the size of the spores are so diverse in the (+) and (—) strains that systematists generally would feel justified in describing them as separate species.

In heterothallic species, strains have been found which from their failure to react with (+) and (—) strains of the same form have been called 'neutral,' and a similar neutrality may be induced by cultivation under adverse conditions. A table under preparation to determine the relative abundance and distribution in nature of the (+), (—) and neutral strains of *Rhizopus* has so far shown that, although neutral strains are not uncommon, the majority of the cultures, obtained from various localities abroad and in this country, belong to either the (+) or the (—) strain.

In all species of both homo- and heterothallic groups in which the process of conjugation has been carefully followed, the swollen portions (*progametes*) from which the gametes are cut off do not grow toward each other, as currently believed, but arise as a result of the stimulus of contact between more or less differentiated hyphæ (*zygophores*) and are from the outset always normally adherent.

In some species the zygophores have been demonstrated to be mutually attractive (*zygotactic*).

In the *heterogamic* subdivision of the homothallic group, a distinct and constant differentiation exists between the zygophoric hyphæ and the gametes derived from them, but in the remaining homothallic forms and in all heterothallic forms no such differentiation is apparent. Thus, while in the heterothallic species the sexual difference inheres in the whole thallus of either strain, in the homothallic forms it is confined to the conjugating branches of a single thallus.

A process of imperfect hybridization will occur between *unlike* strains of different heterothallic species in the same or even in different genera, or between a homothallic form and *both* strains of a heterothallic species, and distinct white lines are produced in many cases at the regions of hybridization.

By taking advantage of this fact it has been possible to group together in two opposite series the strains of all the heterothallic forms under cultivation. When thus grouped, the (—) or less luxuriant strains will fall in one series, while the (+) or more luxuriant will be included in the other.

From the foregoing observations it may be concluded: (*a*) That the formation of zygospores is a sexual process; (*b*) that the mycelium of a homothallic species is bisexual; (*c*) while the mycelium of a heterothallic species is unisexual; (*d*) and further that in the (+) and (—) series of the heterothallic group are represented the two opposite sexes.

The writer intends during the coming year to continue his investigations on the subject of sexuality in the lower fungi, and would be greatly indebted to any mycologists who might be willing to assist him by sending culture material of any of the forms of the Mucorineæ which may be found producing zygospores.

Albert Francis Blakeslee.
Cryptogamic Laboratory,
Harvard University.

ON THE DEVELOPMENT OF PALISADE TISSUE AND RESINOUS DEPOSITS IN LEAVES.

In connection with the experimental investigation of the causes of xerophily in bog plants, new evidence as to the factors involved in the development of palisade cells and resinous deposits has been obtained. It has been found possible, in the case of *Rumex Acetosella* L., to greatly modify its external appearance and internal structure by growing it under various ecological conditions. When grown in moist conditions, with soil and air temperatures approximately the same, the leaves attain a relatively large size and their tissues are exceedingly loose. A poorly developed palisade of one cell-layer and three layers of spongy parenchyma, beneath it, make up the mesophyll. The epidermis is composed of large turgid thin-walled cells, having a very delicate cuticle on the outside.

When grown on dry sand the leaves are notably thickened, reduced in size and the margins become revolute. The mesophyll is very compact and consists of a palisade of two to three cell-layers and a spongy tissue of two cell-layers. The epidermal cells are small and their outer walls are notably thickened. A well-developed cuticle is present.

It has been found that all of these xerophilous characters may be produced by growing the plant in an undrained wet sphagnum substratum, whose temperature is maintained several degrees below that of the air. This effect is obtained even in subdued light. Further, under these conditions the drops of oil or resin, so characteristic of bog xerophytes, are formed in the epidermis and the cells adjacent to the bundles. Such resinous deposits occur also in the plants grown on dry sand, but are wanting under favorable moisture conditions. It is believed that these modifications are, in the case of the bog habitat, a response to the unfavorable conditions for absorption by the roots, occasioned by the low substratum temperature and lack of proper aeration.

That palisade tissues may be greatly increased or developed in shaded conditions is also evident. The experiments suggest that even when such a response is obtained in strong light, it is to be correlated with drouth rather than with light. The increased transpiration brought about by direct insolation, as it increases the temperature and decreases the relative humidity of the air, would seem to be an efficient cause for palisade development. The elongated cells of the palisade, therefore, appear to be an adaptation for the ready transferrence of food materials in the leaf tissues, under the stress of a reduced water supply. The analogy of dry sand habitats and undrained wet bog habitats is certainly indicated.

The details of these experiments and others tending in the same direction will be published elsewhere.

EDGAR N. TRANSEAU.

UNIVERSITY OF MICHIGAN,
May 11, 1904.

ALBINO BROOK TROUT.

AMONG the brook trout hatched at the Adirondack Hatchery, Saranac Inn, N. Y., in March, 1902, there appeared to be some distinct albinos. There were about fifty of these fry out of an entire hatching of 800,000 ordinary brook trout eggs, taken from both wild and confined trout. These albinos were put by themselves, and four reached maturity.

Two of them are typical albinos. They are the same in outline as the ordinary brook trout. The skin is white, mottled with an ochraceous yellow, colored with the typical red and yellow spots. The fins are white, with the red band and yellow mottling. Eyes red. The general appearance of the fish is delicate, and the bones are apparently visible through the seemingly transparent skin. As these fish were reared in captivity they have been confined to the ordinary fish races, and fed on ground liver. One is a male, the other a female. The former now measures seven inches in length; the latter, nine inches.

The other two fish are a grayish white, with dark fins and black eyes.

On November 10, 1903, when the two albinos were twenty months old, they were stripped for eggs and fertilization. At this time their combined weight was approximately one half pound, the female being much the larger. Mr. G. E. Winchester, foreman of the Fish Hatchery, made the following experiments in fertilization: viz., first cross, 527 eggs from female albino × albino male; second cross, 103 eggs from female albino × natural male; third cross, 424 eggs from natural female × albino male.

The eggs, after fertilization, were placed in the hatchery races the same as all brook trout eggs. The hatching began March 1, 1904, and continued until the thirteenth of the month, the period of incubation being the same as that of the ordinary brook trout egg.

The result of the hatching was as follows: From the first cross 32 hatched, or approximately 6 per cent.; from the second cross 43 hatched, or approximately 42 per cent.; from the third cross 416 hatched, or approximately 98 per cent.

At the present time—one month after all the fish were hatched—the following number is living: from the first cross 20, or 62 per cent.; from the second cross none; from the third cross all, or 100 per cent.

The weakness of the pure albinos is indicated by the fact that only 6 per cent. of the eggs proved fertile, and several of these are