## Descriptions

Araucariaceae

Monkey Puzzles, Norfolk Island Pine, Kauri, Candelabra Tree. **Vegetative.** Evergreen (in some, the leaves remain green for up to fifteen years); trees. Resinous (with resin canals in stem medullary rays and cortex, and in the leaves). Main branches whorled. The leafy branchlets not flattened. Mature leaves broad and flat (often broad-based, with many parallel veins), or linear; acicular, or relatively soft (mostly); not clustered; alternate (although the main branches are usually whorled). Longitudinal resin canals present in the leaves. **Reproductive organization.** Monoecious (*Agathis*, usually), or dioecious (*Araucaria*). The ovules borne in female cones. The female cones woody (almost spherical). The seed-cone scales spirally arranged; deciduous, the cones disintegrating at maturity (the seed either shed attached to the cone scale, with the latter serving as wings, or detaching from the cone scale along with a wing); woody. The ovules borne proximal-adaxially on the seed-cone scales. The bract-scales extensively fused to the seed-cone scales in mature cones (though in *Araucaria* the tip is conspicuously free, constituting a “ligule”). The seed-cone scales 1 ovuled. The ovules anatropous. Male cones elongate, the microsporophylls with 5–15 abaxial pollen-sacs in *Agathis*, 8–15 in *Araucaria*. The pollen grains produce numerous prothallial cells. Pollen-sacs 5–15 per microsporophyll. Pollen without air bladders. Pollination anemophilous, with fertilization involving lodgement of the grain on the cone-scale (or in *Araucaria* on the “ligule”), and growth of the pollen tube to the ovule via a nucellar beak projecting through the micropyle (i.e., no “liquid drop” mechanism). **Seeds and seedlings.** Seeds winged. Cotyledons 2(–4). **Wood anatomy.** Growth rings indistict. Heartwood present and distinctively coloured (usually, though often weakly developed), or present but not distinctively coloured, or absent (*Araucaria cunninghamii*). Latewood not conspicuous. Wood without distinct odour; with a distinct taste (*Agathis australis*), or without distinct taste (usually); not greasy; without dimpled grain. Tracheids with alternate bordered pits; without callitroid pit-border thickenings. Earlywood tracheids without spiral thickenings. Axial parenchyma absent. Ray tracheids absent or very infrequent. Earlywood ray cells with horizontal walls thinner than those of the adjacent vertical tracheids above and below the ray. Latewood ray cells with unpitted horizontal walls. Ray cells without indentures; without nodular thickenings on their end walls. Ray tissue without crystals. Earlywood cross-field pits cupressoid (or araucarioid), or piceoid and cupressoid (*Araucaria cunninghamii*). Normal vertical resin ducts absent. **Geography, cytology.** Temperate to tropical; Southern hemisphere, excluding Africa. Basic chomosome number, n = 13. **Taxonomy.** 40 species; *Agathis*, *Araucaria*, *Wollemia*. Subclass (after Christenhusz et al., 2011): Pinidae; Araucariales. **Comments.** *Wollemia nobilis* was discovered in 1994 in a temperate rainforest wilderness area of the Wollemi National Park in New South Wales. Its closest relatives seem to be Jurassic species of *Agathis*, and Cretacious fossils represented by the form genus *Araucarites* and *Araucarioxylon* (wood).

Cephalotaxaceae

Plum Yew, Cow’s Tail Pine. ~Taxaceae. **Vegetative.** Evergreen; small trees and shrubs. Resinous (with resin canals in stem pith and cortex, and in the leaves). Main branches whorled, or opposite. The leafy branchlets flattened in one plane. The vegetative branch systems without conspicuously specialised short-shoots. Mature leaves linear; relatively soft; not clustered; alternate. Longitudinal resin canals present in the leaves; 1 per leaf, this median-abaxial. **Reproductive organization.** Usually dioecious. The ovules borne in female cones (the young cone comprising a thick, rather fleshy axis bearing a few bracts, each bract subtending a pair of transversely placed ovules of which only one or two per cone mature to produce olive-like seeds). The seed-cone scales opposite and decussate; persistent. The ovules ostensibly axillary (in pairs, though arguably each pair terminates an extremely abbreviated short-shoot, with the latter then seen as representing the “ovuliferous scale” of other coniferous cones); paired, orthotropus; 1 integumented (this fused with the nucellus except at its apex). The male cones with spirally arranged microsporophylls. Prothallial cells lacking. Pollen-sacs (2–)3 per microsporophyll. Pollen without air bladders. Pollination anemophilous, involving a “liquid drop” mechanism. **Seeds and seedlings.** Seeds with a fleshy investment; the fleshy investment developed from the integument; wingless. Cotyledons 2. **Wood anatomy.** Growth rings indistict. Heartwood present but not distinctively coloured, or absent. Latewood not conspicuous. Wood without distinct odour; without distinct taste; not greasy; without dimpled grain. Tracheids with neither alternate nor opposite bordered pits; without callitroid pit-border thickenings. Margins of the tori not scalloped. Earlywood tracheids with spiral thickenings. Axial parenchyma present. Axial parenchyma abundant. Axial parenchyma not zonate. Axial parenchyma with nodular thickenings or bead-like on the transverse or end-walls. Ray tracheids absent or very infrequent. Earlywood ray cells with walls similar in thickness to those of adjacent vertical tracheids. Latewood ray cells with pitted horizontal walls. The pitting weak. Ray cells exhibiting indentures at the corners; without nodular thickenings on their end walls. Ray tissue without crystals. Earlywood cross-field pits piceoid. Normal vertical resin ducts absent. **Geography, cytology.** Eastern Himalayas to Japan. Basic chomosome number, n = 12. **Taxonomy.** 7–8 species; *Cephalotaxus*. Subclass (after Christenhusz et al., 2011): Pinidae; Cupressales.

Cupressaceae

Cypresses, Incense Cedars, Junipers, Arbor Vitae. Currently excluding Taxodiaceae. **Vegetative.** Evergreen; trees and shrubs (with all their parts opposite and decussate, or whorled). Resinous (exhibiting resin cells - not ducts - in the wood, but with canals in the stem cortex and leaves). The leafy branchlets flattened in one plane (often), or not flattened. Mature leaves dimorphic (*Juniperus*), or not dimorphic; usually small, scale-like (and decurrent), or linear (sometimes, like the juvenile leaves), or linear and scale-like (in *Juniperus*); when linear, acicular (*Juniperus*); not clustered; opposite and decussate, or whorled. Longitudinal resin canals present in the leaves, or absent from the leaves (sometimes?); in *Fitzroya*, *Juniperus*, 1 per leaf, this median-abaxial (no information for the rest). **Reproductive organization.** Monoecious, or dioecious (e.g., usually so in *Juniperus*). The ovules borne in female cones. The female cones woody, or fleshy and berry-like. The seed-cone scales opposite and decussate, or whorled (then the whorls of three or four members); persistent; fleshy (and berry-like, *Juniperus*), or leathery, or woody. The ovules borne proximal-adaxially on the seed-cone scales. The bract-scales not clearly resolvable from the seed-cone scales (the "ovuliferous scale" vestiges apparently so reduced that the ovules are virtually borne on the bracts). The seed-cone scales 1–2 ovuled (rarely), or 3–20 ovuled. The ovules orthotropus. Male cone scales opposite, decussate or whorled. Pollen-sacs (2–)3–6 per microsporophyll. Pollen without air bladders. Pollination anemophilous, involving a “liquid drop” mechanism. **Seeds and seedlings.** Seeds winged, or wingless. Cotyledons 2 (usually), or 5–6, or 9. **Wood anatomy.** Growth rings indistict, or distinct. Heartwood present and distinctively coloured, or present but not distinctively coloured, or absent. Latewood not conspicuous (mostly), or conspicuous (e.g., in *Thuya* spp.). Wood with a distinct odour, or without distinct odour; with a distinct taste, or without distinct taste; greasy to the touch, or not greasy; without dimpled grain. Tracheids with neither alternate nor opposite bordered pits (uniseriate, except in *Thuya*); with callitroid pit-border thickenings, or without callitroid pit-border thickenings (mostly). Margins of the tori scalloped (e.g., in *Juniperus thurifera* and *Thuya occidentalis*), or not scalloped (mostly). Earlywood tracheids without spiral thickenings. Axial parenchyma present. Axial parenchyma abundant (usually), or scarce. Axial parenchyma zonate, or not zonate. Axial parenchyma with nodular thickenings or bead-like on the transverse or end-walls, or without nodular thickenings on the transverse or end-walls. Rays exclusively uniseriate (commonly), or not exclusively uniseriate (then usually only 1–2 cells wide). Ray tracheids regularly present (e.g., *Chamaecyparis nootkatensis*), or absent or very infrequent (usually). Ray tracheids when present, not dentate. Earlywood ray cells with horizontal walls thinner than those of the adjacent vertical tracheids above and below the ray, or with walls similar in thickness to those of adjacent vertical tracheids (usually). Latewood ray cells with unpitted horizontal walls, or with pitted horizontal walls. The pitting wnen present, strong (*Thujopsis*), or weak (usually). Ray cells exhibiting indentures at the corners, or without indentures; exhibiting nodular or bead-like thickenings on their end walls, or without nodular thickenings on their end walls. Ray tissue without crystals. Earlywood cross-field pits cupressoid (mostly), or piceoid and cupressoid (*Tetraclinis*), or cupressoid and taxodioid (rarely, in *Chamaecyparis*), or taxodioid (e.g., some *Thuja* spp., *Thujopsis*). Normal vertical resin ducts absent. **Geography, cytology.** Cosmopolitan. Basic chomosome number, n = 11. **Taxonomy.** *S. str*., about 115 species; *Actinostrobus*, *Callitris*, *Calocedrus*, *Chamaecyparis*, *Cupressus*, *Diselma*, *Fitzroya*, *Fokienia*, *Juniperus*, *Libocedrus*, *Neocallitropsis*, *Pilgerodendron*, *Platycladus*, *Tetraclinis*, *Thuja*, *Thujopsis*, *Widdringtonia*. Subclass (after Christenhusz et al., 2011): Pinidae; Cupressales.

Cycadaceae

**Vegetative.** Pachycaul (of palm-like habit, from small to 12 metres high and leaves to 3 m or more long, the subterranean to emergent stem to 40 cm wide, with relatively little wood, clothed in persistent leaf bases); evergreen; trees, or shrubs; with apogeotropic roots bearing cyanobacteria, born in coralloid masses just above ground level. Not resinous (secreting mucilage). Mature leaves pinnate (with girdling leaf traces). The leaflets with a prominent midrib and no laterals (the basal ones sometimes reduced to spines). **Reproductive organization.** Dioecious (via X and Y chromosomes). The ovules not in cones (the leaf-like sporophylls alernating with vegetative fronds in a loose terminal rosette, through which the stem subsequently continues to grow); marginal or in notches, on discrete megasporophylls with sterile tips (the tomentose sporophylls flat and elongate, with dilated, acuminate and toothed or pinnatifid apices). The megasporophylls (1–)3–8 ovuled (borne marginally in notches in the lower part of the megasporophyll). The ovules orthotropus. Pollen-sacs numerous, borne abaxially on the cuneate microsporophylls. Pollen without air bladders. Pollination probably always anemophilous; involving a “liquid drop” mechanism. Fertilization involving spirally flagellate, motile spermatozoids. **Seeds and seedlings.** Seeds large, with a fleshy investment; the fleshy investment developed from the integument (from the outer layer of the testa, which surrounds the woody inner one); wingless. Cotyledons 2. **Wood anatomy.** Growth rings indistict (absent, but a few species exhibit successive cambia giving rise to co-axial cylinders of xylem and phloem). Tracheids with opposite and multiseriate bordered pits. **Geography, cytology.** Temperate to tropical; Southeast Asia, southern China, Malaysia, tropical Australia, Oceania, Japan, Africa, and Madagascar. Basic chomosome number, n = 11. **Taxonomy.** About 90 species; *Cycas*. Subclass (after Christenhusz et al., 2011): Cycadidae; Cycadales. **Comments.** Leaves and leaflets usually with more or less circinate vernation.

Ephedraceae

**Vegetative.** Small trees (rarely), or shrubs (mostly being shrubby switch plants, often rhizomatous), or vines (a few). *Casuarina*-like switch-plants photosynthesizing mainly via their grooved and jointed stems, the leaves reduced to small scales which are soon shed. Main branches whorled, or opposite. The leafy branchlets grooved-cylindrical, not flattened. Mature leaves simple (tiny, reduced); scale-like (unilacunar, with two leaf traces); opposite and decussate, or whorled (then usually in whorls of three). **Reproductive organization.** Nearly always dioecious (but with occasional reports of bisexual inflorescences). The reproductive structures organized like reduced angiosperm flowers (with stamen-like antherophores, but with exposed, gymnospermous ovules). The ovules borne in female cones (the cones solitary or clustered at the compound inflorescence nodes, each consisting of a short-shoot bearing 2–4 pairs or whorls of overlapping bracts, the proximal bracts empty and the 1–3 terminal ones subtending female “flowers”). The seed-cone scales opposite and decussate, or whorled; commonly red, often fleshy. The ovules borne erect in the centre of the “flowers”; orthotropus (with an elongated, tubular micropyle); 1 integumented, or 2 integumented (depending on interpretation of the outer one, which may be interpreted as perianth). Male inflorescences solitary or clustered at nodes, each composed of 2–8 descussate pairs or 3-part whorls of membranous bracts, the proximal ones empty; the male “flowers” with a “perianth” comprising 2 antero-posteriorly united, orbicular or obovate members, beyond which the prolonged axis bears 2–8 sessile or stipitate, 2-locular anthers. Pollen without air bladders. Pollination involving a “liquid drop” mechanism; anemophily is said to be prevalent, but with entomophily recorded in a few species. **Seeds and seedlings.** Seeds one to three per cone, with no fleshy investment; wingless. Cotyledons 2. **Wood anatomy.** Growth rings distinct (ring-porous). Secondary xylem with vessels. Normal vertical resin ducts absent. **Geography, cytology.** Temperate to tropical; semiarid and arid areas in North America, Mexico, South America, Europe, Asia, and N and E Africa (including Canary Islands). **Taxonomy.** About 40 species; *Ephedra*. Subclass (after Christenhusz et al., 2011): Gnetidae; Ephedrales. **Comments.** Several species yield ephedrine, an adrenalin-breakdown inhibitor widely used to relieve symptoms of asthma, sinusitis, etc.

Ginkgoaceae

Ginkgo, Maidenhair Tree. **Vegetative.** Deciduous; trees (to 30m high). Not resinous (secreting mucilage). Main branches spiral to whorled (irregularly whorled or produced at indefinite intervals). The leafy branchlets not flattened. The vegetative branch systems including highly specialised, leaf-bearing short-shoots (cf. those of *Larix* and *Cedrus*, producing leaf clusters annually for many years and sometimes subsequently becoming transformed into long-shoots bearing scattered leaves). Mature leaves more or less dimorphic (being more or less bilobed on long-shoots and entire on short-shoots); broad and flat (long-petiolate, the fan-shaped lamina with numerous, regularly dichotomizing veins); alternate. Longitudinal resin canals absent from the leaves. **Reproductive organization.** Dioecious (via an XX female/XY male genetic system). The ovules not in cones (the more or less sessile female flowers each comprising a naked ovule with a basal, collar-like rim theoretically representing two megasporophylls; paired or in twos or threes terminating long, axillary peduncles on the short-shoots); terminating axes; orthotropus; 1 integumented. Male trees produce elongated, catkin-like strobili in the axils of scales or leaves on short-shoots. These bear the numerous stamen-like microsporangiophores, each with 2 pendulous microsporangia which dehisce via a longitudinal slit. Pollen-sacs 2 per microsporophyll (pendulous male catkins borne 3–6 in the axils of scales or leaves on the short shoots, with ‘microsporophylls’ each represented by a bractless, axillary main axis bearing laterally towards its apex a pair of pendulous microsporangia dehiscing via longitudinal slits). Pollen without air bladders. Fertilization involving spirally flagellate, motile spermatozoids. **Seeds and seedlings.** Seeds wingless, with a fleshy investment; the fleshy investment developed from the integument (via its fleshy outer layer, which gives off a nauseating odour of rancid butter, and encloses a stony middle layer, which in turn encloses a watery inner layer surrounding the female prothallus); wingless. Cotyledons usually 2 (unlike the foliage leaves in exhibiting mesarch vascular strands). **Wood anatomy.** Growth rings distinct. Latewood not conspicuous. Wood without distinct odour. Tracheids with opposite and multiseriate bordered pits; without callitroid pit-border thickenings. Margins of the tori not scalloped. Axial parenchyma present. Axial parenchyma zonate. Axial parenchyma without nodular thickenings on the transverse or end-walls. Rays exclusively uniseriate. Ray tissue without crystals. Earlywood cross-field pits cupressoid (or araucarioid). Normal vertical resin ducts absent (but mucilage canals occur throughout the plant). **Geography, cytology.** Temperate; the single species is possibly native to China, but is now unknown in the wild; long cultivated in China and Japan for its edible seeds and its supposed medicinal properties. Basic chomosome number, n = 12. **Taxonomy.** 1 species (*Ginkgo biloba*); *Ginkgo*. Subclass (after Christenhusz et al., 2011): Ginkgoidae; Ginkgoales. **Comments.** Leaves without resin canals, and differing conspicuously from Coniferales in that fertilization is effected by flagellate, motile spermatozoids - cf. cycads, ferns and other vascular cryptogams. Obvious relatives of *G. biloba* occur in fossil deposits up to 200 million years old. Now widely grown around the world from material originating from China, and exploited as "alternative medicine".

Gnetaceae

**Vegetative.** Evergreen; small trees (a few), or shrubs, or vines (mostly). The leafy branchlets not flattened. Mature leaves simple; broad and flat (elliptic, angiosperm-like, with reticulate venation, exstipulate, leathery, with hydathodes); not clustered; opposite and decussate. **Reproductive organization.** Monoecious, or dioecious (mostly). The reproductive structures organized like reduced angiosperm flowers (with stamen-like antherophores, but with exposed, gymnospermous ovules). The female flowers borne in spikes, which are often grouped into more complex inflorescences. The spikes bear decussate bracts, in the axils of which are condensed partial inflorescences of about 3–8 female flowers, which form whorls round the stem and are intermingled with numerous hairlike structures. The female flower has a tubular perianth, cf. that of *Ephedra*, around the single, apparently 2-integumented ovule. After fertilization, the perianth becomes fleshy, the outer integument becomes woody, and the whole forms a drupe-like fruit. The ovules not in cones (being produced in the female “flowers” of uncertain morphological interpretation, in whorls on the spikelike inflorescence axes, each whorl subtended by a fleshy collar); borne erect in the centre of the “flowers”; orthotropus (with a long, projecting, tubular micropyle); 2 integumented (if the outer layer is interpreted as a perianth), or 3 integumented. The male flowers in spikes, these often grouped into more complex inflorescences. The spike bears decussate bracts, in the axils of which are condensed, partial inflorescences of up to 40 flowers. The effectively whorled flowers are intermingled with hairlike structures. At the top of each nodal group in the male inflorescence there is usually a single ring of female flowers, which are rarely fertile. Male flowers with a tubular (2-membered) perianth, and at the top of the projecting axis, right and left, are two sessile unilocular anthers. Pollen without air bladders. Pollination mostly anemophilous, but entomophily associated with nectar secretion is known in a few species; involving a “liquid drop” mechanism. **Seeds and seedlings.** Seeds wingless. Cotyledons 2. **Wood anatomy.** Secondary xylem with vessels. **Geography, cytology.** Sub-tropical and tropical; Indomalaysia, tropical parts of West Africa, Fiji and the northern regions of South America. **Taxonomy.** About 30 species; *Gnetum*. Subclass (after Christenhusz et al., 2011): Gnetidae; Gnetales. **Comments.** Flowers monosexual, in catkin-like formations; the male flower consists of a stamen and perianth, and female flower of an ovule with 2 integuments and perianth.

Pinaceae

Pines, Cedars, Firs, Spruces, Larches, Hemlocks. **Vegetative.** Evergreen (mostly), or deciduous (in *Larix* and *Pseudolarix*); trees (nearly all), or shrubs (a few species of *Pinus*). Resinous (with resin canals in various parts of the plants, though absent from the secondary wood of *Abies*, *Pseudolarix*, *Cedrus* and *Tsuga*). Main branches spiral, or whorled, or spiral to whorled. The leafy branchlets not flattened. The vegetative branch systems without conspicuously specialised short-shoots, or including highly specialised, leaf-bearing short-shoots. Mature leaves linear; acicular; paired or in tight clusters on short-shoots, each cluster with a basal sheath of scales, or not clustered (all are borne singly in *Abies*, *Picea*, *Pseudotsuga* and *Tsuga*, while in *Pinus* they are all paired or clustered on highly contracted short-shoots, and in *Cedrus* and *Larix* they are borne singly on leading long-shoots as well as in clusters on the short-shoots); alternate (or in pseudo-whorls). Longitudinal resin canals present in the leaves (mostly), or absent from the leaves (e.g., some *Picea* species?); 2 per leaf, these lateral (marginal or “median”), or in a horizontal row, or in a peripheral ring, or in an abaxial arc (rarely), or in an adaxial arc. **Reproductive organization.** Monoecious. The ovules borne in female cones (which are confined to mature branches). The female cones woody. The seed-cone scales spirally arranged; persistent, or deciduous, the cones disintegrating at maturity (in *Abies*, the cone scales are shed, but the axis remains attached); woody. The ovules borne proximal-adaxially on the seed-cone scales. The bract-scales more or less free of the seed-cone scales in mature cones. The seed-cone scales 2 ovuled. The ovules anatropous; 1 integumented. The crowded male cones, which take the place of short-shoots, bear spirally arranged microsporophylls each two abaxial pollen-sacs dehiscing via a longitudinal slit. The pollen grains have two prothallial cells. Pollen-sacs 2 per microsporophyll. Pollen with air bladders (e.g., *Pinus*), or without air bladders (e.g., *Larix*). Pollination anemophilous, and in genera with pollen grains equipped with air bladders (e.g., *Pinus*), it involves a “liquid drop” mechanism, the grain being drawn into contact with the nucellus as it floats in receding micropylar fluid. **Seeds and seedlings.** Seeds winged. Cotyledons (3–)4(–15). **Wood anatomy.** Growth rings distinct. Heartwood present and distinctively coloured (brown, reddish or yellow), or present but not distinctively coloured, or absent (whitish, creamy or grey). Latewood not conspicuous, or conspicuous. Wood with a distinct odour, or without distinct odour; with a distinct taste, or without distinct taste; not greasy; without dimpled grain. Tracheids with opposite and multiseriate bordered pits, or with neither alternate nor opposite bordered pits (then the pitting uniseriate); without callitroid pit-border thickenings. Margins of the tori scalloped, or not scalloped. Torus extensions conspicuously present (in *Tsuga* spp.), or absent (mostly). Earlywood tracheids without spiral thickenings. Axial parenchyma present, or present to absent (e.g., *Larix*), or absent (e.g., *Picea*, *Pinus*). Axial parenchyma when present, scarce. Axial parenchyma not zonate. Axial parenchyma with nodular thickenings or bead-like on the transverse or end-walls, or without nodular thickenings on the transverse or end-walls. Rays exclusively uniseriate, or not exclusively uniseriate (then 1–2 or 1–5 cells wide). Ray tracheids regularly present, or absent or very infrequent. Ray tracheids when present, dentate, or not dentate. Earlywood ray cells with horizontal walls thinner than those of the adjacent vertical tracheids above and below the ray, or with walls similar in thickness to those of adjacent vertical tracheids. Latewood ray cells with unpitted horizontal walls, or with pitted horizontal walls. The pitting when present, strong, or weak. Ray cells exhibiting indentures at the corners, or without indentures; exhibiting nodular or bead-like thickenings on their end walls, or without nodular thickenings on their end walls. Ray tissue exhibiting crystals, or without crystals. Earlywood cross-field pits 1(-3), large and simple (or nearly so), or piceoid, or piceoid and cupressoid, or taxodioid, or piceoid, cupressoid, and taxodioid (*Cedrus*), or 1–6 pinoid. Normal vertical resin ducts present (e.g., *Larix*, *Picea*, *Pinus*), or absent (*Abies*). The normal resin ducts with at least some thick-walled epithelial cells, or with only thin-walled epithelial cells; with 7–12 epithelial cells. **Geography, cytology.** Frigid zone to tropical; Northern hemisphere, south to Sumatra, Java, Central America and West Indies. Basic chomosome number, n = 12, or 13 (*Pseudotsuga* only). **Taxonomy.** 232 species; *Abies*, *Cathaya*, *Cedrus*, *Keteleeria*, *Larix*, *Nothotsuga*, *Picea*, *Pinus*, *Pseudolarix*, *Pseudotsuga*, *Tsuga*. Subclass (after Christenhusz et al., 2011): Pinidae; Pinales.

Podocarpaceae

Podocarps, Yellow-woods, Red Pine, Huon Pine, Celery-top Pine, Prince Albert’s Yew. **Vegetative.** Evergreen; trees and shrubs. Resinous (with resin canals in the leaves, but only resin-containing parenchyma cells elsewhere). The leafy branchlets flattened in one plane, or not flattened. Phyllocladineous (*Phyllocladus*), or with normal leaves. Mature leaves relatively broad and flat, or linear, or scale-like; when linear, acicular, or relatively soft; not clustered; alternate (mostly), or opposite and decussate (decussate, in *Microcachrys*). Longitudinal resin canals present in the leaves, or absent from the leaves; when present, 1 per leaf, this median-abaxial. **Reproductive organization.** Monoecious (rarely), or dioecious. The ovules borne in female cones (the cones few-bracted, and each bearing only one seed to maturity), or not in cones (ostensibly, the ‘cone’ being sometimes reduced to a swollen, fleshy receptacle with a single terminal ovule, so that its morphological homologies are esoteric); ostensibly terminating axes, or borne proximal-adaxially on the seed-cone scales (except in *Phyllocladus* and *Microstrobus*, the vestigial “ovuliferous scale” is usually more or less folded round the ovule, constituting an extra envelope designated the ‘epimatium’, which is itels sometimes fused to the integument). The bract-scales more or less free of the seed-cone scales in mature cones. The seed-cone scales assuming they are recognised as such, 1 ovuled. The ovules orthotropus (rarely), or anatropous. Male cones catkin-like, with numerous sporophylls each bearing two sporangia. Pollen-sacs 2 per microsporophyll. Pollen with air bladders (2 or 3, sometimes well developed, sometimes poorly developed or vestigial), or without air bladders (e.g., *Saxegothaea*). The pollination mechanisms are diverse, being by “liquid drop” mechanism only when the grains are equipped with well developed air bladders (cf. *Pinaceae*). **Seeds and seedlings.** Seeds with a fleshy investment; the fleshy investment variously receptacular, or representing a genuine aril, or developed from the cone-scales, or developed from the integument (individually or combinations); wingless. Cotyledons 2. **Wood anatomy.** Growth rings indistict, or distinct. Heartwood present and distinctively coloured, or present but not distinctively coloured, or absent. Latewood not conspicuous. Wood without distinct odour; without distinct taste; not greasy; with dimpled grain (*Podocarpus spicatus*), or without dimpled grain (usually). Tracheids with neither alternate nor opposite bordered pits; without callitroid pit-border thickenings. Margins of the tori not scalloped. Torus extensions conspicuously present (e.g., in *Lagarostrobus*), or absent. Earlywood tracheids without spiral thickenings. Axial parenchyma present, or absent. Axial parenchyma when present, abundant, or scarce. Axial parenchyma not zonate. Axial parenchyma with nodular thickenings or bead-like on the transverse or end-walls (*Saxegothaea*), or without nodular thickenings on the transverse or end-walls. Ray tracheids regularly present (usually, in *Podocarpus*), or absent or very infrequent. Ray tracheids when present, not dentate. Earlywood ray cells with horizontal walls thinner than those of the adjacent vertical tracheids above and below the ray, or with walls similar in thickness to those of adjacent vertical tracheids. Latewood ray cells with unpitted horizontal walls, or with pitted horizontal walls. The pitting wen present, strong, or weak. Ray cells exhibiting indentures at the corners, or without indentures; without nodular thickenings on their end walls. Ray tissue without crystals. Earlywood cross-field pits 1(-3), large and simple (or nearly so), or cupressoid, or 1(-3), large and simple (or nearly so) and taxodioid, or cupressoid and taxodioid, or taxodioid. Normal vertical resin ducts absent. **Geography, cytology.** Mostly Southern hemisphere, extending north to Japan, Central America and West Indies. Basic chomosome number, n = 9–19 (only 14 and 16 unrepresented). **Taxonomy.** 173 species; *Acmopyle*, *Afrocarpus*, *Dacrydium*, *Dacrycarpus*, *Falcatifolium*, *Halocarpus*, *Lagarostrobus*, *Lepidothamnus*, *Manoao*, *Microcachrys*, *Microstrobos*, *Nageia* (*Decussocarpus*), *Parasitaxus*, *Pherosphaera*, *Phyllocladus*, *Podocarpus*, *Prumnopitys*, *Retrophyllum*, *Saxegothaea*, *Sundacarpus*. Subclass (after Christenhusz et al., 2011): Pinidae; Araucariales.

Sciadopityaceae

Japanese Umbrella Pine. **Vegetative.** Evergreen; trees. Resinous. The leafy branchlets not flattened. The vegetative branch systems reasonably interpretable as including highly specialised, leaf-bearing short-shoots. Mature leaves dimorphic; scale-like (on the long-shoots), or 2-veined, evidently representing pairs of ‘needles’ united lengthwise (on the short-shoots); in tight clusters on short-shoots, each cluster with a basal sheath of scales, or not clustered (depending on interpretation of the peculiar “leaves”); whorled. Longitudinal resin canals present in the leaves; in a peripheral ring (this incomplete abaxially). **Reproductive organization.** The ovules borne in female cones. The female cones woody. The seed-cone scales spirally arranged; deciduous, the cones disintegrating at maturity; woody. The ovules borne proximal-adaxially on the seed-cone scales. The bract-scales more or less free of the seed-cone scales in mature cones. The seed-cone scales 5–9 ovuled. The ovules anatropous. Male cones subspherical, in terminal, compact clusters, with spirally arranged sporophylls. Pollen-sacs 5–9 per microsporophyll (?). Pollen without air bladders. Pollination anemophilous, involving a “liquid drop” mechanism. **Seeds and seedlings.** Seeds winged. Cotyledons 2. **Wood anatomy.** Growth rings distinct. Heartwood present and distinctively coloured. Latewood not conspicuous. Wood with a distinct odour; with a distinct taste; not greasy; without dimpled grain. Tracheids with neither alternate nor opposite bordered pits; without callitroid pit-border thickenings. Margins of the tori not scalloped. Earlywood tracheids without spiral thickenings. Axial parenchyma absent. Ray tracheids absent or very infrequent. Earlywood ray cells with horizontal walls thinner than those of the adjacent vertical tracheids above and below the ray. Latewood ray cells with unpitted horizontal walls. Ray cells without indentures; without nodular thickenings on their end walls. Ray tissue without crystals. Earlywood cross-field pits 1(-3), large and simple (or nearly so). Normal vertical resin ducts absent. **Geography, cytology.** Japan. Basic chomosome number, n = 10. **Taxonomy.** 1 species (*S. verticillata*); *Sciadopitys*. Subclass (after Christenhusz et al., 2011): Pinidae; Cupressales.

Stangeriaceae

**Vegetative.** Pachycaul (fern-like rosette plants, with short, tuberous, irregularly branched subterranean stems producing relatively little wood, the leaf bases not persistent); evergreen; with apogeotropic roots bearing cyanobacteria, born in coralloid masses just above ground level. Not resinous (secreting mucilage). Mature leaves pinnate (the rachides with sub-circinate or conspicuously circinate vernation). The leaflets with pinnate venation, having a prominent midrib and dichotomously branching laterals. Mature leaves alternate. **Reproductive organization.** Dioecious (via an XY chromosome system). The ovules borne in female cones; marginal or in notches, on discrete megasporophylls with sterile tips (the megasporophylls peltate). The megasporophylls 2 ovuled (the ovules on the inner-facing margins of the expanded hexagonal ends of the megasporophyll). The ovules orthotropus. Pollen-sacs numerous, borne abaxially on peltate microsporophylls. Pollen without air bladders. Pollination probably anemophilous; involving a “liquid drop” mechanism. Fertilization involving spirally flagellate, motile spermatozoids. **Seeds and seedlings.** Seeds large, with a fleshy investment; the fleshy investment developed from the integument (from the outer layer of the testa, which surrounds the woody inner one); wingless. Cotyledons 2. **Wood anatomy.** Growth rings indistict (absent). Tracheids with opposite and multiseriate bordered pits (in *Bowenia*?), or with neither alternate nor opposite bordered pits (i.e., scalariform in *Stangeria*). **Geography, cytology.** Temperate to tropical; South Africa (*Stangeria*), tropical Australia (*Bowenia*). Basic chomosome number, n = 8 (*Stangeria*). **Taxonomy.** 3 species; *Stangeria* and *Bowenia*. Subclass (after Christenhusz et al., 2011): Cycadidae; Cycadales.

Taxaceae

Yews, California Nutmeg. Including Amentotaxaceae, Austrotaxaceae, Torreyaceae. **Vegetative.** Evergreen; profusely branching trees and shrubs. Resinous (with *Torreya* exhibiting a resin canal in the leaf and resin cells in the wood), or not resinous (*Taxus* and *Austrotaxus*, except that resin cells have rarely been reported from roots). Main branches spiral, or whorled, or opposite. The leafy branchlets flattened in one plane. The vegetative branch systems without conspicuously specialised short-shoots. Mature leaves more or less linear (often somewhat asymmetric); relatively soft; not clustered; alternate (though often appearing two-ranked on mature shoots). Longitudinal resin canals present in the leaves (in *Torreya*), or absent from the leaves (mostly, e.g. *Taxus*); when present, 1 per leaf, this median-abaxial. **Reproductive organization.** Usually dioecious. The ovules solitary, arillate, not in cones; terminating axes (terminating inconspicuous secondary dwarf shoots, as in most yews, or terminating visible dwarf shoots with a few basal scales, as in *Taxus canadensis*, but uncomplicated by vestiges representing reduced short-shoots of the kind characterizing true conifers); orthotropus; 1 integumented. The small male cones bearing peltate-symmetric, *Equisetum*-like sporangiophores with 6–8 pendulous pollen-sacs in *Taxus*, or dorsiventral scale-like sporophylls with 4 abaxial sacs in *Torreya*. In *Austrotaxus*, each sporangiphore is subtended by a bract. Pollen-sacs 2–9 per microsporophyll. Pollen without air bladders (?). Pollination anemophilous, involving a “liquid drop” mechanism. **Seeds and seedlings.** Seeds with a fleshy investment; the fleshy investment representing a genuine aril (a secondary outgrowth from the floral axis, which varies somewhat in form among the genera); wingless. Cotyledons 2. **Wood anatomy.** Growth rings distinct. Heartwood present and distinctively coloured. Latewood not conspicuous. Wood with a distinct odour (*Torreya*), or without distinct odour; without distinct taste; not greasy; without dimpled grain. Tracheids with opposite and multiseriate bordered pits; without callitroid pit-border thickenings. Margins of the tori not scalloped. Earlywood tracheids with spiral thickenings. Axial parenchyma present (in *Austrotaxus*), or absent. Axial parenchyma abundant (in *Austrotaxus*,), or scarce. Axial parenchyma not zonate. Axial parenchyma with nodular thickenings or bead-like on the transverse or end-walls (in *Torreya californica*), or without nodular thickenings on the transverse or end-walls. Rays exclusively uniseriate. Ray tracheids absent or very infrequent. Earlywood ray cells with horizontal walls thinner than those of the adjacent vertical tracheids above and below the ray (Austrotaxus), or with walls similar in thickness to those of adjacent vertical tracheids. Latewood ray cells with unpitted horizontal walls, or with pitted horizontal walls. The pitting when present, strong, or weak. Ray cells exhibiting indentures at the corners; without nodular thickenings on their end walls. Ray tissue without crystals. Earlywood cross-field pits cupressoid, or cupressoid and taxodioid (in *Austrotaxus*). Normal vertical resin ducts absent. **Geography, cytology.** Temperate; Northern hemisphere, south to Celebes and Mexico, *Austrotaxus* in New Caledonia. Basic chomosome number, n = 12. **Taxonomy.** 17 species; *Amentotaxus*, *Austrotaxus*, *Pseudotaxus*, *Taxus*, *Torreya*. Subclass (after Christenhusz et al., 2011): Pinidae. **Comments.** The organization of female reproductive shoots in Taxaceae correspond with those of the ancestral taxads in their relative morphological simplicity (see above), although some extant forms exhibit aggregations of fertile shoots which may represent a relatively recent development. *Taxus baccata* has been well known from ancient times for its toxic properties, and has been thoroughly researched in that context. In addition to the alkaloid taxine, it includes hydrocyanic acid and ephedrine as well as an extremely irritant volatile oil, and all parts of the plant (fresh or dried) except the aril are poisonous to humans and livestock. Surprisingly, information on other members of the family in this connection is proving elusive.