

SYMBIOSIS BETWEEN FUNGI AND SCALE INSECTS

The Genus *Septobasidium*

By Prof. John N. Couch. Pp. ix + 480 + 114 plates. (Chapel Hill, N.C. : University of North Carolina Press ; London : Oxford University Press, 1938.) 5 dollars.

UNDER the able leadership of Prof. W. C. Coker, the Botanical Department of the University of North Carolina has produced several major works on fungi: "The Saprolegniaceæ, with Notes on other Water Molds" (1923); "The Clavarias of the United States and Canada" (1923); "The Gastromycetes of the Eastern United States and Canada" (1928); and "Studies of the Genus *Pythium*" (1931). To these there has recently been added John N. Couch's splendid monograph on the genus *Septobasidium*.

By means of sucking tubes, scale insects obtain their nutriment from the cambial region of the plants to which they become attached. Von Hörnel and Litschauer in 1907 were the first to direct attention to the remarkable fact that, in the dried species of *Septobasidium* investigated by them, scale insects are always present under the hyphal mats formed upon the bark of twigs or branches. Couch, working for more than ten years on living material, has now shown that scale insects are present in the hyphal mats of *Septobasidium* species in general and that the fungi and the insects live together symbiotically. A *Septobasidium* can extend its development only in connexion with scale insects, and when these insects die the growth of the fungus ceases. The insects are protected from their enemies by the fungus, and the fungus draws its nutriment from, and is distributed by, the insects. The symbiotic relationship of the fungi and their associated insects has been discussed by Couch in detail.

In *Septobasidium Burtii*, the life-history of which Couch describes and illustrates very fully, the fungus mat above an insect's body on an oak branch is nowhere in direct contact with the insect, but the two are connected together by numerous coiled hyphæ. This arrangement gives the insect freedom of movement to breathe, so that it will not suffocate. The coiled hyphæ are attached to the insect at the dermal pores and setæ. By means of the threads passing through the natural apertures of the insect's body-wall the haustoria of the fungus within the insect's body are connected with the mat and thence with the other parts of the fungus. The haustoria are found only in the circulatory system or hæmocœl of the insect, and they are coiled in form.

With the help of the haustoria, the fungus obtains the nutriment necessary for its growth and for the production of basidiospores on its exterior surface. Not all the insects beneath a stroma are parasitized, but those that are are dwarfed and incapable of reproduction. The young insects are infected by bud cells formed by the spores and never by fungal hyphæ. Some of the insects which have become infected by crawling over the spore-bearing surface may crawl back beneath the fungus colony under which they were born, others may settle down beneath other fungus colonies, and some settle down on the bare bark. The first two groups of insects are solely responsible for the survival and continued growth of fungus colonies, while the third group, which settle down on clean bark, are solely responsible for the distribution of the fungus. Under natural conditions, whereas the fungus cannot live without the insects, the insects are able to live without the fungus; but the life of insects unprotected by the fungus is precarious.

Septobasidium is widely distributed in the world. There are numerous species in the United States, the West Indies, Brazil, Ceylon, Java, and the Philippine Islands, and a few species have been found in Europe and Australia.

By far the larger part of the volume is devoted to taxonomy. On the basis of the symbiotic relationship, Couch has raised the *Septobasidiaceæ* to the rank of an order, the *Septobasidiales*, coordinate with the *Auriculariales*, the *Uredinales*, and the *Ustilaginales*. A key for identification is followed by a description of 163 species, 5 varieties, and 2 hybrids. Some 56 species are described as new.

The illustrations are numerous and admirable. Among other things they depict: the insect houses and their occupants; the relations of the fungi and insects with one another and with the tree at the expense of which they both ultimately live; the ways in which the fungi extend their colonies by the capture and infection of more and more young insects; and the microscopic details of structure of nearly all the species of *Septobasidium* which have been described.

Prof. Couch is to be heartily congratulated on the outcome of his labours. By long-continued and exact observation he has added greatly to our knowledge of *Septobasidium* species, and at the same time he has made a series of beautiful discoveries concerning the relations of fungi and insects. His book is a valuable addition to biological literature, and its contents will appeal not only to mycologists but also to entomologists and naturalists in general. A. H. REGINALD BULLER.