channels making up the developing thoracic duct, and that finally the hemal cellular elements in question reach the blood stream *via* the thoracic duct and jugular lymph sac. Considering the vast number of blood cells, especially erythrocytes, arising in this region and the probability that they are conveyed to the general circulation by the thoracic duct, this duct assumes, therefore, an additional phase of importance in the chick in that it performs a hemophoric, or blood-carrying, function.

The view that the thoracic duct may arise as detached portions of veins is in the case of the chick quite untenable, since the tissue in which the lymph spaces and channels arise remains notably non-vascular up to the time the first lymphatics appear. The writer believes he has sufficient evidence, soon to be published, to show that the lymphatics arise as isolated lacunæ directly from mesenchymal intercellular spaces, are not in any sense derived from veins, and subsequently coalesce to form the continuous channels of the thoracic duct.

The point recently made by other investigators,[2] namely, that the superficial lymph plexus in the region of the posterior lymph heart in the chick contains stagnant blood which has backed up into it from the veins, is invalid in the case of the thoracic and its blood content because there are no veins in this region from which "backing up" could occur.

ADAM M. MILLER

A POSSIBLE MEANS OF IDENTIFYING THE SEX OF (+) AND (—) RACES IN THE MUCORS

IT has been shown by the writer (1) that the majority of the forms among the mucors are dicœcious, with the sexes separated in male and female races which are capable of being propagated apparently to an indefinite number of vegetative generations by means of nonsexual spores formed in sporangia. In all the dicœcious species carefully investigated the opposite gametes, which are produced and unite to form zygospores when the two sexual races of a given form are grown together, do not appear to differ morphologically. Lacking a definite criterion which an inequality of the gametes would have afforded, the writer has provisionally designated the opposite sexes in these forms by the signs (+) and (—) on account of a generally greater vegetative[1] luxuriance of one sex over the other. That in reality the two sexes are represented in the (+) and (—) groups is shown by the sexual reaction which may occur not only when the (+) and (—) races of the same species are grown together and perfect zygospores are produced, but also by the sexual reaction which may occur when (+) and (—) races belonging to different species are grown together. This reaction between the opposite races of different species has been called imperfect hybridization since it does not lead to the formation of perfect hybrid zygospores, but usually stops short with the formation of progamates, though occasionally gametes are produced which, however, never unite.

A sexual race of a dicœcious species if grown between the (+) and (—) races of another test species used as a standard, will show a line of sexual reactions on one side only. Some of the hermaphroditic species, on the other hand, when similarly grown, show a response to both (+) and (—) test races and produce therefore 2 lines of sexual reactions.

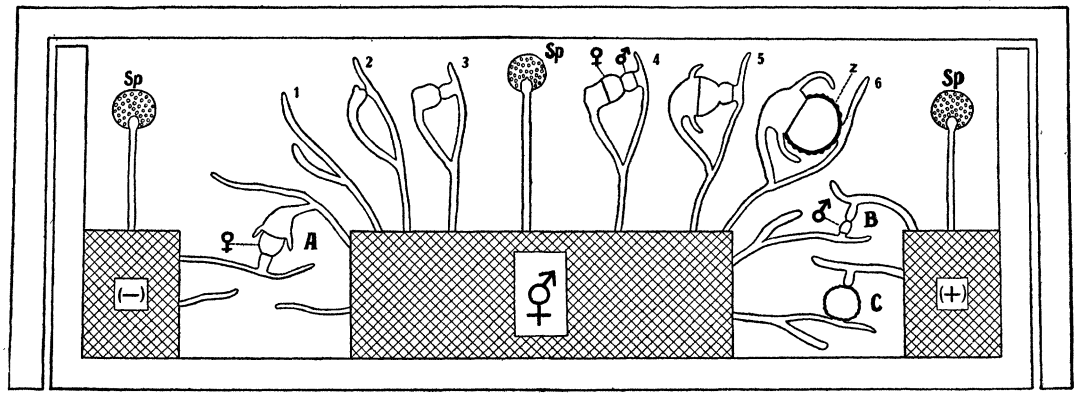
Some few species in the hermaphroditic group are distinctly heterogamic with a constant difference in size between the conjugating gametes. Figs. 1–6 in the accompanying diagram will illustrate the process of conjugation in such forms. It seems reasonable to consider the larger gamete female and the smaller male. Upon this basis, if a sexual reaction could be established between these unequal gametes and the (+) and (—) races, the race reacting with the larger female gamete must be considered male, while the race reacting with the smaller male gamete must be considered female.

[1] "Zygospore Formation a Sexual Process," SCIENCE, N. S., 19: 864–866, 1904; "Sexual Reproduction in the Mucorineæ," *Proc. Am. Acad.*, 40: 205–319, pls. 1–4, 1904.

[2] Clark, E. L., *Anat. Record*, Vol. 6, No. 6, 1912; Clark, E. R., *Anat. Record*, Vol. 6, No. 6, 1912.

The difficulties in technique involved in following the sexual reactions in a thicket of filaments have been overcome by growing the heterogamic hermaphrodite ($\overset{+}{\sigma}$) in a Petri dish between the (+) and (—) test strains and cutting channels in the nutrient agar between the different growths. If the Petri dish be then inverted, the growth of the reacting filaments may be followed in mid air in the channels.

Only a single heterogamic species has been found which will give reactions with both (+) and (—) races and only a single dicœcious species which will react with both male and female gametes of this heterogamic hermaphrodite. These have accordingly been used in making the tests shown in the accompanying diagram.



SEXUAL REACTION BETWEEN A HERMAPHRODITIC MUCOR AND (+) AND (—) RACES OF A DICŒCIOUS SPECIES

Diagrammatic representation of a Petri dish culture showing a heterogamic hermaphroditic mucor ($\overset{+}{\sigma}$) in the center separated by channels on either side from the (+) and (—) races, respectively, of a dicœcious species.

Sp., Sporangia containing spores by means of which the plant may be reproduced nonsexually.

1–6, stages in development of a hermaphroditic zygospore from unequal ♂ and ♀ gametes.

A, sexual reaction between a (—) filament and ♀ gamete.

B, sexual reaction between a (+) filament and ♂ gamete.

C, a ♂ azygospore formed at stimulus of contact with a (+) filament.

In the left hand channel at *A* in the diagram, a filament from the (—) race is shown giving a sexual reaction with the larger ♀ gamete of the hermaphrodite, while in the right-hand channel at *B* a filament of the (+) race is figured, showing a sexual reaction with the smaller ♂ gamete of the hermaphrodite. The male gamete, which has been cut off from a filament of the hermaphrodite at the stimulus of contact with a (+) hypha, frequently surrounds itself with a thick wall and assumes the appearance of a resting azygospore, as is shown at *C*.

Of three other heterogamic hermaphrodites investigated, two show a sexual reaction with the (+) race only and one with the (—) race only. It is difficult to interpret the sexual reaction when shown with only one of the two sexual races.

Judging from the behavior of the forms figured in the diagram one would seem justified in considering the vegetatively more vigorous (+) race as female and the less vigorous (—) race as male.

The details upon which the conclusions in the present article are based are being published in another journal. The article itself is a summary of a paper presented before the Botanical Society of America, January 2, 1913.

A. F. BLAKESLEE