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there should be provided in the Department of Education a course of study for all grades of the public schools, and a call sent to the Department of Conservation for it to furnish specimens for object lessons for this course, if not for actual assistance on occasion.

Every citizen of the state is entitled to know what the resources of the state are and how they may be best conserved in order to bring the largest returns to the people, having in mind the rights of future generations. To meet demand for first hand information, the Department of Conservation has a division of publicity which issues a magazine, "The Conservationist." Its field of service in this line can be greatly enlarged by cooperation with the Department of Education.

In addition to this means of publicity, it is the plan to have the exhibits of all resources of the state to be displayed at the state and county fairs and all large public gatherings. It is the desire of many that each school of the state be provided with suitable exhibits for nature study. For general distribution, there will be prepared leaflets and pamphlets setting out in clear and every-day language occurrence, care, and use of the things of nature.

All this may at first glance appear to be a large order to deliver, but, while much care and consideration is needed to establish in our schools a comprehensive nature study program, the financial burden will be light, and the returns for this and future generations ample. With a will to undertake a task of this kind and a confidence in our children, we cannot and must not falter.

THE INTERRELATIONSHIPS OF BARK BEETLES AND BLUE-STAINING FUNGI IN FELLED NORWAY PINE TIMBER (Abstract)[1]

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A study of two species of bark beetle (*Ips pini* Say and *I. grandicollis* Eichh.) and the fungi associated with them has been made as the first part of a general investigation of the interrelations of insects and fungi in the deterioration of felled logs of Norway pine.

Experimental evidence is presented showing that these bark beetles introduce blue-staining fungi into the logs and that the fungi are rarely, if ever, introduced in any other way.

Two different blue-staining fungi were found associated with these bark beetles. The most prevalent of the two is *Ceratostomella ips* Rumbold, the fungus isolated by Rumbold from the galleries of *Ips calligraphs,* and *I. grandicollis*. The second apparently has not previously been reported. It is briefly described in this paper as *Tuberculariella ips*, n.sp.

[1]Complete paper published in Jour. Agr. Res. 49: 315-342. 1934.

Certain cultures of *Graphium* isolated from stained wood and from the beetles proved to be identical with *Ceratostomella ips*, although they could not be made to produce perithecia. Of 15 cultures derived from single ascospores of *C. ips*, 6 formed only conidia and were identical with the *Graphium* cultures previously isolated. The remaining 9 cultures formed both conidia and perithecia. Perithecia were not produced when the 6 *Graphium* cultures were mated in all combinations.

In addition to the blue-staining fungi, characteristic yeasts were constantly associated with the beetles.

The fungi are introduced by either male or female beetles, and they begin to grow in the inner bark and sapwood soon after introduction. The yeast fungi grow more rapidly at first in the inner bark, but the blue-stain fungi spread more extensively in the sapwood.

Mites are frequently introduced into the logs by the beetles. The mites attach themselves to the underside of the thorax and in the concave wing declivities where they are not easily brushed off. When the beetles enter a log some of the mites leave the beetles and move about in the tunnels as they are constructed by the beetles. Yeast cells and spores of the blue-staining fungi were found adhering to the bodies of the mites. The mites probably aid in distributing the spores about the beetle tunnels.

The blue-staining fungi sporulate profusely during the pupation of the bark beetles. *Ceratostomella ips* forms perithecia more commonly than conidia, but typical *Graphium* coremia are often found in the old egg channels or in the pupal chambers. The perithecia of *C. ips* are usually formed on the walls of the old egg channels with their beaks pointing toward the center of the channels. When moisture conditions are favorable, the spores ooze from the tips in sticky masses. The newly formed beetle leaves its pupal chamber and feeds extensively under the bark before emerging. In doing this it brushes against the sticky spores which adhere to the body of the beetle. Examination of the contents of the intestinal tract of beetles shows that ascospores and even parts of the perithecia are eaten. Large quantities of spores and yeast cells are found in the intestinal tracts of the beetles. These bear no signs of injury, and germination experiments show that they are still viable after passage through the body of the beetles.

The second blue-stain fungus forms masses of sticky conidia in the pupal chambers and in the old egg channels during the pupation period. These spores also adhere to the bodies of the beetles and are passed through the intestinal tract uninjured.

Yeast cells frequently are found in the intestinal tract of the larvae where they also are apparently uninjured. No fungi were found inside the body of the pupae.

Histological study of the mature beetles revealed no anatomical modification to insure transmission of the fungi to the young.

The eggs of the beetles were internally sterile, although yeast and fungus mycelium were abundant in the sawdust plugs covering the eggs in the niches.

Although no nutritional symbiosis could be demonstrated between the beetles and their associated fungi, the relationship is considered as one of true symbiosis in the broader sense. The fungi obviously derive benefit in being disseminated by the beetles and in being introduced into the inner bark of the logs or susceptible trees. The blue-staining fungi, by inhibiting the flow of sap, in all probability make living trees more favorable for beetle development, and by aiding in the decomposition of the inner bark cause it to separate from the wood, creating a more favorable environment for the development of the insect broods. Until a brood of beetles can be reared in a fungus-free log, it cannot safely be concluded that the fungi are not necessary for the normal development of the beetles.

A popular account of this work was presented in the form of a two-reel motion picture made while the work was in progress. The film was photographed by Mr. V. P. Hollis of the Photograph Laboratory of the University of Minnesota. The cost of making the film was provided in part by the General College of the University of Minnesota.

WATER

Abstract of remarks by W. J. MAYO, M.D., *Mayo Clinic*

In the hope of stimulating interest in the problem of water, I wish to devote a few minutes to some of the physical properties of water. We know that three-fourths of the surface of our globe is composed of water. If the solid part were compressed into a ball, water would surround the earth about 2 miles deep. We know that water is compressed naturally to its greatest density at a temperature of 39.2° F., and if this temperature is changed either up or down, the water expands. If the temperature rises to 212° F. at sea level, the water expands in vapor form 1642 times and produces the power which we know so well in connection with steam engines. Water is 819 times heavier than dry air and is vaporized at about 212° F. When it reaches the colder and lighter upper atmosphere, the vapor condenses into a colloid condition we call clouds. Because it exists in colloidal form, before rain is produced some change takes place in the clouds, and a form of energy which we think of as electricity apparently connects the colloid vapor in the upper atmosphere with the earth. When this energy is produced rapidly, it is manifest as lightning.

In order to rain 1 inch or to snow 10 inches, 113 inches of water in colloid form must be suspended over each acre of ground. What produces the attraction that converts the colloid into rain? If one lays a dry hand on certain electrical apparatus, no effect is