Affinities of the Mycetozoa. By Edgar W. Olive.

The chief interest which invests this group of low organisms lies in the fact that the individuals possess a dual relationship; during one stage of their existence resembling certain members of the animal kingdom, while during another, they bear many resemblances to the plant kingdom, through the fungi, with which they agree somewhat in the structure of their organs of reproduction and spores.

The spores, on germinating, produce swarm-cells and plasmodia, instead of mycelium. The swarm-cells, or myxamœbæ, resemble the naked amœbæ of the animal kingdom, while the remarkable plasmodium, although there is no parallel among undoubted animals, seems to partake almost wholly of characters agreed by scientists to be clearly animal.

The sporangium has a membranous wall sometimes resembling the cellulose walls of plants, and its cavity is filled with free spores and in many species a scaffolding support of threads called the capillitium. Probably the resemblance of this reproductive stage to the fungi is of very small amount, being confined to purely external resemblances.

The *Mycetozoa*, as defined by DeBary, embraces two distinct groups, the *Myxomycetes* of Wallroth, and in addition the *Acrasieæ* of Van Tieghem, evidently resembling each other very closely in the fact that their spores send forth swarm-cells which exhibit amœboid movements. The only important difference between the two is the formation of plasmodia by the coalescence of swarm-cells in the former and the formation of pseudoplasmodia by the aggregation of the swarm-cells in the *Acrasieæ*. It was regarded by DeBary as easy to conceive of the common origin of these two closely related groups or of the development of the one from the other. He says that probably the *Myxomycete* plasmodium was evolved from the aggregation plasmodium, since the latter appears to be the less complex form and its fructification much simpler; possibly the development took place in the converse order.

Botanists seem never to have questioned the homology of the pseudoplasmodium of the *Acrasieæ* with the plasmodium of the *Myxomycetes*. This plasmodium is strictly vegetative; during this period nourishment is imbibed. The pseudoplasmodium is not vegetative; it is simply preliminary to the reproductive stage by the aggregating of individuals. It follows, then, the strictly vegetative stage. If lack of analogy can thus be

reasoned into lack of homology, the pseudoplasmodium and plasmodium may not correspond in type of structure.

To DeBary's oft-quoted, but rather ambiguous statement of his estimate with regard to the position of the *Mycetozoa* is due much of the unsettled condition of the group. He says: "I have since the year 1858 placed the *Myxomycetes* under the name *Mycetozoa* outside the limits of the vegetable kingdom, and I still consider this to be their true position." Strangely, however, he included the *Mycetozoa* in all his subsequent botanical works, as if he lacked the courage of his convictions; and other writers of text-books have continued to do the same.

DeBary based his views on his belief that the *Mycetozoa* in their evolutionary development are the terminal members of a series of forms. In his opinion they, like the puff-balls, do not connect with any higher group. He contented himself, then, with seeking for their possible affinities with the inferior forms from which they must have proceeded. Even in this search, he found it impossible to establish exact homologies, for he limited himself to strict resemblances in form, structure, and mode of life. All agree with his conclusions concerning the original starting point; that we are led by a very short step to the naked *Amœbæ* of the animal kingdom. The *Amœbæ* are organisms having the amœboid movements of the swarm-cells of the *Mycetozoa*, which multiply similarly by successive division, but which do not form plasmodia or aggregations in any way. Indeed, in *Sappinia*, which Dangeard places among the *Acrasieæ*, the *Amœbæ* do aggregate at the ends of straws. *Guttulina*, one of the *Acrasieæ*, is really a naked Amœba, differing only in the aggregation of its microcysts into heaps, or sori.

Bütschli has pointed out the probability of the starting point of the naked amœbæ being groups of very simple organisms known as the *Flagellatæ*; and since the swarm-cells of the *Mycetozoa* are furnished with cilia and have all the characters of the simpler *Flagellatæ*, DeBary goes back to these forms as the converging point of the plant and animal kingdoms.

Lister has established beyond a doubt the fact that certain of the *Mycetozoa* have the power of digesting solid food. In his experiments on the plasmodium of *Badhamia*, he proved that it had a remarkable power of discriminating between different foods. He suggests also that another species, *Chondrioderma difforme*, probably uses bacteria as its principal

food. He has repeatedly seen them caught by the pseudopodia of the swarm-cells, ingested in the vacuoles, and gradually dissolved.

Yet, notwithstanding the fact that there are some exceptions to the rule, DeBary definitely states that "the food is taken in during the swarm-cell condition only in the fluid state or state of solution, and this is also the case, at least in most instances, with the plasmodia."

It is quite evident, as Massee has shown, that DeBary deduced all his reasons against the vegetable nature of these organisms from the vegetative stage. In his monograph on the group, Massee combats step by step the position taken by DeBary. He gives the following arguments in support of his views: (1) The frequent presence of cellulose in the cell walls of spores and sporangia; (2) the frequent separation from the protoplasm, during the period of spore formation, of a substance homologous with the substance separated during the same period in the *Ascomycetes*, etc. This forms the capillitium. (3) The frequent separation of lime from the protoplasm at the commencement of the reproductive stage. (4) Agreement with many fungi in contrivance for spore dissemination. (5) The production by free cell formation of spores protected in the early stage by a wall of cellulose, which eventually becomes differentiated, and, as stated by DeBary, "behaves toward reagents in a similar manner to cuticularized plant cell-membranes and to spore-membranes in the fungi." (6) The analogy with undoubted members of the vegetable kingdom, as *Hydrodictyon*, where the naked motile swarm-cells coalesce to form a net.

Massee claims that the observations upon the vegetative stage alone furnish no more convincing proof that the phenomena peculiar to it are incompatible with a condition of vegetable organisms than are the amoeboid forms in such algæ as the *Volvocineæ*.

The presence of cellulose in the stalk cells and spore walls of the *Dictyosteliaceæ* may be adduced as an argument for the plant affinities of the higher *Acrasieæ*.

Thaxter suggests another possible line of genetic connection of the *Myxotozoa* with plants, through the *Myxobacteriaceæ*. He places the *Myxobacteriaceæ* in the *Bacteria*, or *Schizomycetes*, on account of the homologies in the reproduction which they present. In one stage they are a mass of rods, having a slow progressive motion and reproducing rapidly by fission. They are distinguished, however, from other bacteria by having two definitely recurring periods in their life cycle—"one of vegetation, the other of fructification or pseudofructification through the simultaneous and

concerted action of numerous individuals." During the nutritive stage the rods lie separate. Through some contagious impulse they concentrate toward central points, piling up on one another, and gradually change into spores.

As is cautiously suggested, "the resemblance (to the *Acrasieæ*) might be purely accidental," yet the general character of the corresponding periods is practically identical, except for cell differences of the organisms concerned.

If we assume that the pseudoplasmodium of the *Myxobacteriaceæ* indicates a genetic connection with that of the *Acrasieæ*, then the *Mycetozoa* have affinities with higher plants through the *Bacteria*, which are evidently derived forms of the fission-algæ. At any rate, as suggested by Thaxter, "caution is necessary in accepting the views of those who would unceremoniously relegate the *Mycetozoa* to the domain of pure zoölogy."

Morphological Characters of the Scales of Cuscuta.

By Alida M. Cunningham.

The work undertaken and the line of thought pursued throughout has been that of making a revision of the family *Cuscutaceæ* of North America. This work was commenced at the beginning of the present university year and has been pursued since that time with the assistance of Dr. Stanley Coulter of Purdue University. The only complete work on this family which has been given to the public is that of Dr. Engelmann, published in 1859. Since that time a few new species have been added to those named in his work, and some of these have been classified by Dr. Engelmann himself. Like all works of any magnitude, the original is imperfect and incomplete.

This family is one presenting much difficulty, because there are so few characters which can be used in determination and many of the flowers are so minute as to necessitate the constant use of the microscope in examination. For this reason much classification has been done in the past by mere comparison of the unnamed specimens with the named ones. After a study of these plants we are convinced that such a classification is misleading and extremely inaccurate. Again, the plants have such a range of variation, yet merge into each other so closely in some of their