

Encyclopedia of
Extinct Plants

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Chapter- 1

Cooksonia



Cooksonia is an extinct grouping of primitive land plants. The earliest *Cooksonia* date from the middle Silurian, about 425 million years ago; the group continues to be an important component of the flora until the early Devonian. For historical reasons, while *Cooksonia* fossils are distributed globally, most type specimens come from Britain.

Morphology

Only the sporophyte phase of *Cooksonia* is currently known. Individuals were small, a few centimetres tall, and had a simple structure; they lacked leaves, flowers and roots — although it has been speculated that they grew from an unpreserved rhizome. They had a simple stalk, that branched dichotomously a few times. Each branch ended in a sporangium, a rounded, spore-bearing structure. Specimens of one species of *Cooksonia* have a dark stripe in the centre of their stalks, which has been interpreted as the earliest remains of water carrying tissue. Other *Cooksonia* species lacked such conducting tissue.

Cooksonia specimens occur in a range of sizes, and varied in width from ~0.03 to 3 mm. Specimens of different sizes were probably different species, not fragments of larger organisms: fossils occur in consistent size groupings, and sporangia and spore details are

different in organisms of different sizes. The organisms probably exhibited determinate growth.

Some *Cooksonia* species can be shown to bear stomata, which had a role in gas exchange; this was probably to assist in transpiration-driven transport of solutes in the xylem, rather than primarily in photosynthesis, as suggested by their concentration at the tips of the axes. These clusterings of stomata are typically associated with a bulging in the axis at the neck of the sporangium, which may have contained photosynthetic tissue, reminiscent of some mosses.

Physiology

While reconstructions traditionally depict *Cooksonia* as a green and red, photosynthesising, self-sufficient stem, it is likely that the fossils instead preserve a sporophyte generation which was dependent on a gametophyte for its nutrition – a relationship that occurs in modern mosses and liverworts.

However, no fossil evidence of a gametophyte of *Cooksonia* has been discovered to date. Study of smaller *Cooksonia* fossils showed that once the tissue required to support the axes, protect them from desiccation, and transport water had been accounted for, no room remained for photosynthetic tissue. Further, the axis thickness is what would be expected if their sole role was to support the sporangium on their ends. It appears that, originally at least, the role of the axes was solely to ensure continued spore dispersal, even if the axis desiccated.

The widths of *Cooksonia* fossils span an order of magnitude; while the smaller ones could not possibly be self-sufficient, the larger axes could; this provides a possible illustration of the evolution of an independent sporophyte generation.

Taxonomy

The relationships between the known species of *Cooksonia* and modern plants remain unclear. They appear to represent plants that are near to the branching between Rhyniophyta and to the club mosses. It is considered likely that *Cooksonia* is not a clade, but rather represents an evolutionary grade or form genus. Indeed, four different forms of spore, probably representing four different species, have been found in sporangia identified as *C. pertoni*.

Specimens

The first *Cooksonia* species were described by William Henry Lang in 1937 and named in honor of Isabel Cookson, with whom he had collaborated, and who collected the type specimens of *Cooksonia pertoni* in Perton Quarry in 1934.

Five species of *Cooksonia* have been clearly identified. *C. pertoni*, *C. hemisphaerica*, *C. cambrensis*, *C. caledonica* and *C. paranensis*. They are distinguished primarily by the shape of the sporangia.

Chapter- 2

Sigillaria

Sigillaria

Fossil range: Carboniferous to Permian



Sigillaria root (*Stigmaria*) from the Llewellyn Formation.

Scientific classification

Kingdom: Plantae
Division: Lycopodiophyta
Class: Isoetopsida
Order: Lepidodendrales
Family: Lepidodendraceae
Genus: *Sigillaria*

Sigillaria is a genus of extinct, spore-bearing, arborescent (tree-like) plants which flourished in the Late Carboniferous period but dwindled to extinction in the early Permian period. It was a lycopodiophyte, and is related to the lycopsids, or club-mosses, but even more closely to quillworts, as was its associate *Lepidodendron*. *Sigillaria* was a tree-like plant, with a tall, occasionally forked trunk that lacked wood. Support came from a layer of closely packed leaf bases just below the surface of the trunk, while the center was filled with pith. The old leaf bases expanded as the trunk grew in width, and left a diamond-shaped pattern, which is evident in fossils. The trunk had photosynthetic tissue on the surface, meaning that it was probably green.



Sigillaria on display at State Museum of Pennsylvania, from Sharon, Mercer County, Pennsylvania



Sigillaria (bark) on display at State Museum of Pennsylvania, from Scranton, Lackawanna County, Pennsylvania



Replica of *Sigillaria* sp. in a laboratory of practices of the Faculty of Sciences of the University of A Coruña

The trunk was topped with a plume of long, grass-like, microphyllous leaves, so that the plant looked somewhat like a tall, forked bottlebrush. The plant bore its spores (not seeds) in cone-like structures attached to the stem. *Sigillaria*, like many ancient lycopods, had a relatively short life cycle - growing rapidly and reaching maturity in a few years.

Some have suggested that *Sigillaria* was monocarpic, meaning that it died after reproduction, though this is not proven. It was associated with *Lepidodendron*, the scale tree, in the Carboniferous coal swamps.

Chapter- 3

Lepidodendron

Lepidodendron
Fossil range: Carboniferous



The strobilus of *Lepidodendron*

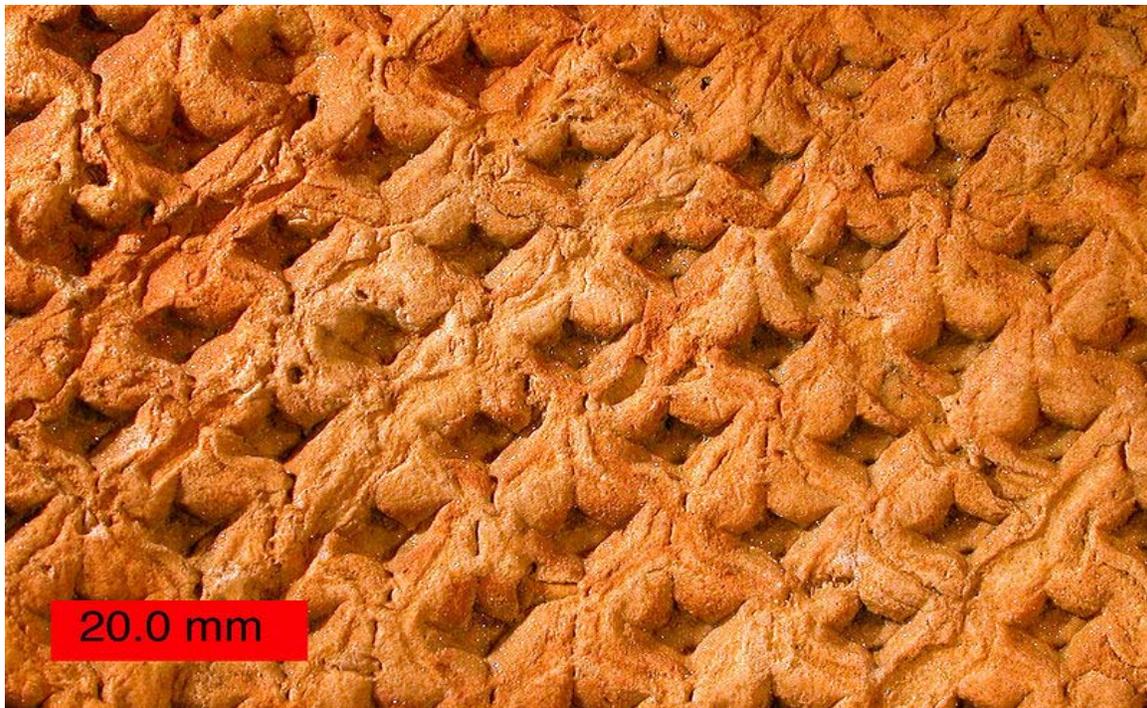
Scientific classification

Kingdom: Plantae
Division: Lycopodiophyta
Class: Isoetopsida
Order: Lepidodendrales
Family: Lepidodendraceae
Genus: *Lepidodendron*

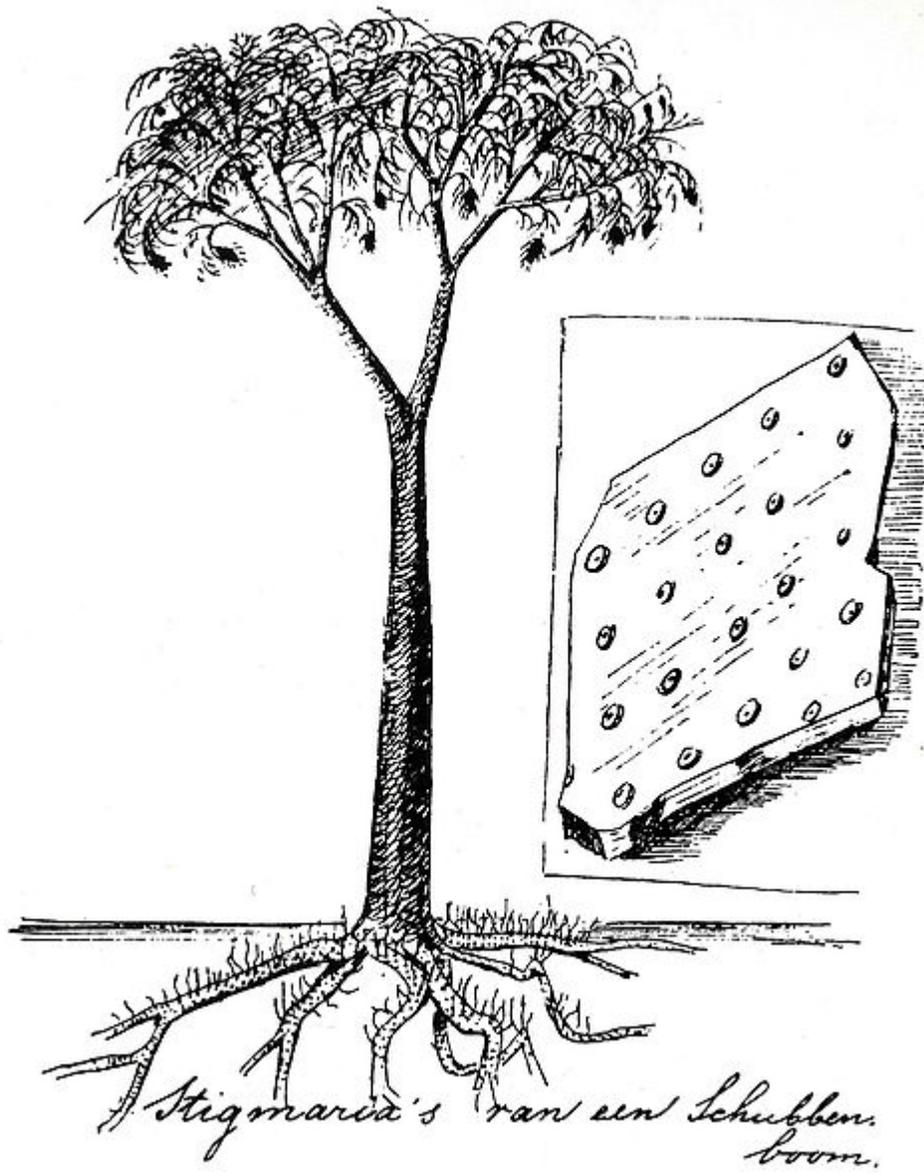
Lepidodendron (also known as the "Scale tree") is an extinct genus of primitive, vascular, arborescent (tree-like) plant related to the Lycopods (club mosses). It was part of the coal forest flora. They sometimes reached heights of over 30 metres (100 ft), and the trunks were often over 1 m (3.3 ft) in diameter, and thrived during the Carboniferous period. Sometimes called "giant club mosses", this is actually not correct as they are actually closer to quillworts than to club mosses.

Lepidodendron had tall, thick trunks that rarely branched and were topped with a crown of bifurcating branches bearing clusters of leaves. These leaves were long and narrow, similar to large blades of grass, and were spirally-arranged. The vascular system was a siphonostele with exarch xylem maturation.

The closely packed diamond-shaped leaf scars left on the trunk and stems as the plant grew provide some of the most interesting and common fossils in Carboniferous shales and accompanying coal deposits. These fossils look much like tire tracks or alligator skin.



External mold of *Lepidodendron* from the Upper Carboniferous of Ohio.



Reconstruction of *Lepidodendron* by Dutch conservationist Eli Heimans (1911).



Lepidodendron on display at the State Museum of Pennsylvania

The scars, or leaf cushions, were composed of green photosynthetic tissue, evidenced by the cuticle covering and being dotted with stomata, microscopic pores through which carbon dioxide from the air diffuses into plants. Likewise, the trunks of *Lepidodendron* would have been green, unlike modern trees which have scaly, non-photosynthetic brown or gray bark.

Lepidodendron has been likened to a giant herb. The trunks produced very little, if any, wood. Most structural support came from a thick, bark-like region. This region remained around the trunk as a rigid layer that did not flake off like that of most modern trees. As the tree grew, the leaf cushions expanded to accommodate the increasing width of the trunk.

The branches of this plant ended in cone-like structures. *Lepidodendron* did not produce seeds like many modern plants. Instead, it reproduced by means of spores. It is estimated that these plants grew rapidly and lived 10–15 years. Some species were probably monocarpic, meaning they reproduced only once toward the end of their life cycle.

Lepidodendron likely lived in the wettest parts of the coal swamps that existed during the Carboniferous period. They grew in dense stands, likely having as many as 1000 to 2000 giant clubmosses per hectare. This would have been possible because they did not branch until fully grown, and would have spent much of their lives as unbranched poles. In its juvenile stages, the trunk was supported by grass-like leaves that grew straight out of the trunk.

By the Mesozoic era, the giant clubmosses had died out and were replaced by smaller clubmosses, probably due to competition from the emerging woody gymnosperms and other plants. *Lepidodendron* is one of the more common plant fossils found in Pennsylvanian (Late Carboniferous) age rocks. They are closely related to other extinct genera, *Sigillaria* and *Lepidendropsis*.

In the 19th Century, due to the reptilian look of the diamond-shaped leaf scar pattern, petrified trunks of *Lepidodendron* were exhibited at fairgrounds as giant fossil lizards or snakes.

The name *Lepidodendron* comes from the Greek *lepidō*, scale, and *dendron*, tree.

Chapter- 4

Calamites

Calamites

Fossil range: Carboniferous–early Permian



A range of *Calamites* specimens, illustrating the different appearance of fossils preserved under different taphonomic modes.

Scientific classification

Kingdom:	Plantae
Division:	Pteridophyta
Class:	Equisetopsida
Order:	Equisetales
Family:	Calamitaceae
Genus:	<i>Calamites</i>

Calamites is a genus of extinct arborescent (tree-like) horsetails to which the modern horsetails (genus *Equisetum*) are closely related. Unlike their herbaceous modern cousins, these plants were medium-sized trees, growing to heights of more than 30 meters (100 feet). They were components of the understories of coal swamps of the Carboniferous period.

Taphonomy

A number of organ taxa have been identified as part of a united organism, which has inherited the name *Calamites* in popular culture. *Calamites* correctly refers only to casts of the stem of Carboniferous/Permian sphenophytes, and as such is a form genus of little taxonomic value. There are two forms of casts, which can give mistaken impressions of the organisms. The most common is an internal cast of the hollow (or pith-filled) void in the centre of the trunk. This can cause some confusion: firstly, it must be remembered that a fossil was probably surrounded with 4-5 times its width in (unpreserved) vascular tissue, so the organisms were much wider than the internal casts preserved. Further, the fossil gets narrower as it attaches to a rhizoid, a place where one would expect there to be the highest concentration of vascular tissue (as this is where the peak transport occurs). However, because the fossil is a cast, the narrowing in fact represents a constriction of the *cavity*, into which vascular tubes encroach as they widen.

Further organ genera belonging to sphenophytes include:

- *Arthropitys* (stems which are preserved in a mineralised form)
- *Astromyelon* (permineralised rhizomes, distinguished from *Arthropitys* by the absence of a carinal canal)
- *Annularia* and *Asterophylites* (form genera of leaf-whorls which are paraphyletic).

Anatomy



The foliage of *Calamites*

The trunks of *Calamites* had a distinctive segmented, bamboo-like appearance and vertical ribbing. The branches, leaves and cones were all borne in whorls. The leaves were needle-shaped, with up to 25 per whorl.

Their trunks produced secondary xylem, meaning they were made of wood. The vascular cambium of *Calamites* was *unifacial*, producing secondary xylem towards the stem center, but not secondary phloem.

The stems of modern horsetails are typically hollow or contain numerous elongated air-filled sacs. *Calamites* was similar in that its trunk and stems were hollow, like wooden tubes. When these trunks buckled and broke, they could fill with sediment. This is the reason pith casts of the inside of *Calamites* stems are so common as fossils.

Reproduction



A *Calamites* rhizoid

Calamites reproduced by means of spores, which were produced in small sacs organized into cones. They are also known to have possessed massive underground rhizomes, which allowed for the production of clones of one tree. This is the only group of trees of their period known to have a clonal habit. This type of asexual reproduction would allow them to spread quickly into new territory, and help to anchor them firmly in the unstable ground along rivers and in newly deposited delta sediments. The rhizomes of *Calamites* look quite similar to the stems in most cases, but have nodes that get progressively closer

together as they approach the apical area (the growth tip that spreads outward through the soil).

Different forms

Calamites come in a variety of different "form genera". One type, *Calamites suckowi*, is distinguishable from other *Calamites* forms by its prominent, swollen nodes and relatively wide-spaced longitudinal ribs. Another example, *Calamites cisti*, has much smaller nodes and the ribs are typically closer together.

In addition, the distance between successive node lines on a *Calamites suckowi* specimen is typically much wider than the diameter. In other forms like *Calamites cisti*, the opposite is true or the specimen is just slightly wider than the diameter.

However, the value of these form taxa is limited. The distance between nodes, for example, is highly variable, and an intercalary meristem means that this distance varied as the organisms grew.

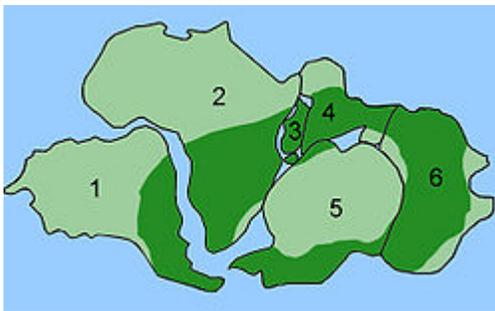
Extinction and classification

The genus *Calamites* has been placed in the plant division Equisetophyta (formerly known as Sphenophyta) and family Calamitaceae. They finally became extinct in the Lower Permian, a time which, however, also saw the origin of the family Equisetaceae, to which the only living sphenophyte genus *Equisetum* belongs.

Chapter- 5

Glossopteris

Glossopteris Fossil range: Permian



Fossils of the gymnosperm *Glossopteris* (dark green) found in all of the southern continents provide strong evidence that the continents were once amalgamated into a supercontinent Gondwana

Scientific classification

Domain: Eukaryota
(unranked): Archaeplastida
Kingdom: Plantae
Division: †Pteridospermatophyta
Order: Glossopteridales
Family: Glossopteridaceae
Genus: *Glossopteris*
Brongniart 1828 ex Brongniart 1831

Species

Glossopteris (Greek *glossa* (γλώσσα), meaning "tongue", because the leaves were tongue-shaped) is the largest and best-known genus of the extinct order of seed ferns known as Glossopteridales (or in some cases as Arberiales or Dictyopteridiales).

History

The Glossopteridales arose around the beginning of the Permian in the Southern Hemisphere. Their distribution across several, now detached, landmasses led Eduard Suess, amongst others, to propose that the southern continents were once amalgamated into a single supercontinent - Gondwana. These plants went on to become the dominant elements of the southern flora through the rest of the Permian but disappeared in almost all places at the end of the Permian. The only convincing Triassic records are very earliest Triassic leaves from Nidpur, India, but even these records are somewhat questionable owing to faulting and complex juxtapositioning of Permian and Triassic strata at Nidpur. Although most modern palaeobotany textbooks cite the continuation of glossopterids into later parts of the Triassic and, in some cases into the Jurassic, these ranges are erroneous and are based on misidentification of morphologically similar leaves such as *Gontriglossa*, *Sagenopteris*, or *Mexiglossa*. Glossopterids were, thus, one of the major casualties of the end-Permian mass-extinction event.

More than 70 fossil species of this genus have been recognized in India alone, with additional species from South America, Australia, Africa, Madagascar and Antarctica. Essentially, *Glossopteris* was restricted to the middle- and high-latitude parts of Gondwana during the Permian. Most northern parts of South America and Africa lack *Glossopteris* and its associated organs. However, in recent years a few disparate localities in Morocco, Oman, Anatolia, the western part of the island of New Guinea, Thailand and Laos have yielded fossils that are of possible glossopterid affinity. These peri-gondwanan records commonly occur together with Cathaysian or Euramerican plant species - the assemblages representing a zone of mixing between the strongly provincial floras of the Permian. Apart from those in India and the perigondwanan localities, a few other fossils from the Northern Hemisphere have been assigned to this group, but these are not identified with great certainty. For example, specimens assigned to *Glossopteris* from the far east of Russia in the 1960s are more likely to be misidentifications of other gymnosperms such as *Pursongia*. Confident assignment of fossil leaves to *Glossopteris* normally requires their co-preservation with the distinctive segmented roots of this group (called *Vertebraria*) or with the distinctive fertile organs.

Taxonomy

Long considered a fern after its discovery in 1824, it was later assigned to the gymnosperms. The genus is placed in the division Pteridospermatophyta. In reality, many of the plant groups included within this division are only distantly related to one another. Glossopterids' relationships with other groups remain obscure. Most recent phylogenetic analyses favour placement of glossopterids as sister to a large group including Corystospermales, Caytoniales, Bennettitales, Pentoxylales, Gnetales (in some analyses), and angiosperms. A few analyses favour alternative links with Ginkgoales, Cordaitales and Pinales.

Glossopteris should strictly be used to refer to the distinctive spathulate fossil leaves with reticulate venation, however, the term has also been used to refer to the parent plant as a whole.

Biology



Glossopteris browniana fossil in the Artis zoo, Amsterdam.

Glossopteris was a woody, seed-bearing shrub or tree, some apparently reaching 30 m tall. They had a softwood interior that resembles conifers of the family Araucariaceae. Seeds were borne on one side of variably branched or fused structures, and microsporangia containing pollen were borne in clusters at the tips of slender filaments. Both the seed- and pollen-bearing organs were partially fused (adnate) to the leaves, or, in some cases, possibly positioned in the axils of leaves. The homologies of the flattened seed-bearing structures have remained particularly controversial with some arguing that the fertile organs represent megasporophylls (fertile leaves) whereas others have

interpreted the structures as flattened, seed-bearing, axillary axes (cladodes). It is unclear whether glossopterids were monoecious or dioecious.

They are interpreted to have grown in very wet soil conditions, similar to the modern Bald Cypress. The leaves ranged from about 2 cm to over 30 cm in length.

The profile of glossopterid trees is largely speculative as complete trees have not been preserved. However, based on analogies with modern high-latitude plants *Glossopteris* trees probably tapered upwards like a Christmas tree and were relatively widely spaced to take advantage of the low-angle sunlight at high latitudes. Instead of needles, they had large, broad lance- or tongue-shaped leaves that fell to the ground at the end of summer. The fossil leaves are commonly found as dense accumulations representing autumnal leaf banks. The fossilized tree rings in the *Glossopteris* trees reveal that they grew steadily each spring-summer and abruptly stopped for winter.

Glossopteris leaves are morphologically simple so there are few characters that can be used to differentiate species. Consequently, many past researchers have considered the Permian *Glossopteris* flora to be rather homogeneous with the same species distributed throughout the Southern Hemisphere. However, more recent studies of the more morphologically diverse fertile organs have shown that taxa had more restricted regional distributions and several intra-gondwanan floristic provinces are recognizable. Nevertheless, several species of leaves found in Antarctica are common in the rocks of similar geologic age in India, located north of the equator and half a world away. Seeds, much too large to be wind-borne, could not have blown across thousands of miles of open sea, nor is it likely they have floated across vast oceans. Observations such as these led the Austrian geologist Eduard Suess to deduce that there had once been a land bridge between these areas. He named this large land mass Gondwanaland (named after the district in India where the plant *Glossopteris* was found). These same observations would also lend support to Alfred Wegener's Continental drift theory.

The first Antarctic specimens of *Glossopteris* were discovered by members of Scott's doomed Terra Nova Expedition. The expedition members abandoned much of their gear in an effort to reduce their load, but kept 35 pounds of *Glossopteris* fossils; these were found alongside their bodies.

Chapter- 6

Archaeamphora

Archaeamphora

Fossil range: Early Cretaceous



Artist's restoration of
Archaeamphora longicervia.

Scientific classification

Kingdom: Plantae
(unranked): Angiosperms
(unranked): Eudicots
(unranked): Asterids
Order: Ericales
Family: ?Sarraceniaceae
Genus: *Archaeamphora*
Species: *A. longicervia*

Binomial name

Archaeamphora longicervia

Li (2005)

Archaeamphora longicervia is an extinct species of pitcher plant bearing close affinities to extant members of the family Sarraceniaceae. Fossil material assigned to this taxon originates from the Early Cretaceous Yixian Formation of northeastern China.

Archaeamphora longicervia is the earliest known carnivorous plant and represents the only fossil record of pitcher plants (with the possible exception of some palynomorphs of uncertain nepenthacean affinity). Furthermore, the monotypic *Archaeamphora* is one of the three oldest known genera of angiosperms (flowering plants). Li (2005) notes that "the existence of a so highly derived Angiosperm in the Early Cretaceous suggests that Angiosperms should have originated much earlier, maybe back to 280 mya as the molecular clock studies suggested".

Etymology

The generic name *Archaeamphora* is derived from the Greek: ἀρχαίος, *archaios*, combining form in Latin *archae-* and the Greek *amphoreus* (*pitcher*). The specific epithet *longicervia* is derived from the Latin *longus* (*long*) and *cervicarius* (*with a neck*). The latter refers to the characteristic constriction in the pitchers of this species.

Fossil material

All known fossil material of *A. longicervia* originates from the Jianshangou Formation in Beipiao, western Liaoning, China. These Early Cretaceous beds constitute the lower part of the Yixian Formation, which is dated at 124.6 million years old. Nine specimens of *A. longicervia* have been found, including holotype CBO0220 and paratype CBO0754.

Description

Archaeamphora longicervia was a herbaceous plant growing to around 50 mm (2 in) in height. The stem, at least 21 mm (.8 in) long and 1.2 mm (.04 in) wide, bore distinctive vertical ridges and grooves. Pitchers were ascidiate in form and 30 to 40 mm (1.2 to 1.6 in) long. Mature pitchers and underdeveloped pitchers or phyllodia-like leaves were arranged spirally around the stem. Pitchers consisted of a tubular base, expanded middle section, constriction around the mouth, and a vertical, spoon-shaped lid. A single wing ran down the adaxial side of each pitcher. Three to five parallel major veins were present on the pitchers, along with a few intercostal veins and numerous small veinlets.

Two unusual bag-like structures were present on each pitcher, one on either side of the central wing. Similar but semi-circular structures were found on the margin of the lid. These structures exhibited strong yellow-green intrinsic fluorescence when exposed to 500 nm wavelength light.

Tiny glands, approximately 4 μm in diameter, were found on the inner surface of the pitchers and partially embedded in the grooves along the veins. These also showed very strong golden-yellow fluorescence.

A single seed was found intimately associated with the fossil material of *A. longicervia* and is presumed to belong to the same species. It is winged and reticulate-tuberculate in morphology, closely resembling the seeds of Sarraceniaceae taxa. The seed is oval-shaped, covered with black-brown warts, and measures 0.9 mm by 1.25 mm (.03 in by .05 in).

Taxonomy

The fossil material of *A. longicervia* was subjected to chemical analysis for oleanane, considered a key marker differentiating angiosperms from gymnosperms. Oleanane was detected in the pitcher plant specimens, suggesting that they belong to the angiosperms.

Several morphological features of *A. longicervia* suggest a close relationship to Sarraceniaceae; both taxa exhibit one or two pitcher wings, a smooth peristome, and pitchers that extend vertically from the top of a short petiole.



Pitchers of *Sarracenia purpurea*

Li (2005) suggests that *A. longicervia* is morphologically similar to modern *Sarracenia purpurea*. It shares with this species the spiral arrangement of its pitchers and phyllodia-like tubular leaves with parallel major veins. *Archaeamphora longicervia* also shows close affinity to species of the genus *Heliamphora* in having pitchers with a long neck and upright lid. Of particular note is the similarity between the thick semi-circular structures on the lid of *A. longicervia* and the large nectar-secreting "spoon" present on the upper posterior portion of *Heliamphora exappendiculata* pitchers.

Li (2005) mentions the discovery of another type of pitcher plant from the same formation. This variety differs from the type material of *A. longicervia* in having pitchers that lack any constriction before the mouth, instead gradually expanding from the petiole into a hollow trumpet-like shape. He suggests that it "should be a different species" from *A. longicervia*. An intermediate form with a wider neck is also reported, suggesting that pitcher plants were already a diversified group in the Early Cretaceous.

Habitat

The area inhabited by *A. longicervia* is thought to have experienced significant climatic fluctuations during the Early Cretaceous, ranging from arid or semi-arid to more humid conditions. The substrate in the region was mostly composed of lacustrine sediments and volcanic rocks.

Chapter- 7

Silphium



Ancient silver coin from Cyrene depicting a stalk of Silphium.

Silphium (also known as *silphion* or *laser*) was a plant of the genus *Ferula*. Generally considered to be an extinct "giant fennel" (although some claim that the plant is really *Ferula tingitana*), it once formed the crux of trade from the ancient city of Cyrene for its use as a rich seasoning and as a medicine. It was so critical to the Cyrenian economy that most of their coins bore a picture of the plant (*illustration, right*).

Silphium was an important species in prehistory, as evidenced by the Egyptians and Knossos Minoans developing a specific glyph to represent the Silphium plant.

The valuable product was the resin (*laser*, *laserpicium*, or *lasarpicium*) of the plant. It was harvested in a manner similar to asafoetida, a plant with similar enough qualities to silphium that Romans, including the geographer Strabo, used the same word to describe both.

Aside from its uses in Greco-Roman cooking (as in recipes by Apicius), many medical uses were ascribed to the plant. It was said that it could be used to treat cough, sore throat, fever, indigestion, aches and pains, warts, and all kinds of maladies. Chief among its medical uses, according to Pliny the Elder, was its role as an herbal contraceptive. Given that many species in the parsley family have estrogenic properties, and some (such as wild carrot) have been found to work as an abortifacient, it is quite possible that the plant was pharmacologically active in the prevention or termination of pregnancy.

Legend said that it was a gift from the god Apollo. It was used widely by most ancient Mediterranean cultures; the Romans considered it "worth its weight in denarii."

Extinction

The reason for silphium's extinction is not entirely known. The plant grew along a narrow coastal area, about 125 by 35 miles, in Cyrenaica (in present-day Libya). Much of the speculation about the cause of its extinction rests on a sudden demand for animals that grazed on the plant, for some supposed effect on the quality of the meat. Overgrazing combined with overharvesting may have led to its extinction. The climate of the maghreb has been drying over the millennia, and desertification may also have been a factor. Another theory is that when Roman provincial governors took over power from Greek colonists, they over-farmed silphium and rendered the soil unable to yield the type that was said to be of such medicinal value. Theophrastus reports that the type of *ferula* specifically referred to as "silphium" was odd in that it only grew in the wild, and could not be successfully grown as a crop in tilled soil. The validity of this report is questionable, however, as Theophrastus was merely passing on a report from another source. Pliny reported that the last known stalk of silphium found in Cyrenaica was given to the Emperor Nero "as a curiosity".

Silphium retained a ghostly literary half-life in lists of aromatics copied one from another, until it makes perhaps its last, spectral appearance in the list of spices that the Carolingian cook should have at hand— *Brevis pimentorum que in domo esse debeant* ("A short list of condiments that should be in the home") — by an author named Vinidarius, whose excerpts of *Apicius* survive in one eighth century uncial manuscript. Vinidarius' own dates may not be much earlier.

Connection with the heart symbol

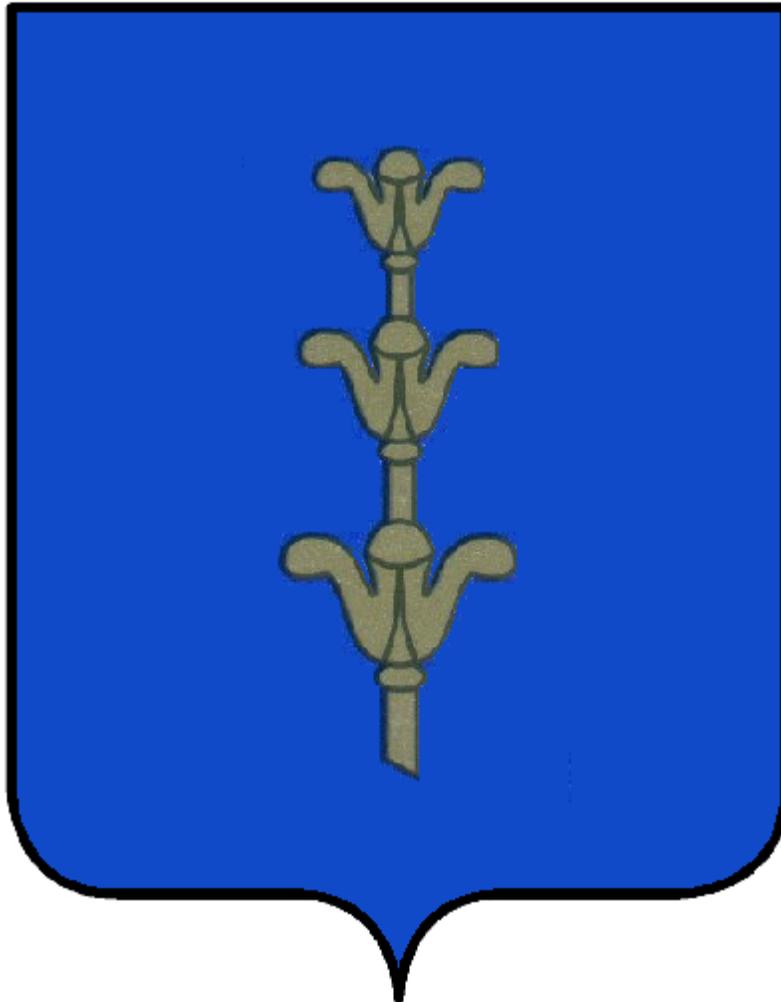


Ancient silver coin from Cyrene depicting a seed/fruit of Silphium.

There has been some speculation about the connection between silphium and the traditional heart shape (♥). The symbol is remarkably similar to the Egyptian "heart soul" (*ib*). The sexual nature of that concept, combined with the widespread use of silphium in ancient Egypt for birth control, and the fact that silphium seeds were heart-shaped, leads to speculation that the character for *ib* may have been derived from the shape of the silphium seed.

Contemporaneous writings help tie silphium to sexuality and love, as *laserpicium* makes an appearance in a poem (Catullus 7) of Catullus to his lover Lesbia. As well as in Pausanias' *Description of Greece* in which he says "For it so happened that his maiden daughter was living in it. By the next day this maiden and all her girlish apparel had disappeared, and in the room were found images of the Dioscuri, a table, and silphium upon it."

Heraldry



Il silfio d'oro reciso di Cirenaica

In the Italian military heraldry *Il silfio d'oro reciso di Cirenaica* (silphium couped or of Cyrenaica) was the symbol granted to the units that fought in the campaigns in North Africa during World War II.

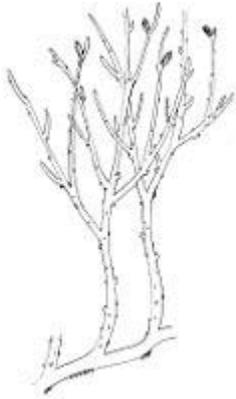
Chapter- 8

Other Prehistoric Plants

Rhynia

Rhynia

Fossil range: Early Devonian



Reconstruction of *Rhynia gwynne-vaughanii*, redrawn after

Scientific classification

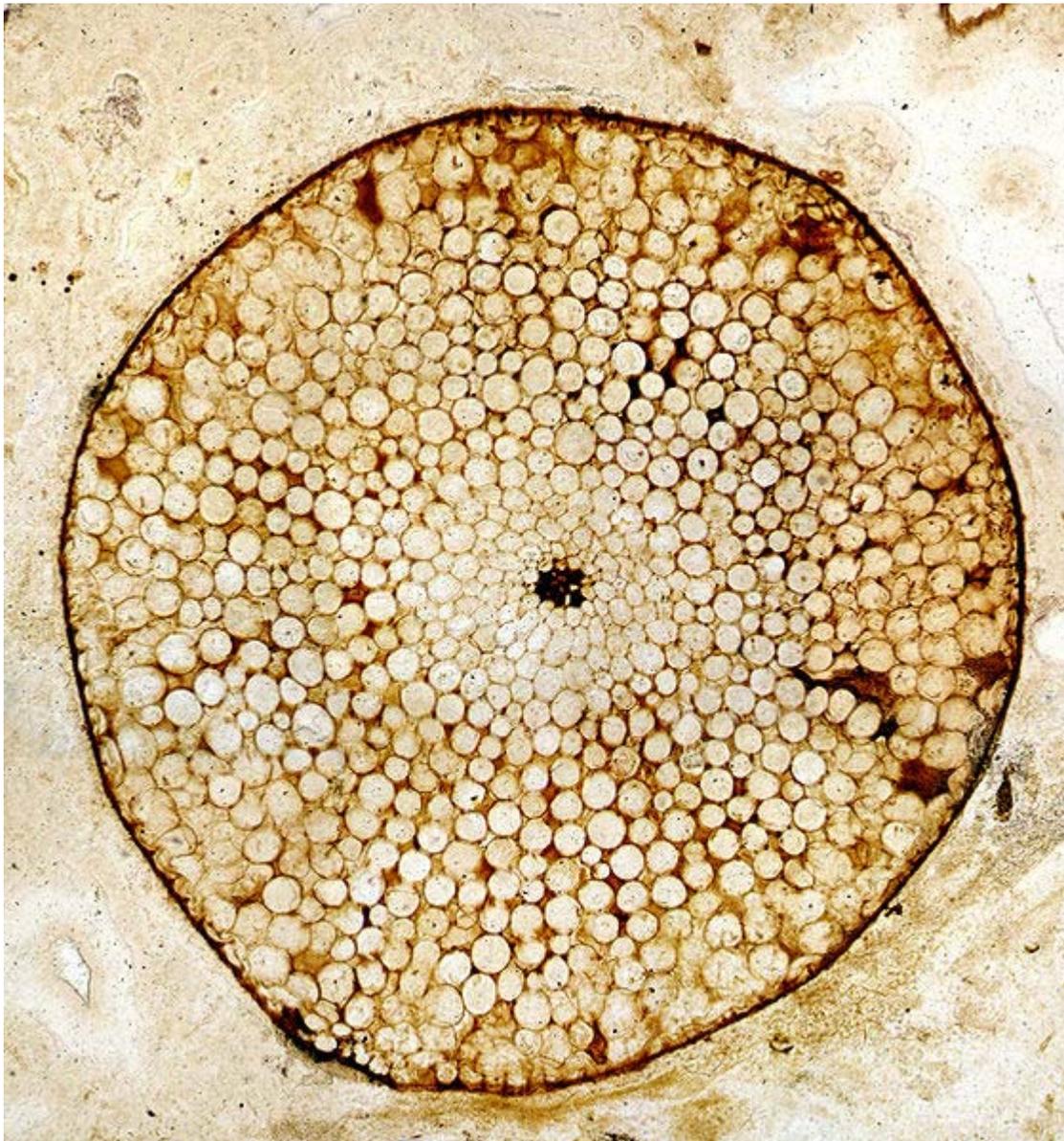
Kingdom: Plantae
Division: Rhyniophyta
Class: Rhyniopsida
Order: Rhyniales
Family: Rhyniaceae
Rhynia
Genus: Kidston & Lang (1917)
Species: *R. gwynne-vaughanii*

Binomial name

Rhynia gwynne-vaughanii
Kidston & Lang (1917)

Rhynia gwynne-vaughanii was the sporophyte generation of a vascular, axial, free-sporing diplohaplontic embryophytic land plant of the Lower Devonian that had anatomical features more advanced than those of the bryophytes, and was basal to modern vascular plants or eutracheophytes.

R. gwynne-vaughanii was first described as a new species by Kidston and Lang in 1917. The species is known only from the Rhynie chert in Aberdeenshire, Scotland, where it grew in the vicinity of a silica-rich hot spring. *Rhynia* was a vascular plant, and grew in association with other vascular plants such as *Asteroxylon mackei*, a probable ancestor of modern clubmosses (Lycopsidea), and with pre-vascular plants such as *Aglaophyton major*, which is interpreted as basal to true vascular plants.



A transverse section of a stem of *Rhynia gwynne-vaughanii*, Lower Devonian, Rhynie chert

Rhynia is thought to have had deciduous lateral branches, which it used to disperse laterally over the substrate and stands of the plant may therefore have been clonal populations.

Evidence of the gametophyte generation of *Rhynia* has been described in the form of crowded tufts of diminutive stems only a few mm in height, with the form genus name *Remyophyton delicatum*. Like those of *Aglaophyton major*, *Horneophyton lignieri* and *Nothia aphylla* the gametophytes of *Rhynia* are dioicous, bearing male and female gametangia (antheridia and archegonia) on different axes. A significant finding is that the axes were vascular, unlike almost all of the gametophytes of modern pteridophytes except for that of *Psilotum*.

Drepanophycus

Drepanophycus

Fossil range: Devonian:
Lochkovian - Frasnian



Scientific classification

Kingdom: Plantae
Division: Lycopodiophyta
Class: Lycopodiopsida
Order: Drepanophycales
Family: Drepanophycaceae
Genus: *Drepanophycus*
Göppert, 1852

Species

- *Drepanophycus spinaeformis*
Göppert (Type species)
- *Drepanophycus crepini*

- (Gilkinet)
- *Drepanophycus qujingensis*
Li & Edwards
 - *Drepanophycus gaspianus*
(Dawson) Kräusel &
Weyland
 - *Drepanophycus spinosus*

Another species has been described:
Drepanophycus colophyllus Grierson &
Banks - but this has since been removed to
the genus *Haskinsia*.

Drepanophycus is a genus of extinct plants of the Division Lycopodiophyta of Early to Late Devonian age, found in Eastern Canada and Northeast USA, China, Russia, and various parts of Northern Europe and Britain.

Description

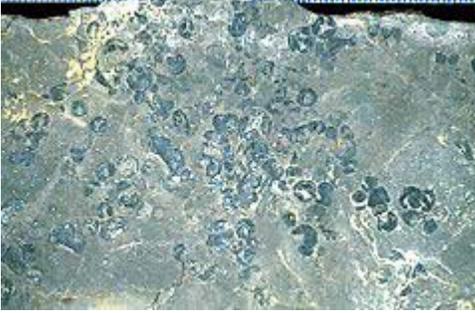
Extinct terrestrial vascular plants of the Devonian period. Stem of the order of several mm to several cm in diameter and several cm to a metre long, erect or arched, dichotomizing occasionally, furnished with true roots at the base. Vascular bundle actinostele, tracheids of primitive annular or helical type (so-called G-type). Leaves are unbranched thorn-shaped (i.e. with a wide base, tapering to a blunt point) microphylls several mm long with a single prominent vascular thread, arranged spirally to randomly on the stem. Sporangia borne singly on the upper leaf surface.

Drepanophycus differs from a closely related genus of the same period, *Baragwanathia*, in the position of the sporangia, and the arrangement and shape of the leaves.

It is more derived than the coexisting genus *Asteroxylon*, which has enations lacking vasculures, in contrast to the true leaves of *Drepanophycus*.

Protosalvinia

Protosalvinia
Fossil range: Late Devonian



A fossil of *Protosalvinia furcata* from Devonian shale of Kentucky, USA.

Scientific classification

Kingdom: Plantae
Phylum: *incertae sedis*
Genus: †*Protosalvinia*

Species

Protosalvinia arnoldii †
Protosalvinia braziliensis †
Protosalvinia furcata †
Protosalvinia ravenna †

Synonyms

Foerstia

Protosalvinia is a prehistoric plant found commonly in shale from shoreline habitats of the Upper Devonian period. The name *Protosalvinia* is a misnomer. The name literally means *early Salvinia*, and was given in the erroneous belief that the fossils were an earlier form of the living aquatic fern *Salvinia*. It is no longer believed that the fossils come from a fern, but deciding exactly what the fossils represent is still a matter of debate. This is surprising when one considers how much is known about the fossils.

The most likely interpretation of *Protosalvinia* is that it represents either a fossil liverwort or brown alga, although no definitive brown algae have been identified from before the Tertiary period, and examination of the spore structure shows no features in common with living groups of brown algae. The living plant was a thallus with short dichotomous branching. The branches in the largest species were as much as one centimeter across. In some fossils, the branching lobes lie flat, but in others the tips of the branches are curled up over the fossil, giving it a round outline. Embedded in the tissues of the thallus are chambers in which spores (200 micrometre diameter) were produced by meiosis.



Microscope slide mount of *Protosalvinia sp.* showing bifurcating thallus.

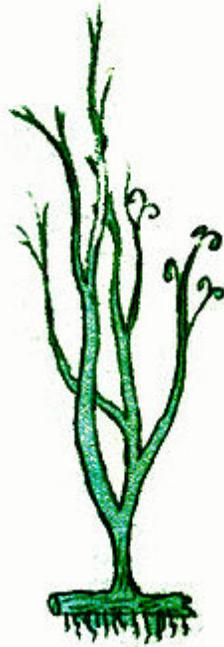
Because *Protosalvinia* is usually preserved as a compression fossil, it can be difficult to determine whether its anatomy is more like a plant or an alga. Some biochemical evidence favors interpretation as an alga. Lignin and cutin have been found in the thalli, and sporopollenin in the spore walls.⁶⁴ The grouping of the spores found in the thallus favors interpretation as a plant. The absence of any stomata on the surface is inconclusive, as all bryophytes lack stomata on the main body of the plant.

However, the tips of *Protosalvinia* branches show evidence of conceptacle-like dips.⁶⁴

Protosalvinia is found in association with conodont elements.

For the present, the relationships of *Protosalvinia* remain uncertain.

Psilophyton



Psilophyton is a fossil genus which currently contains seven species known mostly from compression, impression and some permineralized anatomy. Most specimens come from northern Maine, Gaspé Bay in Quebec, New Brunswick and the Czech Republic. *P. princeps*, *P. forbesii*, *P. dapsile*, *P. charientos*, *P. dawsonii*, *P. microspinosum*, *P. kräuselii* and *P. crenulatum* are the currently accepted members of the genus *Psilophyton*. Variation within the genus is significant.. The average specimen was 60 cm or more tall.

Cordaites

Cordaites is an important genus of extinct gymnosperms which grew on wet ground similar to the Everglades in Florida. Brackish water mussels and crustacea are found frequently between the roots of these trees. The fossils are found in rock sections from the Upper Carboniferous of the Dutch - Belgian - German coal area. A number of many noteworthy types from this line are:

- *Cordaites principalis*
- *Cordaites ludlowi* (named after Ludlow, a coal area in England)

In contrast to many other plant varieties, *Cordaites* seeds are not rare, because they are rather large (up to 10mm); those seeds are named *Cordaicarpus*.



Jardin des Plantes of Paris, France. Glasshouses. September 2010

Araucarioxylon arizonicum



Araucarioxylon arizonicum is an extinct species of conifer that is the state fossil of Arizona. The species is known from massive tree trunks that weather out of the Chinle Formation in desert badlands of northern Arizona and adjacent New Mexico, most notably in the 378.51 square kilometres (93,530 acres) Petrified Forest National Park. There, these trunks are locally so abundant that they have been used as building materials.

In the Triassic period Arizona was a flat tropical expanse in the northwest corner of the supercontinent Pangaea. There, a forest grew in which *A. arizonicum* towered as high as 60 metres (200 ft) and measured more than 60 centimetres (2.0 ft) in diameter. Fossils frequently show boreholes of insects.

The petrified wood of this tree is frequently referred to as "Rainbow wood" because of the large variety of colors some specimens exhibit. The red and yellow are produced by large particulate forms of iron oxide, the yellow being limonite and the red being hematite. The purple hue comes from extremely fine spherules of hematite distributed throughout the quartz matrix, and not from manganese, as has sometimes been suggested.



Agate House Pueblo, constructed with petrified wood

Queries about the validity of this name

In December 2008 W.P. Armstrong expressed doubts about the validity of the biological name *Araucarioxylon arizonicum*.

Abies milleri



Fossil *Abies milleri* foliage and axis

Scientific classification

Kingdom:	Plantae
Division:	Pinophyta
Class:	Pinopsida
Order:	Pinales
Family:	Pinaceae
Genus:	<i>Abies</i>
Species:	<i>A. milleri</i>

Binomial name

Abies milleri
Schorn & Wehr

Abies milleri, an extinct species of fir known from fossil remains found in the early Eocene Ypresian stage deposits in Washington State, USA, is the oldest confirmed record for the fir genus. The species was described from 81 fossil specimens collected from Burke Museum site number A0307 in Ferry County, Washington. The holotype specimen, number # *UWBM 31299*, and the eleven paratype specimens are currently deposited in the collections of the Burke Museum in Seattle, where they were studied and described by Howard E. Schorn and Wesley C. Wehr. Schorn and Wehr published their 1986 type description for *A. milleri* in the *Burke Museum Contributions in Anthropology and Natural History*, Volume 1. The specific epithet, *milleri*, was coined in honor of Charles N. Miller Jr for his contributions to the study and understanding of the conifer family Pinaceae. The studied specimens were excavated from the Tom Thumb Tuff member of the Klondike Mountain Formation in the city of Republic.

A. milleri has been placed in the Fir genus *Abies*, which has between 48 and 55 species native to much of North and Central America, Europe, Asia, and North Africa, occurring in mountains over most of the range. The characters used to separate extant species of *Abies* are based on the reproductive structures such as cone scales, wing seeds and bracts. The placement in *Abies* is based on the dorso-ventrally flattened leaves, and the circular leaf scars, which separate the organs from those of *Pseudotsuga* and *Keteleeria*. Within *Abies*, *A. milleri* shows similarities with *A. kawakamii* and *A. chensiensis* from Asia and with *A. concolor* and *A. lasiocarpa* of North America. *A. milleri* does not show traits which allow placement in any one of *Abies* genus sections, however.

The 81 specimens studied for the *A. milleri* description included 40 cone scales, 21 wing seeds, 10 foliated axes, and two detached needles. Schorn and Wehr placed the different detached organ fossils in the same species based on a number of factors. Where visible, all the cone scales have bracts and are morphologically similar. The scales display impressions on the admedial surface of wing seeds that match the fossil seed dimensions. The needle arrangement is consistent on both foliated and defoliated axes, with attached needles matching isolated needles. All of the fossils occurred in the same stratigraphic layers.

The cone scales up to 32 by 20 millimetres (1.3 by 0.79 in) and 1.25-2 times as long as wide, have a generally triangular to cuneate shape with the distal edge turned upwards and the stalk on half the length of the scale. Sometimes preserved with cone scales are the bracts which average 5 by 4 millimetres (0.20 by 0.16 in) and have a central acuminate flanked by thinner laminae. The wing seeds are up to 27 by 14 millimetres (1.1 by 0.55 in) and have a pterostegium which covers on average three-quarters of the seed. The narrow obovate seed is generally 12 by 4 millimetres (0.47 by 0.16 in), 1-1.5 times the length of the upper wing edge while the wing itself is widest in the distal half. Needles of *A. milleri* reach up to 38 millimetres (1.5 in) long, but have a width of only 1 millimetre (0.039 in) at the base. The leaf base is generally as wide to slightly wider than the leaf and round, with the leaf angled approximately 70 degrees upward from the attachment. Leaf scars on axes are circular to slightly oval, 1.5 by 2 millimetres (0.059 by 0.079 in), and show a vascular bundle scar in the center. Oval leaf scars are oriented with the long axis parallel to the length of the stem axis. While the scars show the leaves to be in a

helical arrangement, the leaves would have had a flattened orientation on either side of the axis.

Corylus johnsonii

Corylus johnsonii



Corylus johnsonii holotype specimen

Scientific classification

Kingdom:	Plantae
Division:	Magnoliophyta
Class:	Magnoliopsida
Order:	Fagales
Family:	Betulaceae
Genus:	<i>Corylus</i>
Species:	† <i>C. johnsonii</i>

Binomial name

Corylus johnsonii

Pigg, Manchester, & Wehr, 2003

Corylus johnsonii is an extinct species of hazel known from fossil fruits found in early Eocene Ypresian stage Klondike Mountain Formation deposits of Northern Washington State. Based on described features, *C. johnsonii* is the oldest definite species in the genus *Corylus*.

The description of the new species by Dr. Kathleen Pigg, Steven Manchester, and Wesley Wehr was based on the study of thirty-four compression fossil specimens found at the UWBM sites B4131 and A0307, the latter being designated the type locality. The specimens are twelve infructescences with attached involucre containing nuts or nut casts, fourteen involucre, and eight isolated paired or single nuts. The holotype specimen

is number "SR 98-01-02 A&B", an infructescence with involucre, and is housed in the Stonerose Interpretive Center in Republic, Washington. The species epithet *johnsonii* was coined in honor of Kirk R. Johnson for his continuing work on, and recognition of the importance of, the Republic Flora.

The infructescences bear between 2 and 3 nuts at the end of a stout stalk. The nuts, 8 to 17 millimetres (0.31 to 0.67 in) in diameter, are ovoid to almost circular in outline and enclosed in an involucre composed of 2 bracts. While most specimens consist of paired involucre with ovoid nuts or nut casts, several paired or isolated nuts are known. On the nuts themselves basal attachment scars cover a small area of nut; distal scars and style remains are preserved in several specimens. A predominant number of the fruits possess more dissected involucre, some having simple spines, while others have both simple and branched spines.

Though described as a single species, the authors noted the wide grade of variation in the involucre morphology, ranging from simple to ones with extensive spines. The involucre also show a spectrum from thin, leafy lobes that display distinct veins to thick lobes with no distinct venation. As specimens of *C. johnsonii* have a full morphology range between the three involucre types, the possibility of multiple species is hard to prove or disprove. However the authors chose to name a single species because of the continuous gradation present between the distinct morphologies.

Of the two sections into which the genus *Corylus* is divided, section *Corylus* and section *Acanthochlamys*, *C. johnsonii* is most similar to three species in the latter. Section *Acanthochlamys* is considered basal within the genus and the three species, *Corylus ferox*, *C. wangii*, and *C. heterophylla* are all native to southeast Asia. Infructescences of *Corylus wangii*, like those of *C. johnsonii*, possess narrow lobes with many unbranched and branched spines, while *C. ferox*-like infructescences have a highly spiny, prickly surface. Specimens within the simple end of the infructescence morphologic range are most similar to *C. heterophylla*. As *C. johnsonii* encompasses a wide morphology range within its features, it is possible it may have diverged out into the modern species. The modern areas of distribution for *C. ferox* and *C. heterophylla* overlap in the Sichuan province of China, while *C. wangii* has a distinct and separate range in southwest China.

Isolated nuts from Paleocene sediments in Greenland, England, and Montana have been attributed to the *Corylus* genus. However all lack the surrounding infructescence that is needed to confirm placement of the nuts in a specific coryloid genus.

Dillhoffia

<i>Dillhoffia</i>
Fossil range: 49.5 Ma
PreЄ
Є
O



Fossil *Dillhoffia cachensis*
calyces

Scientific classification

Kingdom: Plantae
Division: Angiospermae
Class: *incertae sedis*
Family: *incertae sedis*
Genus: †*Dillhoffia*
Species: *D. cachensis*

Binomial name

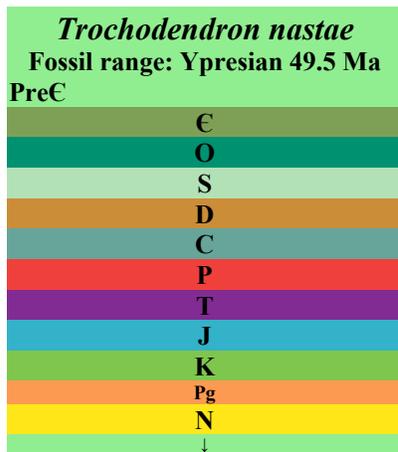
Dillhoffia cachensis
Manchester & Pigg, 2008

Dillhoffia is an extinct monotypic genus of flowering plant with a single species, *Dillhoffia cachensis* known from Ypresian age Eocene fossils found in British Columbia, Canada, and Washington, USA. The genus and species were described from fifteen specimens found in an unnamed formation belonging to the Kamloops group; and two specimens from the Klondike Mountain Formation. The unnamed formation outcrops at the McAbee fossil site near Cache Creek, BC, which is designated the type locality while the two U.S. specimens were recovered from the Tom Thumb Tuff member of the Klondike Mountain Formation in Republic, Washington. It is of interest to note that of the Okanagan highlands fossil sites *Dillhoffia* is only known from two locations, and is absent or has not been identified from the others.

The holotype specimen, number *TMP 83.39.175*, is preserved in the Royal Tyrrell Museum and the paratype specimens are in the Thompson Rivers University and University of Saskatchewan collections. The specimens were studied by paleobotanists Steven Manchester of the University of Florida and Kathleen Pigg of Arizona State University. Manchester and Pigg published the 2008 type description for *D. cachensis* in the journal *Botany*, Volume 86, number 9. They chose the generic name *Dillhoffia* to honor the brothers Richard M. Dillhoff and Thomas A. Dillhoff for their substantial contributions and promotion of Pacific Northwest North American Paleogene floras. The specific name is a reference to Cache Creek, British Columbia, the nearest town to the McAbee site.

Dillhoffia is known from infructescences only. The infructescences are pedunculate having a globose head which bore at least twelve flowers and has been preserved as fossils with several sessile fruits. The fruits are elongate to ellipsoidal in form, being 8–10 millimetres (0.31–0.39 in) by 4–5 millimetres (0.16–0.20 in), and indehiscent. The enlarged calyx present on the fruits is thought to have been used for wind transport, with the calyx being dish to funnel shaped and born approximately three-quarters of the way up the fruit from the base. Formed from a persistent paranth, the calyx may have been accrescent, as small-sized calyces are known. It is unknown what the petals and stamens looked like, as none have been found, possibly being shed during fruit formation. *Dillhoffia* was most likely a non-magnoliid angiosperm as indicated by its inferior ovary, but placement into a specific family is not possible with the fossils known.

Trochodendron nastae



Trochodendron nastae specimen

Scientific classification

Kingdom: Plantae

(unranked): Angiospermae

(unranked): Eudicots

Order: Trochodendrales

Family: Trochodendraceae

Genus: *Trochodendron*

Species: †*T. nastae*

Binomial name

Trochodendron nastae

Pigg, Wehr, & Ickert-Bond, 2001

Trochodendron nastae is an extinct species of flowering plant in the family Trochodendraceae known from fossil leaves found in the early Eocene Ypresian stage Klondike Mountain Formation deposits of Northern Washington State. *T. nastae* is the one of the oldest members of the genus *Trochodendron*, which includes the living species *T. aralioides*, native to Japan, southern Korea and Taiwan and the coeval extinct species *T. drachuckii* from Cache Creek, British Columbia.

Description of the new species by Dr. Kathleen Pigg, Wesley Wehr, and Stephanie Ickert-Bond was based on the study of 11 complete and 55 partial compression fossil specimens with the holotype specimen, number "SR 98-02-01", being housed in the Stonerose Interpretive Center, Republic, Washington. They published their 2001 type description of the species in the *International Journal of Plant Sciences* volume number 162. and named the species *nastae* in honor of Charlotte G. Nast for her work on extinct and living members of the Trochodendrales.

T. nastae has been placed in the genus *Trochodendron* based on the overall shape of the leaves, the secondary vein structure, which forms weak chevrons bracing primary veins, and the tertiary veins forming four to five sided cells. However the primary veins are palmate in structure for *T.nastae* rather than being pinnate as in *T. aralioides*.

Trochodendron shares with *Tetracentron* the very unusual feature in angiosperms, of lacking vessel elements in its wood. This has long been considered a very primitive character, resulting in the classification of these two genera in a basal position in the angiosperms; however, genetic research by the Angiosperm Phylogeny Group has shown it to be in a less basal position (early in the eudicots), suggesting that the absence of vessel elements is a secondarily evolved character, not a primitive one.

Banksia novae-zelandiae

Banksia novae-zelandiae

Fossil range: Oligocene–
Miocene

Scientific classification

Kingdom: Plantae

(unranked): Angiosperms

(unranked): Eudicots

Order: Proteales

Family: Proteaceae

Genus: *Banksia*

Species: ***B. novae-zelandiae***

Binomial name

Banksia novae-zelandiae

R.J.Carp., G.J.Jord., D.E.Lee &
R.S.Hill

Banksia novae-zelandiae is an extinct species of *Banksia*, known only from fossil leaves found on the South Island of New Zealand.

Description

This species is based on several leaf fossils, all with triangular pinnate lobes cut all the way back to the midrib, and indistinct secondary venation. Stomata occur in areoles, and have very wrinkly subsidiary cells. Both leaf surfaces are covered in trichome bases, and the undersurface is covered in cuticular papillae.

Taxonomy

Fossil leaves were found at the Newvale Mine, Waimumu Coalfield, Southland District, South Island, New Zealand (46°8′33″S 168°45′6″E﻿ / ﻿46.1425°S 168.75167°E﻿ / -46.1425; 168.75167), in a thin leaf litter bed located in a seam of the middle Gore Lignite Measures.

B. novae-zelandiae was first published in 2010. The specific epithet refers to New Zealand, where the fossils were found. The fossils are assigned to Banksieae based on several structural grounds, including brachyparacytic stomata, a trichome base architecture unique to Banksieae, "banksioid" venation, and the pinnate leaf lobes. Within Banksieae they are assigned to genus *Banksia* because of their cuticular papillae and the division of the leaves into triangular lobes all the way back to the midrib, neither of which occurs in any other Banksieae genus. (Before the 2007 transfer of *Dryandra* into *Banksia*, it was realised that there was no way to distinguish these two genera based solely on foliar characters, and so fossil leaves were classified into the form genera *Banksieaephyllum* and *Banksieaeformis*. Now, however, they may simply be assigned to *Banksia*.)

Although the cuticular papillae are regarded as evidence that the species belongs to *Banksia*, their unusual structure, together with some ornamentation of the trichome bases, and the absence of any features of extant *Banksia* recognised as derived, suggests that

B. novae-zelandiae is basal to all extant *Banksia* species; that is, it belongs to the stem group of *Banksia*.

Habitat

The leaf litter bed in which *B. novae-zelandiae* was found is regarded as of late Oligocene to early Miocene origin, and is thought to have accrued in swamps associated with a coastal delta. The bed mainly contains species with sclerophyllous leaves, with no broad-leaved rainforest element in evidence, suggesting a heath-like environment. The vegetation has been interpreted as growing in a warm and constantly wet climate, and the extensive beds of lignite in the area suggest an area with poor drainage.

Biogeography

Banksia novae-zelandiae encompasses the first fossil *Banksia* material found outside Australia. It shows that the *Banksia* lineage once occurred in New Zealand, but because the species is regarded as belonging to the stem group, it does not contradict previous evidence suggesting that the crown group of *Banksia* arose in southwest Australia some time after the Paleogene.

Under the long-held view that the New Zealand flora has a Gondwanan element that has survived there at least since the Cretaceous, the presence of *B. novae-zelandiae* in New Zealand can be adequately explained by vicariance. It is harder to reconcile it with the recent claim that New Zealand was completely submerged in the late Oligocene, as this would require the unlikely (but possible) dispersal of seeds across thousands of kilometers of ocean.

Banksia kingii

Banksia kingii
Fossil range: Late Pleistocene



Banksia kingii
fossil cone

Scientific classification

Kingdom:	Plantae
(unranked):	Angiosperms
(unranked):	Eudicots
Order:	Proteales
Family:	Proteaceae
Genus:	<i>Banksia</i>
Subgenus:	<i>Banksia</i>
Section:	<i>Banksia</i>
Series:	<i>Salicinae</i>
Species:	<i>B. kingii</i>

Binomial name

Banksia kingii
Jordan & Hill

Banksia kingii is an extinct species of tree or shrub in the plant genus *Banksia*. It is known only from fossil leaves and fruiting "cones" found in Late Pleistocene sediment at Melaleuca Inlet in western Tasmania. These were discovered by Deny King in the workings of his tin mine. The leaves and fruiting cones were discovered at different locations, and since the sediment had been removed during mining, the stratigraphy of the fossils is unknown. The sediment from which they were recovered was alluvial, consisting of large, well-rounded fragments of quartz and schist.



B. kingii leaf

The fossil leaves are about 12 centimetres long and one centimetre wide and very thick and robust. They clearly belong to genus *Banksia*, section *Banksia*, series *Salicinae*, but not to any of the extant species in that series. The leaves of *B. plagiocarpa* (Dallachy's Banksia) are similar in form, shape and robustness, but differ strongly in structure. Leaves of *B. saxicola* (Grampians Banksia) are structurally the most similar to *B. kingii*, but have a different shape. There also appear to be some affinities with *B. marginata* (Silver Banksia) and *B. canei* (Mountain Banksia), but insufficient to warrant the fossil's ascription to those species. The fossils are therefore considered representative of a new species, *B. kingii*.

The fossil fruiting structures are cylindrical, about 6 centimetres high and 4½ centimetres wide. The structure had lost its old flower parts. It appears to be most closely related to *B. saxicola* and *B. canei*, with some similarities to *B. marginata*. The taxonomic situation therefore appears highly similar for both leaves and fruiting structures, and so the fruiting structures are ascribed to *B. kingii* despite the absence of any direct connection to the fossil leaves.

The species is believed to represent an extinct lineage. It is possible that it is an ancestor of *B. marginata*, although *B. marginata* must have speciated well before the extinction of *B. kingii*, given how widely it is now distributed. Extinction of *B. kingii* probably occurred in the late Quaternary, and may have been caused by the climatic and physical disruption of glaciation, or by increased fire frequency due to human activity.

A formal description of *B. kingii* was published in 1991 by Gregory J. Jordan and Robert S. Hill, who named the species in honour of the discover, Deny King. Hence the species' full name is "*Banksia kingii* Jordan & Hill". The holotype and a number of other specimens are stored in the Department of Plant Science at the University of Tasmania.

Chapter- 9

Encephalartos woodii

Wood's Cycad



A large stem of *Encephalartos woodii* at the Durban Botanic Gardens

Conservation status



Extinct in the Wild (IUCN 3.1)

Scientific classification

Kingdom: Plantae
Division: Cycadophyta
Class: Cycadopsida
Order: Cycadales

Family: Zamiaceae
Genus: *Encephalartos*
Species: *E. woodii*

Binomial name

Encephalartos woodii
Sander

Wood's Cycad (*Encephalartos woodii*) is a cycad in the genus *Encephalartos*, and is endemic to the Ongoye Forest of KwaZulu-Natal, South Africa. It is one of the rarest plants in the world, being extinct in the wild with all specimens being clones of the type. The specific and common name both honour John Medley Wood, curator of the Durban Botanic Garden and director of the Natal Government Herbarium of South Africa, who discovered the specimen in 1895.



Cone of *Encephalartos woodii*



Portion of a leaf showing leaflets

Description

It is palm tree like, and can reach a height of 6 metres (20 ft). The trunk is about 30–50 centimetres (12–20 in) in diameter, thickest at the bottom, and topped by a crown of 50–150 leaves. The leaves are glossy and dark green, 150–250 centimetres (59–98 in) in length, and keeled with 70–150 leaflets, the leaflets falcate (sickle-shaped), 13–15 centimetres (5–6 in) long and 20–30 millimetres (0.8–1 in) broad.

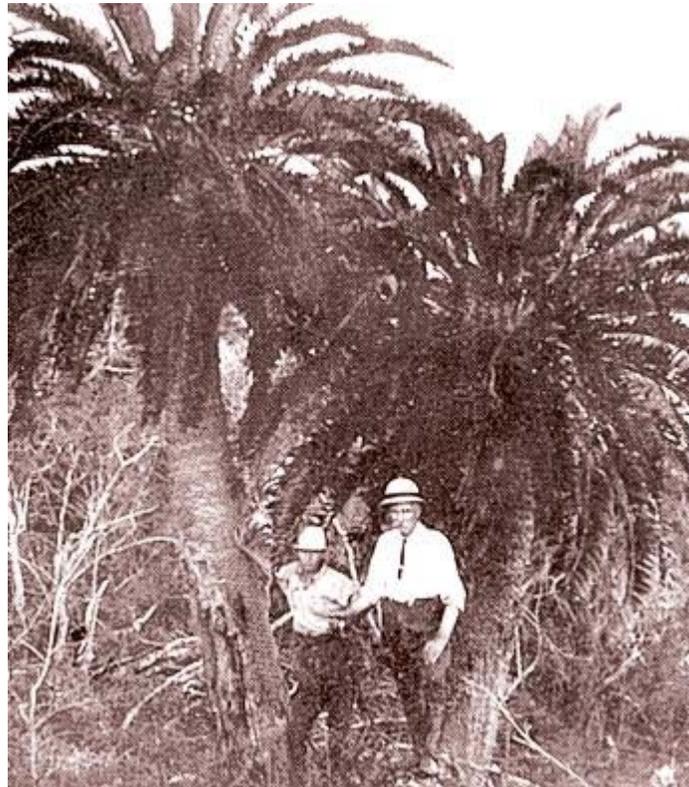
E. woodii is dioecious, meaning it has separate male and female plants, however no female plant has ever been discovered. The male strobili are cylindrical, 20–40

centimetres (7.9–16 in) long, exceptionally up to 120 centimetres (47 in), and 15–25 centimetres (6–10 in) in diameter; they are a vivid yellow-orange colour. A single plant may bear from around six to eight simultaneously.

Taxonomy

Encephalartos woodii was first described by Wood as a variety of *E. altensteinii* (as *E. altensteinii* var. *bispinna*), and raised to the rank of species in 1908 by the English horticulturalist Henry Sander from studying a specimen in his collection, which was apparently one of the basal offsets taken from the original clump. It has been considered that *Encephalartos woodii* is most closely related to *E. natalensis*. Some authorities consider *E. woodii* to not be a true species but rather a mutant *E. natalensis* or a relic of some other species. Yet others consider this plant to be a natural hybrid between *E. natalensis* and *E. ferox*. To determine the relationship between *E. natalensis* and *E. woodii*, the RAPD technique was used to generate genetic fingerprints and data analysed using distance methods. Based on RAPD fingerprints, the intraspecific genetic variation among different *E. natalensis* plants is similar to the interspecific variation between *E. natalensis* and *E. woodii*, which confirms the close relationship between *E. natalensis* and *E. woodii*.

Distribution and Habitat



The last two stems of Wood's Cycad at Ongoye in the early 1900's



One of the original stems in the Durban Botanic Gardens



Another large stem of *E. woodii* at the Durban Botanic Gardens

Original Distribution

The only known wild plants of *E. woodii* were a cluster of four stems of one plant discovered by Wood in 1895 in a small area of Ngoya Forest, now known by its proper Zulu name of *Ongoye*, which is in KwaZulu-Natal, South Africa. The site where this plant was found was on a steep south-facing slope on the fringes of the forest. The annual rainfall at the site ranges between 750–1,000 millimetres (30–39 in), and the climate has hot summers and mild winters.

Removal from Natural Habitat



Original stem at Durban Botanic Gardens, 2010



Encephalartos woodii in the Royal Botanic Gardens, Kew



Male cone of *E. woodii* in California

A basal offset of the main stems was removed and sent to Kew Gardens in 1899. Three basal offsets were collected by Wood's deputy, James Wylie, in 1903 and planted in the Durban Botanic Gardens. One specimen was received at the National Botanic Gardens of Ireland in Glasnevin in 1905 where the register records it as "*Encephalartos way of E. Alten[steinii]*" costing 1 guinea from Sander & Sons. In a 1907 expedition, Wylie collected two of the larger stems and noted that of the remaining two, one of them (the largest of the four original stems) was badly mutilated and he did not expect it to survive. By 1912 there was only one 3 metres (9.8 ft) tall trunk left in the wild, and in 1916, the Forestry Department arranged to have it removed and sent to the Government Botanist in Pretoria. It is thought that this trunk subsequently died in 1964.

Current Distribution

These plants are currently distributed in various botanical institutions around the world. Two of the larger trunks that Wylie collected in the 1907 expedition are still to be seen in

the Durban Botanic Gardens. A sucker from one of the Durban Botanic Gardens plants was sent to Kirstenbosch near Cape Town, South Africa in 1916 by James Wylie. The plant that was sent to Kew Gardens in 1899 was grown in the Palm House until April 1997 and then moved to the Temperate House where it produced, for the first time, a male cone in September 2004. In the United States; a specimen is housed in the conservatory at Longwood Gardens near Philadelphia, Pennsylvania and three specimens are to be seen at Lotus Land in Santa Barbara, California where they were planted in 1979. The specimen at Longwood Gardens was received in 1969 after a request was made to the Durban Botanic Gardens by one of Longwood's former directors, Dr. Russell Seibert, when he went on a plant exploration voyage to South Africa in the 1960s. The rooted plant was first taken to the Research Department at Longwood where the gardeners nurtured the plant until it was ready to be displayed in the Conservatory. The Longwood specimen produces cones in early winter. In Europe; a specimen is housed in the Netherlands at Hortus Botanicus in Amsterdam and in Orto Botanico di Napoli in Italy, although this specimen may have died. The specimen in Ireland at Glasnevin is said to be "probably the tallest" specimen of *E. woodii* in Europe.

Conservation Status

Despite numerous excursions in the Ongoye-Mtunzini area, no other specimens of *Encephalartos woodii* have ever been found. All known specimens of *Encephalartos woodii* are clones of the only known male plant which was completely removed from the wild. For these reasons, the plant is considered extinct in the wild.

Legislation

As is the case with all members of the genus *Encephalartos*, *Encephalartos woodii* is protected by both national and international legislation:

In South Africa one requires a permit from Nature Conservation to move, sell, buy, donate, receive, cultivate and sell Endangered Flora and to own adult cycads. On an international level all species and hybrids of *Encephalartos* are on Appendix I of CITES, the Convention on International Trade in Endangered Species of Wild Fauna and Flora. This means that wild collected material may not be traded and for each and every artificially cultivated *Encephalartos* plant or piece of a plant or a cone or pollen or seed, being carried over an international border requires a CITES Export Permit issued by the authority of the exporting country, and a CITES Import Permit issued by the authority of the importing country.

Reproduction and Propagation



Offshoots (suckers) showing roots developing on the largest one



A female *E. natalensis* x *woodii* with cones

Vegetative Reproduction

Encephalartos woodii reproduces with rapidly-growing suckers.

Sexual Reproduction

Unless a female plant is found, *E. woodii* will never reproduce naturally. However, the next best thing has been accomplished. Wood's Cycad forms fertile hybrids with *E. natalensis*. If each offspring is subsequently crossed with *E. woodii* and the process is then repeated, after several generations, the female offspring will be close to what a female *Encephalartos woodii* would be like. Genetic analysis of chloroplast DNA of F1 hybrids between *E. woodii* and *E. natalensis* showed that all chloroplasts are inherited from the female *E. natalensis*, indicating that multigenerational hybrid offspring would have *E. natalensis* chloroplasts and could never be "pure" *E. woodii*.

Distribution of Hybrids



Encephalartos natalensis x *E. woodii* at Orto botanico di Palermo

Several hybrids between *E. woodii* and other species of *Encephalartos* have been produced including:

- *Encephalartos gratus* x *E. woodii* at Lotus Land, California.
- *Encephalartos natalensis* x *E. woodii* at Orto botanico di Palermo in Italy, and in various collections in South Africa and the United States.
- *Encephalartos transvenosus* x *E. woodii* in collections in South Africa and the United States.

Gallery



Male cone of *E. woodii* in California



A hybrid *E. woodii* x *E. natelensis*

Chapter- 10

Franklinia

Franklinia



Flower and leaves in the fall

Conservation status



Extinct in the Wild (IUCN 2.3)

Scientific classification

Kingdom: Plantae

(unranked): Angiosperms

(unranked): Eudicots

(unranked): Asterids

Order: Ericales

Family: Theaceae

Franklinia

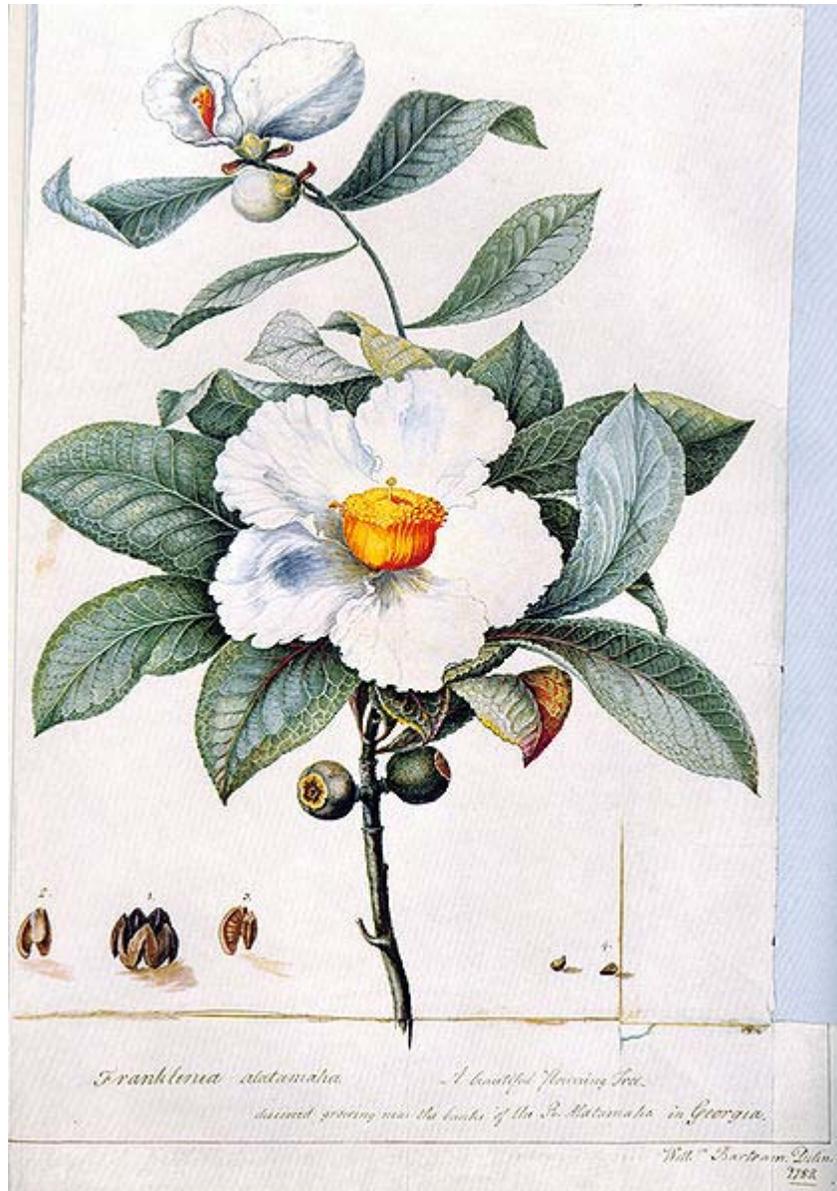
Genus: W.Bartram ex Marshall,
1785

Species: *F. alatamaha*

Binomial name

Franklinia alatamaha

W.Bartram ex Marshall



Franklinia alatamaha by William Bartram (1782)

Franklinia is a monotypic genus in the tea plant family, Theaceae. The sole species in this genus is a flowering tree, *Franklinia alatamaha*, commonly called the **Franklin tree**, and native to the Altamaha River valley in Georgia in the southeastern United States. It has been extinct in the wild since the early 19th century, but survives as a cultivated ornamental tree.

In the past, some botanists have included *Franklinia* within the related genus *Gordonia*. The southeastern North American species *Gordonia lasianthus* differs in having evergreen foliage, flowers with longer stems, winged seeds, and conical seed capsules. (*Franklinia* was often known as *Gordonia pubescens* until the middle of the 20th century.)

Franklinia is now thought to be closer in relation to the Asian genus *Schima*. Recent DNA studies and examinations of floral ontogeny in the Theaceae place *Franklinia* together with *Gordonia* and *Schima* in a subtribe. (Tsou 1998). Hybrid crosses have been produced between *Franklinia alatamaha* and *Gordonia lasianthus*, and between *Franklinia alatamaha* and *Schima argentea*. (Orton 1977; Ranney et al. 2003).

Description

Franklinia alatamaha is a deciduous large shrub or small tree growing to 10 m (33 ft) tall, but commonly 4.5–7.5 m (15–25 ft). It is commercially available for garden cultivation. It is prized for its fragrant white flowers, similar to camellia blossoms. Flowers appear mid-summer to early fall, and may last as the tree's leaves change color.

The tree has a symmetrical, somewhat pyramidal shape, with different individuals of the species forming almost identical crowns. It forms several vertical trunks close to ground level. The bark is gray with vertical white striations and has a ridged texture. The alternate, obovate leaves are up to 6 in (15 cm) in length and turn a bright orange-red in the fall. Although difficult to transplant, once established *Franklinia* can live a century or more.

Franklinia fruit develops slowly. The seed capsules require 12–14 months to mature. When ripe the 5-valved spherical capsules split above and below in a unique manner. Anecdotal evidence suggests viable seed production is enhanced where two or more plants are present in close proximity.



Leaves



Leaf closeup

History

Philadelphia botanists John and William Bartram first observed the tree growing along the Altamaha River near Fort Barrington in the British colony of Georgia in October 1765. John Bartram recorded "*severall very curious shrubs*" in his journal entry for October 1, 1765. William Bartram returned several times to the same location on the Altamaha during a collecting trip to the American South, funded by Dr. John Fothergill of London. William Bartram collected *Franklinia* seeds during this extended trip to the South from 1773 through 1776, a journey described in his book *Bartram's Travels* published in Philadelphia in 1791. William Bartram brought seed of *Franklinia* back to Philadelphia in 1777, and had flowering plants by 1781. After several years of study, Bartram assigned the "*rare and elegant flowering shrub,*" to a new genus *Franklinia*, named in honor of his father's great friend Benjamin Franklin. The new plant name, *Franklinia alataamaha* was first published by a Bartram cousin, Humphry Marshall in 1785 in his catalogue of North American trees and shrubs entitled *Arbustrum Americanum*. (Marshall 1785: 48-50; Fry 2001).

William Bartram was the first to report the extremely limited distribution of *Franklinia*. "*We never saw it grow in any other place, nor have I ever since seen it growing wild, in all my travels, from Pennsylvania to Point Coupe, on the banks of the Mississippi, which*

must be allowed a very singular and unaccountable circumstance; at this place there are two or 3 acres (12,000 m²) of ground where it grows plentifully." (W. Bartram 1791: 468).

The tree was last verified in the wild in 1803 by the English plant collector John Lyon, (although there are hints it may have been present into at least the 1840s. See: Bozeman and Rogers 1986). The cause of its extinction in the wild is not known, but has been attributed to a number of causes including fire, flood, overcollection by plant collectors, and fungal disease introduced with the cultivation of cotton plants. (Dirr 1998: 390-391).

All the Franklin trees known to exist today are descended from seed collected by William Bartram and propagated at Bartram's Garden in Philadelphia.



Trunk bark



Autumn leaves

Cultivation

The Franklin tree has a reputation among gardeners for being difficult to cultivate, especially in urban environments. It prefers sandy, high-acid soil, and does not tolerate compacted clay soil, excessive moisture, or any disturbance to its roots. The Franklin tree has no known pests, but it is subject to a root-rot disease and does not endure drought well.

Chapter- 11

Plants Extinct in the Wild

Cosmos atrosanguineus

Cosmos atrosanguineus



Conservation status



Extinct in the Wild (IUCN 2.3)

Scientific classification

Kingdom: Plantae
(unranked): Angiosperms
(unranked): Eudicots
(unranked): Asterids
Order: Asterales

Family: Asteraceae
Tribe: Heliantheae
Genus: *Cosmos*
Species: *C. atrosanguineus*

Binomial name

Cosmos atrosanguineus
(Hook.) Voss

Cosmos atrosanguineus (**Chocolate Cosmos**) is a species of *Cosmos*, native to Mexico, where it is extinct in the wild. The species was introduced into cultivation in 1902, where it survives as a single clone reproduced by vegetative propagation.

It is a herbaceous perennial plant growing to 40-60 cm tall, with a fleshy tuberous root. The leaves are 7-15 cm long, pinnate, with leaflets 2-5 cm long. The flowers are produced in a capitulum 3-4.5 cm diameter, dark red to maroon-dark brown, with a ring of six to ten (usually eight) broad ray florets and a center of disc florets; they have a light vanillin fragrance (like many chocolates), which becomes more noticeable as the summer day wears on.

Cultivation and uses

The single surviving clone is a popular ornamental plant, grown for its rich dark red-brown flowers. It is not self-fertile, so no viable seeds are produced, and the plant has to be propagated by division of the tubers.

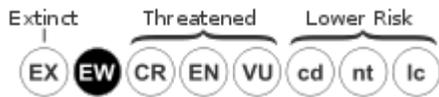
It requires partial sun or full sun, and flowers from mid to late summer. It is frost-sensitive; in temperate zones, the tuber has to be dug up and stored in a frost-free store over the winter.

Lotus berthelotii

Lotus berthelotii



Conservation status



Extinct in the Wild (IUCN 2.3)

Scientific classification

Kingdom: Plantae
 Division: Magnoliophyta
 Class: Magnoliopsida
 Order: Fabales
 Family: Fabaceae
 Subfamily: Faboideae
 Tribe: Loteae
 Genus: *Lotus*
 Species: *L. berthelotii*

Binomial name

Lotus berthelotii
 Lowe ex Masf.

Lotus berthelotii is a perennial plant endemic to the Canary Islands, in the genus *Lotus*. This plant is either extinct in the wild or persists as a few individuals. In 1884 it was already classed as "exceedingly rare" and plant collection probably hastened its decline.

Description

Lotus berthelotii has a creeping or trailing habit, with leaves divided into 3-5 slender leaflets, each leaflet 1-2 cm long and 1 mm broad, densely covered with fine silvery hairs. The flowers are orange-red to red, peaflower-shaped, but slender, 2-4 cm long and 5-8 mm broad.

The flowers of *Lotus berthelotii* and some other Canary Island species appear to be adapted for bird pollination. It was once thought that the original pollinators of these plants (and other genera such as *Isoplexis* and *Canarina*) were sunbirds which had become extinct on the Canary Islands, explaining why they are rare and considered endangered species (Vogel 1954; Vogel et al. 1984; Valido et al. 2004). However more recent work has shown that these plants are adequately pollinated by non-specialist flower visiting birds, particularly the Canary Island Chiffchaff (*Phylloscopus canariensis*), and in fact show some specific adaptations to infrequent pollination by these birds, such as extended flower lifespans .

However, the cultivated population studied by Ollerton et al. (2008) set no fruit, despite the plants receiving large amounts of pollen on their stigmas. This may be because the population was a single, self incompatible clonal genotype; whether this is true of all

plants in cultivation is unknown, but may have important implications for the conservation of this species if it is extinct in the wild.

Cultivation

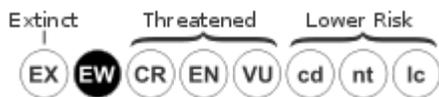
Lotus berthelotii is cultivated in the horticulture trade and widely available as an ornamental plant with its needle-like silvery foliage and red flowers for: traditional gardens, container (pots), and drought tolerant water conserving gardens. A golden orange flowering cultivar is also grown.

Sophora toromiro

Sophora toromiro



Conservation status



Extinct in the Wild (IUCN 2.3)

Scientific classification

Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order: Fabales
Family: Fabaceae
Genus: *Sophora*
Species: *S. toromiro*

Binomial name

Sophora toromiro
Skottsb.

Sophora toromiro, commonly known as **Toromiro**, is a species of flowering tree in the legume family, Fabaceae, that is endemic to Easter Island. Heavy deforestation had eliminated most of the island's forests by the first half of the 17th century (Orliac 2005), and the once common toromiro became rare and ultimately extinct in the wild. The tree is

being reintroduced to the island in a scientific project partly led jointly by the Royal Botanic Gardens, Kew and the Gothenburg Botanical Garden, where the only remaining plants of this species with a documented origin were propagated in the 1960s from seeds collected from a single tree by Thor Heyerdahl. It is sometimes claimed that all toromiro trees are derived from this single individual, but research has determined that at least one other tree's descendants survive (Maunder *et al.*, 2000).

Local tradition has it that the rongorongo tablets of Easter Island are made of toromiro. However, all tablets of native wood tested by modern methods have turned out to be *Thespesia populnea* (Orliac 2005).

Jellyfish tree

Jellyfish tree



Jellyfish tree with fruit.

Conservation status



Critically Endangered (IUCN 2.3)

Scientific classification

Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order: Malpighiales
Family: **Medusagynaceae**
Engl. & Gilg
Genus: **Medusagyne**
Baker
Species: ***M. oppositifolia***

Binomial name

Medusagyne oppositifolia
Baker



Mahé, home of jellyfish trees.

The **jellyfish tree** (*Medusagyne oppositifolia*), the only species of the family **Medusagynaceae**, is a critically endangered and unusual tree endemic to the island of Mahé, of the Seychelles. The plant was thought to be extinct until a few individuals were discovered in the 1970s.

The gynoecium of the flower resembles the tentacles of a jellyfish, hence the common and generic names of the plant. This plant exhibits many adaptations to dry climate, strange on a moist archipelago. It can withstand drought, and its seeds disperse by the wind. This suggests it has Gondwanan origins.

The genus *Medusagyne* is often included in the family Ochnaceae, e.g. in the Angiosperm Phylogeny Group classification. The small tropical American family Quinaceae is also included in this broad concept of Ochnaceae.

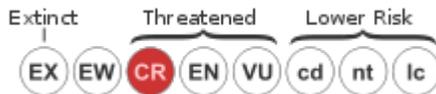
Café marron

Ramosmania rodriguesii



'*Ramosmania rodriguesii* in cultivation at the Royal Botanic Gardens, Kew

Conservation status



Critically Endangered (IUCN 2.3)

Scientific classification

Kingdom:	Plantae
Division:	Magnoliophyta
Class:	Magnoliopsida
Order:	Gentianales
Family:	Rubiaceae
Genus:	<i>Ramosmania</i> Tirveng. & Verde.

Species

Ramosmania heterophylla
Ramosmania rodriguesii

Café marron or *Ramosmania rodriguesii* is native to the island of Rodrigues in the Indian Ocean.

History

It was thought *Ramosmania rodriguesii* was extinct until a single surviving tree was spotted by a schoolboy in 1980, who was shown a drawing of the plant by his teacher. The only image of the plant was made in 1877, by a European visitor, passing through Rodrigues. By the 1950s, it was presumed to be extinct. Cuttings were taken to Kew Gardens, and although the plant regularly flowers, it never produced seed until horticulturists discovered how to pollinate the flowers.

In 2003 the café marron bore its first fruit with viable seeds. Slow but steady efforts have been made to grow more café marron trees and speed up the pollination process. *Ramosmania rodriguesii* is a Critically endangered plant species.