

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

冷杉属 *leng shan shu*

Fu Ligu (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 cylindrical; 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. $2n = 24^*$.

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 cylindrical (length more than $2.5 \times$ 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 cylindrical, 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 $10 \times$ 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 cylindrical; 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, cylindrical 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. chayuenis*

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 sessile, erect, black or violet-brown at maturity, shortly cylindrical 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 exerted, 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 sessile, green, ripening brown, cylindrical or ovoid-cylindrical, 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), 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, cylindrical, 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 cylindrical-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 exerted 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 exerted, 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 exerted, 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, cylindrical 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 exerted 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 & Gausson; *A. kansouensis* Bordères &

Gausson; *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 &

Gausson) Rushforth; *A. fabri* var. *minensis* (Bordères &

Gausson) Silba; *A. minensis* Bordères & Gausson.

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-Petersbourg* 10: 486. 1866.

臭冷杉 *chou leng shan*

Abies sibirica Ledebour var. *nephrolepis* Trautvetter ex

Maximowicz, *Mém. Acad. Imp. Sci. Saint-Petersbourg*

(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-cylindrical or cylindrical, 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 exerted, 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 chayuenensis* 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, cylindrical. 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, cylindrical, 12–15 cm. Seed scales flabellate-trapeziform, 1.2–2.2 × 1.7–2.8 cm. Bracts usually exerted, 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, cylindrical, 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-Petersbourg 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 sessile, yellowish brown at maturity, cylindrical, 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, cylindrical or ovoid-cylindrical, 6–11 × 3–4 cm. Seed scales flabellate-trapeziform, 1.3–1.5 × 1.4–1.8 cm. Bracts exerted, 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 cylindrical, 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, cylindrical 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, \pm 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 \times 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 sessile, black-purple at maturity, 9–10 \times 4–4.5 cm. Seed scales at middle of cones almost flabellate-trapeziform or reniform-trapeziform, thick, incurved, 1.5–1.9 \times 1.8–2.2 cm. Bracts cuneate-obovate, 5/6 as long as to \pm equaling seed scales, apex shortly cuspidate, cusp exerted, 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 \times 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 sessile, dark purple, ovoid or oblong-ovoid. Seed scales at middle of cones flabellate-trapeziform or -reniform, 1.5–2 \times 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 \times 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, cylindrical, 8.5–20 \times 4.5–7.5 cm. Seed scales at middle of cones flabellate-trapeziform, 2.3–2.8 \times 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, \pm 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 \times 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 sessile, purple, maturing brown-purple, ellipsoid-ovoid or cylindrical-ovoid, 4–8 \times 3–4 cm. Seed scales at middle of cones reniform, broadly flabellate- or rhombic-elliptic, 1.2–1.4 \times 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 \times 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, cylindrical or ovoid-cylindrical, 4–14 \times 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.

