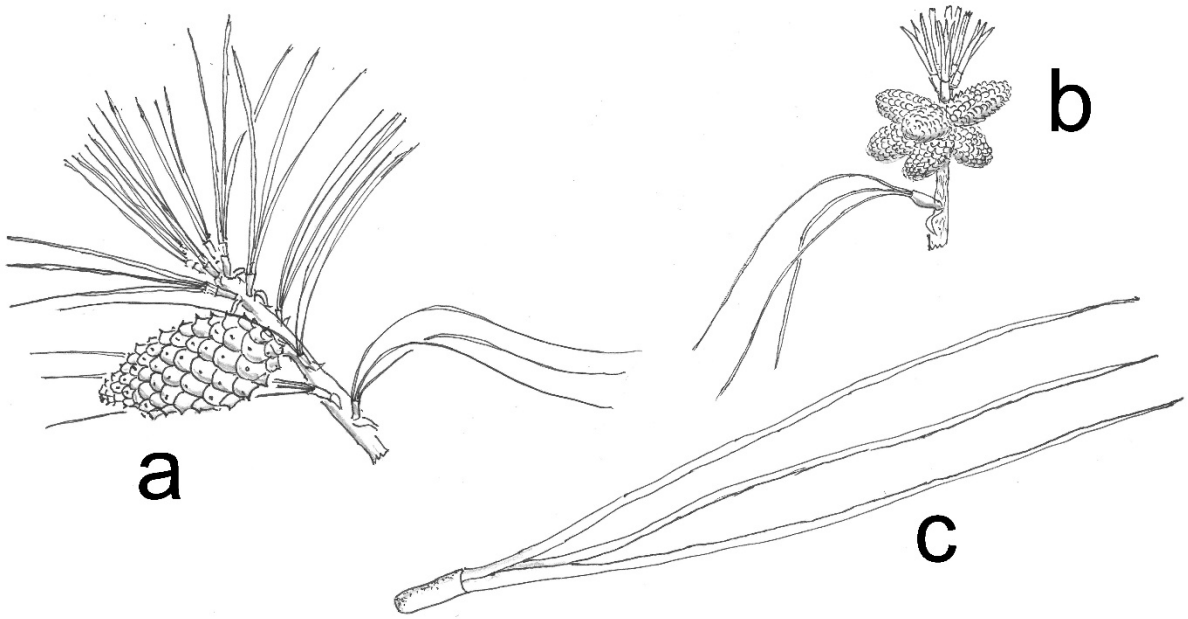
Chapter 13. **Gymnosperms: Conifers and allies**

The Conifers and allies:

Gymnosperms

GYMNOSPERMS (Conifers and allies)

General physiognomy. Gymnosperms (literally "naked seed") are vascular plants that reproduce by means of an exposed seed, or ovule. Unlike true flowering plants (angiosperms), whose ovules are sheltered inside closed ovaries, the ovules of gymnosperms are borne on open bracts, commonly arranged in cones, or "strobili."



Gymnosperms-at-a-glance: Trees with linear, often acicular leaves and reproductive structures in open bracts arranged along a shortened axis or cone: (a) Female cone branching from a shoot of ponderosa pine (*Pinus ponderosa*), (b) whorl of male cones near the apex of a shoot, and (c) acicular leaves, often called "pine-needles", in whorls of 3 (or more in other pine species) supported by a basal sheath.

Vegetative morphology. All modern gymnosperms are woody perennials. Like flowering plants, they have two conducting tissues, xylem and phloem; the xylem —the plant's wood— conducts water and minerals from the roots to the rest of the plant and also provides structural support. The phloem —the plant's bark— distributes the sugars, amino acids, and organic nutrients manufactured in the leaves to the non-photosynthetic tissues of the plant. The shoot of the gymnosperms, like that of flowering plants, is organized in a succession of reiterating growth modules: a succession of nodes with leaves and axillary buds distributed along the stem and separated from each other by long or short internodes. Also like flowering plants, many gymnosperms develop lateral short shoots (called "brachyblasts") on the axillary buds, producing whorls of leaves that add photosynthetic surface without the expense of adding more wood, as in pine needle bundles. The leaves of most gymnosperms have a relatively simple structure, with parallel venation and often with acicular (needle-like) shape.

Reproductive morphology. In most gymnosperms the male pollen cones, or micro-strobili, contain small bracts that bear pollen sacs on their lower surfaces. The number of pollen sacs may vary from two in the male cones of many conifers to hundreds in some cycads. Within the pollen sacs, generative cells undergo meiotic division to produce haploid germ cells in the pollen grains.

The larger female ovulate cones, or mega-strobili, may be borne on the same plant that bears the male strobili (as in conifers) or on separate plants (as in cycads and Ginkgo). A female cone contains many scales that contain the ovules. Within each bract, a single cell undergoes meiotic division to produce four haploid germ cells, three of which typically abort while the remaining one grows and develops to form the ovule.

For pollination to take place, in many gymnosperms a sticky "pollination droplet" oozes from a tiny hole in the female cone bracts to catch pollen grains floating in the air. In other species, the pollen grain settles on the surface of the female cone from where it germinates, producing a pollen tube that grows into the bracts towards the ovule. The time interval between pollination and maturation of the embryo into a viable seed varies among different groups, ranging from a few months to over one year in pines.

Not all gymnosperm cones are dry and woody, some are fleshy and attract fruit dispersers. In cycads and ginkgos the outer layer of the seed (the seed coat, or "sarcotesta") becomes fleshy and fruit-like. Although appreciated by some frugivores, the sarcotesta of the ginkgo seeds contains butyric acid, which is also found in rancid butter and vomit, and, although many animals are attracted to it, it is often perceived when ripe as foul-smelling by many persons. Others gymnosperms, such as yews, have a fleshy structure, known as an aril, surrounding the seed. Finally, the cone-bracts of the junipers become fleshy as they ripen, to produce the juniper false "berries" that are commonly eaten by birds.

Taxonomic relationships. Gymnosperms are a large and heterogeneous group, with widely different branches. Some taxonomists even question the idea that all gymnosperms have a single common ancestor, or that they form a single evolutionary branch of the plant kingdom. Within this line of thought, it is argued that the development of naked seeds in strobili may have arisen more than once during the long evolution of seed plants.

In California, native gymnosperms occur in three families of conifers (Pinaceae, Cupresaceae, and Taxaceae), and in one family of shrubby desert plants, the Ephedraceae. In gardens throughout Southern California plants in two other conifer families are also widely cultivated (Araucariaceae and Podocarpaceae), plus a remarkable family of palm-resembling gymnosperms, the Cycadaceae.

Pinaceae (the pine family): Monoecious, resinous evergreen trees with leaf-needles, these often organized in leaf=bundles, seed cones with mostly woody, sometimes papery, scales arranged spirally around the central rachis.

Taxaceae (the yew family): Shrubs and small trees with needle-like leaves and seed cones consisting of a single large seed surrounded by a fleshy aril.

Taxodiaceae (the bald cypress family): Large, often gigantic conifer trees with short (<2 cm) awl- or needlelike leaves and small, woody seed cones with spirally arranged, often diamond-shaped scales.

Cupressaceae (the cypress family): Evergreen shrubs or trees with fragrant, scalelike leaves and round to globe-shaped, woody, or sometimes fleshy seed cones.

Ephedraceae (the desert-tea family): Dryland or desert small (< 1 m high) shrubs with jointed, green twigs, and leaves reduced to minute scales.

Biodiversity and distributions. Gymnosperms were dominant in the Mesozoic Era (about 252.2 million to 66 million years ago), during which time some of the modern families originated (Pinaceae,

Araucariaceae, Cupressaceae). Although since the Cretaceous Period (about 145 million to 66 million years ago) gymnosperms have been gradually displaced by the more recently evolved angiosperms, they are still widely successful in many parts of the world and occupy large areas of earth's surface with 88 genera and over one thousand species. Conifer forests, for example, cover vast regions of northern temperate lands, and gymnosperms frequently grow in more northerly latitudes than do angiosperms.

Economic uses and ethnobotany. Although humans do not consume many gymnosperms for food (mostly because of their high content of resins), their economic importance is immense. First and foremost, conifers are the main providers of good quality wood for construction, paper pulp, boat building, and carpentry. Pine, fir, spruce, and cedar are prime examples of top-quality conifers that are used for lumber. The resins in conifer wood can be distilled and fractioned into different components. Resin spirits, called turpentine and other derivates, are used to make soap, varnish, nail polish, food additives, gum, and perfumes. The "fruit" (i.e., the fleshy aril) of yews (*Taxus* sp.) are highly aromatic and have been used for centuries to flavor gin, an alcoholic distillate of rye. The green stems of many species of the desert gymnosperm *Ephedra* (joint-fir, desert tea) contain a compound called *ephedrine* used in modern medicine as a stimulant and decongestant, and to treat hypotension associated with anaesthesia.

California genera and species. With 16 genera and more than 100 species distributed throughout the state, gymnosperms are an important group in California. Some of the most common ones are the following:

Pinus coulteri (Coulter's pine) – Large-coned pine with stout, short needles, common in canyons and ridges in the mountain ranges of Southern California.

Cupressus forbesii (Tecate cypress; now *Hesperocyparis forbesii*) – Mostly distributed in mountains near the Mexican border. Cones remain unopened for many years, and release the seeds after wildfires.

Juniperus californica (California juniper) – Dioecious small trees, occurring in dry canyons throughout our region, and in the transition slopes towards the Mojave Desert.

Sequoia sempervirens (coastal redwood) – Evergreen, long-lived, monoecious tree living 1,200–1,800 years or more; includes the tallest living trees on earth (115.5 m in height).

Sequoiadendron giganteum (giant sequoia) – Massive tree (often > 10 m in diameter) occurring naturally only in a few groves on the western slopes of the Sierra Nevada Mountains.

Ephedra californica (jointfir, desert tea) – Spindly small shrub (< 1 m tall) with greenish twigs that age to a yellowish-gray. Tiny leaves at nodes on the twigs and dry-out in drought. Male plants produce clumps of pollen cones at the nodes and female plants produce egg-shaped seed cones each about 1 cm long.