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ANCIENT HISTORY IN THE PLANT WORLD

PLANTS of the present have received much attention, but plants of the past are just coming into prominence. And by plants of the past we mean not plants of a hundred years or so ago, but plants of a hundred million years ago. It is generally known that coal was formed by plant deposits of long ago, many of which were ferns. The idea that ferns formed a large part of the coal came from the fact that the impressions found in the coal looked like the leaves of present-day ferns. Impressions are the marks left by decayed leaves or stems of which the substance is reduced to carbon in which there is no structure preserved. Recently, botanists have begun to study the plant remains found in calcareous balls. These balls, known as "coal balls," are found in connection with coal deposits. In the balls the cellular structure of the plants is preserved by a chemical replacement in which the chemical constituents of the cells are replaced by calcium compounds. Thus, the cell structure of the plants of many thousand years ago may be studied with certainty. The technique of making slides of fossil plants is very different from that of making slides of living plants. The coal balls must be cut with a saw charged with diamond dust. The slabs which are cut off the balls are relatively thick. They are mounted on marble slabs with shellac or Canada balsam, and then ground down to a thickness of about a thirty-second of an inch, after which they are remounted on glass slides and ground with progressively finer carborundum powder until they are transparent.

Study of these sections reveals some very interesting facts. At one period of geologic history, the Pteridophytes or "ferns and their allies" were very prominent and grew to giant size. The fossil ground pines grew to a height of seventy or eighty feet with a considerable development of secondary wood, whereas their present-day descendents are prostrate forms or do not grow much over ten inches high in temperate regions. The same relationship holds for the horsetails, or "scouring rushes." The fossil horsetails were large forms, and with the fossil Lycopods (ground pines) formed a large part of the fossil swamp flora. The fossil horsetails are especially interesting in that they had already advanced to the condition of an endarch siphonstele, which is still the most advanced type of stele, a condition which at the present time is found only among the seed plants with the exception of the present-day horsetails.

Another interesting fact that has developed from the study of coal balls is that almost all of the supposed fern fronds found in coal are now considered to belong to the "seed ferns" or seed-bearing plants with fern-like leaves. We know that this is true because these fern-like fronds have been found with seeds attached—seeds which resemble in structure the seeds of our modern "evergreen" or coniferous trees.

Imagine then what a swamp might have looked like a few hundred million years ago. The fossil Lycopods were something like the palms in general shape—their trunks were bare to a height of sixty feet or more and this trunk was topped by a dichotomously branching mass of small branches which bore long narrow leaves and long slender cones. Some of the Lyco-

pod trunks were marked with diagonal rows of diamond-shaped leaf scars, and some others were marked with vertical rows of circular leaf scars. Growing among these Lycopods were fossil horsetails. These horsetails were of the same general shape as the horsetails of today. They had a long central axis from which the branches went out in whorls—a ring of branches going out of the main axis. These trees had cones too, but they were shorter in proportion to their width, and the leaves were shorter and less prominent. The bark of these trees was ridged. The horsetails and Lycopods probably all grew in shallow water or at the edge of the water in much the same way that the present-day alders and swamp maples grow. There is another interesting plant which is found associated with the Lycopods and horsetails. It was a slender plant which had leaves much like a four-leaved clover. At the present time there is a dispute as to whether this form was a climbing plant or a water plant. The cross section of the stem of this plant is one of the most beautiful of all stem sections. The stele is a triarch protostele, and the secondary wood opposite the protoxylem is much smaller than the rest of the secondary wood, making a very beautiful pattern. The technical name of this plant is Sphenophyllum.

There you have the outstanding forms of that paleozoic swamp. Now imagine that swamp with the large amount of débris of fallen logs, branches, and dead leaves which you find in an ordinary swamp of today. These logs and branches lay for many years slowly sinking into the mud and partly decaying. The outer bark was often destroyed, leaving only the wood, or perhaps the bark remained but the more delicate tissue between the bark and wood was destroyed. Often the fallen logs served as places of anchorage for young plants, consequently we often find that the preserved material has been penetrated by numerous small roots of plants which were growing on it. As these logs and branches sank deeper and deeper into the mud, parts of them were replaced by calcium compounds and thus turned into stone, while other parts were turned into coal. Sometimes the outline of a leaf or stem was preserved in limestone, but the actual plant material was reduced to structureless carbon. We call this kind of fossils "impressions" because only the outline or shape is left imprinted upon the limestone.

A very good idea of the process of coal formation might be gained by a visit to a peat bog. Peat bogs are undrained swamps in which the plant material only partially decays, and is deposited at the bottom of the bogs. In a young bog there is a deep body of water in the center. Plants gradually grow out on the surface of the water, forming a quaking mat. As the plants on the mat increase in size the mat begins to sink and eventually adds to the deposit on the bottom. After this a new mat forms. This process is continued until the bog is filled up—a process covering hundreds of years. This deposit of partially decayed plant material is called peat and is used for fuel in many rural communities of Europe. Peat formation is the first step in coal formation. Further development into coal is brought about by added pressure from above through many centuries until the peat is changed into coal and the materials found associated with it. The coal which we use now was formed in the carboniferous period of the paleozoic age.

A remnant from a later period of geologic history is the Gingko or Maidenhair tree. This tree is fairly common in parks and may be found along several of the streets of Washington, D. C. It is frequently referred to among botanists as "the tree which should have become extinct long ago," and the interesting thing about it is that it would have become extinct if left to itself. One of the Chinese traditions is

that the Ginkgo tree is a sacred tree, and for that reason it has been kept alive all these years because it has been cultivated in the Chinese temple gardens. It has repeatedly been reported as growing wild, but in every case, subsequent investigations have revealed the existence of temple ruins around the site of the "wild" Gingko trees. And so, thanks to a Chinese tradition we have this living representative of an age from which everything else has become extinct.

Probable direct descendants from contemporaries of the Ginkgo tree are the Cycads. These interesting plants have a very peculiar distribution—of the nine genera still living, four are found only in the western hemisphere and five in the eastern hemisphere. The Cycads are cultivated somewhat as greenhouse plants and are usually erroneously called palms. One of them, Cycas revoluta, an eastern hemisphere genus, is used quite extensively in funeral sprays and Palm Sunday decorations. All of the forms are tropical or sub-tropical. The fact that they are so widely distributed and so isolated, together with the fact that similar forms were much more prominent in an earlier period is evidence that they are gradually becoming extinct.

The present-day conifers are a remnant of a once more prominent group. Almost the oldest fossil deposits found contain fragments of coniferous trees—in fact, the seed ferns mentioned before were really ancestors of the present-day conifers. So we see a steady waxing and waning of forms. The Lycopods which were once the most prominent type of vegetation are now in grave danger of becoming extinct, so lavishly and carelessly are they used for ornamental purposes in Christmas wreaths and ropes. It almost seems that in the light of the antiquity of these forms they might be treated with a little more respect. The horsetails are more prominent at the present time than the Lycopods and probably owe their present condition to the fact that they are particularly adapted to subsist and propagate themselves in situations in which the competition from other plants is not very keen. One group of present-day plants has not been found in very old fossil deposits, and that group is the one known as the flowering plants. Whether this fact indicates that the group has developed from some other forms recently or whether it indicates that flowering plants grew in past ages under poor conditions for preservation is a matter for conjecture and dispute. The modification of form which some types have undergone, the diversity of types and the prominence of the group would lead to the opinion that the group is of considerable age, because of the probable length of time necessary for these changes to have taken place.

Glaciation seems to have been an important factor in the distribution of plants; at least in the more northern parts of the world. At one time the northern part of North America was probably tropical, but each time the glacier crept south the plants retreated before it until what had been a tropical region was covered by many thousand feet of ice. Then as the ice retreated the plants followed it back north, going first up the valleys and then creeping slowly over the hills and up the mountains. But as the northward migration of plants started, some of the plants stayed behind in places where they seemed well adapted to live. This is the reason that we find so many pockets of typical mountain plants in our lowland bogs, where the climate is very different from that of their former home, but because of the nature of the soil and the contour of the land the general growing conditions are those of their former homes. Interesting evidences of a former tropical or sub-tropical climate in the northern United States are the fossil animals found there. In one particular place there is an outcrop of a coral reef. It is known that

corals will not live in water which goes below sixty degrees in temperature, so the obvious conclusion is that the reef was formed at least under sub-tropical conditions.

Comparatively little has been done along the line of paleobotanical research and it is very likely that a thorough working over of the material will clear up many matters of interest in establishing plant origins and plant relationships. It is a wide field of which only the borders have been touched, and it has a fascination to many people equal to the fascination of discovering and studying lost civilizations.

M. DORISSE HOWE

HOW OUR ANIMALS BECAME THEMSELVES

"COWS furnish food for man and eat other harmful insects." This rather startling statement was once given by a city girl in answer to an examination question regarding the economic value of cattle. Amusing as it is, it reveals an ignorance of facts which should be matters of general information for everyone. Most striking is the lack of knowledge shown concerning the nature of man in relation to other animals. It is doubtful if the girl in question would have liked it had her comrades called her an insect, and equally uncertain that she had any clear idea of what constitutes an insect, let alone a human being.

A full and complete knowledge of man's position in the universe, even that infinitesimal part of it which we call the earth, is possibly the most useful factor in giving to us individually the broad, sympathetic tolerance and understanding needed to make of us teachers who are something more than mere imparters of information. The study of biology will go a long way toward giving us this knowledge, but even biology as we usually think of it, lacks perspective in that it deals with the world of living things, plants and animals, now dwelling on the earth. No matter how much we may know of this phase of the subject, our knowledge is a good deal like the view one has of a forest when one is passing over in a plane. One sees the tops of the trees, and may get an oblique glimpse once in a while, but actually learns very little of what lies underneath, or of the forces which have made the trees what they are. To get a true perspective on biological interrelationships, one needs to know at least some of the big steps in the making of our modern world. Elsewhere in this number Miss Howe has told something of the plants which have preceded those which we know and which have largely determined what our plants of the present must be. In the present article I am attempting to sketch with a few bold strokes, the fascinating picture of the world of animals that lived in the ages of the world's youth, and to show how they solved problems, problems so important that had they not been successfully met, the modern world could never have come to be.

We do not know how living matter began. We possibly have a hint in those mysterious substances, the bacteriophages and the mosaic diseases of certain plants. These two, bacteriophage and mosaic, have many of the attributes of living substance, yet do not seem to be truly alive as we understand life. It is even barely possible that we have, here in these substances, matter which is in our own time undergoing that most important of all steps, the transition from the non-living to the living state. That some such process took place at some time very early in the earth's history we are reasonably certain. That it took thousands and hundreds of thousands of years, we may be sure. Creation is a mighty and a very gradual thing, a force which has been operative for ages and is still continuing.

Although we know nothing positive concerning the origin of living matter, we may