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Introduction to gymnosperms, general characters, life cycle, diversity and origin of gymnosperms.

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Abstract

Gymnosperms are a diverse group of seed-bearing plants that are distinct from flowering plants in that they do not have carpels that encapsulate their seeds as flowering plants do. It is believed that all gymnosperms originated from a common ancestor in the Devonian period known as "progymnosperm stock." Gymnosperms were able to exploit upland and drier habitats in the late Paleozoic because of key adaptations that involved the retention of the megagametophyte within a protective coating to form a seed on the parent sporophyte, the dissemination of the microgametophyte in durable pollen, the production of complex root systems, and extensive development of secondary xylem in the stem. These habitats had not been occupied by earlier free-sporing In the late Paleozoic, gymnosperms underwent a period of diversification and were the primary donors of organic matter to some of the greatest coal deposits in the world, which were accumulating at that time. After going through a period of widespread extinctions at the end of the Permian, gymnosperms re-radiated in the Triassic and continued to dominate the global floras until the middle of the Cretaceous. After that, angiosperms began to gradually supplant gymnosperms as the dominant form of plant life on Earth. There are over a thousand species of gymnosperms in the contemporary flora, although both their diversity and range have shrunk drastically since the Mesozoic era. They continue to predominate huge areas of the boreal forests in the northern hemisphere, and in other parts of the globe they do so locally in vegetation types that are more confined. Gymnosperms that are still alive today provide contemporary civilization access to a variety of food, industrial, and medicinal resources.

Keywords: biotechnology, functional evolution, gene families, gymnosperms, PDR gene family, reproductive biology, stress

Introduction

Gymnosperms are an ancient group of plants that contain some well-known surviving forms such as conifers, cycads, and ginkgos, in addition to a wide range of considerably less well-known and long-lost species. Gymnosperms also include several plants that have since been extinct. In spite of the relatively low number of surviving species, this group is very important geologically. The Mesozoic period was dominated by gymnosperms. It was at this time that the majority of the main subgroups first appeared, had periods of diversification, and ultimately met their ultimate demise, which was extinction. There is a lot of controversy around the origin of gymnosperms and, in particular, their links with angiosperms (flowering plants). Phylogenetic analyses unequivocally demonstrate that these two populations are closely related to one another; nevertheless, the precise nature of their familial connection is not yet known. It is necessary to have a knowledge of the relationship between these two groups in order to construct a family tree of gymnosperms and to find out where flowering plants got their start. The fossil record is still very important for understanding the evolutionary patterns of gymnosperms, despite the fact that most of the variety of gymnosperms has been extinct. The field of molecular systematics has, as of late, presented an immense quantity of fresh data for comparison purposes. Because of this, we are now capable of reconstructing family trees with a level of accuracy that has never been seen before. This has helped throw fresh light on the development of gymnosperms as well as their vast and complex fossil history.

Diversity of Gymnosperms

The modern gymnosperms may be broken down into four different phyla. The first three, which are the Coniferophyta, Cycadophyta, and Gingkophyta, have a similar pattern of seed development and produce secondary cambium, which are cells that build the vascular system of the trunk or stem and are partly specialized for water movement. On the other hand, these three phyla are not particularly close relatives to one another in terms of their phylogenetic relationships. Because they generate real xylem tissue, members of the fourth phylum, the Gnetophyta, are thought to be the most closely related group to angiosperms.

Coniferophytes

The phylum of gymnosperms known as conifers has the greatest number of different species than any other. In most cases, the trees involved are rather tall and possess leaves that resemble either scales or needles. Because of their thin form and thick cuticle, leaves lose less water through evaporation than other plant parts. Snow is readily dislodged from needle-shaped leaves, which helps to keep the burden low and reduces the likelihood of branches collapsing. The dominance of coniferous trees at high elevations and in cold regions may be explained by their ability to tolerate low temperatures and arid conditions. Evergreen trees that belong to the genus Conifer include, but are not limited to, pines, spruces, firs, cedars, sequoias, and yews. There are certain species that are deciduous, meaning they shed their leaves in the autumn. Both the European larch and the tamarack are examples of conifers that lose their needles in

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the fall. The wood from coniferous trees, which is known as "soft wood" due to the absence of vessel components but presence of tracheids, is obtained from a great number of species.

Figure 26.2C.126.2C.1: Diversity of conifers: Conifers are the dominant form of vegetation in cold or arid environments and at high altitudes. Shown here are the (a) evergreen spruce Picea sp., (b) juniper Juniperus sp., (c) sequoia Sequoia Semervirens, which is a deciduous gymnosperm, and (d) the tamarack Larix larcinia. Notice the yellow leaves of the tamarack

gymnosperm, any plant with a vascular system that reproduces by means of an exposed seed or ovule, as opposed to angiosperms, sometimes known as flowering plants, whose seeds are encased inside fruits or mature ovaries. The seeds of many gymnosperms, sometimes known as "naked seeds" because they are not visible until the plant has reached full maturity, are carried in cones. Taxonomists acknowledge four separate divisions of extant (nonextinct) gymnospermous plants. These divisions are called Pinophyta, Cycadophyta, Ginkgophyta, and Gnetophyta. Together, these divisions include 88 genera and more than 1,000 species that may be found all over the globe. At the Mesozoic Era (which lasted from around 252.2 million to 66 million years ago), gymnosperms were the predominate plant kind. It was during this time that several of the current families first appeared (Pinaceae, Araucariaceae, Cupressaceae). Although gymnosperms have been gradually displaced by the more recently evolved angiosperms since the Cretaceous Period (about 145 million to 66 million years ago), they are still successful in many parts of the world and occupy large areas of the Earth's surface. This is because gymnosperms evolved more slowly than angiosperms. Gymnosperms, as opposed to angiosperms, are often better suited to growing in more northerly latitudes. Conifer forests, for instance, occupy extensive swaths of land in northern temperate zones.

General features

The sporophyte, or asexual, generation is represented by the component of the plant that is visible (i.e., the developing stem and branches) in all living gymnosperm groups. A sporophyte is a plant that contains reproductive organs on its stem, which also includes roots and leaves. The xylem and phloem are the two conductive tissues found in gymnosperms, which classify them as vascular plants. The xylem not only supports the plant but also transports nutrients and water from the roots. The sugars, amino acids, and organic nutrients synthesized in the leaves are transported to the plant's nonphotosynthetic tissues through the phloem.

While remaining within the microsporangium, the microspore starts to germinate into the male gametophyte, marking the beginning of the gametophyte phase. It takes just one microspore nucleus to undergo mitosis and create many daughter cells. The male gametophyte, or pollen grain, is released at this time and carried by the wind or insects. Megastrobili are female ovulation cones that may develop on the same plant as microstrobili (as in conifers) or on other plants entirely (as in cycads and Ginkgo). There are numerous scales on a megastrobilus, and they are called megasporophylls, and they contain megasporangia. An individual cell inside the megasporangium undergoes meiotic division to yield four haploid megaspores, of which three are normally degenerate. What's left of the megaspore undergoes mitosis to become the female gametophyte. The megasporangium and megaspore wall grow in proportion to the increasing number of liberated nuclei. The ovule is mature and open to fertilization at this point.

Cycads

Large, complex cycad leaves give these plants a look similar to palm trees, which is why they do well in moderate climes and are sometimes misidentified. Cycads are unique among gymnosperms in that their huge strobili or cones may be pollinated by insects rather than the wind (see Figure 3). During the Mesozoic, when dinosaurs roamed the earth, large cycads were common, but now just a hundred or so species remain. Several species are now protected by international treaties because they are in danger of extinction. Their visually appealing form makes them popular choices for decorative plantings in tropical and subtropical environments.

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Figure 3. This Encephalartos ferox cycad has large cones and broad, fern-like leaves. (credit: Wendy Cutler)

Ginkgophytes

Ginkgo biloba is the only living member of the ginkgophytes family (Figure). Its fan-shaped, leaves, which are yellowed and shed off the tree in the fall, are unusual among seed plants due to their dichotomous venation pattern. G. biloba was kept alive and well over the ages because it was grown by Chinese Buddhist monks in monasteries. Because of its exceptional resistance to pollutants, it is often used for landscaping in public areas. The sex organs for humans and animals are grown on different plants. Because the female plant's seeds smell like rancid butter, most gardeners avoid planting them.

Ginkgo. This plate from the 1870 book *Flora Japonica, Sectio Prima (Tafelband)* depicts the leaves and fruit of *Ginkgo biloba*, as drawn by Philipp Franz von Siebold and Joseph Gerhard Zuccarini.

Gymnosperm Life Cycle

Gymnosperms go through a sexual phase and an asexual phase in their life cycle. The term "generational alternation" describes this pattern of existence. The sexual phase, also known as the gametophyte generation, is when gametes are produced. The asexual phase, also called the sporophyte generation, is responsible for the production of spores. When it comes to vascular plants, the sporophyte production is the most important part of the plant life cycle. Roots, leaves, stems, and cones are all considered part of the sporophyte, the main body of the plant, in gymnosperms. Sporophyte cells are diploid, meaning they have two sets of chromosomes rather than one. Haploid spores are created during meiosis, and the sporophyte is in charge of this process. As the haploid gametophytes originate from spores, each spore has a full complement of chromosomes. In plants, sperm and eggs are produced by different gametophytes, which mate to create a new diploid zygote during pollination. In the end, the zygote develops into a new diploid sporophyte, completing the cycle. The sporophyte phase accounts for the vast majority of a gymnosperm's life cycle, and the survival of the subsequent gametophyte generation is wholly reliant on the sporophyte generation.

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