

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

云杉属 yun shan shu

Fu Ligu (傅立国 Fu Li-kuo), Li Nan (李楠); Thomas S. Elias<sup>1</sup>

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 cylindrical; pollen 2-saccate. Seed cones solitary, pendulous at maturity, ovoid-cylindric or cylindrical, 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.  $2n = 24^*$ .

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,  $\pm$  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*
- 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  $\pm$  incurved, rounded ..... 16. *P. farreri*
- 2b. Seed scales loosely arranged before maturity, thin, flexible,  $\pm$  leathery or papery.
- 5a. Leaves subflattened,  $\pm$  broadly rhombic in cross section; seed cones usually (4–)7–15  $\times$  2.5–5 cm ..... 11. *P. likiangensis*
- 5b. Leaves flattened; seed cones usually 2.5–6  $\times$  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  $\times$  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  $\times$  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*

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- 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-Petersbourg 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 cylindrical 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.

白托 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, furniture, 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.

大果青托 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.

青托 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. Pritzl, 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, purp-

lish 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 reddish 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, cylindrical-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-cylindrical 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. Pritzl, 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.



