollen cones growing from lateral buds, solitary, rarely clustered in umbels from a single bud, ellipsoid or ovoid; pollen with ring-shaped, saccate structure near distal pole, rarely ± 2-saccate. Seed cones terminal (rarely lateral) on 2nd-year branchlets, solitary, pendulous, rarely erect, ovoid-globose to cylindric or obovoid-oblong, maturing in 1st year. Seed scales thin, woody, persistent. Bracts included, rarely with slightly exserted, apical cusp. Seeds small, with small resin vesicles adaxially. Cotyledons 3–6. Germination epigeal. 2*n* = 24*.

Nine or ten species: E Asia and North America: four species (three endemic) in China.

1a. Leaves radially spreading (emerging in false whorls on lateral branchlets), blade with lines of stomata on each surface; pollen cones clustered in umbels from a single lateral bud; seed cones ± erect, bracts slightly exserted at apex ..... 1. *T. longibracteata*

1b. Leaves pectinately arranged, blade with lines of stomata on abaxial surface only; pollen cones solitary; seed cones pendulous, bracts wholly included

2a. Seed scales thin, slightly recurved distally; branchlets brown lanate ..... 2. *T. dumosa*

2b. Seed scales thick, not recurved distally; branchlets not brown lanate.

3a. Seed scales loosely arranged, narrowly elliptic, ca. 2 × as long as wide; seed cones ovoid-cylindric or narrowly ovoid ..... 3. *T. oblongisquamata*

3b. Seed scales densely arranged, variable in shape, as long as or only slightly longer than wide; seed cones ovoid-globose or obovoid-oblong ..... 4. *T. chinensis*

1. Tsuga longibracteata W. C. Cheng, Contr. Biol. Lab. Chin. Assoc. Advancem. Sci., Sect. Bot., 7(1): 1. 1932.

长苞铁杉 chang bao tie shan

Nothotsuga longibracteata (W. C. Cheng) Hu ex C. N. Page.

Trees to 30 m tall; trunk to 1 m d.b.h.; bark dark brown, longitudinally fissured; branchlets drying brownish yellow or reddish brown, aging brown-gray or dark brown, glabrous; winter buds scales keeled abaxially. Leaves with petiole 1–1.5 mm; blade 1.1–2(–2.4) cm × 1–2(–2.5) mm, smooth or faintly grooved, stomatal

lines 7–12 adaxially, 10–16 along each surface abaxially, margin entire, apex somewhat acute or slightly obtuse. Seed cones purplish or red, maturing to dark brown, 2–5.8 × 1.2–2.5 cm, persistent for several years, then breaking off whole or sometimes disintegrating. Seed scales at middle of cones broadly rhombic or suborbicular, 0.9–2.2 × 1.2–2.5 cm, base peltate-auriculate, apex truncate-rounded. Bracts subspatulate, 0.7–1.8 cm, apical cusp acute or acuminate. Seeds triangular-ovoid, 4–8 × 2.5–3 mm; wing ovate-oblong, apex rounded. Pollination Mar–Apr, seed maturity Oct.

• Forming small, pure stands, or in evergreen, broad-leaved, sclerophyllous forests (species of *Castanopsis*, *Lithocarpus*, and *Quercus*), or mixed, mesophytic forests (*Fagus longipetiolata*, *Pinus kwangtungensis*, *Tetracentron sinensis*, etc.) on steep, sunny mountain slopes and ridges on acidic soils in areas with cool, temperate, humid climate and abundant rainfall and fog; (300–)400–1900(–2300) m. C and S Fujian, N Guangdong, C and N Guangxi, E Guizhou, S Hunan, S Jiangxi.

A vulnerable species; few trees survive in most populations because of large scale logging. R. R. Mill concurs with Page and other recent authors that this species is sufficiently distinct to be treated in its own genus as *Nothotsuga longibracteata*. It differs strikingly from other species of *Tsuga* as follows: leaves radially spreading, stomatal lines present on each surface; pollen cones clustered in umbels from a single lateral bud; seed cones ± erect; bracts included except for slightly exserted, apical cusp. The name *Tsugo-keteleeria* Van Campo & Gaussen, described as a hybrid between *Tsuga* and *Keteleeria*, is invalid (ICBN, Art. 32.1(b) and H.6.2), as is the combination *Tsugo-keteleeria longibracteata* (W. C. Cheng) Van Campo & Gaussen.

An ideal tree for afforestation in mountains above middle elevations in subtropical regions. The timber is used for construction and furniture.

2. Tsuga dumosa (D. Don) Eichler in Engler & Prantl, Nat. Pflanzenfam. 2(1): 80. 1887.

云南铁杉 yun nan tie shan

Pinus dumosa D. Don in Lambert, Descr. Pinus 2: 55. 1824; *Abies yunnanensis* Franchet; *Pinus brunoniana* Wallich; *Tsuga brunoniana* (Wallich) Carrière; *T. calcarea* Downie; *T. chinensis* (Franchet) E. Pritzel subsp. *wardii* (Downie) E. Murray; *T. dumosa* var. *yunnanensis* (Franchet) Silba; *T. dura* Downie; *T. intermedia* Handel-Mazzetti; *T. leptophylla* Handel-Mazzetti; *T. wardii* Downie; *T. yunnanensis* (Franchet) E. Pritzel; *T. yunnanensis* subsp. *dura* (Downie) E. Murray.

Trees to 40 m tall; trunk to 2.7 m d.b.h.; bark brownish gray or gray-brown, thick, longitudinally fissured; crown pyramidal; branchlets initially yellowish or reddish brown, turning light brown or dark gray in 2nd or 3rd year, ridged and grooved, brown lanate. Leaves pectinately arranged, linear, rarely narrowly linear-lanceolate, 1–2.4(–3.5) cm × 1.5–3 mm, grooved adaxially, abaxial stomatal bands white, distal margin entire or serrulate, apex obtuse, entire or occasionally emarginate. Seed cones light green, maturing light brown, ovoid or narrowly so, 1.5–3 × 1–2 cm. Seed scales obovate-orbicular, 1–1.4 × 0.7–1.2 cm, base only slightly convex, distal part slightly recurved, very thin, smooth. Bracts cuneate-rhombic, margin denticulate, apex 2-lobed. Seeds obliquely ovoid or narrowly ovoid, 0.8–1.2 cm including wing. Pollination Apr–May, seed maturity Oct–Nov.

Mountain slopes, river basins; 2300–3500 m. Sichuan, S Xizang, N and W Yunnan [Bhutan, N India, N Myanmar, Nepal, Sikkim, N Vietnam].

The timber is used for construction and furniture.

3. Tsuga oblongisquamata (W. C. Cheng & L. K. Fu) L. K. Fu & Nan Li, Novon 7: 263. 1997.

矩鳞铁杉 ju lin tie shan

Tsuga chinensis (Franchet) E. Pritzel var. *oblongisquamata* W. C. Cheng & L. K. Fu in W. C. Cheng & al., Acta Phytotax. Sin. 13(4): 83. 1975.

Branchlets brownish yellow or brown, relatively stout, 1.5–2 mm in diam. Leaves without white bands of stomata, margin entire, apex rounded or slightly emarginate. Seed cones narrowly ovoid or ovoid-cylindric, 2–3 × 1.5–2.5 cm. Seed scales loosely overlapping, narrowly orbicular, ca. 2 × as long as wide, exposed part glabrous. Bracts without cusp at apex.

• Valleys, river basins; 2600–3200 m. S Gansu, W Hubei, N and W Sichuan.

Closely related to *Tsuga chinensis* and perhaps better treated as a variety of that species.

4. Tsuga chinensis (Franchet) E. Pritzel, Bot. Jahrb. Syst. 29: 217. 1900.

铁杉 tie shan

Trees to 50 m tall; trunk to 1.6 m d.b.h.; bark dark gray, longitudinally fissured, flaking; crown pyramidal; branchlets brown-yellow or grayish yellow initially, turning grayish yellow, gray, or brownish gray in 2nd or 3rd year, slender, pubescent; winter bud scales appressed or keeled at base of branchlets. Leaves pectinately arranged, linear, 1.2–2.7 cm × 2–3 mm, abaxial stomatal bands grayish green, margin entire, apex obtuse, entire or emarginate. Seed cones light green, maturing pale gray-yellow or pale brown, ovoid-globose to cylindric or obovoid-oblong, 1.5–4 × 1.2–2.5 cm. Seed scales at middle of cones densely arranged, square-orbicular, pentagonal-ovate, or compressed orbicular, 0.9–1.2 × 0.8–1.1 cm, apex rounded or nearly truncate. Bracts cuneate-obovate or obtriangular, apex erose. Seeds 7–9 mm including obliquely ovate wing. Pollination Apr, seed maturity Oct.

• Mountains, mixed forests, valleys, river basins; 1000–3500 m. Anhui, Fujian, S Gansu, Guangdong, Guangxi, N Guizhou, W Henan, W Hubei, Hunan, Jiangxi, S Shaanxi, Sichuan, Taiwan, Xizang, Yunnan, Zhejiang.

The timber is used for construction, aircraft, furniture, and in mines. The bark is used for producing tannin, the trunk for resin, and the roots, trunk, and branches for aromatic oils.

1a. Branchlets gray or yellow-gray, ca. 1 mm in diam.; seed cones ovoid, 1.5–2.5 × 1.2–1.6 cm.
  2a. Seed scales pentagonal-ovate, subsquare, or suborbicular ..... 4a. var. *chinensis*
  2b. Seed scales compressed orbicular or nearly semiorbicular ..... 4b. var. *formosana*
1b. Branchlets brownish yellow or brown, 1.5–2 mm in diam.; seed cones ovoid-globose, narrowly ovoid, ovoid-cylindric, or shortly cylindric, 2–4 × 1.5–3 cm.
  3a. Seed cones ovoid-globose, 2–2.5 × 1.8–2 cm; seed scales almost square, exposed part smooth, shining .. 4c. var. *patens*
  3b. Seed cones narrowly ovoid, ovoid-cylindric, or shortly cylindric, (2–)2.5–4 × 1.5–3 cm; seed scales narrowly ovate, oblong, or square-orbicular, exposed part striate and glabrous, or pubescent.
    4a. Seed cones slender, narrowly ovoid or ovoid-cylindric; seed scales narrowly ovate or oblong, exposed part striate, glabrous, margin thickened ..... 4d. var. *forrestii*
    4b. Seed cones stout, shortly cylindric; seed scales square-orbicular, exposed part pubescent, margin not thickened ..... 4e. var. *robusta*

4a. Tsuga chinensis var. **chinensis**

铁杉(原变种) tie shan (yuan bian zhong)

Abies chinensis Franchet, J. Bot. (Morot) 13: 259. 1899; *Tsuga chinensis* var. *tchekiangensis* (Flous) W. C. Cheng & L. K. Fu; *T. dumosa* (D. Don) Eichler var. *chinensis* (Franchet) E. Pritzel; *T. tchekiangensis* Flous.

Branchlets gray or yellow-gray, ca. 1 mm in diam. Seed cones ovoid, 1.5–2.5 × 1.2–1.6 cm. Seed scales pentagonal-ovate, subsquare, or suborbicular.

• Mountains, river basins; 1000–3200 m. Anhui, Fujian, S Gansu, Guangdong, Guangxi, NW Guizhou, W Henan, W Hubei, Hunan, Jiangxi, S Shaanxi, Sichuan, Xizang, Yunnan, Zhejiang.

4b. Tsuga chinensis var. **formosana** (Hayata) H. L. Li & H. Keng, Taiwania 5: 64. 1954.

台湾铁杉 tai wan tie shan

Tsuga formosana Hayata, Gard. Chron., ser. 3, 43: 194. 1908; *T. chinensis* var. *daibuensis* S. S. Ying.

Branchlets gray or yellow-gray, ca. 1 mm in diam. Seed cones ovoid, 1.5–2.5 × 1.2–1.6 cm. Seed scales compressed orbicular or almost semiorbicular.

• Mountains; 2000–3500 m. Taiwan.

4c. Tsuga chinensis var. **patens** (Downie) L. K. Fu & Nan Li, Novon 7: 263. 1997.

长阳铁杉 chang yang tie shan

Tsuga patens Downie, Notes Roy. Bot. Gard. Edinburgh 14: 16. 1923; *T. chinensis* subsp. *patens* (Downie) E. Murray.

Branchlets brownish yellow or brown, 1.5–2 mm in diam. Seed cones ovoid-globose, 2–2.5 × 1.8–2 cm. Seed scales almost square, thick, exposed part smooth and shining.

• Mountains; 2000–2300 m. W Hubei (Changyang Xian).

4d. Tsuga chinensis var. **forrestii** (Downie) Silba, Phytologia 68: 72. 1990.

丽江铁杉 li jiang tie shan

Tsuga forrestii Downie, Notes Roy. Bot. Gard. Edinburgh 14: 18. 1923.

Branchlets brownish yellow or brown, 1.5–2 mm in diam. Seed cones narrowly ovoid or ovoid-cylindric, (2–)2.5–4 × 1.5–3 cm. Seed scales narrowly ovate or oblong, exposed part striate, glabrous, margin thickened.

• Mountains, valleys, mixed forests; 2000–3000 m. NE Guizhou (Jiangkou: Fanjing Shan), SW Sichuan, NW Yunnan.

A vulnerable plant.

4e. Tsuga chinensis var. **robusta** W. C. Cheng & L. K. Fu in W. C. Cheng & al., Acta Phytotax. Sin. 13(4): 83. 1975.

大果铁杉 da guo tie shan

Branchlets brownish yellow or brown, 1.5–2 mm in diam. Seed cones ovoid-cylindric or narrowly ovoid, 2–4 × 1.5–2.5 cm. Seed scales square-orbicular, exposed part pubescent. Bracts cuspidate at apex.

• Mountains; ca. 1800 m. W Hubei (Badong Xian), W Sichuan (Yalong Jiang valley).

7. PSEUDOLARIX Gordon, Pinetum 292. 1858, nom. cons.

金钱松属 jin qian song shu

Chrysolarix H. E. Moore; *Laricopsis* Kent.

Trees deciduous; trunk monopodial, straight, terete; branches irregularly whorled; branchlets strongly dimorphic: long branchlets with leaves spirally arranged and radially spreading; short branchlets with leaves radially arranged in

false whorls of 10–30 (often spirally spread like a discoid star). Leaves green, turning golden yellow before falling in autumn, narrowly oblanceolate-linear, flattened, 1.5–4 mm wide, flexible, stomatal lines abaxial, in 2 bands, separated by midvein, vascular bundle 1, resin canals 2 or 3 (–7), marginal. Pollen cones terminal on short branchlets, borne in umbellate clusters of 10–25, pendulous at maturity; pollen 2-saccate. Seed cones solitary, shortly pedunculate, erect or ± spreading, ovoid-globose, 2-seeded, maturing in 1st year. Seed scales thick, woody, deciduous at maturity. Bracts adnate to seed scales at base and shed together with them at maturity. Seeds with large, backward projecting wing extending beyond scale margin at maturity. Cotyledons 4–7. 2*n* = 44*.

• One species: China.

1. Pseudolarix amabilis (J. Nelson) Rehder, J. Arnold Arbor. 1: 53. 1919.

金钱松 jin qian song

Larix amabilis J. Nelson, Pinaceae 84. 1866; *Abies kaempferi* Lindley; *Chrysolarix amabilis* (J. Nelson) H. E. Moore; *Laricopsis kaempferi* (Lindley) Kent; *Pseudolarix fortunei* Mayr; *P. kaempferi* Gordon; *P. pourtetii* Ferré.

Trees to 40 m tall; trunk to 3 m d.b.h.; bark gray-brown, rough, scaly, flaking; crown broadly conical; long branchlets initially reddish brown or reddish yellow, glossy, glabrous, becoming yellowish gray, brownish gray, or rarely purplish brown in 2nd or 3rd year, finally gray or dark gray; short branchlets slow growing, bearing dense rings of leaf cushions; winter buds ovoid, scales free at apex. Leaves bluish green adaxially, pale green abaxially, slightly curved or straight, 2–5.5 cm × 1.5–4 mm, slightly keeled adaxially, stomatal lines present on abaxial surface, midvein prominent abaxially, apex acute. Seed cones green or yellow-green, maturing reddish brown, obovoid or ovoid, 5–7.5 × 4–5 cm. Seed scales ovate-lanceo late, 2.8–3.5 × ca. 1.7 cm, with a longitudinal, central, densely pubescent ridge adaxially, base with 2 lateral auricles, apex emarginate. Bracts ovate-lanceolate, 1/4–1/3 as long as seed scales, margin denticulate. Seeds white, ovoid, 6–7 mm; wing light yellow or brownish yellow, glossy adaxially, triangular-lanceolate, ca. 2.5 cm. Pollination Apr, seed maturity Oct.

• Evergreen and deciduous, broad-leaved mixed, forests; 100–1500 m. Native range difficult to discern owing to long history of cultivation but probably the lower Chang Jiang valley: N Fujian, Hunan, N Jiangxi, N Zhejiang; cultivated in S Anhui, W Hubei, S Jiangsu, E Sichuan.

A rare species (as a native plant). The wood is used for furniture, boat building, and bridges. An excellent ornamental tree with its attractive crown and golden autumn color.

8. KETELEERIA Carrière, Rev. Hort. 37: 449. 1866.

油杉属 you shan shu

Trees evergreen; bark longitudinally fissured; crown broad; branches irregular, long; branchlets weakly ridged and grooved with poorly defined pulvini and small, circular leaf scars; short branchlets absent. Leaves spirally and usually ± pectinately arranged, or occasionally almost radially spreading, linear to lanceolate, flattened, midvein raised on both sides, stomatal lines usually all abaxial, in 2 bands separated by midvein, sometimes also a few adaxial lines present, vascular bundle 1, resin canals 2, sublateral, marginal. Pollen cones lateral or terminal, 4–8 in umbellate clusters, arising from a single bud; pollen 2-saccate. Seed cones terminal, solitary, erect, cylindric or conical-cylindric, maturing in 1st year; rachis breaking off near base or slowly disintegrating. Seed scales woody, persistent. Bracts ligulate-spatulate, 1/2–3/5 as long as seed scales, apex cuspidate or 3-lobed. Seeds triangular-oblong, covered on 1 side by wing, together as long as seed scales; wing lustrous, semitrullate or cuneate, leathery-membranous. Cotyledons 2–4. Germination hypogeal. 2*n* = 24*.

Three to five species: China, Laos, Vietnam; five species (three endemic) in China.

1a. Leaves narrowly linear-lanceolate or lanceolate; seed scales at middle of cones rhombic-ovate or narrowly so, apex ± emarginate ..... 1. *K. hainanensis*

1b. Leaves linear; seed scales variable in shape, apex entire, erose-denticulate, or slightly concave.

2a. Seed scales compressed orbicular, oblong, or rhombic-orbicular, widest at or above middle, as wide as or wider than long, apex entire, truncate-rounded, or ± convex; wing cuneate; leaves 1.5–4 cm 2. *K. fortunei*

2b. Seed scales variously shaped, widest below or rarely at middle, as long as or longer than wide, distal margin erose-denticulate, emarginate, or entire, apex ± narrowed, recurved; wing semitrullate; leaves often longer.

3a. Seed scales rhombic-ovate, distinctly longer than wide, apex subacute, erose-denticulate; leaves 4–6.5 cm, margin not recurved, apex usually ± mucronate ..... 3. *K. evelyniana*

3b. Seed scales subcordate, rhombic-subcordate, or -ovate, as long as or slightly longer than wide, apex
obtuse, entire or concave, rarely weakly denticulate; leaves usually shorter, margin slightly recurved,
apex obtuse or truncate.
4a. Branchlets densely rusty brown pubescent in 1st or 2nd year; seed scales black-brown, pentagonal-ovate,
densely rusty brown pubescent abaxially, apex concave ..... 4. *K. pubescens*
4b. Branchlets glabrous or slightly pubescent in 1st or 2nd year; seed scales brown-yellow, variously
shaped but not pentagonal, glabrous abaxially, apex often ± recurved ..... 5. *K. davidiana*

1. Keteleeria hainanensis Chun & Tsiang, Acta Phytotax. Sin. 8: 259. 1963.
海南油杉 hai nan you shan
Keteleeria evelyniana Masters var. *hainanensis* (Chun & Tsiang) Silba.
Trees to 30 m tall; trunk to 2 m d.b.h.; bark light gray or yellowish brown, rough, irregularly and longitudinally fissured; crown conical; branchlets reddish brown in 1st or 2nd year, finally grayish brown or gray, glabrous. Leaves almost radially spreading, narrowly linear-lanceolate or lanceolate, 5–14 cm × 3–4(–9) mm, stomatal lines abaxial, 8–16 in each band, apex usually acuminate. Seed cones cylindric, 14–18 × ca. 7 cm, base usually narrowed. Seed scales at middle of cones rhombic-ovate, ca. 4 × 2.5–3 cm, exposed part glabrous abaxially, apex narrowed, ± emarginate. Seeds nearly triangular-ellipsoid, 1.4–1.6 cm × 6–7 mm; wing yellowish brown, semitrullate. Pollination Jan–Feb, seed maturity following winter.
• Hills, mountains; 1000–1400 m. Hainan.
An endangered species. However, some authors regard it as representing the juvenile growth of *Keteleeria evelyniana*.

2. Keteleeria fortunei (A. Murray bis) Carrière, Rev. Hort. 37: 449. 1866.
油杉 you shan

Trees to 30 m tall; trunk to 1 m d.b.h.; bark dark gray, rough, longitudinally fissured; crown pyramidal; branchlets initially orange-red or reddish, turning yellowish gray or yellowish brown in 2nd or 3rd year, ± pubescent. Leaves pectinately arranged in lateral sets, linear, 1.2–3(–4) cm × 2–4 mm, stomatal lines (0–)2–4(–10) adaxially and 12–17 in each band abaxially, apex obtuse, rarely acute or slightly notched. Seed cones cylindric or oblong-cylindric, 6–18(–20) × (3.5–)5–6.5 cm. Seed scales compressed orbicular, rhombic-orbicular, or rarely oblong, thick or thin, (1.8–)2.5–3.2 × (1.8–)2.7–3.5 cm, exposed part glabrous abaxially, margin entire, apex convex, rounded, or rounded-truncate. Seeds oblong, 1–1.3 cm × 5–6 mm; wing yellowish brown, ± cuneate, apex oblique. Pollination Mar–Apr, seed maturity Oct.
Hills, mountains, broad-leaved forests; 200–1400 m. S Fujian, Guangdong, Guangxi, Guizhou, S Hunan, SW Jiangxi, SE Yunnan, SW Zhejiang [N Vietnam].
A vulnerable species in China. The timber is used for construction and furniture. The species is also cultivated for afforestation and as an ornamental.

1a. Leaf scars obviously protruding on branchlets, dark; seed scales thin . 2c. var. *oblonga*
1b. Leaf scars not obviously protruding on branchlets; seed scales relatively thick.
2a. Margin of seed scales compressed orbicular, truncate-rounded, broadly rounded, or emarginate; wing of seeds broadest distally; apex of leaves obtuse 2a. var. *fortunei*
2b. Margin of seed scales rhombic or rhombic-orbicular, usually rounded; wing of seeds broadest near middle; apex of leaf rounded or notched ..... 2b. var. *cyclolepis*

2a. Keteleeria fortunei var. **fortunei**
油杉(原变种) you shan (yuan bian zhong)
Picea fortunei A. Murray bis, Proc. Roy. Hort. Soc. London 2: 421. 1862.
Leaf scars not protruding on branchlets. Leaves thick, 1.2–3 cm × 2–4 mm, margin narrow and flat or wide and revolute, apex obtuse. Seed scales compressed orbicular, thick, apex truncate-rounded, broadly rounded, or emarginate. Wing of seeds broadest distally.
Hills, mountains, broad-leaved forests; 200–1400 m. S Fujian, E and S Guangdong, Guangxi [N Vietnam (Cao Bang province)].
2b. Keteleeria fortunei var. **cyclolepis** (Flous) Silba, Phytologia 68: 35. 1990.
江南油杉 jiang nan you shan
Keteleeria cyclolepis Flous, Bull. Soc. Hist. Nat. Toulouse 69: 402. 1936.
Leaf scars not protruding on branchlets. Leaves thin, 1.5–4 cm × 2–4 mm, apex rounded or notched. Seed scales rhombic, rhombic-orbicular, or suborbicular, thick, apex rounded (rarely broadly so). Wing of seeds broadest at middle.
• Hills, mountains; 300–1400 m. N Guangdong, E and NW Guangxi, Guizhou, S Hunan, SW Jiangxi, SE Yunnan, SW Zhejiang.
2c. Keteleeria fortunei var. **oblonga** (W. C. Cheng & L. K. Fu) L. K. Fu & Nan Li, Novon 7: 261. 1997.
矩鳞油杉 ju lin you shan
Keteleeria oblonga W. C. Cheng & L. K. Fu in W. C. Cheng & al., Acta Phytotax. Sin. 13(4): 82. 1975.

Leaf scars obviously protruding on branchlets, dark. Seed scales oblong, very thin.

• Hills; 400–700 m. W Guangxi (Tianyang Xian).

3. Keteleeria evelyniana Masters, Gard. Chron., ser. 3, 33: 194. 1903.

云南油杉 yun nan you shan

Keteleeria delavayi Tieghem; *K. dopiana* Flous; *K. evelyniana* var. *pendula* Hsüeh.

Trees to 40 m tall; trunk to 1 m d.b.h.; bark grayish brown, irregularly and longitudinally fissured, flaking; branchlets reddish or brownish red, turning gray-brown, yellow-brown, or brown, usually initially pubescent, glabrous in 2nd or 3rd year. Leaves narrowly linear, usually slightly falcate, (2–)4–6.5 cm × 2–3.5 mm, stomatal lines (0–)4–20 adaxially, 28–38 in each band abaxially, apex usually mucronate. Seed cones cylindric, (7–)9–20(–25) × (3.5–) 4–6.5 cm. Seed scales at middle of cones rhombic-ovate, (2–)3–4 × (2–)2.5–3 cm, exposed part of abaxial surface pubescent or nearly glabrous, apex subacute, erose-denticulate. Seeds oblong, 0.9–1.4 cm × 5–7 mm; wing yellowish brown, semitrullate. Pollination Apr–May, seed maturity Oct.

Mountains, river basins; 700–2900 m. W Guizhou, W Sichuan, Yunnan [Laos, Vietnam].

The timber is used for construction, bridge building, furniture, and wood fiber.

4. Keteleeria pubescens W. C. Cheng & L. K. Fu in W. C. Cheng & al., Acta Phytotax. Sin. 13(4): 82. 1975.

柔毛油杉 rou mao you shan

Keteleeria davidiana (Bertrand) Beissner var. *pubescens* (W. C. Cheng & L. K. Fu) Silba.

Bark dark brown or brownish gray, longitudinally fissured. Branchlets green in 1st or 2nd year, finally dark brown or dark reddish brown, densely pubescent. Leaves irregularly pectinately arranged on lateral branchlets, directed forward on main and cone-bearing branchlets, linear, 1.5–3 cm × 3–4 mm, stomatal lines abaxial, margin reflexed when dry, apex obtuse or acute. Seed cones glaucous when immature, ellipsoid-cylindric, 7–11 × 3–3.5 cm. Seed scales at middle of cones subcordate, ca. 2 × 2 cm, densely pubescent abaxially, distal margin emarginate or truncate, slightly recurved. Wing of seeds light brown, semitrullate.

• Hills, mountains; 600–1000 m. N Guangxi, S Guizhou.

Some authors place this species within *Keteleeria davidiana*.

5. Keteleeria davidiana (Bertrand) Beissner, Handb. Nadelholzk 424. 1891.

铁坚杉 tie jian shan

Trees to 50 m tall; trunk to 2.5 m d.b.h.; bark dark gray, rough, longitudinally fissured, flaking; crown oblate; branchlets initially yellowish gray, yellow, or light gray, turning gray or light brown in 2nd or 3rd year, pubescent or glabrous. Leaves usually pectinately arranged, linear, 2–5 cm × 3–4.5 mm, stomatal lines few or none adaxially, 20–32 in each band abaxially, margin slightly revolute, apex obtuse or slightly emarginate. Seed cones cylindric or ovoid-cylindric, (5–)8–21 × (3.5–)4–6 cm. Seed scales at middle of cones subcordate or rhombic-subcordate, 2.5–3.2 × 2.2–2.8 cm, glabrous or ± pubescent abaxially, distal margin entire or slightly denticulate, apex ± narrowed, often reflexed. Seeds oblong, 1–1.5 cm × 6–8 mm; wing light brown, semitrullate. Pollination Mar, seed maturity Oct–Nov.

• Hills, mountains, hot and dry valleys; 200–1500 m. SE Gansu, N Guangxi, Guizhou, W Hubei, SW Hunan, S Shaanxi, SE Sichuan, Taiwan, Yunnan.

The timber is used for construction, bridge building, furniture, and wood fiber.

1a. Leaf scars obviously protruding on branchlets, dark ..... 5c. var. *formosana*

1b. Leaf scars obscurely protruding on branchlets.

2a. First-year branchlets yellowish gray or light gray; apex of seed scales ± narrowed; winter buds ovoid ..... 5a. var. *davidiana*

2b. First-year branchlets yellow; apex of seed scales obtuse-rounded; winter buds globose ..... 5b. var. *calcarea*

5a. Keteleeria davidiana var. **davidiana**

铁坚杉(原变种) tie jian shan (yuan bian zhong)

Pseudotsuga davidiana Bertrand, Bull. Soc. Philom. Paris, sér. 6, 9: 38. 1872; *Abies sacra* Franchet; *Keteleeria chienpeii* Flous; *K. davidiana* var. *chienpeii* (Flous) W. C. Cheng & L. K. Fu; *K. davidiana* var. *sacra* (Franchet) Beissner & Fitschen; *K. esquirolii* H. Léveillé; *K. fortunei* (A. Murray bis) Carrière var. *xerophila* (Hsüeh & S. H. Hao) Silba; *K. sacra* (Franchet) Beissner; *K. xerophila* Hsüeh & S. H. Hao; *Podocarpus sutchuenensis* Franchet.

First-year branchlets yellowish gray or light gray. Winter buds ovoid. Leaf scars obscurely protruding on branchlets. Apex of seed scales ± narrowed.

• Hills, mountains, hot and dry valleys; 600–1500 m. SE Gansu, NE Guangxi, Guizhou, W Hubei, SW Hunan, S Shaanxi, SE Sichuan, Yunnan.

5b. Keteleeria davidiana var. **calcarea** (W. C. Cheng & L. K. Fu) Silba, Phytologia 68: 34. 1990.

黄枝油杉 huang zhi you shan

Keteleeria calcarea W. C. Cheng & L. K. Fu in W. C. Cheng & al., Acta Phytotax. Sin. 13(4): 82. 1975.

First-year branchlets yellow. Winter buds globose. Leaf scars obscurely protruding on branchlets. Apex of seed scales obtuse-rounded.

- Usually on calcareous mountains; 200–1100 m. N Guangxi, S Guizhou.

A vulnerable plant. The timber is used for construction and furniture. The plant is also cultivated for afforestation and as an ornamental.

5c. Keteleeria davidiana var. **formosana** (Hayata) Hayata, J. Coll. Sci. Imp. Univ. Tokyo 25(19): 221. 1908.

台湾油杉 tai wan you shan

Keteleeria formosana Hayata, Gard. Chron., ser. 3, 43: 194. 1908.

Leaf scars obviously protruding on branchlets, dark.

- Hills; 300–900 m. Taiwan.

9. ABIES Miller, Gard. Dict., Abr. ed. 4, 1: [11]. 1754.

冷杉属 leng shan shu

Fu Liguo (傅立国 Fu Li-kuo), Li Nan (李楠); Thomas S. Elias

Trees evergreen; branches regularly whorled; branchlets opposite (rarely whorled), with orbicular, depressed leaf scars and persistent bud scales at base; short branchlets absent; winter buds usually 3 at apex of branchlets, subglobose, ovoid, or conical, often resinous. Leaves spirally arranged, radially spreading, or pectinately arranged in lateral sets, linear, straight or curved, flattened, grooved adaxially, stomatal bands 2, abaxial, vascular bundle 1, resin canals 2(–10 outside China), marginal (in hypodermis) or median (in mesophyll), rarely submedian, base twisted. Pollen cones borne in leaf axils of previous year's branchlets, pendulous, narrowly ellipsoid or oblong when young, finally cylindric; pollen 2-saccate. Seed cones pedunculate or sessile, erect, ovoid-cylindric or shortly cylindric, maturing in 1st year. Seed scales closely overlapping, often reniform, trapeziform, or flabellate, woody, base narrowed, deciduous at maturity. Bracts oblong, obcordate, or obovate, with exserted or included, sometimes reflexed cusp. Seeds borne in a membranous cup, obliquely ovoid or cuneate-oblong; wing well developed, persistent, cuneate-dolabriform or oblong-cuneate. Cotyledons (3 or)4–8(–12). Germination epigeal. 2*n* = 24*.

About 50 species: Asia, Europe, North America; 22 species (14 endemic, one introduced) in China.

Abies pindrow (Royle ex D. Don) Royle, Ill. Bot. Himal. Mts. 1: t. 86. 1836, occurs in Afghanistan, N India, Kashmir, and Nepal, growing on alpine lithosols, either as pure stands or with *Cedrus deodara*, *Picea smithiana*, and *Tsuga dumosa*, and at elevations of 2000–3000(–3700) m. It should be searched for in similar habitat in SW Xinjiang and W Xizang. It is related to *A. chensiensis* and *A. holophylla*.

1a. Seed cones narrowly cylindric (length more than 2.5 × width), rachis conical, slender.
  2a. Bracts of seed cones exserted and reflexed; seed scales reniform ..... 6. *A. nephrolepis*
  2b. Bracts of seed cones included; seed scales cuneate-flabellate.
    3a. Leaves strongly ascending, densely covering branchlets; winter buds usually more than 3 mm 19. *A. kawakamii*
    3b. Leaves slightly ascending, those on lower side of branchlets laterally spreading, more remote and leaving branchlets visible; winter buds 2–3 mm ..... 9. *A. sibirica*
1b. Seed cones ovoid, conical, or broadly cylindric, rachis conical, conical-cylindric, or fusiform, stout.
  4a. Rachis of seed cones conical, not thick; seed scales thickest at or below middle; branchlets usually thin.
    5a. Seed cones oblong-conical; bracts strongly exserted; resin canals of leaves 2–4.
      6a. Bracts of seed cones slightly exserted, not reflexed, oblanceolate; winter buds large (to 10 × 5 mm); leaves light green ..... 8. *A. firma*
      6b. Bracts of seed cones exserted, reflexed at distal margin, spatulate; winter buds smaller; leaves dark green ..... 16. *A. beshanzuensis*
    5b. Seed cones ovoid-oblong to cylindric; bracts included or only cusps exserted near base of cones; resin canals of leaves 2.
      7a. Leaves 1.5–3(–3.5) cm; seed cones violet-blue, oblong-cylindric to ovoid-oblong, 2.5–3.5(–4) cm wide.
        8a. Leaves spreading pectinately or at least parted on upper side of branchlets, apex emarginate (obtuse on cone-bearing branchlets) ..... 22. *A. ernestii*
        8b. Leaves often reflexed on upper side of branchlets, apex acute or obtuse ..... 21. *A. recurvata*
      7b. Leaves 2–5(–9) cm; seed cones yellowish green to violet-blue, cylindric or ovoid-cylindric, 3.5–6 cm wide.
        9a. Leaf apex on vegetative branchlets entire ..... 10. *A. holophylla*
        9b. Leaf apex on vegetative branchlets emarginate or 2-cleft.

10a. Leaves 3–3.5 mm wide, 2–4.8 cm long, apex obtuse (rarely slightly emarginate); seed cones dark brown when mature; bracts spatulate, apex 9–10 mm wide ... 16. *A. beshanzuensis*

10b. Leaves 2.5–3 mm wide (or wider, but then more than 4.5 cm long), apex emarginate at least on vegetative branchlets; seed cones light brown when mature; bracts not spatulate.

11a. Leaves usually 2–4.5 cm; seed cones 10–14 cm ..... 2. *A. chensiensis*

11b. Leaves to 7.5 cm or more; seed cones 4–10(–14) cm ..... 22. *A. ernestii*

4b. Rachis of seed cones fusiform or conical-cylindric, thick; seed scales usually apically thickened; branchlets usually stout.

12a. Bark exfoliating in large, papery flakes ..... 1. *A. squamata*

12b. Bark not as above.

13a. Seed cones usually 10–17 × 4–7 cm; bracts included; leaves pectinately arranged, 2.5–6 cm × 2.2–3.5 mm, margin slightly recurved, apex emarginate or 2-cleft ..... 20. *A. spectabilis*

13b. Seed cones smaller, if larger than 10 × 5 cm then usually with bracts exserted; leaves more radially spreading, shorter or with margin strongly revolute.

14a. Leaf margin strongly revolute; stomatal bands white, partly hidden.

15a. Bracts of seed cones gradually terminating in a short cusp, not or only slightly exserted; young branchlets yellowish brown ..... 18. *A. densa*

15b. Bracts of seed cones abruptly terminating in an elongated, subulate cusp, usually (or at least the cusp) exserted; young branchlets red-brown.

16a. Seed scales 1.3–1.5 × 1.4–1.8 cm; bracts oblong-spatulate, apical cusp 3–5 mm ..... 11. *A. delavayi*

16b. Seed scales 1.7–2 × 1.8–2.2 cm; bracts cuneate-obovate, apical cusp ca. 2 mm ..... 17. *A. nukiangensis*

14b. Leaf margin of leaves not revolute or only very slightly recurved; stomatal bands entirely visible.

17a. Bracts of seed cones not exserted; leaf apex on vegetative branchlets 2-cleft 13. *A. forrestii*

17b. Bracts of seed cones (or at least the cusps) exserted; leaf apex on vegetative branchlets not 2-cleft.

18a. Seed cones green or yellowish green during growing season; bracts exserted, reflexed ..... 12. *A. yuanbaoshanensis*

18b. Seed cones purple or purplish blue during growing season; bracts not reflexed.

19a. Young branchlets yellowish brown, mostly glabrous ..... 15. *A. fabri*

19b. Young branchlets usually purplish brown, reddish brown, or dark orange-brown.

20a. Seed cones 5–9 × 3–4 cm; apex of bracts rounded or emarginate, terminating in an abrupt, small cusp.

21a. Leaves very densely arranged in overlapping, pectinate rows, 1–2.5(–4.3) cm; bracts of seed cones mostly included or slightly exserted with very short cusps ..... 3. *A. fanjingshanensis*

21b. Leaves less densely arranged, longer, especially on shaded branchlets; bracts of seed cones exserted with much longer cusps ..... 5. *A. fargesii*

20b. Seed cones larger, or if less than 9 × 4 cm then with differently shaped bracts.

22a. Seed cones 7–10(–14) × 4–5(–6) cm; young branchlets smooth, shining, glabrous ..... 13. *A. forrestii*

22b. Seed cones usually less than 8 cm, often broadly barrel-shaped or ovoid; young branchlets ± densely rusty brown pubescent.
23a. Resin canals of leaves marginal ..... 14. *A. georgei*
23b. Resin canals of leaves median.
24a. First-year branchlets dark red-brown or dark brown ..... 4. *A. ferreana*
24b. First-year branchlets light yellowish gray, yellowish brown, or grayish brown ..... 7. *A. chayuensis*

1. Abies squamata Masters, Gard. Chron., ser. 3, 39: 299. 1906.
鳞皮冷杉 lin pi leng shan
Trees to 40 m tall; trunk to 1 m d.b.h.; bark of trunk breaking into square, rough plates, inner bark red when fresh, bark of young trees and 4th-year branchlets exfoliating into irregularly papery scales (like that of *Betula*). Branchlets brown, turning brownish gray in 2nd or 3rd year, ± pubescent or glabrous; winter buds globose, resinous. Leaves densely arranged, ascending on upper side of branchlets, spreading in 2 lateral sets on lower side, dark green adaxially, linear, ± falcate, 1.5–3 cm × ca. 2 mm, stomatal lines in 2 white bands separated by midvein abaxially, 3–15 near apex adaxially (where incomplete), resin canals 2, median or almost marginal in young leaves, apex acute or obtuse. Seed cones subsessile, erect, black or violet-brown at maturity, shortly cylindric or narrowly ovoid, 5–8 × 2.5–3.5 cm. Seed scales at middle of cones almost reniform, ca. 1.3 × 1.5 cm, apex thickened. Bracts slightly exserted, obovate-cuneate, 1–1.4 cm, distal margin erose-denticulate, apex rounded or slightly emarginate, cusp recurved or straight. Seeds oblong-cuneate, ca. 5 mm; wing as long as seed.
• Mountains; 3000–4700 m. S Gansu, S Qinghai, W and N Sichuan, SE Xizang.
The timber is used for construction, furniture, and wood pulp.
2. Abies chensiensis Tieghem, Bull. Soc. Bot. France 38: 413. 1892.
秦岭冷杉 qin ling leng shan
Trees to 50 m tall; branchlets yellowish gray or brownish yellow, glabrous or puberulent; winter buds conical, resinous, Leaves ± pectinately arranged in 2 lateral sets, dark green adaxially, linear, flattened, 1.5–4.8 cm, stomatal lines in 2 white bands abaxially, resin canals 2, marginal or median on cone-bearing branchlets, apex 2-cleft acute or obtuse on cone-bearing branchlets. Seed cones subsessile, green, ripening brown, cylindric or ovoid-cylindric, 7–10 × 3–4 cm. Seed scales at middle of cones reniform, ca. 1.5 × 2.5 cm, exposed part densely pubescent abaxially. Bracts included, ligulate, ca. 3/4 as long as seed scales, distal margin erose-denticulate, apex with short cusp. Seeds obtriangular-ellipsoid, ca. 8 mm; wing cuneate, ca. 5 mm.
• Mountains; 2300–3000 m. S Gansu, SW Henan (Neixiang Xian), W Hubei, S Shaanxi, W Sichuan.
A vulnerable species. The timber is light in weight, soft, fine grained, and used for construction.
3. Abies fanjingshanensis W. L. Huang & al., Acta Phytotax. Sin. 22: 154. 1984.
梵净冷杉 fan jing leng shan
Abies fargesii Franchet var. *fanjingshanensis* (W. L. Huang & al.) Silba.
Trees to 20 m tall; trunk to 65 cm d.b.h.; bark dark gray; branchlets initially red-brown, darker in 2nd or 3rd year; winter buds ovoid. Leaves radially spreading or ascending on upper side of branchlets, pectinately arranged in 2 lateral sets on lower side, linear, unequal, 1–4.3 cm × 2–3 mm, stomatal lines in 2 bands abaxially, resin canals 2, marginal on vegetative branchlets, median on cone-bearing branchlets, apex obtuse. Seed cones shortly pedunculate, purple-brown, ripening dark brown, cylindric, 5–6 × ca. 4 cm. Seed scales at middle of cones reniform, ca. 1.5 × 1.8–2.2 cm, exposed part densely pubescent. Bracts spatulate, ca. 4/5 as long as seed scales, distal margin rounded or emarginate, apex with an acute, small cusp. Seeds slightly appressed, narrowly ovoid, ca. 8 mm; wing broadly cuneate, ca. 7 mm.
• 2100–2350 m. NE Guizhou (Jiangkou: Fanjing Shan).
An endangered species.
4. Abies ferreana Bordères & Gaussen, Trav. Lab. Forest. Toulouse T. 1(4, 15): 8. 1947.
中甸冷杉 zhong dian leng shan
Trees to 20 m tall; trunk to 1 m d.b.h.; bark gray-brown, or dark gray, fissured into longitudinal scales; branchlets reddish brown or dark brown in 1st year, densely rusty brown pubescent; winter buds globose, resinous. Leaves ascending on upper side of branchlets, pectinately arranged in 2 lateral sets on lower side, dark green and bright adaxially, oblanceolate-linear, flattened, 1–2.3 cm × 2–2.5 mm, stomatal lines in 2 white bands abaxially, resin canals 2, median, apex obtuse or emarginate. Seed cones dark purple or blue-black, oblong or cylindric-ovoid, ca. 7 × 3.5–4 cm. Seed scales flabellate-trapeziform, 1.6–2 × 1.6–2.2 cm, base stalked. Bracts oblong-cuneate-spatulate, apex acuminate or cuspidate, usually exserted and reflexed.

Seeds 7–10 mm; wing light violet-brown, cuneate, 7–8 mm.

• Mountains; 3300–4000 m. SW Sichuan, NW Yunnan.

The timber is used for construction and the bark yields tannin.

1a. Apex of bracts rounded, with an acute cusp, usually reflexed or recurved ..... 4a. var. *ferreana*
1b. Apex of bracts acuminate, obviously exserted, neither reflexed nor recurved 4b. var. *longibracteata*

4a. Abies ferreana var. **ferreana**
中甸冷杉(原变种) zhong dian leng shan (yuan bian zhong)
Abies forrestii Coltman-Rogers var. *ferreana* (Bordères & Gaussen) Farjon & Silba; *A. rolii* Bordères & Gaussen; *A. yuana* Bordères & Gaussen.

Apex of bracts rounded, with an acute cusp, usually reflexed or recurved.

• Mountains; 3300–3800 m. SW Sichuan, NW Yunnan.

4b. Abies ferreana var. **longibracteata** L. K. Fu & Nan Li, Novon 7: 261. 1997.
长苞中甸冷杉 chang bao zhong dian leng shan
Apex of bracts acuminate, obviously exserted, neither reflexed nor recurved.

• Mountains; ca. 4000 m. NW Yunnan (Zhongdian Xian).

5. Abies fargesii Franchet, J. Bot. (Morot) 13: 256. 1899.
巴山冷杉 ba shan leng shan
Trees to 40 m tall; bark dark gray or dark gray-brown, rough, flaking or breaking into irregular plates; branchlets red-brown, gray-brown, or light brown, glabrous, pubescent, or ± rusty brown pubescent; winter buds ovoid or subglobose, resinous. Leaves ascending on upper side of branchlets, pectinately arranged in 2 lateral sets on lower side, dark green and bright adaxially, oblanceolate-linear, flattened, 1–2.5(–3) cm × 1.5–4 mm, stomatal lines in 2 white bands abaxially, resin canals 2, median or marginal, apex emarginate, rarely obtuse or acute. Seed cones ripening dark purple or red-brown, slightly glaucous or not, cylindric or shortly so, 3–10 × 3–4 cm. Seed scales at middle of cones reniform or flabellate-reniform, 0.8–1.5 × 1.3–2 cm. Bracts obovate-cuneate, distal margin erose-denticulate, apex with cusp exserted or slightly so. Seeds obtriangular-ovoid; wing cuneate.

• Mountains, river basins; 1500–3900 m. S Gansu, W Henan, W Hubei, S Shaanxi, Sichuan.

The timber is used for construction, furniture, and wood pulp.

1a. First-year branchlets red-brown or slightly purple, glabrous or puberulent ..... 5a. var. *fargesii*
1b. First-year branchlets light brown or gray-brown, densely rusty brown pubescent on lateral branchlets, usually glabrous on main branchlets ..... 5b. var. *faxoniana*

5a. Abies fargesii var. **fargesii**
巴山冷杉(原变种) ba shan leng shan (yuan bian zhong)
Abies fargesii var. *hupehensis* Silba; *A. fargesii* var. *sutchuenensis* Franchet; *A. fargesii* var. *tieghemi* Bordères & Gaussen; *A. kansouensis* Bordères & Gaussen; *A. sutchuenensis* (Franchet) Rehder & E. H. Wilson.

First-year branchlets red-brown, sometimes slightly purple, glabrous or puberulent.

• Mountains; 1500–3700 m. S Gansu, W Henan, W Hubei, S Shaanxi, N Sichuan.

5b. Abies fargesii var. **faxoniana** (Rehder & E. H. Wilson) Tang S. Liu, Quart. J. Taiwan Mus. 24: 151. 1971.
岷江冷杉 min jiang leng shan
Abies faxoniana Rehder & E. H. Wilson in Sargent, Pl. Wilson. 2: 42. 1914; *Abies delavayi* Franchet var. *faxoniana* (Rehder & E. H. Wilson) A. B. Jackson; *A. fabri* (Masters) Craib subsp. *minensis* (Bordères & Gaussen) Rushforth; *A. fabri* var. *minensis* (Bordères & Gaussen) Silba; *A. minensis* Bordères & Gaussen.

First-year branchlets light brown or gray-brown, densely rusty brown pubescent on lateral branchlets, usually glabrous on main branchlets.

• Mountains, river basins; 2700–3900 m. S Gansu, Sichuan.

6. Abies nephrolepis (Trautvetter ex Maximowicz) Maximowicz, Bull. Acad. Imp. Sci. Saint-Pétersbourg 10: 486. 1866.
臭冷杉 chou leng shan
Abies sibirica Ledebour var. *nephrolepis* Trautvetter ex Maximowicz, Mém. Acad. Imp. Sci. Saint-Pétersbourg (Sav. Etr.) 9: 206. 1859.

Trees to 30 m tall; trunk to 1.2 m d.b.h.; bark gray, with longitudinal, oblong plates or scales; branchlets light brown, turning gray or gray-brown in 2nd or 3rd year, densely light pubescent; winter buds globose, resinous. Leaves pectinately arranged in 2 lateral sets, ascending on main and cone-bearing branchlets, light green adaxially, linear, flattened, (1–)1.5–2.5 (–3) cm × ca. 1.5 mm, stomatal lines in 2 white bands abaxially, resin canals 2, median, apex emarginate sometimes acute on main and cone-bearing branchlets. Seed cones sessile, purple-brown or dark purple at maturity, ovoid-cylindric or cylindric, 4.5–9.5 × 2–3 cm. Seed scales at middle of cones reniform or flabellate-reniform, rarely flabellate-trapeziform, 1–1.5 × 1.4–2.2 cm, exposed part densely pubescent, lateral margins orbicular or auriculate, erose-denticulate. Bracts included or slightly exserted, obovate, 3/5–4/5 as long as or rarely equaling seed scales, apex with cusp ca. 3 mm. Seeds slightly appressed, obovoid-triangular, 4–6 mm; wing brown, cuneate, usually slightly shorter than seeds. Cotyledons 4 or 5. Pollination Apr–May, seed maturity Sep–Oct.

Hills, mountains; 300–2100 m. Hebei, Heilongjiang, Jilin, Liaoning, Shaanxi [Korea, E Russia].

Abies "*sibirico-nephrolepis*" Takenouchi & J. J. Chien (Acta Phytotax. Sin. 6: 153. 1957) was described from Heilongjiang as a natural

hybrid between *A. nephrolepis* and *A. sibirica*. However, the name is a hybrid formula and not a true epithet (ICBN, Art. H.10.3).

The timber of *Abies nephrolepis* is used for construction, furniture, or wood pulp.

7. Abies chayuensis W. C. Cheng & L. K. Fu in W. C. Cheng & al., Acta Phytotax. Sin. 13(4): 83. 1975.

察隅冷杉 cha yu leng shan

Abies forrestii Coltman-Rogers var. *chayuensis* (W. C. Cheng & L. K. Fu) Silba.

Trees to 30 m tall; branchlets light yellowish gray, yellowish brown, or grayish brown in 1st year, pubescent. Leaves ascending on upper side of branchlets, pectinately arranged in 2 lateral sets on lower side, linear, flattened, 1.5–2.5 cm × ca. 3 mm, stomatal lines in 2 white bands abaxially, resin canals 2, median, margin slightly revolute, apex obtuse or emarginate. Seed cones erect, purple when young, cylindric. Bracts with denticulate distal margin, apex broadly rounded, caudate centrally, cusp ca. 5 mm.

- High mountains, S-facing slopes; ca. 3800 m. SE Xizang.

Some authors place this species within *Abies ferreana*.

8. Abies firma Siebold & Zuccarini, Fl. Jap. 2: 15. 1842.

日本冷杉 ri ben leng shan

Abies bifida Siebold & Zuccarini; *A. firma* var. *bifida* (Siebold & Zuccarini) Masters.

Trees to 50 m tall; trunk to 2 m d.b.h.; bark black, rough, scaly, fissured; crown pyramidal; branchlets grayish yellow, turning light gray or yellowish gray in 2nd or 3rd year, glabrous, or puberulent in groove; winter buds ovoid, slightly resinous. Leaves almost radially spreading or ascending on upper side of branchlets, pectinately arranged in 2 lateral sets on lower side, bright green adaxially, linear, 2–3.5(–5) cm × 3–4 mm, stomatal lines in 2 white bands abaxially, resin canals 2, median, sometimes also 2 marginal canals in leaves of cone-bearing branchlets, apex emarginate or obtuse. Seed cones green, maturing yellow- or gray-brown, cylindric, 12–15 cm. Seed scales flabellate-trapeziform, 1.2–2.2 × 1.7–2.8 cm. Bracts usually exserted, apex with abrupt, acute cusp. Seeds with cuneate-oblong wing. Pollination Apr–May, seed maturity Oct.

Cultivated. Jiangsu (Nanjing Shi), Jiangxi (Lu Shan), Liaoning, Shandong (Qingdao Shi), Taiwan [native to Japan].

9. Abies sibirica Ledebour, Fl. Altaic. 4: 202. 1833.

鲜卑冷杉 xian bei leng shan

Trees to 35 m tall; trunk to 1 m d.b.h.; bark gray brown, smooth; branchlets yellowish gray, shining; winter buds globose, resinous. Leaves ascending, rarely pectinately arranged in 2 lateral sets, light green adaxially, linear, flattened, (1.5–)2–3 (–4) cm × ca. 1.5 mm, stomatal lines in 2 white bands abaxially, resin canals 2, median, apex emarginate, acute or obtuse on cone-bearing branchlets. Seed cones brown or dark brown at maturity, cylindric, 5–9.5 × 2.5–3.5 cm. Seed scales at middle of cones obtriangular-flabellate or flabellate-trapeziform, usually slightly contracted at middle, 1.7–2.5 × 1.6–2.4 cm, exposed part densely pubescent abaxially, base pedicellate. Bracts cuneate-obovate, short, 1/3–1/2 as long as seed scales, distal margin erose-denticulate, apex slightly rounded. Seeds slightly appressed, obtriangular, ca. 7 mm; wing light blue distally, cuneate, 0.7–1.3 cm. Pollination May, seed maturity Oct–Nov.

Mountains, river basins; 1900–2400 m. NE Xinjiang [Kazakstan, Mongolia, N Russia].

Only var. *sibirica*, described here, occurs in China; var. *semenovii* (B. Fedtschenko) Farjon (*A. semenovii* B. Fedtschenko) occurs in Kyrgyzstan and differs as follows: branchlets prominently ridged and grooved; resin canals marginal; seed cones yellowish brown; bracts broader.

A vulnerable species in China. The timber is used for construction, furniture, and wood pulp.

10. Abies holophylla Maximowicz, Bull. Acad. Imp. Sci. Saint-Pétersbourg 10: 487. 1866.

杉松 shan song

Abies yoneyamae K. Satô.

Trees to 30 m tall; trunk to 1 m d.b.h.; bark gray or dark brown; branchlets yellowish gray or yellow-brown, turning gray or gray-brown, shining, glabrous; winter buds ovoid, resinous. Leaves pectinately arranged in 2 lateral sets, ascending on upper side of cone-bearing branchlets, dark green and shining adaxially, linear, flattened, 2–4 cm × 1.5–2.5 mm, stomatal lines in 2 white bands abaxially, resin canals 2, median, apex acuminate or acute. Seed cones subsessile, yellowish brown at maturity, cylindric, 6–14 × 3.5–4 cm. Seed scales almost flabellate-trapeziform or obtriangular-flabellate, distal part thickened and broadly rounded, exposed part densely pubescent abaxially. Bracts cuneate-obovate, short, less than 1/2 as long as seed scales, apex with an acute cusp. Seeds obtriangular, 8–9 mm; wing ca. 1.5 cm, cuneate-oblong. Cotyledons 5 or 6. Pollination Apr–May, seed maturity Oct.

Mountains; 500–1200 m. SE Heilongjiang, E and S Jilin, E Liaoning [Korea, E Russia].

11. Abies delavayi Franchet, J. Bot. (Morot) 13: 255. 1899.

苍山冷杉 cang shan leng shan

Trees to 25 m tall; trunk to 1 m d.b.h.; bark gray-brown, rough, longitudinally splitting; crown pyramidal; branchlets initially red-brown or brown, then darkened in 2nd or 3rd year, glabrous, rarely pubescent when young; winter buds globose, resinous. Leaves spirally arranged, radially spreading ± forward or pectinately arranged in 2 lateral sets, bright dark green, linear, often curved or “S”-shaped, flattened, 1.5–3 cm × 1.7–2.5 mm, stomatal lines in 2 white bands abaxially, resin canals 2, marginal, margin strongly revolute, apex emarginate. Seed cones shortly pedunculate, black at maturity, glaucous, cylindric or ovoid-cylindric, 6–11 × 3–4 cm. Seed scales flabellate-trapeziform, 1.3–1.5 × 1.4–1.8 cm. Bracts exserted, oblong-spatulate, apex with a narrow, usually recurved cusp 3–5 mm. Seeds

obovate; wing brown, cuneate-dolabriform. Pollination May, seed maturity Oct.

Mountains; 3000–4300 m. SE Xizang, NW Yunnan [N Myanmar].

The timber is used for construction, furniture, and wood pulp, and the bark yields tannin.

1a. Branchlets dark, glabrous, rarely pubescent on young branchlets; leaves densely arranged, usually 1.5–2 cm ..... 11a. var. *delavayi*
1b. Branchlets light, usually densely pubescent; leaves loosely arranged, usually 2–3 cm 11b. var. *motuoensis*

11a. Abies delavayi var. **delavayi**
苍山冷杉(原变种) cang shan leng shan (yuan bian zhong)

Branchlets dark, glabrous, rarely pubescent on young branchlets. Leaves densely arranged, usually 1.5–2 cm.
Mountains; 3300–4300 m. SE Xizang, NW Yunnan [N Myanmar].

11b. Abies delavayi var. **motuoensis** W. C. Cheng & L. K. Fu in W. C. Cheng & al., Acta Phytotax. Sin. 13(4): 83. 1975.
墨脱冷杉 mo tuo leng shan

Branchlets light, usually densely pubescent. Leaves loosely arranged, usually 2–3 cm.
• Mountains; 3000–3800 m. SE Xizang (Motuo Xian).

12. Abies yuanbaoshanensis Y. J. Lü & L. K. Fu in L. K. Fu & al., Acta Phytotax. Sin. 18: 206. 1980.
元宝山冷杉 yuan bao shan leng shan
Trees to 25 m tall; trunk to 60 cm d.b.h.; bark dark red-brown, irregularly fissured; branchlets initially yellow- or light brown, turning brownish black in 2nd or 3rd year, glabrous; winter buds brown-red, conical, very resinous. Leaves slightly or rarely radially spreading and shorter on upper side of branchlets, laterally spreading and longer on lower side, linear, 1–2.7 cm × 1.8–2.5 mm, stomatal lines in 2 white bands abaxially, resin canals 2, marginal, margin recurved when dry, apex emarginate. Seed cones green or yellow-green, ripening light brown-yellow, shortly cylindric, 8–9 × 4.5–5 cm. Seed scales at middle of cones flabellate-trapeziform, ca. 2 × 2.2 cm, exposed part densely pale pubescent, margin recurved, auriculate laterally at base, distal part thickened, apex rounded-truncate. Bracts obviously exserted and recurved, at least as long as seed scales, distal part widely rounded, apex with a small cusp. Seeds obtriangular-ellipsoid, vesicular, dark red-brown resinous, ca. 1 cm; wing cuneate, ca. 2 × longer than seed. Pollination May, seed maturity Oct.

• 1700–2100 m. N Guangxi (Rongshui Miaozu Zizhixian, Yuanbao Shan).

An endangered species.

13. Abies forrestii Coltman-Rogers, Gard. Chron., ser. 3, 65: 150. 1919.
川滇冷杉 chuan dian leng shan

Abies chengii Rushforth; *A. delavayi* Franchet var. *forrestii* (Coltman-Rogers) A. B. Jackson; *A. forrestii* var. *chengii* (Rushforth) Silba.

Trees to 20 m tall; bark dark gray, flaking; branchlets red-brown or brown, darkened or turning dark gray in 2nd or 3rd year, initially puberulent; winter buds globose or obovoid, resinous. Leaves ascending on upper side of branchlets, pectinately arranged in 2 lateral sets on lower side, bright green adaxially, linear, (1.5–)2–3(–4) cm × 2–2.5 mm, stomatal lines in 2 white bands abaxially, resin canals 2, marginal, apex emarginate, rarely acute or obtuse. Seed cones sessile, dark brown-purple or black-brown at maturity, cylindric or shortly so, 7–12 × 3.5–6 cm. Seed scales at middle of cones flabellate-trapeziform, 1.3–2 × 1.3–2.3 cm, margin auriculate laterally. Bracts cuneate-obovate, distal margin broadly rounded, apex with exserted, straight or recurved cusp 4–7 mm. Seeds ca. 1 cm; wing light brown or red-brown, broadly cuneate. Pollination May, seed maturity Oct–Nov.
• Mountains; 2500–4200 m. SW Sichuan, E Xizang, NW Yunnan.
The timber is used for construction, and tannin is extracted from the bark.

14. Abies georgei Orr, Notes Roy. Bot. Gard. Edinburgh 18: 1. 1933.
长苞冷杉 chang bao leng shan
Trees to 30 m tall; trunk to 1 m d.b.h.; bark dark gray, flaking; branchlets red- or dark brown, densely rusty brown pubescent; winter buds resinous. Leaves densely arranged, ascending on upper side of branchlets, pectinately arranged on lower side, bright green adaxially, obovate-linear, straight or curved, 1.5–2.5 cm × 2–2.5 mm, resin canals 2, marginal, margin slightly revolute, apex emarginate, rarely acute or obtuse. Seed cones sessile, black at maturity, ovoid-cylindric, 7–11 × 4–5.5 cm. Seed scales flabellate-trapeziform, 1.9–2.1 × 1.8–2.3 cm, margin auriculate laterally near base, broadly rounded, thickened, and incurved distally. Bracts obviously exserted, oblanceolate, 2.3–3 cm × 4–5 mm, apex acuminate or rounded and slightly emarginate, with a lanceolate or abrupt and short cusp. Seeds obliquely ellipsoid, 1–1.2 cm; wing brown, ca. 7 mm. Pollination apr, seed maturity Oct.

• Mountains; 2500–4200 m. SW Sichuan, SE Xizang, NW Yunnan.

A vulnerable species. The timber is used for construction, furniture, and wood pulp. The species is also cultivated for afforestation.

1a. Bracts obviously longer than seed scales, apex acuminate, with a lanceolate cusp 14a. var. *georgei*
1b. Bracts equaling or slightly longer than seed scales, apex rounded, slightly emarginate, with an abrupt, short, central cusp 14b. var. *smithii*

14a. Abies georgei var. **georgei**

长苞冷杉(原变种) chang bao leng shan (yuan bian zhong)

Abies delavayi Franchet var. *georgei* (Orr) Melville; *A. forrestii* Coltman-Rogers var. *georgei* (Orr) Farjon.

Bracts obviously longer than seed scales, apex acuminate, with a lanceolate cusp.

• Mountains; 3400–4200 m. SW Sichuan, SE Xizang, NW Yunnan.

14b. Abies georgei var. **smithii** (Viguié & Gaussen) W. C. Cheng & L. K. Fu in W. C. Cheng & al., Acta Phytotax. Sin. 13(4): 63. 1975.

急尖长苞冷杉 ji jian chang bao leng shan

Abies forrestii var. *smithii* Viguié & Gaussen, Trav. Lab. Forest. Toulouse T. 1(2, 1): 177. 1929; *A. delavayi* var. *smithii* (Viguié & Gaussen) Tang S. Liu.

Bracts equaling or slightly longer than seed scales, apex rounded, slightly emarginate, with an abrupt, short, central cusp.

• Mountains; 2500–4000 m. NW Yunnan.

15. Abies fabri (Masters) Craib, Notes Roy. Bot. Gard. Edinburgh 11: 278. 1919.

冷杉 leng shan

Keteleeria fabri Masters in F. B. Forbes & Hemsley, J. Linn. Soc., Bot. 26: 555. 1902; *Abies delavayi* Franchet var. *fabri* (Masters) D. R. Hunt.

Trees to 40 m tall; trunk to 1 m d.b.h.; bark gray or dark gray, flaking; branchlets initially light brown or grayish yellow, turning brownish gray in 2nd or 3rd year, puberulent or glabrous; winter buds globose or ovoid, resinous. Leaves ascending on upper side of branchlets, pectinately arranged in 2 lateral sets on lower side, bright green adaxially, linear, 1.5–3 cm × 2–2.5 mm, stomatal lines in 2 white bands abaxially, resin canals 2, marginal, margin revolute, apex emarginate or obtuse. Seed cones shortly stalked, slightly glaucous, ovoid-cylindric or shortly cylindric, 6–11 × 3–4.5 cm. Seed scales at middle of cones flabellate-trapeziform, 1.4–2 × 1.6–2.4 cm, margin auriculate laterally. Bracts cuneate-obovate, apex broadly rounded, shortly cuspidate, cusp slightly exserted, reflexed, acute. Seeds narrowly ellipsoid, 1.3–1.6 cm including black-brown, cuneate wing. Pollination May, seed maturity Oct.

• Mountains, river basins; 1500–4000 m. Sichuan.

The timber is used for construction, furniture, and wood pulp. The bark is used for producing resin, and the leaves for dry oil.

16. Abies beshanzuensis M. H. Wu, Acta Phytotax. Sin. 14(2): 16. 1976.

百山祖冷杉 bai shan zu leng shan

Trees to 30 m tall; trunk to 60 cm d.b.h.; bark pale gray, irregularly scaly; branchlets initially light yellow or brown-yellow, sometimes turning gray-black in 3rd or 4th year, glabrous or puberulent; winter buds ovoid to conical, resinous. Leaves spirally arranged, ascending on upper side of main branchlets, pectinately arranged in 2 lateral sets on lower side and on lateral branchlets, linear, unequal, (1–)1.5–3.5(–4.2) cm × 2.5–3.5 mm, stomatal lines in 2 white bands abaxially, resin canals 2, marginal, apex emarginate. Seed cones green or green-yellow, becoming brown-yellow, green-brown, or dark brown at maturity, ellipsoid-cylindric or cylindric, 7–12 × 3.5– 4.5 cm. Seed scales at middle of cones flabellate-trapeziform, rarely reniform-trapeziform, 1.8–2.5 × 2.5–3.3 cm, base auriculate, margin erose-denticulate laterally. Bracts constricted at middle, distal part spatulate, orbicular, or truncate, apex cuspidate, cusp exserted, reflexed, acute, small. Seeds obtriangular, 1.3–2.4 cm including broadly dolabriform wing. Pollination May, seed maturity Oct–Nov.

• Mountains, hills; 1400–1800 m. NE Guangxi, S Hunan, W Jiangxi, SW Zhejiang.

An endangered species.

1a. Seed cones brownish yellow or light brown, cylindric; seed scales at middle of cones 1.8–2.4 × 2.5–3 cm; seed 1.3–1.9 cm including wing; winter buds ovoid 16a. var. *beshanzuensis*

1b. Seed cones green-brown or dark brown, cylindric-ellipsoid; seed scales at middle of cones 2.3–2.5 × 3–3.3 cm; seed 2–2.4 cm including wing; winter buds conical 16b. var. *ziyuanensis*

16a. Abies beshanzuensis var. **beshanzuensis**

百山祖冷杉(原变种) bai shan zu leng shan (yuan bian zhong)

Abies fabri (Masters) Craib var. *beshanzuensis* (M. H. Wu) Silba.

Winter buds ovoid. Seed cones brownish yellow or light brown, cylindric; seed scales at middle of cones 1.8–2.4 × 2.5–3 cm. Seeds 1.3–1.9 cm including wing.

• About 1700 m. SW Zhejiang (Qingyuan: Baishanzu Shan).

16b. Abies beshanzuensis var. **ziyuanensis** (L. K. Fu & S. L. Mo) L. K. Fu & Nan Li, Novon 7: 261. 1997.

资源冷杉 zi yuan leng shan

Abies ziyuanensis L. K. Fu & S. L. Mo in L. K. Fu & al., Acta Phytotax. Sin. 18: 208. 1980; *A. dayuanensis* Q. X. Liu; *A. fabri* var. *ziyuanensis* (L. K. Fu & S. L. Mo) Silba.

Winter buds conical. Seed cones green-brown or dark brown, cylindric-ellipsoid; seed scales at middle of cones 2.3–2.5 × 3–3.3 cm. Seeds 2–2.4 cm including wing.

• Hills; 1400–1800 m. NE Guangxi (Ziyuan Xian), S Hunan (Chengbu Miaozu Zizhixian, Ling Xian, Xinning Xian), W Jiangxi (Jinggang Shan).

17. Abies nukiangensis W. C. Cheng & L. K. Fu in W. C. Cheng & al., Acta Phytotax. Sin. 13(4): 83. 1975.

怒江冷杉 nu jiang leng shan

Abies delavayi Franchet var. *nukiangensis* (W. C. Cheng & L. K. Fu) Farjon & Silba.

Trees to 20 m tall; trunk to 1 m d.b.h.; branchlets initially red-brown or brown, darkened in 2nd or 3rd year, densely pubescent, with projecting leaf scars; winter buds globose, slightly resinous. Leaves pectinately arranged in 2 lateral sets or ascending on upper side of branchlets, dark green adaxially, linear, (1.2–)1.8–3.2(–4.3) cm × 1.5–2.5 mm, stomatal lines in

2 white bands abaxially, resin canals 2, marginal, margin revolute, apex emarginate. Seed cones black at maturity, slightly glaucous, cylindric, 7–10 × 3.7–4.5 cm. Seed scales at middle of cones flabellate-trapeziform, 1.7–2 × 1.8–2.2 cm, margin auriculate at base. Bracts cuneate-obovate, apex rounded, with an acute cusp ca. 2 mm. Seeds obtriangular, 1.6–1.9 cm including shorter wing; wing dark brown or red-brown, base cuneate, apex truncate.

River basins; 2500–3100 m. Sichuan, NW Yunnan [NE India, N Myanmar, N Vietnam].

18. Abies densa Griffith, Not. Pl. Asiat. 4: 19. 1854.

锡金冷杉 xi jin leng shan

Abies spectabilis (D. Don) Spach var. *densa* (Griffith) Silba.

Trees to 60 m tall; bark scaly; branchlets initially grayish yellow or light brown, turning yellowish gray or grayish brown in 2nd or 3rd year, ± pubescent; winter buds resinous. Leaves radially spreading or ascending on upper side of branchlets, pectinately arranged in 2 lateral sets on lower side, linear, 2–4.5 cm × 2.5–3 mm, stomatal lines usually in 2 white bands abaxially, resin canals 2, marginal, abaxial, margin revolute, apex obtuse or emarginate. Seed cones subsessile, black-purple at maturity, 9–10 × 4–4.5 cm. Seed scales at middle of cones almost flabellate-trapeziform or reniform-trapeziform, thick, incurved, 1.5–1.9 × 1.8–2.2 cm. Bracts cuneate-obovate, 5/6 as long as to ± equaling seed scales, apex shortly cuspidate, cusp exserted, acute. Seeds with wing black-brown, cuneate-oblong, and truncate at apex.

Mountains; 2800–3700 m. S Xizang [Bhutan, NE India, Nepal, Sikkim].

19. Abies kawakamii (Hayata) T. Itô, Encycl. Japon. 2: 167. 1909.

台湾冷杉 tai wan leng shan

Abies mariesii Masters var. *kawakamii* Hayata, J. Coll. Sci. Imp. Univ. Tokyo 25(19): 223. 1908.

Trees to 35 m tall; trunk to 1 m d.b.h.; bark gray-brown, scaly; branchlets initially yellowish brown, turning brown or brown-gray in 2nd or 3rd year, densely pubescent; winter buds globose, resinous. Leaves radially spreading or pectinately arranged in 2 lateral sets, bright green adaxially, linear, 1–2.8 cm × 1.5–2 mm, stomatal lines in 2 white bands abaxially, few and almost to apex adaxially, resin canals 2, marginal, apex slightly emarginate or obtuse. Seed cones subsessile, dark purple, ovoid or oblong-ovoid. Seed scales at middle of cones flabellate-trapeziform or -reniform, 1.5–2 × 2–2.5 cm. Bracts included, 1/2–3/5 as long as seed scales. Seeds 7–9 mm; wing ca. as long as seed.

- Mountains; 2400–3800 m. Taiwan.

20. Abies spectabilis (D. Don) Spach, Hist. Nat. Vég. Phan. 11: 422. 1841.

藏冷杉 zang leng shan

Pinus spectabilis D. Don, Prodr. Fl. Nepal. 2: 55. 1825; *Abies webbiana* (Wallich ex D. Don) Lindley; *Pinus webbiana* Wallich ex D. Don.

Trees to 50 m tall; trunk to more than 1.5 m d.b.h.; bark rough, scaly; branchlets yellowish gray, brown, or reddish brown, furrowed, pubescent or glabrous, densely leafy; winter buds globose or ovoid, resinous. Leaves ascending on upper side of cone-bearing branchlets, pectinately arranged in 2 lateral sets on young and vegetative branchlets, bright green adaxially, linear, 2–6 cm × 2–2.5 mm, stomatal lines in 2 white bands abaxially, resin canals 2, marginal, apex emarginate or 2-cleft. Seed cones dark purple, maturing to dark brown or blue-brown with a little purple, cylindric, 8.5–20 × 4.5–7.5 cm. Seed scales at middle of cones flabellate-trapeziform, 2.3–2.8 × 2.8–3.4 cm, margin auriculate and thin laterally. Bracts included, spatulate, 1/3–1/2 as long as seed scales, apex with an acute, short cusp. Seeds ca. 1 cm; wing broadly cuneate, longer than seeds, apex truncate.

Mountains; 2600–3800 m. Xizang [Afghanistan, N India, Kashmir, Nepal].

21. Abies recurvata Masters, J. Linn. Soc., Bot. 37: 423. 1906.

紫果冷杉 zi guo leng shan

Trees to 40 m tall; bark dark gray or red-brown, rough, irregularly fissured, flaking; branchlets initially yellow or yellowish gray, yellowish gray or gray in 2nd or 3rd year. Leaves radially spreading, ± pectinately arranged, strongly ascending or recurved on upper side of branchlets, especially on cone-bearing branchlets, bright green adaxially, slightly glaucous abaxially, oblanceolate-linear, (1–)1.2–1.6(–2.5) cm × 2.5–3.5 mm, stomatal lines in 2 grayish green bands abaxially, usually 2–8 and incomplete adaxially, resin canals 2, marginal, apex acute or obtuse. Seed cones subsessile, purple, maturing brown-purple, ellipsoid-ovoid or cylindric-ovoid, 4–8 × 3–4 cm. Seed scales at middle of cones reniform, broadly flabellate- or rhombic-elliptic, 1.2–1.4 × 1.2–2.5 cm, margin sometimes auriculate at base, constricted at middle, thin, broadly rounded, and slightly incurved toward apex. Bracts oblong-spatulate, constricted at middle, 1/2–3/4 as long as seed scales, distal margin denticulate, apex broadly rounded, with an acute, short cusp. Seeds obliquely ovoid, ca. 8 mm; wing dark brown or black, 3–5 mm, cuneate-oblong, apex truncate.

- River basins, mountains; 2300–3600 m. S Gansu, N Sichuan.

The timber is hard and used for construction, furniture, and wood pulp.

22. Abies ernestii Rehder, J. Arnold Arbor. 20: 85. 1939.

黄果冷杉 huang guo leng shan

Trees to 60 m tall; trunk to 2 m d.b.h.; bark dark gray, longitudinally flaking; crown conical; branchlets yellow, brownish yellow, or yellow-gray, turning gray or gray-brown in 2nd or 3rd year, initially glabrous or puberulent. Leaves ascending on upper side of branchlets, pectinately arranged in 2 lateral sets on lower side, bright green adaxially, linear, falcate or straight, 1–7 cm × 2–2.5 mm, stomatal lines in 2 light green or pale bands abaxially, rarely present adaxially when 2–4, incomplete, and almost to apex, resin canals 2, marginal, apex emarginate or acute. Seed cones initially green, yellowish green, or brownish green, brown-yellow or brown at maturity, cylindric or ovoid-cylindric, 4–14 × 3–3.5 cm. Seed scales at middle of cones broadly obtriangular- or trapeziform-flabellate, 1.7–3 × 2.2–3.5 cm, exposed part densely pubescent, margin strongly auriculate at base, constricted at middle, thin and incurved toward apex. Bracts included, 1/3–1/2 as long as seed scales, ridged adaxially, apex cuspidate. Seeds obliquely triangular, 7–9 mm; wing brown or purple-brown, 0.8–1.8 cm, margin denticulate. Pollination Apr–May, seed maturity Oct.

• Mountains, mixed forests of *Quercus* and *Pinus;* 2500–3800 m. SW Gansu, W Hubei, N and W Sichuan, E Xizang, NW Yunnan.

The timber is used for construction and paper.

1a. Leaves densely arranged, ± recurved, thin, 1–3 cm; seed cones 4–10 cm ..... 22a. var. *ernestii*
1b. Leaves loosely arranged, straight, thicker, 4–7 cm; seed cones usually 10–14 cm 22b. var. *salouenensis*

22a. Abies ernestii var. **ernestii**

黄果冷杉(原变种) huang guo leng shan (yuan bian zhong)

Abies beissneriana Rehder & E. H. Wilson; *A. chensiensis* Tieghem var. *ernestii* (Rehder) Tang S. Liu; *A. recurvata* Masters var. *ernestii* (Rehder) C. T. Kuan.

Leaves densely arranged, ± recurved, thin, 1–3 cm. Seed cones 4–10 cm.

• Mountains; 2500–3800 m. SW Gansu, W Hubei, N and W Sichuan, E Xizang, ?NW Yunnan.

22b. Abies ernestii var. **salouenensis** (Bordères & Gaussen) W. C. Cheng & L. K. Fu, Fl. Reipubl. Popularis Sin. 7: 93. 1978.

大黄果冷杉 da huang guo leng shan

Abies salouenensis Bordères & Gaussen, Trav. Lab. Forest. Toulouse T. 1(4, 15): 4. 1947; *A. chensiensis* subsp. *salouenensis* (Bordères & Gaussen) Rushforth; *A. chensiensis* var. *salouenensis* (Bordères & Gaussen) Silba; *A. chensiensis* subsp. *yulongxueshanensis* Rushforth; *Abies chensiensis* var. *yulongxueshanensis* (Rushforth) Silba; *A. recurvata* var. *salouenensis* (Bordères & Gaussen) C. T. Kuan.

Leaves loosely arranged, straight, thicker, 4–7 cm. Seed cones brown-yellow or brown, usually 10–14 × ca. 5 cm.

• Mountains, mixed forests of *Quercus* and *Pinus;* 2600–3200 m. SE Xizang, NW Yunnan.

10. CEDRUS Trew, Cedr. Lib. Hist. 1: 6. 1757, nom. cons.

雪松属 xue song shu

Trees evergreen, monoecious; branchlets strongly dimorphic: long branchlets growing several cm each year and bearing very slow-growing, lateral short branchlets; winter buds small, scales persistent. Leaves spirally arranged and radially spreading on long branchlets, shorter and very densely clustered on short branchlets, needlelike, triangular or ± quadrangular in cross section, stiff, stomatal lines present both adaxially and abaxially, most numerous abaxially, vascular bundles 2, almost fused, resin canals 2, small, marginal. Cones borne on apex of short branchlets, solitary, erect. Pollen cones with many spirally arranged microsporophylls; microsporangia 2; pollen not saccate. Seed cones erect, light purple at fertilization, maturing in 2nd(or 3rd) year; ovulate scales spirally arranged, sessile, with small bracts and 2 ovules adaxially. Seed scales closely arranged, large, woody, those at base and apex of cone sterile, deciduous at maturity. Bracts minute, falling together with seed scales at maturity from persistent, central axis. Seeds with large, membranous wing. Cotyledons usually 6–10. Germination epigeal. 2*n* = 24.

Four species: NW Africa, SW Asia (including Cyprus), W Himalayan region; two species (one introduced) in China.

1a. Branchlets pendulous; leaves triangular in cross section, 2.5–5 cm; seed cones usually 7–12 × 5–9 cm 1. *C. deodara*
1b. Branchlets usually not pendulous; leaves ± quadrangular in cross section, 1.5–3.5 cm; seed cones ca. 7 × 4 cm ..... 2. *C. atlantica*

1. Cedrus deodara (Roxburgh) G. Don in Loudon, Hort. Brit. 1: 388. 1830.

雪松 xue song

Pinus deodara Roxburgh, Fl. Ind., ed. 1832, 3: 651. 1832; *Cedrus libani* A. Richard subsp. *deodara* (Roxburgh) P. D. Sell; *C. libani* var. *deodara* (Roxburgh) J. D. Hooker.

Trees to 60 m tall; trunk to 3 m d.b.h.; bark dark gray, cracking into irregular scales; branches horizontal, slightly tilted or slightly pendulous; long branchlets usually pendulous, pale grayish yellow and densely pubescent with some white powder in 1st year, thereafter grayish; winter bud scales curved outward at base. Leaves radially spreading on long branchlets, in apparent fascicles of 15–20 on short branchlets, initially

pale green, aging dark green, linear but broader distally, triangular in cross section, 2.5–5 cm × 1–1.5 mm, hard, stomatal lines 2 or 3 adaxially and 4–6 abaxially, apex acuminate. Seed cones shortly pedunculate, pale green, initially with some white powder, becoming reddish brown when ripe, ovoid or broadly ellipsoid, 7–12 × 5–9 cm. Seed scales flabellate-obtriangular, 2.5–4 × 4–6 cm, margin auriculate into a claw at base, cuneate in central part, incurved distally. Seeds ± triangular, ca. 1 cm; wing ca. 1.5 × 2 cm.

Native in extreme SW Xizang; extensively cultivated as an ornamental in Anhui, Fujian, Guangdong, Guangxi, Hebei, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Liaoning, Shaanxi, Shandong, Taiwan, Yunnan, Zhejiang [E Afghanistan, N India, Kashmir, W Nepal, NW Pakistan]. The timber is utilized in shipbuilding, furniture, bridges, and construction.

2. Cedrus atlantica (Endlicher) Manetti ex Carrière, Traité Gén. Conif. 285. 1855.

北非雪松 bei fei xue song

Pinus atlantica Endlicher, Syn. Conif. 137. 1847; *Cedrus libani* A. Richard subsp. *atlantica* (Endlicher) Battandier & Trabut; *C. libani* var. *atlantica* (Endlicher) J. D. Hooker.

Trees to 30 m tall; trunk to 1.5 m d.b.h.; crown pyramidal when young; branchlets horizontal or tilted upward distally; branchlets many 2-ranked, opposite or alternate, usually not pendulous, pale yellow-brown, pubescent in 1st year, thereafter dark gray; winter buds conical. Leaves on short branchlets in apparent fascicles of 19–28, dark green, linear, ± quadrangular in cross section, 15–35 cm × ca. 1 mm, stomatal lines 2–5 along both surfaces, apex acuminate. Seed cones tinged purple before fertilization, pale brown at maturity, ovoid-columnar to columnar, ca. 7 × 4 cm. Seed scales flabellate or obtriangular, ca. 3.5 mm wide. Seeds ± triangular, ca. 1.2 cm; wing cuneate, 1.3–1.5 cm.

Cultivated as an ornamental. Jiangsu (Nanjing Shi) [native to NW Africa (Algeria, Morocco)].

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