An Introduction to the Mesozoic Palaeobotany
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The Mesozoic age was a time of great changes, not only in animals but also in the terrestrial vegetation. The Mesozoic flora was the vegetation eaten by the dinosaurs, other reptiles and mammal herbivores during this Era. New genus and new plants, e.g. gymnosperms, first appeared in their current recognizable forms. Ferns had already appeared in Palaeozoic but their diversity and spread increased in the Mesozoic. Conifers, cycads and the living fossil ginkgo dominated and made up the forests. Angiosperms and flowers also appeared in Mesozoic and began to diversify and take over from the other plants. This article expounds the main characteristic features of the Mesozoic terrestrial vegetation. It follows the evolution of the flora in chronological order and points out the most dominating plants, and the appearance of new genera.

Before the Mesozoic Era, in the Cambrian Era, many land plants had made their appearance and put their mark on the environment on Earth. The land plants do not appear to have undergone such a dramatic mass extinction like the terrestrial animals at the end of the Palaeozoic Era. Ferns, carboniferous pteridosperms (seed ferns), lycopsides and horsetails had already appeared but when come to the Mesozoic, the flora and fauna changed in many different ways. Some groups increased in diversity but others went through reduction of numbers. Lycopod trees for example, that dominated the coal-forming swamps in the Carboniferous Period, horsetails, that is a single genus of homosporopus vascular plants and cordaite trees, that looked very similar to conifers but became extinct probably in the Triassic Period. Among plants that increased but were still abundant in the end of Permian, and beginning of Triassic, are ferns and seed ferns. Most trees that were bigger than

![Figure 1](image_url)

**Figure 1**
The numbers of species of terrestrial vegetation from Silurian to Tertiary. gymnosperms appear in the Carboniferous period but diversify quickly during the Triassic period. Angiosperms appeared early in Cretaceous and increased dramatically, in the number of angiosperms through the mid-Cretaceous.
ferns belong to three groups of plants; all characterized by exposed seeds and had already appeared in the Permian; bennettitales and cycads, followed by conifers and ginkgos. Late in the Mesozoic the rise of angiosperms began and became extremely important in all of Earth’s floras and also for insects and bigger animals.

**FERNS AND SEED FERNS**

Ferns were a major component of Late Palaeozoic vegetation, but underwent a dramatic decline at the end of the Permian Period. The “Age of Ferns” in the late Carboniferous Period had passed. Only three families persisted into the Mesozoic Era and they have survived to the present day albeit with a relatively restricted distribution. Nevertheless, ferns were still widespread in the Triassic and Jurassic forests.

The remains of seed ferns are common fossils in rocks of Carboniferous age. They are generally characterized as having been slender trees or, in some cases, woody, climbing vines. They were generally large, up to 5 metres tall and their large fronds were so fernlike that these plants were long regarded as ferns but now they are known to be an artificial group of primitive seed-bearing plants which however were reduced in abundance and apparently failed to survive into the Jurassic Period. In fact sources are not unanimous about when seed ferns became extinct, but it is certain that they had disappeared from fossil record before the end of the Cretaceous Era.

Glossopteris is an extinct group of seed plants that arose during the Permian on the great southern continent of Gondwanaland and became a dominant part of the southern flora but dwindled to extinction by the end of the Triassic. Glossopteris was long considered a fern but later assigned to the gymnosperms. Some authorities consider glossopteris to have been large trees with a substantial trunk and close to the ancestral angiosperm.

**GYMNOSPERMS**

The first appearance of seed plants, or spermatophytes, stretches back into Devonian. Seed plants have some major advantages over all other plants and are therefore very important. Most important is that they are independent from water as a intermediary of the transport of the sperm to the egg. The seed allows the next generation to lie dormant for months and in that way seed can survive droughts, fire and other natural catastrophes.

Seed plants are divided into two groups, gymnosperms and angiosperms. The phylum Gymnosperm first appeared in the Permian Era and included the tallest and the oldest trees and many common trees like pine, spruce, fir, hemlock and cedar. The flora may have looked similar to the flora today but absence of flowering plant made it rather homonymous.

When the Jurassic Era began, the seed-fern floras of the Triassic declined in importance. The heirs were the gymnosperms. One ancient group of gymnosperms that were among the most prominent plants were cycads, unique and palm like plants with a crown of large compound leaves and a stout trunk, sparcely branched or unbranched. They appeared at least 250 million years ago during the Permian Period, with possible ancestors in the Upper Carboniferous, and were so numerous and dominating in the Mesozoic Era, along with the superficially similar bennettitales, that
At the end of Paleozoic cordaites disappear but conifers appear and diversify rapidly in the Triassic Most consider that the origin of cycads suggests that they originated from the pteridosperms. cycadoids, because their growth habit and leaf structure is similar to that of the cycads. Studies of seed- and pollen-producing structures of bennettitales have demonstrated, however, that they are remarka
dibly different to those of cycads. Their reproductive structure, that was bisexual in some species, suggests a closer relationship with angiosperms and therefore it is still uncertain where bennettitales fit phylogenetically.

Even though the earliest conifer in the fossil record was discovered from the upper Carboniferous locality, the evolution and radiation of the conifers occurred ~ 248-206 million years ago in
the Triassic Era. It is suggested that they most probably inhabited the drier environments of upper areas, from where they subsequently radiated. Characteristics that distinguish extant Coniferales include a pyramidal arborescent growth form; small simple leaves that are often needle-like in appearance and the rooting systems are simple in structure and consist of a branching tap-root system. Nine families that radiated at the Mesozoic time still have widespread global coverage today.

Five distinct vegetation biomes have been identified for the biographical distribution of global vegetation during the early Jurassic. The higher latitudes of both hemispheres were characterized by relatively low species diversity, but dominance of ginkgos and macrophyllus conifers, together with ferns. Closer to the equator, in the lower latitudes where the climate was warmer, the biomes were more rich of cycads, bennettitales and microphyllus conifers. By the early Jurassic, global floras, for the first time, contained a significant component of vegetation recognizably similar to the present day’s.

**The living fossil - Ginkgo biloba**

Ginkgophytes, as already mentioned, are gymnosperms phylum with active cambial growth and fan-shaped leaves. They first appeared in the Permian and increased in the Triassic.

Ginkgo biloba is the only living member of the whole Phylum Ginkgophyta. It was “rediscovered” in 1950’s in temple gardens of China where these sacred trees were carefully tended and have been saved from extinction for the foreseeable future. Now *Ginkgo biloba* is valued in many parts of the world as an attractive, fungus- and insect-resistant ornamental tree. It looks more like a hardwood tree than a conifer and the unusual fan-shaped leaves are easily recognized with parallel veins and the outer margin either split or entire. It is a slow-growing but tall and beautiful tree, and unlike other gymnosperms it is deciduous. In autumn the leaves turn a beautiful golden colour before falling. It is also known as the maidenhair tree because of the resemblance of its bilobed leaves to those of the maidenhair fern. *G. biloba* may be the oldest living seed plant, and it is regarded by some as one of the wonders of the world. Each individual is either male or female, bearing small reproductive organs of one sex or another.

![Ginkgo: (a) habit of G.Biloba; (b) fossil (upper) and modern (lower) leaves; (c) fossil male reproductive structure; (d) fossil pollen; (e) female reproductive structure (fossil seed).](image)

**Figure 3**

*Leaf of Ginkgo Biloba*

**Figure 4**
Figure 5

Suggested biomes for the Early Jurassic with representatives of the most abundant and/or dominant fossil plant taxa shown.

ANGIOSPERMS

Perhaps the most important evolution for the terrestrial life in the Cretaceous Period and in fact probably the whole Era was the appearance of the angiosperms. Angiosperms include all flowering plants and also the important hardwood trees such as oak, ivy and maple. These are the dominant plants in the world today, accounting for between 300 and 400 families and 250,000-300,000 species but in evolutionary terms, flowering plants are relatively recent. The oldest, clearly identifiable fossils of angiosperms are 135 million years old, from the early Cretaceous, 300 million years later than the first vascular plant and 220 million years later than the first seed plant. Various hypotheses have been suggested to account for their relatively late appearance in the fossil record, including a bias in the fossil evidence, a particular combination of environmental conditions and/or biotic interactions that led to their later evolution. Two biotic interactions that are especially interesting are the coevolution of flowering plants with low-
browsing dinosaurs and with pollinating insect groups.

The unique characteristics of the angiosperms include flowers, closed carpels and double fertilizing leading to endosperm formation. Extremely rapid diversification of angiosperms led to replacement of the declining cycads, bennettitales and ginkgophytes.

Although the gymnosperm floras were still abundant, the rapid diversification and radiation of the angiosperms led to their increasing domination throughout the world during the 35 million years of the upper Cretaceous.

A number of factors seem to have been important in the early and continuing success of the angiosperms. One important factor is the evolution of the precise system of pollination and specialized mechanisms of seed dispersal that became characteristic of the more advanced flowering plants allowing them to exist as widely scattered individuals in many kinds of habitat. They evolved a set of features that attracted a wide variety of pollinators. The use of bright colours, ultra-violet signalling and scents attracted insects and birds to them to help with pollination and in this way they ensured a high degree of cross-pollination and evolutionary development.

The step between gymnosperms and angiosperms is still not very well understood and has been a matter of great interest to paleobotanists for a long time. The most striking results from recent phylogenetic analyses, based on fossils, morphological and molecular data, support earlier ideas that bennettitales and gnetophytes are the seed plants most closely related to angiosperms.

Reconstruction of the biogeographical distribution of vegetation during the late Cretaceous indicates that six global biomes can be recognized during this period, with all but the highest latitudes dominated by angiosperms.

![Graph showing the diversification of angiosperms over time](image)

**Figure 6**

Angiosperms Evidence from fossil leaf assemblages (summed genus and species diversity) indicating the major expansion of the angiosperms from -140 Ma and a dramatic increase in the absolute number (summed diversity) of angiosperms through the mid-Cretaceous (ca. 10 Ma) Data taken from 147 late Jurassic to Palaeocene macrofossil floras.

Beside the aesthetic appeal of the flowering plants they are also important in other ways. Barely a day goes by in which our lives are not affected by flowering plants. Nearly all our food and spices comes from flowering plants; grains, nuts, fruits, vegetables, coffee, tea, wine, tequila, beer and chocolate, the cotton in our clothes, linen, dyes and also opium, cocaine, tobacco and medicines such as aspirin.
SUMMARY

In the Mesozoic Era the terrestrial vegetation evolved greatly. At the beginning of the Era, plants from the Carboniferous Period were very common, especially ferns, seed ferns, lycopsides and horsetails. The gymnosperms appeared also in Carboniferous Period but did not become dominant until Triassic. In the last part of Triassic and Jurassic, gymnosperms increased in diversity and many new species were formed. The most dominating plants were ginkgo, cycads, bennettitales and conifers. Ferns and seed ferns still grew in the forests and were important as food for animals but many of the gymnosperms were large plants and trees and therefore they were more prominent in the flora. In the Cretaceous the angiosperms began to appear and they increased their diversity and quantity in a very short time. These coloured flowers and fruit bearing trees dramatically changed the appearance of the forests. At the end of the Era, flowers and large trees were spread all over the earth and provided a most encouraging environment for both insects and animals. The biomes were diverse and grew well. Under these circumstances, dinosaurs, birds, insects and small mammals flourished in the forests.

Figure 7 Suggested biomes for the late Cretaceous with representatives of the most abundant and/or dominant fossil plant taxa shown.
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