rector A. B. Conner, of the Texas Agricultural Experiment Station.

DR. WILLIAM FRANCIS THOMPSON, director of investigations and professor of fisheries for the International Fisheries Commission at the University of Washington, has recently completed the preliminary studies called for by a treaty in 1924 between Canada and the United States establishing a commission for investigation of the halibut fisheries. As a result of these studies, a new treaty dealing with the regulation of the fisheries and continuing the scientific work has been signed and confirmed. This is said to be the first treaty for the conservation of a species of marine fish.

DISCUSSION

THE MEGAGAMETOPHYTE OF PINUS

THE classic work of Hofmeister presents the development of the megagametophyte of several gymnosperms which he studied in the years 1848 and 1849. He introduced for the first time the general course of events in the growth of the gametophyte of gymnosperms. Subsequent corrections in this life history appeared at intervals with the progressive improvements in the methods of histological technique. Hofmeister, influenced no doubt by his study of the life history of mosses and ferns, concluded that the megagametophyte of gymnosperms grows in a manner similar to that of the Fern Allies, as he knew of it in *Selaginella*. Up to the present time this conclusion in general has been accepted by most botanists.

That the gymnosperms and Fern Allies are closely related has been seriously questioned recently by workers in paleobotany and plant anatomy. This controversy concerning the phylogeny of gymnosperms brought forth the expression that the evidence obtained from a study of plant morphology is unreliable as an indicator of relationship. Unfortunately we have only a fragmentary knowledge of a few of these life histories and none are complete in every detail.

The description of the growth of the megagametophyte of *Pinus* as presented in current botanical literature is incomplete and inaccurate. Evidence of a centripetal growth of the gametophyte has not been found in any of the gymnosperms other than *Pinus*. In *Pinus* centripetal growth has been inferred but the progress for such a development has never been presented in detail. There is too little evidence to support the general rule that centripetal growth of the megagametophyte occurs in most of the gymnosperms. In a text-book of botany of recent publication, we find the growth of the megagametophyte conveniently arranged in five stages.

> The female gametophyte, in nearly all gymnosperms, develops in a general way as in *Selaginella* and *Isoetes*. At least five stages in the development should be borne in mind; (1) Free nuclear division by which a varying number of free nuclei are distributed through the cytoplasm of the megaspore; (2) Parietal placing of these nuclei by the development of a central vacuole; (3) Continued free nuclear division; (4) Formation of a parietal tissue by the development of cell walls separating the free nuclei; (5) Centripetal growth of this tissue until it fills the cavity of the enlarging megaspore which is now known as the embryo sac.

The proper view of the development of the megagametophyte of *Pinus*, as obtained by a study of a close series of *Pinus flexilis* and *P. scopulorum* collected in the Rocky Mountain National Park, Colorado, during the past three growing seasons, differs greatly from the present accepted description. The various phases of growth will be given in the order comparable to the five stages in the previous quotation. (1) After the megaspore mother cell has divided, the first cell of the gametophyte remains in the resting stage until the zone of nutritive cells (spongy tissue) becomes active. This nutritive tissue persists for a long time in the digestion of the nucellus. (2) As a result of the activity of the digestive tissue and the enlargement of the nucellus, a large vacuole is formed. The megagametophyte develops by free nuclear division in the center of the enlarging vacuole. (3) The cytoplasm surrounding the free nuclei remains connected in strands and the young gametophyte in the center of the vacuole takes on the form of a tangled skein or network. (4) A megagametophyte consisting of a separate parietal tissue surrounding a central cavity does not appear in normal sporangia. Nutritive cells in the final stages of digestion, however, are still present in a parietal position at the time archegonia first appear. (5) The normal growth of the gametophyte is centrifugal, never centripetal. The embryo sac is completely filled by the gametophyte at the time of fertilization or soon after.

In the development of a carpellate cone of *Pinus*, two or three years, depending on the species, are required for the seeds to reach maturity. During this time interval the number of abortive ovules gradually increases as development progresses. The carpels externally appear alike at maturity but the number of seeds in a cone may vary from a few to a hundred or more. The average number of mature seeds found

is seldom as great as fifty per cent. of the total number capable of development.

At any time during the growth of the gametophyte, development may be arrested. Many megasporangia fail to renew their growth in the spring following the dormant period of winter. In *Pinus nigra* var. *austriaca* soon after the beginning of the second growing season the megagametophyte of abnormal sporangia takes on the form of a hollow sphere very much in appearance like a Volvox colony. In the process of disintegration the free cells of this abnormal gametophyte press out toward the margin of the vacuole and there assume the parietal position. These gametophytes never develop archegonia. It is possible that a person limited to material of one season may happen on abnormal ovules with the free nuclei of the gametophyte in a parietal position and later in the season he may obtain normal material with archegonia and gametophyte in a central position. From such a combination of abnormal and normal materials centripetal growth of the gametophyte might be inferred.

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PAUROPODA IN ALASKA

I HAVE been studying small and somewhat obscure arthropods of several widely separate groups, but with a number of features in common. They have no wings, they have no eyes and they live in decaying vegetable material under logs or stones or in humus. In the insect groups I have collected Campodea, Japyx and Protura. Among the centipede-like forms I have searched for Symphyla and Pauropoda.

Members of all these delicate, white, eyeless forms may all occur in one environment, but it is more common to find but one group represented in one place. I have collected from the eastern United States to the western and from Cuba and Mexico to central Alaska. The two insect genera mentioned above and Symphyla are by far the easiest to find. Pauropoda may be obtained by the funnel method or by more direct collecting in the field, but I have never found Protura except with a funnel. I did not use this apparatus in Alaska last summer, and I am not surprised that I did not find any Proturans by the methods used. They may be there; I have not really made a very serious attempt to find them. For the other groups I searched hours in a number of widely separated localities in Alaska, British Columbia and Yukon Territory and found not a single representative of any of the more easily collected animals. The only group obtained in these northern regions was Pauropoda. These were found in but four places. None were collected in southern Alaska. At Skagway several were obtained with mites, Collembola and some other insects. They were under stones in a dense wood. In comparing these with other previously collected specimens I found their nearest relationships were with some obtained the year before well up towards the timber line on Mt. Hood, Oregon. At Dawson City I was especially successful in obtaining Pauropoda. It was a slightly rainy day, moisture conditions on the ground were just right, and I was able to obtain quite a number of specimens. They were about one half way up the mountain back of Dawson City. Next at Eagle, Alaska, a few specimens were found in the woods about a mile from the Yukon.

During several days I searched in the McKinley National Park, and although mites, small centipedes and Collembola were encountered no Pauropoda were seen at any time. It may have been too damp, as heavy rains came frequently.

At Currie a few more of these minute eighteen-legged forms were found. All but one of the four lots encountered were of the genus Stylopauropus, those from Eagle alone were of the genus Pauropus. In fact more than nine tenths of all the specimens collected were of the genus Stylopauropus. In general to the southward Pauropus is more often encountered than the other.

So far as I know this record is the first for these arthropods in Alaska and so far as I have been able to learn these must be farther north than those reported from the old world. But not finding these small animals is no sure proof that they may not be present in a region. It is very easy to overlook them, as indeed all the other forms mentioned, but if one is collecting one particular kind of animal he is apt to find those which were not conspicuous. I have now collected these Pauropoda from the eastern United States, from Mexico both north and south and now from Alaska. I did not find any in Cuba, although I searched in many places.

The species found differ but little from each other, rather minor characters separate them into species. Records from others as well as those of my own suggest a world-wide distribution of two genera.

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MORE ABOUT CITATIONS

SOME comments received since the article "A uniform scheme for citations" was printed (SCIENCE, April 10, 1931, pp. 390–392) indicate the desirability of a few additional notes.

The U. S. Geological Survey scheme is applicable not only to footnote citations but to bibliographic or