

Revision of two species of *Araucaria* (Araucariaceae) in Chinese taxonomic literature

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Abstract Based on the lectotypes of *Araucaria cunninghamii* and *A. heterophylla*, the status of those species as cited in Chinese taxonomic literature, such as *Flora of Guangzhou*, *Dendrology of China*, *Iconographia Cormo-phytorum Sinicorum*, *Flora Reipublicae Popularis Sinicae*, *Sylva Sinica*, *Flora of China* and *Higher Plants of China*, was reviewed. *Araucaria heterophylla* has linear, acute juvenile leaves held at an angle of less than 45° to the branchlet and without an obvious adaxial keel and scale-like adult leaves on terminal branchlets; *A. cunninghamii* has bilaterally compressed, subulate, shortly pungent juvenile leaves held at an angle of 45°–90° and with an obvious keel on both surfaces and tetragonous, subulate adult leaves on terminal branchlets. The names *A. cunninghamii* and *A. heterophylla* have been misapplied in Chinese taxonomic literature and should be *A. heterophylla* (Salisb.) Franco and *A. cunninghamii* Aiton ex A. Cunn. respectively.

Key words *Araucaria cunninghamii* Aiton ex A. Cunn., *Araucaria heterophylla* (Salisb.) Franco, taxonomic revision.

The genus *Araucaria* Juss. includes plants of great economic and ornamental value. For example, *A. cunninghamii* is one of the five major ornamental trees for warm temperate parks and *A. heterophylla* is well known worldwide as a pot or tub plant (Bailey, 1914; Den Ouden & Boom, 1965; Boutelje, 1980; Everett, 1981; Ying, 1985^①). The phylogeny of three genera of Araucariaceae, *Araucaria*, *Agathis* and *Wollemia*, was presented by Gilmore and Hill (1997), and by NPWS (1998).

The use of the name *Araucaria cunninghamii* (Hoop pine) in different articles and books has been inconsistent (Backer & van den Brink, 1963; Ying, 1985^①; Huxley, 1992; GRIN, 1994; Hill, 1998; Farjon, 1998, 2001; IPNI, 2004). In Chinese taxonomic literature (How, 1956; Cheng, 1961; Cheng & Fu, 1964; Institute of Botany, Chinese Academy of Sciences, 1972; Institute of Botany, Jiangsu Province, 1977; Cheng & Fu, 1978; Cheng et al., 1982; Fu et al., 1999; Fu, 2000), the names *A. cunninghamii* and *A. heterophylla* have been confused, because two specimens, *Y. Jiang* (*Y. Tsiang*) 16605 and *S. Q. Chen* (*S. H. Chun*) 7347, had been wrongly identified as *A. cunninghamii* and then cited in the *Flora of Guangzhou* in 1956. It should be noted that no species of Araucariaceae are native to China; all trees of the family are introduced and often of unknown (wild)

provenance.

1 Material and methods

Herbarium material of *Araucaria cunninghamii* and *A. heterophylla* was examined in the following herbaria: AU, FJSI, HITBC, IBSC, KUN, PE. Field surveys were conducted in all areas where *Araucaria* is grown in China. The lectotypes of *Araucaria cunninghamii* (Fig. 1) and *A. heterophylla* (Fig. 2) were used for comparison. Leaves of representative samples (Table 1) were embedded in paraffin and sectioned. The ratio of the width to the thickness of juvenile leaves of *Araucaria cunninghamii* and *A. heterophylla* was compared.

2 Results and discussion

Araucaria cunninghamii Aiton ex A. Cunn. in Lamb., Descr. *Pinus*. 3rd ed. 2: unnumbered pages. 1832. Type: East Coast New Holland 1818–1829, *A. cunningham* s.n. (Lectotype=specimen on far left of sheet, K!).

Araucaria heterophylla auct. non (Salisb.) Franco. W. C. Cheng, Dend. China 228. 1961; Institute of Botany, Jiangsu Province, Fl. Jiangsu. 85. 1977; W. C. Cheng & L. K. Fu in Fl. Reip. Pop. Sin. 7: 28. 1978; W. C. Cheng et al. in Sylva Sin. 1: 160. 1982; L. K. Fu et al. in Fl. China 4: 10. 1999; L. K. Fu in Higher Plants of China 3: 13. 2000.

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① Ying S-S. 1985. Coloured illustrated flora of Taiwan with the introduced plants. Published by Author.



Figs. 1–4. 1. The lectotype of *Araucaria cunninghamii* (*A. cunningham* s.n., K) (only seed cone and the branchlet attaching seed cone in the left of picture). A, keeled on the abaxial of leaves; B, seed cone ovoid. Photo: A. Farjon. 2. The lectotype of *A. heterophylla* (*P. G. King* s.n., G). A, linear and falcate leaves; B, acute apex being never pungent. Photo: A. Farjon. 3. Two forms of subulate leaves of *A. cunninghamii* (*S. H. Chun* 8280, IBSC). A, bilaterally compressed leaves held at right angle to branchlet; B, axially depressed leaves encircling branchlet. Photo: H. S. Liu. 4. Specimen of *A. heterophylla* (*S. H. Chun* 7347, IBSC) misidentified as *A. cunninghamii* in *Flora of Guangzhou*. A, scale-like leaves without keel on the abaxial surface; B, subglobose seed cone. Photo: H. S. Liu.

Juvenile leaves on terminal branchlets of *Araucaria cunninghamii* are subulate, shortly pungent and held at an angle to the stem of 45°–90° (Fig. 3). The ratio of thickness to width of juvenile leaves is usually more than 1.7–3.1 to 1. Transverse paraffin sections show the leaves to be elliptical in outline. Adult leaves on the terminal branchlets of *A. cunninghamii* are tetragonous and subulate (Figs. 1, 3). Both juvenile and adult leaves have an obvious keel on both surfaces (Fig. 3). Table 2 gives a morphological comparison of *A. cunninghamii* and *A. heterophylla*.

Araucaria cunninghamii is endemic to Australia and New Guinea. The oldest tree of *Araucaria* in China, *A. cunninghamii* (misidentified as *A. heterophylla* in *The Marvellous Spectacle of Trees of China* (State Forestry Administration, P. R. China, 2003)), was introduced in 1864 and is now 35 m tall and 123 cm in diameter.

Araucaria heterophylla (Salisb.) Franco in An. Inst. Super. Agron. 19: 11. 1952. Type: Australia, Norfolk Island, *P. G. King s.n.* (lectotype, G!).—*Eutassa heterophylla* Salisb. in Trans. Linn. Soc. London 8: 316. 1807.

Araucaria cunninghamii auct. non Aiton ex A. Cunn. F. C. How. Fl. Guangzhou. 68. 1956; W. C. Cheng, Dend. China. 227. 1961; W. C. Cheng & L. K. Fu in Fl. Hainan. 1: 214. 1964; Institute of Botany, CAS, Icon. Cormophyt. Sin. 1: 316. 1972; W. C. Cheng & L. K. Fu in Fl. Reip. Pop. Sin. 7: 28. 1978; W. C. Cheng et al. in Sylva Sin. 1: 160. 1982; L. K. Fu et al. in Fl. China 4: 9. 1999; L. K. Fu in Higher

Plants of China 3: 13. 2000.

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The juvenile leaves on the terminal branchlets of *Araucaria heterophylla* are falcate and linear. The ratio of the thickness to width of the juvenile leaves is 1:1 or less. Transverse paraffin sections show the lower portion of juvenile leaves to be quadrangular and the upper portion to be obdeltoid. Both juvenile and adult leaves have no obvious adaxial keel. The adult leaves on the terminal branchlets of *A. heterophylla* are scale-like. Bailey (1933) for *Araucaria* cultivated in North America and Hill (1998) for species of *Araucaria* of Australia, did not mention the growth angle of the leaves on terminal branchlets. The adult leaves, except on terminal branchlets, of *A. heterophylla* are not obviously scale-like (Fig. 4). The apices of the bracts of *A. heterophylla* are upcurved or reflexed (Fig. 4).

The bark of *A. cunninghamii* and *A. heterophylla* is shown in Fig. 5 and Fig. 6.

Araucaria heterophylla is endemic to Norfolk Island and it is the most famous plant of the island (Green, 1994).

The specimen, *J. J. Hong 235*, was identified incorrectly as *A. cunninghamii* in *Flora Reipublicae Popularis Sinicae*, and specimens *Y. Tsiang 16605* and *S. H. Chun 7347* were identified wrongly as *A. cunninghamii*.

As ornamental plants, *A. heterophylla* and *Cycas revoluta* are common in southern China.

Table 1 Origin of materials

Taxon	Locality	Voucher
<i>Araucaria cunninghamii</i> Aiton ex A. Cunn.	Xiamen, Fujian, China (福建厦门)	H. S. Liu (刘海桑) 2008101 (AU)
<i>A. heterophylla</i> (Salisb.) Franco	Xiamen, Fujian, China (福建厦门)	H. S. Liu (刘海桑) 2008102 (AU)

Table 2 Comparison of *Araucaria cunninghamii* and *A. heterophylla*

Character	<i>Araucaria cunninghamii</i> (Hoop Pine)	<i>Araucaria heterophylla</i> (Norfolk Island Pine)
Crown of mature tree	Wide conical.	Narrow conical, esp. pagoda-shaped because of branches on stem in regular wheels.
Bark	Peeling in layers; exposing smooth inner bark after outer bark is exfoliated.	Peeling in flakes; exposing rough inner bark after outer bark is exfoliated.
Juvenile leaves on terminal branchlets	8–16 mm long, 1–2 mm wide. Subulate, straight or slightly curved; short pungent; keeled on both adaxial and abaxial surfaces, bilaterally compressed. Arranged loosely, at an angle of 45°–90° from their branchlet.	6–12.5 mm long, 1 mm wide. Linear, falcate; acute, not pungent; slightly or not keeled on adaxial surface, never bilaterally compressed. Arranged close, at an angle less than 45° from their branchlet.
Adult leaves on terminal branchlets	6–10 mm long, 2–3 mm wide. Subulate, acuminate, obviously keeled on abaxial surface.	4–8 mm long, 3–6 mm wide. Scale-like, horny apex, without obvious keel on abaxial surface.
Pollen cone	2–4 cm long, 0.5–0.7 cm in diameter.	4–9 cm long, 0.8–2 cm in diameter.
Seed cone	6–10 cm long, 5–7 cm in diameter.	7.5–12 cm long, 6–10 cm in diameter.
Seed size and 1000 seed weight	1.5–2 cm long, 0.7–1 cm wide; 150–300 g.	2.5–3 cm long, 1.2–1.5 cm wide; 1750–2500 g.



Figs. 5, 6. 5. Bark of *Araucaria cunninghamii* (FJISB). A, slightly rough, peeling in layers; B, bright, smooth inner bark after exfoliation of outer bark. Photo: H. S. Liu. 6. Bark of *A. heterophylla* (FJISB). A, rough, peeling in flakes. B, dull, rough inner bark after exfoliation of outer bark. Photo: H. S. Liu.

Key to *Araucaria cunninghamii* and *A. heterophylla*

- 1a. Juvenile leaves bilaterally compressed, subulate, shortly pungent, diverging from branchlet at 45°–90°, transverse sections elliptic, thickness to width ratio greater than 1.7 : 1; adult leaves on terminal branchlets tetragonous, subulate ... **A. cunninghamii**
- 1b. Juvenile leaves linear, acute, diverging from branchlet at less than 45°, transverse sections quadrangular to obdeltoid, thickness to width ratio not more than 1 : 1; adult leaves on terminal branchlets scale-like **A. heterophylla**

3 Conclusions

The names *Araucaria cunninghamii* and *A. heterophylla* have been misapplied in China. Thus *A. cunninghamii* and *A. heterophylla*, as cited in Chinese literature, are *A. heterophylla* (Salisb.) Franco and *A. cunninghamii* Aiton ex A. Cunn. respectively.

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中国分类学文献中南洋杉属两种之订正

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摘要 通过调查,对*Araucaria cunninghamii*和*A. heterophylla*的选模式和中国分类学文献(如《广州植物志》、《中国树木学》、《中国高等植物图鉴》、《中国植物志》、《中国树木志》、《Flora of China》、《中国高等植物》)的*A. cunninghamii*和*A. heterophylla*(或*A. excelsa*)作比较,证实中国分类学文献中的*A. cunninghamii*和*A. heterophylla*(或*A. excelsa*)分别是*A. heterophylla*(Salisb.) Franco和*A. cunninghamii* Aiton ex A. Cunn.。这两种植物的叶形变化较大,但有明显的区别:诺福克南洋杉*A. heterophylla*幼树的末级小枝的叶细长呈线形、叶尖急尖,生长角小于45°,腹面无明显的脊,成龄株的末级小枝的叶扁平呈鳞片状;南洋杉*A. cunninghamii*幼树的末级小枝的叶呈两侧扁的钻形、叶尖短刺状,生长角45°–90°,腹背两面具明显的脊,成龄株的末级小枝的叶呈四棱状钻形。

关键词 南洋杉; 诺福克南洋杉; 分类修订