



## A new classification and linear sequence of extant gymnosperms

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### Abstract

A new classification and linear sequence of the gymnosperms based on previous molecular and morphological phylogenetic and other studies is presented. Currently accepted genera are listed for each family and arranged according to their (probable) phylogenetic position. A full synonymy is provided, and types are listed for accepted genera. An index to genera assists in easy access to synonymy and family placement of genera.

### Introduction

Gymnosperms are seed plants with an ovule that is not enclosed in a carpel, as is the case in angiosperms. The ovule instead forms on a leaf-like structure (perhaps homologous to a leaf), or on a scale or megasporophyll (homologous to a shoot) or on the apex of a (dwarf) shoot. Megasporophylls are frequently aggregated into compound structures that are often cone-shaped, hence the colloquial name for some of the group: conifers. Homologies of the ovuliferous structures as yet are not entirely resolved. Seeds of gymnosperms may be enclosed at maturity by fused cone scales or bracts, which are sometimes fleshy causing the fruiting structures (cones) to be confused with berries (e.g. juniper “berries”). In spite of their often slow rates of growth and long periods between pollination and seed maturity, gymnosperms can be dominant in some areas. Some extant cycads and gnetophytes are entirely or primarily insect pollinated, whereas *Ginkgo* and all conifers are wind pollinated. Only a few species are known to be polyploid, and no species are reported to be allopolyploid. Extant gymnosperms are not numerous. There are about 1026 species in all: the three ‘non-conifer’ groups comprise ca 310 species of cycads in 10 genera, one extant ginkgophyte and 80–100 gnetophytes in three genera; according to Farjon (2010) there are a total of ca 615 species of conifers in 70 accepted genera.

Hori *et al.* (1985) were the first to find that extant gymnosperms were sister to the angiosperms, but they included only three genera, *Cycas*, *Ginkgo* and *Metasequoia*, so this was not considered a particularly good evaluation of the topic. Troitsky *et al.* (1991) used ribosomal RNA and also found extant gymnosperms to be monophyletic, but they too sampled taxa thinly; although a total of 11 genera were used (three cycads, two gnetophytes, *Ginkgo* and five conifers), and only up to six genera from the whole set were included in each analysis. Likewise, Hasebe *et al.* (1992) used plastid *rbcL* sequences on a small set of taxa and similarly found extant gymnosperms to be monophyletic. The first broadly sampled molecular phylogenetic study to examine gymnosperm relationships was that of Chaw *et al.* (1997), and like the other studies they found extant gymnosperms to be sister to the angiosperms. Chase *et al.* (1993) assumed that the sister group relationship of

gymnosperms and angiosperms in these earlier studies was spurious and perhaps due to insufficient taxon-sampling and/or long-branch attraction, so they assigned the cycads the position of sister to the rest. However, molecular studies have continued to demonstrate monophyly for both groups of extant seed plants (Ran *et al.* 2010).

Although the extant taxa are clearly monophyletic, their relationships to the numerous and diverse groups of fossil gymnosperms remain obscure and incompletely understood. We have not provided a formal name for the clade composed of the extant taxa; we may never know their relationships to all groups of fossil gymnosperms, which makes it difficult to know how to classify all groups of gymnosperms, living and extinct, so we have avoided this problem by simply naming only the four extant subclasses. Thus, we recognise each of the four extant groups as subclasses of class Equisetopsida (as in Chase & Reveal 2009). This view differs from those favoured by other workers who have separated cycads, *Ginkgo*, gnetophytes and conifers as a whole, or even individual groups within conifers such as pines, Araucariaceae + Cupressaceae, Taxaceae and Podocarpaceae, individual classes, namely Cycadopsida Brongn., Ginkgoopsida Engl., Gnetopsida Eichler ex Kirpotenko, Pinopsida Burnett (Coniferopsida), Araucariopsida A.V. Bobrov & Melikian, Taxopsida Lotsy and Podocarpaceae Doweld & Reveal (cf. Sporne 1965, Bierhorst 1971, Doweld & Reveal 1999, Melikian & Bobrov 2000, Bobrov & Melikian 2006).

Traditionally the cycads, *Ginkgo*, and Araucariaceae have been considered 'primitive' in the sense that they each have a long fossil history extending back to the Permian (cycads) or Jurassic, and extant members of these three groups resemble the fossils (e.g. Passalia *et al.* 2010, Sun *et al.* 2008, Kunzmann 2007), although in each case the extant taxonomic diversity is less than in the past. Gnetidae were often considered as the sister group of angiosperms (Chase *et al.* 1993), and *Gnetum* L. indeed resembles an angiosperm in general habit. For this reason, Araucariaceae were often placed at the beginning of gymnosperms, whereas Gnetidae were placed at the end. Of course, retention of plesiomorphic characters is not necessarily reflected in molecular phylogenetic trees. Early branching groups may have evolved many apomorphic characters, whereas later branching groups may have retained plesiomorphic characters. This is especially the case in ancient groups where many lineages have become extinct, such as lycophytes, ferns, gymnosperms and magnoliids.

The exact position of Gnetidae with respect to the other subclasses of extant gymnosperms has been problematic and controversial, particularly in light of studies that indicated them to be embedded in the conifer clade as sister to Pinaceae (the so-called gnepine hypothesis: Qiu *et al.* 1999). Burleigh & Mathews (2004) conducted a long series of experiments that looked at phylogenetic signals in nucleotide positions that varied at different rates in genes from all three genomic compartments, and they found no consistency of position for Gnetidae. Other studies have found Gnetidae as sister to all other extant seed plants (Rydin *et al.* 2002), but this does not fit the fossil record in a stratigraphic sense. Morphologically, a close relationship between Gnetidae and either Pinaceae (gnepine hypothesis) or all conifers (gnetifer hypothesis) seems unlikely, but there have been suggestions in the literature that presaged this molecular result (Bailey 1944, Eames 1952). The basic conclusion of Burleigh & Mathews was that it is difficult to use molecular data to evaluate this question, but the most consistent and perhaps reasonable result supports the gnepine hypothesis. Recently, Braukmann *et al.* (2010) found a large number of structural alterations of the plastid genome that are shared by all conifers and Gnetidae, and in particular Gnetidae and Pinaceae uniquely share the loss of all *ndh* genes in their plastid genomes, which also supports the gnepine relationship. If this relationship continues to gain support, then we would advocate naming of the non-Pinaceae conifers as a new subclass rather than including Gnetidae in Pinidae.

Linear representations of phylogenetic classifications are particularly useful as tools to arrange plant material systematically in herbaria. A linear classification of the angiosperms, primarily for that purpose, was devised according to APG II by Haston *et al.* (2007), and this was updated according to APG III by Haston *et al.* (2009). We here present an analogous linear classification of the extant gymnosperms. Presentation differs from the two papers of Haston *et al.* (2007, 2009) in that our classification includes genera as well as families, and it includes all known synonyms at the ranks of subclass, order, family and genus. For this linear classification we have followed recent phylogenetic results published by Chaw *et al.* (1997, 2000), Ran *et al.*

(2010), and other authors as cited under individual entries. Furthermore, we have placed genera that were not sampled where we think they probably belong. For each name we have indicated its nomenclatural type by "T." followed by the type the taxon name. An alphabetical index to genera is given in Appendix 1.

## Linear sequence of extant gymnosperms and bibliography

**SUBCLASS I. CYCADIDAE** Pax in K.A.E. Prantl, *Lehrb. Bot.* ed. 9: 203 (1894).—T.: Cycadaceae.  
*Zamiidae* Doweld, *Tent. Syst. Pl. Vasc.*: xv (2001).—T.: Zamiaceae.

**ORDER A. CYCADALES** Pers. ex Bercht. & J. Presl, *Přir. Rostlin*: 262 (1820).—T.: Cycadaceae.  
*Zamiales* Burnett, *Outl. Bot.*: 490 (1835).—T.: Zamiaceae.  
*Stangeriales* Doweld, *Tent. Syst. Pl. Vasc.*: xv (2001).—T.: Stangeriaceae.

**Family 1. Cycadaceae** Pers., *Syn. Pl.* 2: 630 (1807), *nom. cons.*—T.: *Cycas* L.  
1 genus, ca 107 species, East Africa to Japan and Australia.

**1.1. *Cycas*** L., *Sp. Pl.* 2: 1188 (1753).—T.: *C. circinalis* L.

*Todda-Pana* Adans., *Fam.* 2: 25. (1763), *nom. illeg.* by typification.—T.: *Cycas circinalis* L.

*Dyerocycas* Nakai, *Chosakuronbun Mokuroku [Ord. Fam. Trib. Nov.]* 208 (1943).—T.: *D. micholitzii* (Dyer) Nakai (≡ *Cycas micholitzii* Dyer).

*Epicycas* de Laub. in D.J. de Laubenfels & F.A.C.B. Adema, *Blumea* 43: 388 (1998), *nom. illeg.*—T.: *E. micholitzii* (Dyer) de Laub. (≡ *Cycas micholitzii* Dyer).

**Family 2. Zamiaceae** Horan., *Prim. Lin. Syst. Nat.*: 45 (1834).—T.: *Zamia* L.

9 genera, ca 206 species, tropical and subtropical Africa, Australia and America. The phylogenetic tree followed here is that of Zgurski *et al.* (2008).

*Encephalartaceae* Schimp. & Schenk in K.A. Zittel, *Handb. Palaeontol., Palaeophyt.* 2: 215 (1880).—T.: *Encephalartos* Lehm.

*Stangeriaceae* Schimp. & Schenk in K.A. Zittel, *Handb. Palaeontol., Palaeophyt.*: 216 (1880).—T.: *Stangeria* T. Moore

*Boweniaceae* D.W. Stev., *Amer. J. Bot.* 68: 1114 (1981).—T.: *Bowenia* Hook. f.

*Dioaceae* Doweld, *Tent. Syst. Pl. Vasc.*: xv. (2001).—T.: *Dioon* Lindl.

*Microcycadaceae* Tarbaeva, *Anat.-Morf. Str. Sem. Cycad.*: 19 (1991).—T.: *Microcycas* (Miq.) A. DC.

**2.1. *Dioon*** Lindl., *Edwards's Bot. Reg.* 29 (Misc.): 59 (1843), as '*Dion*', *nom. et orth. cons.*—T.: *D. edule* Lindl.

*Platyzamia* Zucc., *Abh. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss.* 4(2): 23 (1845).—T.: *P. rigida* Zucc.

**2.2. *Bowenia*** Hook. f., *Bot. Mag.* 89: ad t. 5398 (1863).—T.: *B. spectabilis* Hook. f.

**2.3. *Macrozamia*** Miq., *Monogr. Cycad.* 35 (1842).—T.: *M. spiralis* (Salisb.) Miq. (≡ *Zamia spiralis* Salisb.)

**2.4. *Lepidozamia*** Regel, *Bull. Soc. Imp. Naturalistes Moscou* 30: 182 (1857).—T.: *L. peroffskyana* Regel.

*Catakidozamia* W. Hill, *Gard. Chron.* 1865: 1107 (1865).—T.: *C. hopei* W. Hill

**2.5. *Encephalartos*** Lehm., *Nov. Stirp Pug.* 6: 3 (1834).—T.: *E. caffer* (Thunb.) Lehm. (≡ *Cycas caffra* Thunb.)

**2.6. *Stangeria*** T. Moore, *Hooker's J. Bot. Kew Gard. Misc.* 5: 228 (1853).—T.: *S. paradoxa* T. Moore

**2.7. *Ceratozamia*** Brongn., *Ann. Sci. Nat. Bot.*, ser. 3, 5: 7 (1846).—T.: *C. mexicana* Brongn.

**2.8. *Microcycas*** (Miq.) A. DC., *Prodr.* 16: 538 (1868).—T.: *M. calocoma* (Miq.) A. DC. (≡ *Zamia calocoma* Miq.)

**2.9. *Zamia*** L., *Sp. Pl.*, ed. 2, 2: 1659 (1763), *nom. cons.*—T.: *Z. pumila* L.

*Palma-Filix* Adans., *Fam.* 2: 21, 587 (1763), *nom. rej.*

*Aulacophyllum* Regel, *Gartenflora* 25: 140 (1876).—T.: *A. skinneri* (Warsz.) Regel (≡ *Zamia skinneri* Warsz.)

*Palmifolium* Kuntze, *Rev. Gen.* 2: 803 (1891), *nom. illeg.* (≡ *Palma-Filix* Adans., *nom. rej.* ≡ *Zamia* L., *nom. cons.*)

*Chigua* D.W. Stev., *Mem. New York Bot. Gard.* 57: 170 (1990).—T.: *C. restrepoi* D.W. Stev. (≡ *Zamia restrepoi* (D.W. Stev.) A.J. Lindstr., see Lindstrom (2009)).

**SUBCLASS II. GINKGOIDAE** Engl. in H.G.A. Engler & K.A.E. Prantl, *Nat. Pflanzenfam. Nachtr.*: 341 (1897).—  
T.: Ginkgoaceae.

**ORDER B. GINKGOALES** Gorozh., *Lekts. Morf. Sist. Archegon.*: 73 (1904).—T.: Ginkgoaceae.

**Family 3. Ginkgoaceae** Engl. in H.G.A. Engler & K.A.E. Prantl, *Nat. Pflanzenfam. Nachtr.*: 19 (1897), *nom. cons.*—T.: *Ginkgo* L.  
1 genus, 1 extant species, China.

**3.1. *Ginkgo*** L., *Mant.* 2: 313 (1771).—T.: *G. biloba* L.  
*Salisburia* Sm., *Trans. Linn. Soc. London* 3: 330 (1797), *nom. illeg.*—T.: *S. adiantifolia* Sm. (≡ *Ginkgo biloba* L.)  
*Pterophyllus* J.Nelson, *Pinaceae*: 163 (1866), *nom. illeg.*, non Lév. (1844, Agaricaceae).—T.: *P. salisburyensis* J.Nelson,  
*nom. illeg.* (≡ *Ginkgo biloba* L.)

**SUBCLASS III. GNETIDAE** Pax in K.A.E. Prantl, *Lehrb. Bot.*, ed. 9: 203 (1894).—T.: Gnetaceae.  
*Ephedridae* Cronquist, Takht. & Zimmerm. ex Reveal, *Phytologia* 79: 69 (1996).—T.: Ephedraceae.  
*Welwitschiidae* Cronquist, Takht. & Zimmerm. ex Reveal, *Phytologia* 79: 71 (1996).—T.: Welwitschiaceae.

**ORDER C. WELWITSCHIALES** Skottsbo. ex Reveal, *Phytologia* 74: 174 (1993).—T.: Welwitschiaceae.

**Family 4. Welwitschiaceae** Caruel, *Nuovo Giorn. Bot. Ital.* 11: 16 (1879), *nom. cons.*—T.: *Welwitschia*  
Hook.f.  
*Tumboaceae* Wettst., *Handb. Syst. Bot.* 2(1): 158 (1903).—T.: *Tumboa* Welw., *nom. rej.* (≡ *Welwitschia* Hook.f., *nom. cons.*)  
1 genus, 1 species, Namibia, Angola.

**4.1. *Welwitschia*** Hook.f., *Gard. Chron.* 1862: 71 (1862), *nom. cons.*—T.: *W. mirabilis* Hook.f.  
*Tumboa* Welw., *Gard. Chron.* 1861: 75. (1861), *nom. rej.*

**ORDER D. GNETALES** Blume in C.F.P. von Martius, *Consp. Regn. Veg.*: 11 (1835).—T.: Gnetaceae.

**Family 5. Gnetaceae** Blume, *Nov. Pl. Expos.*: 23 (1833), *nom. cons.*—T.: *Gnetum* L.  
*Thoaceae* Kuntze in T.E. von Post & C.E.O. Kuntze, *Lex. Gen. Phan.*: 615 (1903).—T.: *Thoa* Aubl.  
1 genus, 30 species, India, Malesia, tropical West Africa, Amazonian South America.

**5.1. *Gnetum*** L., *Syst. Nat.*, ed. 12, 2: 637; *Mant.* 1: 18, 125 (1767).—T.: *G. gnemon* L.  
*Thoa* Aubl., *Hist. Pl. Guiane*: 874 (1775).—T.: *T. urens* Aubl.  
*Abutua* Lour., *Fl. Cochinch.*: 630 (1790).—T.: *A. indica* Lour.  
*Gnemon* [Rumpf ex] Kuntze, *Rev. Gen.* 2: 796 (1891), *nom. illeg.*—T.: *G. ovalifolia* O.Kuntze (≡ *Gnetum gnemon* L.)

**ORDER E. EPHEDRALES** Dumort., *Anal. Fam. Pl.*: 11 (1829).—T.: Ephedraceae.

**Family 6. Ephedraceae** Dumort., *Anal. Fam. Pl.*: 11 (1829), *nom. cons.*—T.: *Ephedra* L.  
1 genus, ca 40 species, Mediterranean Europe, North Africa, warm temperate Asia, North America and western South America.

**6.1 *Ephedra*** L., *Sp. Pl.* 2: 1040 (1753).—T.: *E. distachya* L.  
*Chaetocladius* J.Nelson, *Pinaceae*: 161 (1866), *nom. illeg.*—T.: *C. distachyus* (L.) J.Nelson (as ‘*distachys*’) ≡ *Ephedra distachya* L.

**SUBCLASS IV. PINIDAE** Cronquist, Takht. & Zimmerm., *Taxon* 15: 134 (1966).—T.: Pinaceae.  
*Taxidae* Ehrend. ex Reveal, *Phytologia* 79: 71 (1996).—T.: Taxaceae.  
*Podocarpidae* Doweld & Reveal, *Phytologia* 84: 366 (1999).—T.: Podocarpaceae.

*Araucariidae* Doweld, *Tent. Syst. Pl. Vasc.*: xx (2001).—T.: Araucariaceae.

*Cupressidae* Doweld, *Tent. Syst. Pl. Vasc.*: xix (2001).—T.: Cupressaceae.

Note: —The name ‘Coniferales’ has been used for this clade but it is not based on an existing genus. The use of names based on ‘Conifer-’ (e.g. Coniferopsida, Coniferidae, Coniferales etc.) should be avoided.

**ORDER F. PINALES** Gorozh., *Lekts. Morf. Sist. Archegon.*: 88 (1904).—T.: Pinaceae.

*Abietales* Link, *Handbuch* 2: 474 (1829).—T.: *Abietaceae*.

**Family 7. Pinaceae** Spreng. ex F.Rudolphi, *Syst. Orb. Veg.*: 35 (1830), *nom. cons.*—T.: *Pinus* L.

*Cedraceae* Vest, *Anleit. Stud. Bot.*: 265, 280. 1818.—T.: *Cedrus* Trew

*Abietaceae* Gray, *Nat. Arr. Brit. Pl.* 2: 222, 223. (1822), *nom. cons.*—T.: *Abies* Mill.

*Piceaceae* Gorozh., *Lekts. Morf. Sist. Archegon.*: 79. (1904).—T.: *Picea* A.Dietr.

11 genera, ca 225 species, Temperate to tropical Eurasia, Sumatra, Philippines, North America south to Nicaragua, West Indies. The phylogenetic tree published by Liston *et al.* (2003) has been used to create this sequence.

**7.1. *Cedrus*** Trew, *Cedr. Lib. Hist., Apol. Mant.* 1: 6 (1757), *nom. cons.*, non Duhamel (1755, *nom. rej.*), non Mill. (1757, = *Cedrela* P.Browne, *Meliaceae*).—T.: *C. libani* A.Rich. (≡ *Pinus cedrus* L.)

**7.2. *Pinus*** L., *Sp. Pl.* 2: 1000 (1753).—T.: *P. sylvestris* L.

*Pinea* Wolf, *Gen. Pl.*: 156 (1776).—T.: not designated.

*Strobis* (Sweet ex Spach) Opiz, *Lotos* 4: 94 (1854).—T.: *S. weymouthiana* Opiz (≡ *Pinus strobus* L.)

*Caryopitys* Small, *Fl. S.E. U.S.*: 29 (1903).—T.: *C. edulis* (Engelm.) Small (≡ *Pinus edulis* Engelm.)

*Apinus* Neck. ex Rydb., *Bull. Torrey Bot. Club* 32: 597 (1905).—T.: *Pinus cembra* L.

*Leucopitys* Nieuwl., *Amer. Midl. Naturalist* 3: 69 (1913), *nom. illeg.* (≡ *Strobis* (Sweet ex Spach) Opiz)

*Ducampopinus* A.Chev., *Rev. Int. Bot. Appl. Agric. Trop.* 24: 30 (1944).—T.: *D. krempfii* (Lecomte) A.Chev. (≡ *Pinus krempfii* Lecomte)

**7.3. *Cathaya*** Chun & Kuang, *Acta Bot. Sin.* 10: 245 (1962).—T.: *C. argyrophylla* Chun & Kuang

**7.4. *Picea*** A.Dietr., *Fl. Berlin* 1(2): 794 (1824).—T.: *P. rubra* A.Dietr., *nom. illeg.* (≡ *Picea abies* (L.) H.Karst., ≡ *Pinus abies* L.)

*Veitchia* Lindl., *Gard. Chron.* 1861: 265 (1861) *nom. rej.* non *Veitchia* H.Wendl., (1868, *Arecaceae*), *nom. cons.*—T.: *V. japonica* Lindl. Note: —This is ambiguously synonymous with *Picea*; the identity of the type species is unknown.

**7.5. *Pseudotsuga*** Carr., *Traité Conif.*, ed. 2: 256 (1867).—T.: *P. douglasii* (Sabine ex D.Don) Carr. (≡ *Pinus douglasii* Sabine ex D.Don) [correct name *P. menziesii* (Mirb.) Franco]

*Abietia* A.H.Kent, *Man. Conif.*, ed. 2: 474 (1900), *nom. illeg.*

**7.6. *Larix*** Mill., *Gard. Dict. Abr.*, ed. 4: [unpaged.] (1754).—T.: *L. decidua* Mill. (≡ *Pinus larix* L.)

**7.7. *Pseudolarix*** Gordon, *Pinetum*: 292 (1858), *nom. cons.*—T.: *P. kaempferi* Gordon [correct name *P. amabilis* (J.Nelson) Rehder]

*Laricopsis* A.H.Kent, *Man. Conif.*, ed. 2: 403 (1900), *nom. illeg.*, non Fontaine (1889).—T.: *L. kaempferi* (Gordon) A.H.Kent (≡ *Pseudolarix kaempferi* Gordon)

*Chrysolarix* H.E.Moore, *Baileya* 13: 133 (1965).—T.: *C. amabilis* (J.Nelson) H.E.Moore (≡ *Larix amabilis* J.Nelson)

**7.8. *Tsuga*** (Endl.) Carr., *Traité Conif.*: 185 (1855).—T.: *T. sieboldii* Carr. (≡ *Abies tsuga* Siebold & Zucc.)

*Hesperopeuce* (Engelm.) Lemmon, *Bienn. Rep. Calif. State Board Forest.* 3: 126 (1890).—T.: *H. pattoniana* (J.Jeffrey ex A.Murray) Lemmon (≡ *Abies pattoniana* J.Jeffrey ex A.Murray)

**7.9. *Nothotsuga*** Hu ex C.N.Page, *Notes Roy. Bot. Gard. Edinburgh* 45: 390 (1989).—T.: *N. longibracteata* (W.C.Cheng) C.N.Page (≡ *Tsuga longibracteata* W.C.Cheng)

**7.10. *Keteleeria*** Carr., *Rev. Hort.* 37: 449 (1866).—T.: *K. fortunei* (A.Murray) Carr. (≡ *Picea fortunei* A.Murr., as ‘*fortuni*’).

**7.11. *Abies*** Mill., *Gard. Dict. Abr.*, ed. 4, vol. 1: [unpaged.] (1754).—T.: *A. alba* Mill. (≡ *Pinus picea* L.)

*Picea* D.Don ex Loud., *Arbor. Frut. Brit.* 4: 2329 (1838), *nom. illeg.*, non A.Dietr. (1824).

**ORDER G. ARAUCARIALES** Gorozh., *Lekts. Morf. Sist. Archegon.*: 72 (1904).—T.: Araucariaceae.  
*Podocarpaceae* Pulle ex Reveal, *Novon* 2: 239 (1992).—T.: Podocarpaceae.  
*Saxegothaeales* Doweld & Reveal, *Phytologia* 84: 365 (1999).—T.: Saxegothaeaceae.  
*Falcatifoliales* Melikian & A.V.Bobrov, *Bot. Zhurn. (Moscow & Leningrad)* 85(7): 61 (2000).—T.: Falcatifoliaceae.  
*Parasitaxales* Melikian & A.V.Bobrov, *Bot. Zhurn. (Moscow & Leningrad)* 85(7): 61 (2000).—T.: Parasitaxaceae  
*Microstroboles* Melikian & A.V.Bobrov ex Doweld & Reveal, *Novon* 11: 396 (2001).—T.: Microstrobaceae.

**Family 8. Araucariaceae** Henkel & W.Hochst., *Syn. Nadelhölz.*: xvii, 1 (1865), *nom. cons.*—T.: *Araucaria* Juss.

*Dammaraceae* Link, *Abh. Konigl. Akad. Wiss. Berlin* 1827: 157 (1830), *nom. illeg.*—T.: *Dammara* Link.

*Agathidaceae* (Vierh.) Baum.-Bodenh. ex A.V.Bobrov & Melikian, *Komarovia* 4: 61 (2006).—T.: *Agathis* Salisb.

3 genera, 41 species, Southeast Asia and Philippines to Australasia, Pacific, southern South America.

**8.1. Araucaria** Juss., *Gen.* 413 (1789). T.: *A. imbricata* Pav., *nom. illeg.* (≡ *Pinus araucana* Molina)

*Dombeya* Lam., *Encycl. Meth., Bot.* 2: 301 (1786), *nom. illeg.*, non L'Hér. (1785), *nom. rej.*—T.: *D. chilensis* Lam., *nom. illeg.* (≡ *Pinus araucana* Molina)

*Columbea* Salisb., *Trans. Linn. Soc. London* 8: 317 (1807), *nom. illeg.*—T.: *C. quadrifaria* Salisb., *nom. illeg.* (≡ *Pinus araucana* Molina)

*Eutassa* Salisb., *Trans. Linn. Soc. London* 8: 316 (1807).—T.: *E. heterophylla* Salisb. (= *Araucaria heterophylla*).

*Eutacta* Link, *Linnaea* 15: 543 (1842).—T.: *E. cunninghamii* (Aiton ex A. Cunn.) Link (type designated here by Mill & Farjon) (= *Araucaria cunninghamii* Aiton ex A. Cunn.).

*Quadrifaria* Manetti ex Gordon, *Pinet. Suppl.* 14 (1862).—T.: *Q. imbricata* (Pav.) Manetti ex Gordon (= *Araucaria araucana*).

*Marywildea* A.V.Bobrov & Melikian, *Komarovia* 4: 57 (2006).—T.: *M. bidwillii* (Hook.) A.V.Bobrov & Melikian (≡ *Araucaria bidwillii* Hook.).

*Titanodendron* A.V.Bobrov & Melikian, *Komarovia* 4: 60 (2006).—T.: *T. hunsteinii* (K.Schum.) A.V.Bobrov & Melikian (≡ *Araucaria hunsteinii* K.Schum.).

**8.2. Wollemia** W.G.Jones, K.D.Hill & J.M.Allen, *Telopea* 6: 173 (1995).—T.: *W. nobilis* W.G.Jones, K.D.Hill & J.M.Allen

**8.3. Agathis** Salisb., *Trans. Linn. Soc. London* 8: 311 (1807), *nom. cons.*—T.: *A. loranthifolia* Salisb., *nom. illeg.* (≡ *Pinus dammara* (Lamb.) L.C.Rich.)

*Dammara* Link, *Enum. Pl. Horti Berol.* 2: 411 (1822), *nom. illeg.*, non Gaertner (1790).

*Salisburyodendron* A.V.Bobrov & Melikian, *Komarovia* 4: 62 (2006).—T.: *S. australis* (Lamb.) A.V.Bobrov & Melikian (≡ *Agathis australis* Salisb.).

**Family 9. Podocarpaceae** Endl., *Syn. Conif.*: 203 (1847), *nom. cons.*—T.: *Podocarpus* L'Hér. ex Pers.

*Phyllocladaceae* Bessey, *Nebraska Univ. Stud.* 7: 325 (1907).—T.: *Phyllocladus* Rich. ex Mirb.

*Phyllocladaceae* E.L.Core ex H.Keng, *Taiwania* 18(2): 142 (1973), *nom, illeg.*—T.: *Phyllocladus* Rich. ex Mirb.

*Pherosphaeraceae* Nakai, *Tyosen-Sanrin* 158: 15 (1938).—T.: *Pherosphaera* W.Archer bis

*Nageiaceae* D.Z.Fu, *Acta Phytotax. Sin.* : 522 (1992).—T.: *Nageia* Gaertn.

*Acmopylaceae* Melikian & A.V.Bobrov, *Proc. Intern. Conf. Plant Anat. Morph. (St. Petersburg)* 1997: 93 (1997).—T.: *Acmopyle* Pilg.

*Saxegothaeaceae* Gausson ex Doweld & Reveal, *Phytologia* 84: 365. (1999).—T.: *Saxegothaea* Lindl., *nom. cons.*

*Microcachrydaceae* Doweld & Reveal, *Phytologia* 84: 365 (1999).—T.: *Microcachrys* Hook.f.

*Bracteocarpaceae* Melikian & A.V.Bobrov, *Bot. Zhurn. (Moscow & Leningrad)* 85(7): 60 (2000).—T.: *Bracteocarpus* Melikian & A.V.Bobrov

*Dacrycarpaceae* Melikian & A.V.Bobrov, *Bot. Zhurn. (Moscow & Leningrad)* 85(7): 59 (2000).—T.: *Dacrycarpus* de Laub.

*Falcatifoliaceae* Melikian & A.V.Bobrov, *Bot. Zhurn. (Moscow & Leningrad)* 85(7): 61 (2000).—T.: *Falcatifolium* de Laub.

*Halocarpaceae* Melikian & A.V.Bobrov, *Bot. Zhurn. (Moscow & Leningrad)* 85(7): 60 (2000).—T.: *Halocarpus* Quinn

*Lepidothamnaceae* Melikian & A.V.Bobrov, *Bot. Zhurn. (Moscow & Leningrad)* 85(7): 63 (2000).—T.: *Lepidothamnus* Phil.

*Microstrobaceae* Doweld & Reveal, *Novon* 11: 396 (2001).—T.: *Microstrobos* J.Garden & L.A.S.Johnson

*Parasitaxaceae* Melikian & A.V.Bobrov, *Bot. Zhurn. (Moscow & Leningrad)* 85(7): 61 (2000).—T.: *Parasitaxus* de Laub.

*Prumnopityaceae* Melikian & A.V.Bobrov, *Bot. Zhurn. (Moscow & Leningrad)* 85(7): 58 (2000).—T: *Prumnopitys* Phil. 19 genera, ca 180 species, Tropical African mountains, Japan to Australia and New Zealand, SW Pacific, South America, Central America, Caribbean Islands. Phylogenetic analyses followed here are those of Kelch (1997, 1998), Conran *et al.* (2000) and Sinclair *et al.* (2002).

**9.1. *Phyllocladus*** Rich. ex Mirb., *Mém. Mus. Hist. Nat.* 13: 48 (1825), *nom. cons.*—T.: *P. billardieri* Mirb, *nom. illeg.* (= *Podocarpus aspleniifolius* Labill.) [correct name: *Phyllocladus aspleniifolius* (Labill.) Hook.f.]

*Podocarpus* Labill., *Novae Holl. Pl. Spec.* 2: 71, t. 221 (1806), *nom. rej.* (= *Phyllocladus* by typification)

*Thalamia* Spreng., *Anleit.*, ed. 2, 2: 218 (1817), *nom. illeg.*—T.: *T. aspleniifolia* (Labill.) Spreng. (= *Podocarpus aspleniifolius* Labill.)

*Brownetera* Rich. ex Tratt., *Gen. Nov. Pl.: ad t.* [14] (1825), *nom. illeg.* —T.: *B. aspleniifolia* (Labill.) Tratt. (= *Podocarpus aspleniifolius* Labill.)

**9.2. *Lepidothamnus*** Phil., *Linnaea* 30: 730 (1861).—T.: *L. fonkii* Phil.

**9.3. *Prumnopitys*** Phil., *Linnaea* 30: 731 (1861).—T.: *P. elegans* Phil. [correct name: *P. andina* (Poepp. ex Endl.) de Laub.]

*Stachycarpus* (Endl.) Tiegh., *Bull. Soc. Bot. France* 38: 163 (1891).—T.: *S. andinus* (Poepp. ex Endl.) Tiegh., as ‘*andina*’ (= *Prumnopitys andina* (Poepp. ex Endl.) de Laub., = *Podocarpus andinus* Poepp. ex Endl., as ‘*andina*’)

*Stachypitys* A.V.Bobrov & Melikian, *Bot. Zhurn. (Moscow & Leningrad)* 85(7): 58 (2000) *nom. illeg.*, non Schenk (1867, fossil).—T.: *S. ferrugineus* (G.Benn. ex D.Don) A.V.Bobrov & Melikian (= *Prumnopitys ferruginea* (G.Benn. ex D.Don) de Laub., = *Podocarpus ferrugineus* G.Benn. ex D.Don).

*Van-Tieghemia* A.V.Bobrov & Melikian, *Bot. Zhurn. (Moscow & Leningrad)* 85(7): 58 (2000) *nom. illeg.*, non *Vantieghemia* Kuntze (1891, fungus).—T.: *V. montana* (Humb. & Bonpl. ex Willd.) A.V.Bobrov & Melikian (= *Prumnopitys montana* (Humb. & Bonpl. ex Willd.) de Laub., = *Podocarpus montanus* Humb. & Bonpl. ex Willd.).

*Botryopitys* Doweld, *Turczaninowia* 3(4): 37 (2001).—T.: *B. montana* (Humb. & Bonpl. ex Willd.) Doweld (= *Prumnopitys montana* (Humb. & Bonpl. ex Willd.) de Laub., = *Podocarpus montanus* Humb. & Bonpl. ex Willd.).  
Note:—*Botryopitys* is a new name coined by Doweld for the illegitimate name *Van-Tieghemia* A.V.Bobrov & Melikian.

**9.4. *Sundacarpus*** (J.Buchholz & N.E.Gray) C.N.Page, *Notes Roy. Bot. Gard. Edinburgh* 45: 378 (1989).—T.: *S. amarus* (Blume) C.N.Page (= *Podocarpus amarus* Blume, as ‘*amara*’)

**9.5. *Halocarpus*** Quinn, *Austral. J. Bot.* 30: 317 (1982).—T.: *H. bidwillii* (Hook.f. ex Kirk) Quinn (= *Dacrydium bidwillii* Hook.f. ex Kirk)

**9.6. *Parasitaxus*** de Laub., *Fl. Nouv. Calédonie* 4: 44 (1972).—T.: *P. usta* (Vieill.) de Laub., as ‘*ustus*’ (= *Dacrydium ustum* Vieill.)

**9.7. *Lagarostrobos*** Quinn, *Austral. J. Bot.* 30: 316 (1982).—T.: *L. franklinii* (Hook.f.) Quinn (= *Dacrydium franklinii* Hook.f.)

**9.8. *Manoao*** Molloy, *New Zealand J. Bot.* 33: 196 (1995).—T.: *M. colensoi* (Hook.) Molloy (= *Dacrydium colensoi* Hook.)

**9.9. *Saxegothaea*** Lindl., *J. Hort. Soc. London* 6: 258 (1851), as ‘*Saxe-Gothaea*,’ *nom. & orth. cons.*—T.: *S. conspicua* Lindl.

*Squamataxus* J.Nelson, *Pinaceae* 168 (1866), *nom. illeg.*—T.: *S. albertiana* J.Nelson, *nom. illeg.* (= *Saxegothaea conspicua* Lindl.)

**9.10. *Microcachrys*** Hook.f., *London J. Bot.* 4: 149 (1845).—T.: *M. tetragona* (Hook.) Hook.f. (= *Athrotaxis tetragona* Hook.)

**9.11. *Pherosphaera*** W.Archer bis, *Hooker's J. Bot. Kew Gard. Misc.* 2: 52 (1850).—T.: *P. hookeriana* W.Archer bis

*Microstrobos* J.Garden & L.A.S.Johnson, *Contr. New South Wales Natl. Herb.* 1: 315 (1951).—T.: *M. fitzgeraldii* (F.Muell.) L.A.S.Johnson (= *Pherosphaera fitzgeraldii* F.Muell.)

**9.12. *Acropyle*** Pilg. in H.G.A. Engler, *Nat. Pflanzenr.* IV. 5 (Heft 18): 117 (1903).—T.: *A. pancheri* (Brongn. & Gris) Pilger (= *Dacrydium pancheri* Brongn. & Gris)

**9.13. *Dacrycarpus*** de Laub., *J. Arnold Arbor.* 50: 315 (1969).—T.: *D. dacrydioides* (A.Rich.) de Laub. (=

*Podocarpus dacrydioides* A.Rich.)

*Bracteocarpus* A.V.Bobrov & Melikian, *Byull. Moskovsk. Obshch. Isp. Prir., Otd. Biol.*, ser. 2, 103(1): 58 (1998).—T.: *B. imbricatus* (Blume) A.V.Bobrov & Melikian (≡ *Dacrycarpus imbricatus* (Blume) de Laub., ≡ *Podocarpus imbricatus* Blume)

*Laubenfelsia* A.V.Bobrov & Melikian, *Bot. Zhurn. (Moscow & Leningrad)* 85(7): 60 (2000).—T.: *L. vieillardii* (Parl.) A.V.Bobrov & Melikian, *non rite publ.* (≡ *Dacrycarpus vieillardii* (Parl.) de Laub.). Note:—Although the name of the single species of *Laubenfelsia* was invalidly published, the generic name *Laubenfelsia* has been considered to be valid (R.K. Brummitt, pers. comm. to Mill, 19 February 2001).

**9.14. *Dacrydium*** Lamb., *Descr. Pinus* 1: 93 (1807).—T.: *D. cupressinum* Sol. ex Lamb.

*Corneria* A.V.Bobrov & Melikian, *Bot. Zhurn. (Moscow & Leningrad)* 85(7): 62 (2000), *nom. illeg.*, *non Cornera* Furtado (1955, *Arecaceae*).—T.: *C. elata* (Roxb.) A.V.Bobrov & Melikian (≡ *Dacrydium elatum* (Roxb.) Wall. ex Hook. ≡ *Juniperus elata* Roxb.)

*Gaussonia* A.V.Bobrov & Melikian, *Bot. Zhurn. (Moscow & Leningrad)* 85(7): 62 (2000).—T.: *G. lycopodioides* (Brongn. & Gris) A.V.Bobrov & Melikian (≡ *Dacrydium lycopodioides* Brongn. & Gris)

*Metadacrydium* M.G.Baum.-Bod. ex Melikian & A.V.Bobrov, *Bot. Zhurn. (Moscow & Leningrad)* 85(7): 63 (2000).—T.: *M. araucarioides* (Brongn. & Gris) M.G.Baum.-Bod. ex Melikian & A.V.Bobrov (≡ *Dacrydium araucarioides* Brongn. & Gris)

**9.15. *Falcatifolium*** de Laub., *J. Arnold Arbor.* 50: 308 (1969).—T.: *F. falciforme* (Parl.) de Laub. (≡ *Podocarpus falciformis* Parl.)

**9.16. *Retrophyllum*** C.N.Page, *Notes Roy. Bot. Gard. Edinburgh* 45: 379 (1989).—T.: *R. vitiense* (Seem.) C.N.Page (≡ *Podocarpus vitiensis* Seem.)

*Decussocarpus* de Laub., *J. Arnold Arbor.* 50: 340 (1969), *nom. illeg.*—T.: *D. vitiensis* (Seem.) de Laub. (≡ *Retrophyllum vitiense* (Seem.) C.N.Page ≡ *Podocarpus vitiensis* Seem.) Note:—The name *Decussocarpus* is illegitimate because it included the earlier name *Nageia* Gaertn. The type is not a *Nageia* and was later described as *Retrophyllum*.

**9.17. *Nageia*** Gaertn., *Fruct. Sem. Pl.* 1: 191 (1788).—T.: *N. japonica* Gaertn., *nom. illeg.* (≡ *N. nagi* (Thunb.) Kuntze, ≡ *Myrica nagi* Thunb.)

**9.18. *Afroparpus*** (J.Buchholz & N.E.Gray) C.N.Page, *Notes Roy. Bot. Gard. Edinburgh* 45: 383 (1989).—T.: *A. falcatus* (Thunb.) C.N.Page, as '*falcata*' (≡ *Taxus falcata* Thunb.)

**9.19. *Podocarpus*** L'Hér. ex Pers., *Syn. Pl.* 2: 580 (1807), *nom. cons.*—T.: *P. elongates* (Aiton) L'Her. ex Pers. (≡ *Taxus elongata* Aiton, *typ. cons.*)

*Margbensonia* A.V.Bobrov & Melikian, *Byull. Moskovsk. Obshch. Isp. Prir., Otd. Biol.*, ser. 2, 103(1): 59 (1998).—T.: *M. macrophylla* (Thunb.) A.V.Bobrov & Melikian (≡ *Podocarpus macrophyllum* (Thunb.) Sweet, ≡ *Taxus macrophylla* Thunb.)

**ORDER H. CUPRESSALES** Link, *Handbuch* 2: 470 (1829).—T.: Cupressaceae.

*Taxales* Link, *Handbuch* 2: 470 (1829).—T.: Taxaceae.

*Taxodiales* Schimp., *Traité Paléont. Vég.* 2: 309 (1870).—T.: Taxodiaceae.

*Cephalotaxales* Takht. ex Reveal, *Phytologia* 74: 175 (1993).—T.: Cephalotaxaceae.

*Sciadopityales* Takht. ex Reveal, *Phytologia* 75: 176 (1993).—T.: Sciadopityaceae.

*Actinostrobales* Doweld, *Tent. Syst. Pl. Vasc.* xx (2001).—T.: Actinostrobaeae.

*Athrotaxidales* Doweld, *Tent. Syst. Pl. Vasc.* xix (2001).—T.: Athrotaxidaceae.

*Cunninghamiales* Doweld, *Tent. Syst. Pl. Vasc.* xix (2001).—T.: Cunninghamiaceae.

**Family 10. Sciadopityaceae** Luerss., *Grundz. Bot.*: 265 (1877)—T.: *Sciadopitys* Siebold & Zucc.  
1 genus with a single species in Japan.

**10.1. *Sciadopitys*** Siebold & Zucc., *Fl. Jap.* 2: 1 (1842).—T.: *S. verticillata* (Thunb.) Siebold & Zucc. (≡ *Taxus verticillata* Thunb.)

**Family 11. Cupressaceae** Gray, *Nat. Arr. Brit. Pl.* 2: 222. (1822), *nom. cons.*—T.: *Cupressus* L.

*Juniperaceae* J.Presl & C.Presl, *Delic. Prag.*: 142 (1822).—T.: *Juniperus* L.

*Thujaaceae* Burnett, *Outl. Bot.*: 502, 1149 (1835).—T.: *Thuja* L.

*Cunninghamiaceae* Siebold & Zucc., *Fl. Jap.* 2: 1, 3 (1842).—T.: *Cunninghamia* R.Br.



*Taxodiaceae* Saporta, *Ann. Sci. Nat., Bot.*, ser. 5, 4: 44 (1865), *nom. cons.*—T.: *Taxodium* Rich.  
*Sequoiaceae* C.Koch ex Luerss., *Grundz. Bot.*: 265 (1877).—T.: *Sequoia* Endl.  
*Cryptomeriaceae* Gorozh., *Lekts. Morf. Sist. Archegon.*: 88 (1904).—T.: *Cryptomeria* D.Don  
*Thujopsidaceae* Bessey, *Nebraska Univ. Stud.* 7: 325 (1907).—T.: *Thujopsis* Siebold & Zucc. ex Endl.  
*Actinostroboaceae* Lotsy, *Vortr. Bot. Stammesgesch.* 3: 98 (1911).—T.: *Actinostrobus* Miq.  
*Callitridaceae* Seward, *Fossil Pl.* 4: 124, 151, 336 (1919).—T.: *Callitris* Vent.  
*Limnopyaceae* Hayata, *Bot. Mag. (Tokyo)* 46: 25. 1932.—T.: *Taxodium* Rich.  
*Taiwaniaceae* Hayata, *Bot. Mag. (Tokyo)* 46: 26 (1932).—T.: *Taiwania* Hayata  
*Tetraclinaceae* Hayata, *Bot. Mag. (Tokyo)* 46: 27 (1932).—T.: *Tetraclinis* Masters  
*Microbiotaceae* Nakai, *Tyosen-Sanrin* 165: 13 (1938).—T.: *Microbiota* Komarov  
*Metasequoiaceae* S.Miki ex Hu & W.C.Cheng, *Bull. Fan Mem. Inst. Biol.*, ser. 2, 1: 154 (1948).—T.: *Metasequoia* Hu & W.C.Cheng

*Athrotaxidaceae* Doweld, *Prosyllab. Tracheophyt.*: xix (2001).—T.: *Athrotaxis* D.Don  
*Libocedraceae* Doweld, *Novosti Sist. Vyssh. Rast.* 33: 42 (2001).—T.: *Libocedrus* Endl.  
*Neocallitropsidaceae* Doweld, *Prosyllab. Tracheophyt.*: xx (2001).—T.: *Neocallitropsis* Florin  
*Widdringtoniaceae* Doweld, *Prosyllab. Tracheophyt.*: xx (2001).—T.: *Widdringtonia* Endl.  
*Arceuthidaceae* A.V.Bobrov & Melikian, *Komarovia* 4: 79 (2006).—T.: *Arceuthos* Antoine & Kotschy  
*Diselmaceae* A.V.Bobrov & Melikian, *Komarovia* 4: 96 (2006).—T.: *Diselma* Hook.f  
*Fitzroyaceae* A.V.Bobrov & Melikian, *Komarovia* 4: 80 (2006), 'Fitz-Royaceae'.—T.: *Fitzroya* Hook.f. ex Lindl.  
*Pilgerodendraceae* A.V.Bobrov & Melikian, *Komarovia* 4: 87 (2006).—T.: *Pilgerodendron* Florin  
*Platykladaceae* A.V.Bobrov & Melikian, *Komarovia* 4: 97 (2006).—T.: *Platykladus* Spach  
 29 genera, ca 130 species, nearly cosmopolitan. This sequence is based on the phylogenetic trees of Gadek *et al.* (2000) and Little *et al.* (2004).

**11.1. *Cunninghamia*** R.Br. in L.C.M. Richard, *Comm. Bot. Conif. Cycad.* 149 (1826), *nom. cons.*, non Schreb. (1791), *nom. rej.*—T.: *C. sinensis* R.Br., *nom. illeg.* (= *C. lanceolata* (Lamb.) Hook., ≡ *Pinus lanceolata* Lamb.)

*Belis* Salisb., *Trans. Linn. Soc. London* 8: 315 (1807), *nom. rej.*—T.: *B. jaculifolia* Salisb., *nom. illeg.* (= *Pinus lanceolata* Lamb.)

*Jacularia* Raf., *Gard. Mag. & Reg. Rural Domest. Improv.* 8: 247 (1832), *nom. illeg.*

*Raxopitys* J.Nelson, *Pinaceae*: 97 (1866)—T.: *R. cunninghamii* J.Nelson, *nom. illeg.* (≡ *Pinus lanceolata* Lamb.)

**11.2. *Taiwania*** Hayata, *J. Linn. Soc., Bot.* 37: 330 (1906).—T.: *T. cryptomerioides* Hayata

**11.3. *Athrotaxis*** D.Don, *Ann. Nat. Hist.* 1: 234 (1838).—T.: *A. selaginoides* D.Don

**11.4. *Metasequoia*** Hu & W.C.Cheng, *Bull. Fan Mem. Inst. Biol.*, ser. 2, 1(2): 154 (1948), *nom. cons.*, non Miki (1941), *nom. rej.* = fossil).—T.: *M. glyptostroboides* Hu & W.C.Cheng, *nom. & typ. cons.*

**11.5. *Sequoia*** Endl., *Syn. Conif.*: 197 (1847), *nom. cons.*—T.: *S. sempervirens* (D.Don) Endl. (≡ *Taxodium sempervirens* D.Don)

**11.6. *Sequoiadendron*** J.Buchholz, *Amer. J. Bot.* 26: 536 (1939), *nom. cons. prop.*—T.: *S. giganteum* (Lindl.) J.Buchholz (≡ *Wellingtonia gigantea* Lindl.)

*Wellingtonia* Lindl., *Gard. Chron.* 1853: 823 (1853), *nom. illeg.*, non Meisn. (1840).—T.: *W. gigantea* Lindl.

*Americus* Hanford, *Great Calif. Tree*: 6 (1854), *nom. rej. prop.*—T.: *A. gigantea* (Lindl.) Hanford (≡ *Sequoiadendron giganteum* (Lindl.) J.Buchholz ≡ *Wellingtonia gigantea* Lindl.)

*Washingtonia* Winslow, *Calif. Farmer* 2: 58 (1854), *nom. inadmis.*, non Raf. ex J.M.Coulter (1900), *nom. cons.*—T.: *W. californica* (= *Sequoiadendron giganteum* (Lindl.) J.Buchholz ≡ *Wellingtonia gigantea* Lindl.)

**11.7. *Cryptomeria*** D.Don, *Ann. Nat. Hist.* 1: 233 (1838).—T.: *C. japonica* (Thunb. ex L.f.) D.Don (≡ *Cupressus japonica* Thunb. ex L.f.)

**11.8. *Glyptostrobus*** Endl., *Syn. Conif.*: 69 (1847).—T.: *Taxodium japonicum* Brongn., *nom. illeg.*, non (L.f.) Brongn. (= *G. pensilis* (Staunton ex D.Don) K.Koch)

**11.9. *Taxodium*** Rich., *Ann. Mus. Natl. Hist. Nat.* 16: 298 (1810).—T.: *T. distichum* (L.) Rich. (≡ *Cupressus disticha* L.)

*Schubertia* Mirb., *Nouv. Bull. Sci. Soc. Philom. Paris* 3: 123 (1812), *nom. rej.*—T.: *S. disticha* (L.) Mirb. (≡ *Cupressus disticha* L.)

*Cupressinata* J.Nelson, *Pinaceae*: 61 (1866), *nom. illeg.*—T.: *C. disticha* (L.) J.Nelson (≡ *Taxodium distichum* (L.) Rich. ≡ *Cupressus disticha* L.)

- 11.10. *Papuacedrus*** H.L.Li, *J. Arnold Arbor.* 34: 25 (1953).—T.: *P. papuana* (F.Muell.) H.L.Li (≡ *Libocedrus papuana* F.Muell.)
- 11.11. *Austrocedrus*** Florin & Boutelje, *Acta Horti Berg.* 17(2): 28 (1954).—T.: *A. chilensis* (D.Don) Pic.Serm. & Bizzarri (≡ *Thuja chilensis* D.Don)
- 11.12. *Libocedrus*** Endl., *Syn. Conif.*: 42 (1847).—T.: *L. doniana* Endl., *nom. illeg.* (≡ *L. plumosa* (D.Don) Sarg. ≡ *Dacrydium plumosum* D.Don)  
*Stegocedrus* Doweld, *Novit. Syst. Pl. Vasc.* 33: 42 (2001).—T.: *S. austrocaledonica* (Brongn. & Gris) Doweld (≡ *Libocedrus austrocaledonica* Brongn. & Gris).
- 11.13. *Pilgerodendron*** Florin, *Svensk Bot. Tidskr.* 24: 132 (1930).—T.: *P. uviferum* (D.Don) Florin (≡ *Juniperus uvifera* D.Don)
- 11.14. *Widdringtonia*** Endl., *Gen. Pl. Suppl.* 2: 25 (1842).—T.: *W. cupressoides* (L.) Endl. (≡ *Thuja cupressoides* L.)  
*Pachylepis* Brongn., *Ann. Sci. Nat. (Paris)* 30: 189 (1833), *nom. illeg.*, non Less. (1832).—T.: *P. cupressoides* (L.) Brongn. (≡ *Widdringtonia cupressoides* (L.) Endl. ≡ *Thuja cupressoides* L.)  
*Parolinia* Endl., *Gen. Pl. Suppl.* 1: 1372 (1841), *nom. illeg.*, non Webb (1840, Brassicaceae).—T.: *Thuja cupressoides* L.
- 11.15. *Diselma*** Hook.f., *Fl. Tasmaniae* 1(5): 353 (1857).—T.: *D. archeri* Hook.f.
- 11.16. *Fitzroya*** Hook.f. ex Lindl., *J. Hort. Soc. London* 6: 264 (1851), as ‘Fitz-Roya’, *nom. & orth. cons.*—T.: *F. patagonica* Hook.f. ex Lindl. (≡ *F. cupressoides* (Molina) I.M.Johnst. ≡ *Pinus cupressoides* Molina)  
*Cupressstellata* J.Nelson, *Pinaceae*: 60 (1866).—T.: *Cupressstellata patagonica* (Hook.f. ex Lindl.) J.Nelson (≡ *Fitzroya patagonica* Hook.f. ex Lindl.)
- 11.17. *Callitris*** Vent., *Decas Gen.* 10 (1808).—T.: *C. rhomboidea* R.Br. ex Rich. & A.Rich.  
*Frenela* Mirb., *Mém. Mus. Hist. Nat.* 13: 30, 74 (1825), *nom. illeg.*—T.: *Frenela rhomboidea* (R.Br. ex Rich. & A.Rich.) Endl., by typification (≡ *Callitris rhomboidea* R.Br. ex Rich. & A.Rich.)  
*Cyparissia* Hoffmanns., *Preis-Verzeichn. Pfl.*, ed. 7: 20 (1833), *nom. illeg.*—T.: *C. australis* (Pers.) Hoffmanns. (≡ *Cupressus australis* Pers. = *Callitris rhomboidea* R.Br. ex Rich. & A.Rich.)  
*Octoclinis* F.Muell., *Trans. & Proc. Philos. Inst. Victoria* 2(1): 21 (1857).—T.: *O. macleayana* F.Muell.  
*Laechhardtia* Gordon, *Pinetum Suppl.*: 40 (1862).—T.: *L. macleayana* Gordon, *nom. illeg.* (≡ *Frenela variabilis* Carr.)  
*Nothocallitris* A.V.Bobrov & Melikian, *Komarovia* 4: 85 (2006).—T.: *N. sulcata* (Parl.) A.V.Bobrov & Melikian (≡ *Callitris sulcata* Parl.).
- 11.18. *Actinostrobus*** Miq. in J.G.C. Lehmann, *Pl. Preiss.* 1: 644 (1845).—T.: *A. pyramidalis* Miq.
- 11.19. *Neocallitropsis*** Florin, *Palaeontographica, Abt. B, Paläophytol.* 85B: 590 (1944).—T.: *N. araucarioides* (Compton) Florin (≡ *Callitropsis araucarioides* Compton)  
*Callitropsis* Compton, *J. Linn. Soc., Bot.* 45: 432 (1922), *nom. illeg.*, non Oersted (1864).—T.: *C. araucarioides* Compton
- 11.20. *Thujopsis*** Siebold & Zucc. ex Endl., *Gen. Suppl.* 2: 24 (1842), *nom. cons.*—T.: *T. dolabrata* (Thunb. ex L.f.) Siebold & Zucc. (≡ *Thuja dolabrata* Thunb. ex L.f.)  
*Dolophyllum* Salisb., *J. Sci. Arts (London)* 2: 313 (1817), *nom. rej.*—T.: *Thuja dolabrata* Thunb. ex L.f.
- 11.21. *Thuja*** L., *Sp. Pl.* 2: 1002 (1753).—T.: *T. occidentalis* L.  
*Thya* Adans., *Fam. Pl.* 2: 480 (1763), *nom. illeg.*
- 11.22. *Fokienia*** A.Henry & H.H.Thomas, *Gard. Chron.*, ser. 3. 49: 67 (1911).—T.: *F. hodginsii* (Dunn) A.Henry & H.H.Thomas (≡ *Cupressus hodginsii* Dunn)
- 11.23. *Chamaecyparis*** Spach, *Hist. Nat. Vég. Phan.* 11: 329 (1841).—T.: *C. sphaeroidea* Spach, *nom. illeg.* (≡ *C. thyoides* (L.) Britton, Sterns & Poggenb. ≡ *Cupressus thyoides* L.)  
*Retinispora* Siebold & Zucc., *Fl. Jap.* 2: 36 (1844).—T.: *R. obtusa* Siebold & Zucc.  
*Shishindenia* Makino ex Koidz., *Acta Phytotax. Geobot.* 9: 101 (1940).—T.: *S. ericoides* (Boehm.) Makino ex Koidz. (≡ *Chamaecyparis obtusa* var. *ericoides* Boehm.)  
Note: —*Chamaecyparis obtusa* ‘Ericoides’ is a cultivar, not a natural variety of *C. obtusa*.
- 11.24. *Cupressus*** L., *Sp. Pl.* 2: 1002 (1753).—T.: *C. sempervirens* L.  
*Callitropsis* Oerst., *Vidensk. Meddel. Dansk Naturhist. Foren. Kjøbenhavn* 1864: 32. (1864), *nom. rej. prop.*—T.: *C. nootkatensis* (D.Don) Florin (≡ *Cupressus nootkatensis* D.Don).

*Xanthocyparis* Farjon & T.H.Nguyễn, in Farjon *et al.*, *Novon* 12: 179 (2002), *nom. cons. prop.*—T.: *X. vietnamensis* Farjon & T.H.Nguyễn  
*Tassilicyparis* A.V.Bobrov & Melikian, *Komarovia* 4: 72 (2006).—T.: *T. dupreziana* (A.Camus) A.V.Bobrov & Melikian (= *Cupressus dupreziana* A.Camus).  
*Platyacyparis* A.V.Bobrov & Melikian, *Komarovia* 4: 73 (2006).—T.: *P. funebris* (Endl.) A.V.Bobrov & Melikian (= *Cupressus funebris* Endl.).  
*Hesperocyparis* Bartel & R.A.Price, *Phytologia* 91: 179 (2009).—T.: *H. macrocarpa* (Hartw. ex Gordon) Bartel (= *Cupressus macrocarpa* Hartw. ex Gordon)  
*Neocupressus* de Laub., *Novon* 19: 301 (2009), *nom. illeg.*—T.: *N. macrocarpa* (Hartw. ex Gordon) de Laub. (= *Cupressus macrocarpa* Hartw. ex Gordon)

Note:—Adams *et al.* (2009) showed that *Cupressus* formed two clades: the Old World clade of *Cupressus* was sister to *Juniperus*, whereas the New World clade of *Cupressus* (*Hesperocyparis*) included *Xanthocyparis vietnamensis* and *Callitropsis nootkatensis*. However, Mao *et al.* (2010) showed that *Cupressus* in its broad sense including *Xanthocyparis* and *Callitropsis* is monophyletic with weak support. Until resolution of the phylogenetic position of *Cupressus* is achieved, we take a conservative option and maintain *Cupressus* in a broad sense, including *Callitropsis*, *Hesperocyparis* and *Xanthocyparis*.

**11.25. *Juniperus*** L., *Sp. Pl.* 2: 1038 (1753).—T.: *J. communis* L.  
*Sabina* Mill., *Gard. Dict. Abr.*, ed. 4, 3 (1754).—T.: *S. vulgaris* Antoine (= *Juniperus sabina* L.)  
*Cedrus* Duhamel, *Traité Arb. Arbust.* 1: xxviii, 139. t. 52 (1755), *nom. rej.*—T.: Not designated.  
*Thujaecarpus* Trautv., *Pl. Imag.* 11 (1844).—T.: *T. juniperinus* Trautv., *nom. illeg.* (= *Juniperus oblonga* M.Bieb. = *J. communis* var. *saxatilis* Pall.).  
*Arceuthos* Antoine & Kotschy, *Oesterr. Bot. Wochenbl.* 4: 249 (1854).—T.: *A. drupacea* (Labill.) Antoine & Kotschy (= *Juniperus drupacea* Labill.)  
*Sabinella* Nakai, *Tyosen-Sanrin* 165: 14 (1938).—T.: *S. phoenicea* (L.) Nakai (= *Juniperus phoenicea* L.)

**11.26. *Calocedrus*** Kurz, *J. Bot.* 11: 196 (1873).—T.: *C. macrolepis* Kurz  
*Heyderia* C.Koch, *Dendrologie* 2(2): 177 (1873), *nom. illeg.*, non Link (1833, fungus).—T.: *H. decurrens* (Torrey) C.Koch (= *Calocedrus decurrens* (Torrey) Florin = *Libocedrus decurrens* Torrey).

**11.27. *Tetraclinis*** Masters, *J. Roy. Hort. Soc.* 14: 250 (1892).—T.: *T. articulata* (Vahl) Masters (= *Thuja articulata* Vahl)

**11.28. *Platycladus*** Spach, *Hist. Nat. Vég. Phan.* 11: 333 (1841).—T.: *P. stricta* Spach, *nom. illeg.* (= *P. orientalis* (L.) Franco = *Thuja orientalis* L.)  
*Biota* (D.Don) Endl., *Syn. Conif.*: 46 (1847), *nom. illeg.*, non Cass. (1825).—T.: *B. orientalis* (L.) Endl. (= *Thuja orientalis* L.)

**11.29. *Microbiota*** Komarov, *Bot. Mater. Gerb. Glavn. Bot. Sada RSFSR* 4(23/24): 180 (1923).—T.: *M. decussata* Komarov

**Family 12. Taxaceae** Gray, *Nat. Arr. Brit. Pl.* 2: 222, 226 (1822), *nom. cons.*—T.: *Taxus* L.  
*Cephalotaxaceae* Neger, *Nadelhölzer* 23, 30 (1907).—T.: *Cephalotaxus* Siebold & Zucc. ex Endl.  
*Amentotaxaceae* Kudô & Yamam., in Kudô, *J. Soc. Trop. Agric.* 3: 110 (1931).—T.: *Amentotaxus* Pilg.  
*Austrotaxaceae* Nakai, *Tyosen-Sanrin* 158: 14 (1938).—T.: *Austrotaxus* Compton  
*Torreya* Nakai, *Tyosen-Sanrin* 158: 14, 23 (1938).—T.: *Torreya* Arnott

6 genera, 28 species, Eurasia to Malesia, North Africa, New Caledonia, North America to Central America. This sequence follows the phylogenetic trees of Hao *et al.* (2008). Taxaceae are monophyletic when *Cephalotaxus* and *Amentotaxus* are included (Price 2003). One could argue that the phylogenetic results of Hao *et al.* (2008) support an alternative classification of three families (Taxaceae, Cephalotaxaceae and Amentotaxaceae), but we have here opted for a wider circumscription of Taxaceae instead of these small families.

**12.1. *Austrotaxus*** Compton, *J. Linn. Soc., Bot.* 45: 427 (1922).—T.: *A. spicata* Compton

**12.2. *Pseudotaxus*** W.C.Cheng, *Res. Notes Forest. Inst. Natl. Centr. Univ. Nanking, Dendrol.*, ser. 1: 1 (1948).—T.: *P. chienii* (W.C.Cheng) W.C.Cheng (= *Taxus chienii* W.C.Cheng)  
*Nothotaxus* Florin, *Acta Horti Berg.* 14: 394 (1948), *nom. illeg.*

**12.3. *Taxus*** L., *Sp. Pl.* 2: 1040 (1753).—T.: *T. baccata* L.

- Verataxus* J.Nelson, *Pinaceae*: 168 (1866).—T.: *Taxus communis* J.Nelson (≡ *T. baccata* L.)
- 12.4. *Cephalotaxus*** Siebold & Zucc. ex Endl., *Gen. Pl. Suppl.* 2: 27 (1842).—T.: *C. pedunculata* Siebold & Zucc. ex Endl., *nom. illeg.* (= *C. harringtonii* (Knight ex J.Forbes) K.Koch ≡ *Taxus harringtonii* Knight ex J.Forbes)
- 12.5. *Amentotaxus*** Pilger, *Bot. Jahrb. Syst.* 54: 41 (1916).—T.: *A. argotaenia* (Hance) Pilger (≡ *Podocarpus argotaenia* Hance)
- 12.6. *Torreya*** Arnott, *Ann. Nat. Hist.* 1: 130 (1838), *nom. cons.*, non Raf. (1818, *Lamiaceae*), non Raf. (1819, *Cyperaceae*), non Spreng (1820, *Verbenaceae*), non A.Eaton (1929, *Loasaceae*), all *nom. rej.*—T.: *T. taxifolia* Arnott
- Tumion* Raf., *Good Book*: 63 (1840), *nom. illeg.*—T.: *T. taxifolium* (Arnott) Greene (≡ *Torreya taxifolia* Arnott)
- Struvea* Rchb., *Deutsche Bot. Herbarienbuch*: 222, 236 (1841), *nom. rej.*—T.: *Torreya taxifolia* Arnott
- Caryotaxus* Zucc. ex Henkel & Hochst., *Syn. Nadelhölzer*: 365 (1865), *nom. illeg.*—T.: *C. nucifera* (L.) Henkel & W.Hochst. (≡ *Taxus nucifera* L. ≡ *Torreya nucifera* (L.) Siebold & Zucc.)
- Foetataxus* J.Nelson, *Pinaceae*: 167 (1866), *nom. illeg.*—T.: *F. montana* J.Nelson, *nom. illeg.* (≡ *Torreya taxifolia* Arnott)

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## References

- Adams, R.P., Bartel, J.A. & Price, R.A. (2009) A new genus, *Hesperocyparis*, for the cypresses of the western hemisphere. *Phytologia* 91: 160–185.
- Bailey, I.W. (1944) The development of vessels in angiosperms and its significance in morphological research. *American Journal of Botany* 31: 421–428.
- Bierhorst, D.W. (1971) *Morphology of vascular plants*. Macmillan, New York.
- Bobrov, A.V.F.Ch. & Melikian, A.P. (2006) A new class of coniferophytes and its system based on the structure of the female reproductive organs. *Komarovia* 4: 47–115.
- Braukmann, T., Kuzmina, M. & Stefanović, S. (2010) Structural changes in the plastid genome of gymnosperms support the “gnepine” hypothesis. Abstract, *Botany 2010*, available on-line: <http://2010.botanyconference.org/engine/search/index.php?func=detail&aid=287>.
- Burleigh, J.G. & Mathews, S. (2004) Phylogenetic signal in nucleotide data from seed plants: implications for resolving the seed plant tree of life. *American Journal of Botany* 91: 1599–1613.
- Chase, M.W. & 41 co-authors (1993) Phylogenetics of seed plants: an analysis of nucleotide sequences from the plastid gene *rbcL*. *Annals of the Missouri Botanical Garden* 80: 528–580.
- Chase, M.W. & Reveal, J.L. (2009) A phylogenetic classification of the land plants to accompany APG III. *Botanical Journal of the Linnean Society* 161: 122–127.
- Chaw, S.-M., Parkinson, C.L., Cheng, Y., Vincent, T.M. & Palmer, J.D. (2000) Seed plant phylogeny inferred from all three plant genomes: monophyly of extant gymnosperms and origin of Gnetales from conifers. *Proceedings of the National Academy of Sciences, USA* 97: 4086–4091.
- Chaw, S.-M., Zharkikh, A., Sung, H.-M., Lau, T.-C. & Li, W.-H. (1997) Molecular phylogeny of extant gymnosperms and seed plant evolution: analysis of nuclear 18S rRNA sequences. *Molecular Biology and Evolution* 14: 56–68.
- Conran, J.G., Woods, G.M., Martin, P.G., Dowd, J.M., Quinn, C.J., Gadek, P.A. & Price, R.A. (2000) Generic relationships within and between the gymnosperm families Podocarpaceae and Phyllocladaceae based on an analysis of the chloroplast gene *rbcL*. *Australian Journal of Botany* 48: 715–724.
- Doweld, A.B. & Reveal, J.L. (1999, as ‘1998’) Validation of new suprageneric names in Pinophyta. *Phytologia* 84: 363–367.
- Eames, A.J. (1952) Relationships of Ephedrales. *Phytomorphology* 2: 79–100.
- Farjon, A. (2010) *A Handbook of the World's Conifers*. E.J. Brill, Leiden/Boston.

- Gadek, P.A., Alpers, D.L., Heslewood, M.M. & Quinn, C.J. (2000) Relationships within Cupressaceae *sensu lato*: a combined morphological and molecular approach. *American Journal of Botany* 87: 1044–1057.
- Hao, D.C., Xiao, P.G., Huang, B.L., Ge, G.B. & Yang, L. (2008) Interspecific relationships and origins of Taxaceae and Cephalotaxaceae revealed by partitioned Bayesian analyses of chloroplast and nuclear DNA sequences. *Plant Systematics and Evolution* 276: 89–104.
- Hasebe, M., Kofuji, R., Ito, M., Kato, M., Iwatsuki, K. & Veda, K. (1992) Phylogeny of gymnosperms inferred from *rbcL* gene sequences. *Botanical Magazine (Tokyo)* 105: 673–679.
- Haston, E., Richardson, J.E., Stevens, P.F., Chase, M.W. & Harris, D.J. (2007) A linear sequence of Angiosperm Phylogeny Group II families. *Taxon* 56: 7–12.
- Haston, E., Richardson, J.E., Stevens, P.F., Chase, M.W. & Harris, D.J. (2009) The linear Angiosperm Phylogeny Group (LAPG) III: a linear sequence of the families in APG III. *Botanical Journal of the Linnean Society* 161: 128–131.
- Hori, H., Lim, B.-L. & Osawa, S. (1985) Evolution of green plants as deduced from 5S. rRNA sequences. *Proceedings of the National Academy of Sciences, USA* 82: 820–823.
- Kelch, D.G. (1997) The phylogeny of the Podocarpaceae based on morphological evidence. *Systematic Botany* 22: 113–131.
- Kelch, D.G. (1998) Phylogeny of Podocarpaceae: comparison of evidence from morphology and 18S rDNA. *American Journal of Botany* 85: 986–996.
- Kunzmann, L. (2007) Araucariaceae (Pinopsida): aspects in palaeobiogeography and palaeobiodiversity in the Mesozoic. *Zoologischer Anzeiger* 246: 257–277.
- Lindstrom, A.J. (2009) Typification of some species names in *Zamia* L. (Zamiaceae), with an assessment of the status of *Chigua* D. Stev. *Taxon* 58: 265–270.
- Liston, A., Gernandt, D.S., Vining T.F., Campbell, C.S. & Piñero, D. (2003) Molecular phylogeny of Pinaceae and *Pinus*, in: Mill, R.R. (ed.), *Proceedings of the Fourth International Conifer Conference [Acta Horticulturae No. 615]*. International Society for Horticultural Science, Leuven, pp. 107–114.
- Little, D.P., Schwarzbach, A.E., Adams, R.P. & Hsieh, C.-F. (2004) The circumscription and phylogenetic relationships of *Callitropsis* and the newly described genus *Xanthocyparis* (Cupressaceae). *American Journal of Botany* 91: 1872–1881.
- Mao, K., Hao, G., Liu, J., Adams, R.P. & Milne, R.I. (2010) Diversification and biogeography of *Juniperus* (Cupressaceae): variable diversification rates and multiple intercontinental dispersals. *New Phytologist* 188: 254–272.
- Melikian, A.P. & Bobrov, A.V. (2000) Morfologiya shchenskikh reproduktivnykh obganov i op't rostroenniya filogeneticheskoy sistemy poryadkov Podocarpaceae, Cephalotaxales i Taxales. [Morphology of female reproductive structures and an attempt of the construction of phylogenetic system of orders Podocarpaceae, Cephalotaxales and Taxales]. *Botanicheskij Zhurnal (Moscow & Leningrad)* 85(7): 50–68.
- Passalia, M.G., Del Fueyo, G. & Archangelsky, S. (2010) An Early Cretaceous zamiaceous cycad of South West Gondwana: *Restrepophyllum* nov. gen. from Patagonia, Argentina. *Review of Palaeobotany and Palynology* 161: 137–150.
- Price, R.A. (2003) Generic and familial relationships of the Taxaceae from *rbcL* and *matK* sequence comparisons, in: Mill, R.R. (ed.), *Proceedings of the fourth international conifer conference [Acta Horticultural No. 615]*. International Society for Horticultural Science, Leuven, pp. 235–237.
- Qiu, Y.-L., Lee, J., Bernasconi-Quadroni, F., Soltis, D.E., Soltis, P.S., Zanis, M., Zimmer, E.A., Chen, Z., Savolainen, V. & Chase, M.W. (1999) The earliest angiosperms: evidence from mitochondrial, plastid and nuclear genomes. *Nature* 402: 404–407.
- Ran, J.-H., Gao, H. & Wang, X.-Q. (2010) Fast evolution of the retroprocessed mitochondrial *rps3* gene in conifer II and further evidence for the phylogeny of gymnosperms. *Molecular Phylogenetics and Evolution* 54: 136–149.
- Rydin, C., Källersjö, M. & Friis, E.M. (2002) Seed plant relationships and the systematic position of Gnetales based on nuclear and chloroplast DNA: conflicting data, rooting problems, and the monophyly of conifers. *International Journal of Plant Sciences* 163: 197–214.
- Sinclair, W.T., Mill, R.R., Gardner, M.F., Woltz, P., Jaffré, T., Preston, J., Hollingsworth, M.L., Ponge, A. & Möller, M. (2002) Evolutionary relationships of the New Caledonian heterotrophic conifer *Parasitaxus usta* (Podocarpaceae), inferred from chloroplast *trnL-F* intron/spacer and nuclear rDNA ITS2 sequences. *Plant Systematics and Evolution* 233: 79–104.
- Sporne, K.R. (1965) *The morphology of gymnosperms*, ed. 1. Hutchinson, London.
- Sun, C., Dilcher, D.L., Wang, H., Sun, G. & Ge, Y. (2008) A study of *Ginkgo* leaves from the Middle Jurassic of Inner Mongolia, China. *International Journal of Plant Sciences* 169: 1128–1139.
- Troitsky, A.V., Melekhovets, Y.F., Rakhimova, G.M., Bobrova, V.K., Valiejo-Roman, K.M. & Antonov, A.S. (1991) Angiosperm origin and early stages of seed plant evolution deduced from rRNA sequence comparisons. *Journal of Molecular Evolution* 32: 253–261.
- Zgurski, J.M., Rai, H.S., Fai, Q.M., Bogler, D.J., Francisco-Ortega, J. & Graham, S.W. (2008) How well do we understand the overall backbone of cycad phylogeny? New insights from a large, multigene plastid data set. *Molecular Phylogenetics and Evolution* 47: 1232–1237.

## Appendix 1. Index to gymnosperm genera

Below we provide an alphabetic list to the genera of gymnosperms. Accepted genera are printed in bold followed by the family. Synonymous genera are in italics followed by the currently accepted genus and their family.

- Abies* Mill.—Pinaceae  
*Abietia* A.H.Kent = *Pseudotsuga*—Pinaceae  
*Abutua* Lour. = *Gnetum*—Gnetaceae  
*Acmopyle* Pilg.—Podocarpaceae  
*Actinostrobus* Miq.—Cupressaceae  
*Afrocarpus* (J.Buchholz & N.E.Gray) C.N.Page—Podocarpaceae  
*Agathis* Salisb.—Araucariaceae  
*Amentotaxus* Pilg.—Taxaceae  
*Americus* Hanford = *Sequoiadendron*—Cupressaceae  
*Pinus* Neck. ex Rydb. = *Pinus*—Pinaceae  
*Araucaria* Juss.—Araucariaceae  
*Arceuthos* Antoine & Kotschy = *Juniperus*—Cupressaceae  
*Athrotaxis* D.Don—Cupressaceae  
*Aulacophyllum* Regel = *Zamia*—Zamiaceae  
*Austrocedrus* Florin & Boutelje—Cupressaceae  
*Austrotaxus* Compton—Taxaceae  
*Belis* Salisb. = *Cunninghamia*—Cupressaceae  
*Biota* (D.Don) Endl. = *Platycladus*—Cupressaceae  
*Botryopitys* Doweld = *Prumnopitys*—Podocarpaceae  
**Bowenia** Hook.f.—Zamiaceae  
*Bracteocarpus* A.V.Bobrov & Melikian = *Dacrycarpus*—Podocarpaceae  
*Brownetera* Rich. ex Tratt. = *Phyllocladus*—Podocarpaceae  
**Callitris** Vent.—Cupressaceae  
*Callitropsis* Compton = *Neocallitropsis*—Cupressaceae  
*Callitropsis* Oerst. = *Cupressus*—Cupressaceae  
**Calocedrus** Kurz—Cupressaceae  
*Caryopitys* Small = *Pinus*—Pinaceae  
*Caryotaxus* Zucc. ex Henkel & Hochst. = *Torreya*—Taxaceae  
*Catakidozamia* W.Hill = *Lepidozamia*—Zamiaceae  
**Cathaya** Chun & Kuang—Pinaceae  
*Cedrus* Duhamel = *Juniperus*—Cupressaceae  
**Cedrus** Trew—Pinaceae  
**Cephalotaxus** Siebold & Zucc.—Taxaceae  
**Ceratozamia** Brongn.—Zamiaceae  
*Chaetocladus* J.Nelson = *Ephedra*—Ephedraceae  
**Chamaecyparis** Spach—Cupressaceae  
*Chigua* D.W.Stev. = *Zamia* L.—Zamiaceae  
*Chrysolarix* H.E.Moore = *Pseudolarix*—Pinaceae  
*Columbea* Salisb. = *Araucaria*—Araucariaceae  
*Corneria* A.V.Bobrov & Melikian = *Dacrydium*—Podocarpaceae  
**Cryptomeria** D.Don—Cupressaceae  
**Cunninghamia** R.Br.—Cupressaceae  
*Cupressinnata* J.Nelson = *Taxodium*—Cupressaceae  
*Cupressstellata* J.Nelson = *Fitzroya*—Cupressaceae  
**Cupressus** L.—Cupressaceae  
**Cycas** L.—Cycadaceae  
*Cyparissia* Hoffmanns. = *Callitris*—Cupressaceae  
**Dacrycarpus** de Laub.—Podocarpaceae  
**Dacrydium** Lamb.—Podocarpaceae  
*Dammara* Link = *Agathis*—Araucariaceae  
*Decussocarpus* de Laub. = *Retrophyllum*—Podocarpaceae  
**Dioon** Lindl.—Zamiaceae  
**Diselma** Hook.f.—Cupressaceae  
*Dolophyllum* Salisb. = *Thujopsis*—Cupressaceae  
*Dombeya* Lam. = *Araucaria*—Araucariaceae  
*Ducampopinus* A.Chev. = *Pinus*—Pinaceae

*Dyerocycas* Nakai = *Cycas*—Cycadaceae  
*Encephalartos* Lehm.—Zamiaceae  
*Ephedra* L.—Ephedraceae  
*Epicycas* de Laub. = *Cycas*—Cycadaceae  
*Eutacta* Link = *Araucaria*—Araucariaceae  
*Eutassa* Salisb. = *Araucaria*—Araucariaceae  
*Falcatifolium* de Laub.—Podocarpaceae  
*Fitzroya* Hook.f. ex Lindl.—Cupressaceae  
*Foetataxus* J.Nelson = *Torreya*—Taxaceae  
*Fokienia* A.Henry & H.H.Thomas—Cupressaceae  
*Frenela* Mirb. = *Callitris*—Cupressaceae  
*Gaussenia* A.V.Bobrov & Melikian = *Dacrydium*—Podocarpaceae  
*Ginkgo* L.—Ginkgoaceae  
*Glyptostrobus* Endl.—Cupressaceae  
*Gnemon* Kuntze = *Gnetum*—Gnetaceae  
*Gnetum* L.—Gnetaceae  
*Halocarpus* Quinn—Podocarpaceae  
*Hesperocyparis* Bartel & R.A.Price = *Cupressus*—Cupressaceae  
*Hesperopeuce* (Engelm.) Lemmon = *Tsuga*—Pinaceae  
*Heyderia* C.Koch = *Calocedrus*—Cupressaceae  
*Jacularia* Raf. = *Cunninghamia*—Cupressaceae  
*Juniperus* L.—Cupressaceae  
*Keteleeria* Carr.—Pinaceae  
*Laechhardtia* G.Gordon = *Callitris*—Cupressaceae  
*Lagarostrobos* Quinn—Podocarpaceae  
*Laricopsis* A.H.Kent = *Pseudolarix*—Pinaceae  
*Larix* Mill.—Pinaceae  
*Laubenfelsia* A.V.Bobrov & Melikian = *Dacrycarpus*—Podocarpaceae  
*Lepidothamnus* Phil.—Podocarpaceae  
*Lepidozamia* Regel—Zamiaceae  
*Leucopitys* Nieuwl. = *Pinus*—Pinaceae  
*Libocedrus* Endl.—Cupressaceae  
*Macrozamia* Miq.—Zamiaceae  
*Manoao* Molloy—Podocarpaceae  
*Margbensonia* A.V.Bobrov & Melikian = *Podocarpus*—Podocarpaceae  
*Marywildea* A.V.Bobrov & Melikian = *Araucaria*—Araucariaceae  
*Metadacrydium* M.G.Baum.-Bod. ex Melikian & A.V.Bobrov = *Dacrydium*—Podocarpaceae  
*Metasequoia* Hu & W.C.Cheng—Cupressaceae  
*Microbiota* Komarov—Cupressaceae  
*Microcachrys* Hook.f.—Podocarpaceae  
*Microcycas* (Miq.) A.DC.—Zamiaceae  
*Microstrobos* J.Garden & L.A.S.Johnson = *Pherosphaera*—Podocarpaceae  
*Nageia* Gaertn.—Podocarpaceae  
*Neocallitropsis* Florin—Cupressaceae  
*Neocupressus* de Laub. = *Cupressus*—Cupressaceae  
*Nothocallitris* A.V.Bobrov & Melikian = *Callitris*—Cupressaceae  
*Nothotaxus* Florin = *Pseudotaxus*—Taxaceae  
*Nothotsuga* Hu ex C.N.Page—Pinaceae  
*Octoclinis* F.Muell. = *Callitris*—Cupressaceae  
*Pachylepis* Brongn. = *Widdringtonia*—Cupressaceae  
*Palma-Filix* Adans. = *Zamia*—Zamiaceae  
*Palmifolium* Kuntze = *Zamia*—Zamiaceae  
*Papuacedrus* H.L.Li—Cupressaceae  
*Parasitaxus* de Laub.—Podocarpaceae  
*Parolinia* Endl. = *Widdringtonia*—Cupressaceae  
*Pherosphaera* W.Archer bis—Podocarpaceae  
*Phyllocladus* Rich. & Mirb.—Podocarpaceae  
*Picea* A.Dietr.—Pinaceae  
*Picea* D.Don ex Loud. = *Abies*—Pinaceae  
*Pilgerodendron* Florin—Cupressaceae  
*Pinea* Wolf = *Pinus*—Pinaceae

*Pinus* L.—Pinaceae  
*Platycladus* Spach—Cupressaceae  
*Platycyparis* A.V.Bobrov & Melikian = *Cupressus*—Cupressaceae  
*Platyzamia* Zucc. = *Dioon*—Zamiaceae  
*Podocarpus* L'Hér. ex Pers.—Podocarpaceae  
*Podocarpus* Labill. = *Phyllocladus*—Podocarpaceae  
*Prumnopitys* Phil.—Podocarpaceae  
*Pseudolarix* Gordon—Pinaceae  
*Pseudotaxus* Cheng—Taxaceae  
*Pseudotsuga* Carr.—Pinaceae  
*Pterophyllum* J.Nelson = *Ginkgo*—Ginkgoaceae  
*Quadrifaria* Manetti ex Gordon = *Araucaria*—Araucariaceae  
*Raxopitys* J.Nelson = *Cunninghamia*—Cupressaceae  
*Retinispora* Siebold & Zucc. = *Chamaecyparis*—Cupressaceae  
*Retrophyllum* C.N.Page—Podocarpaceae  
*Sabina* Mill. = *Juniperus*—Cupressaceae  
*Sabinella* Nakai = *Juniperus*—Cupressaceae  
*Salisburia* Sm. = *Ginkgo*—Ginkgoaceae  
*Salisburyodendron* A.V.Bobrov & Melikian = *Agathis*—Araucariaceae  
*Saxegothaea* Lindl.—Podocarpaceae  
*Schubertia* Mirb. = *Taxodium*—Cupressaceae  
*Sciadopitys* Siebold & Zucc.—Sciadopityaceae  
*Sequoia* Endl.—Cupressaceae  
*Sequoiadendron* J.Buchholz—Cupressaceae  
*Shishindenia* Makino ex Koidz. = *Chamaecyparis*—Cupressaceae  
*Squamataxus* J.Nelson = *Saxegothaea*—Podocarpaceae  
*Stachycarpus* (Endl.) Tiegh. = *Prumnopitys*—Podocarpaceae  
*Stachypitys* A.V.Bobrov & Melikian = *Prumnopitys*—Podocarpaceae  
*Stangeria* T.Moore—Zamiaceae  
*Stegocedrus* Doweld = *Libocedrus*—Cupressaceae  
*Strobus* (Sweet ex Spach) Opiz = *Pinus*—Pinaceae  
*Struvea* Reichenb. = *Torreya*—Taxaceae  
*Sundacarpus* (J.Buchholz & N.E.Gray) C.N.Page—Podocarpaceae  
*Taiwania* Hayata—Cupressaceae  
*Tassilicyparis* A.V.Bobrov & Melikian = *Cupressus*—Cupressaceae  
*Taxodium* Rich.—Cupressaceae  
*Taxus* L.—Taxaceae  
*Tetraclinis* Masters—Cupressaceae  
*Thalamia* Spreng. = *Phyllocladus*—Podocarpaceae  
*Thoa* Aubl. = *Gnetum*—Gnetaceae  
*Thuja* L.—Cupressaceae  
*Thujaecarpus* Trautv. = *Juniperus*—Cupressaceae  
*Thujopsis* Siebold & Zucc. ex Endl.—Cupressaceae  
*Thya* Adans. = *Thuja*—Cupressaceae  
*Titanodendron* A.V.Bobrov & Melikian = *Araucaria*—Araucariaceae  
*Todda-Pana* Adans. = *Cycas*—Cycadaceae  
*Torreya* Arn.—Taxaceae  
*Tsuga* (Endl.) Carr.—Pinaceae  
*Tumboa* Welw. = *Welwitschia*—Welwitschiaceae  
*Tumion* Raf. = *Torreya*—Taxaceae  
*Van-Tieghemia* A.V.Bobrov & Melikian, *nom. illeg.* = *Prumnopitys*—Podocarpaceae  
*Verataxus* J.Nelson = *Taxus*—Taxaceae  
*Veitchia* Lindl. = *Picea*?—Pinaceae  
*Washingtonia* Winslow = *Sequoiadendron*—Cupressaceae  
*Wellingtonia* Lindl. = *Sequoiadendron*—Cupressaceae  
*Welwitschia* Hook.f.—Welwitschiaceae  
*Widdringtonia* Endl.—Cupressaceae  
*Wollemia* W.G.Jones, K.D.Hill & J.M.Allen—Araucariaceae  
*Xanthocyparis* Farjon & T.H.Nguyễn = *Cupressus*—Cupressaceae  
*Zamia* L.—Zamiaceae