is no membranous connexion all round the girdle of the type which has often been postulated.

Electron microscopical observations have therefore revealed that the dinoflagellate transverse flagellum is one of the more complex types of flagellum known. In view of its specialized and unusual function this is perhaps not altogether surprising. Further details of the structure of dinoflagellate flagella will be published elswhere.

B. LEADBEATER
J. D. DODGE

Department of Botany,
Birkbeck College,
London, W.C.1.

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Production of New Physiologic Races in *Puccinia striiformis* (Yellow Rust) by Heterokaryosis

THERE is no known pycnial stage in *P. striiformis*, and so it is impossible for new physiologic races to arise as a result of sexual recombination, the best known method in *P. graminis*[1]. Nevertheless, there are at least thirty known races on wheat alone in Europe and Asia[2] and two new races, 2*B* and 8*B*, have appeared in Britain within the past 15 years[3], and the epidemic in 1966 on the wheat variety Rothwell Perdix may well be caused by a further new race. Mutation and cytoplasmic change are possible causes of the production of new races, but it seemed to us that heterokaryosis[4] or parasexual phenomena[5] in the uredospore stage (both known in *P. graminis*) could be involved.

Experiments were carried out involving the mixture of uredospores of two physiologic races. A mixture of the uredospores of races 2*B* and 8*B* was inoculated on to seedlings of Strubes Dickkopf (a wheat susceptible to both races) and thirty single uredospore cultures were made from the resulting infection. When tested on the eleven standard differential wheat varieties[6] with the addition of Cappelle Desprez (distinguishing race 2*B* from race 2) and Heines VII (distinguishing race 8*B* from race 8), twenty-seven isolates resembled one or other parent, but the other three differed significantly from either (Table 1) in their reactions on four of the differential hosts. The reactions are given on the standard scale[6], 0 being immune and IV highly susceptible. *SSC* 4 (and *SSC* 27, which closely resembled it) are less virulent than the parent races, but *SSC* 21 is more virulent, and could be of considerable importance if it became established in the field. Both races appear to be different from any previously described[2].

Table 1. REACTIONS OF NEW PHYSIOLOGIC RACES AND THEIR PARENTS

Race	Vilmorin 23	Rouge prolifique barbu	Heines VII	Cappelle Desprez
2*B*	IV	II–IV	0	IV
8*B*	0–I	0–II	0–IV	0
SSC 4	I–II	0	0	IV
SSC 21	IV	II–IV	0–IV	IV

The production of these races can be explained on the basis of heterokaryosis: the parasexual cycle may be involved, but it is not necessary to invoke it to explain the results obtained, and the simplest explanation, that of simple reassortment of heterokaryotic nuclei, is preferred. Each uredospore possesses two nuclei, and if these were, after hyphal fusion, to change partners, two but not more than two new races would be expected if the parent races were heterokaryotic. The formation of hyphal fusions, and the passage of cell contents from one germ tube to another, have been observed by us, and will be described fully elsewhere.

The production of new physiologic races by hybridization in the uredospore stage provides a method for determining, in the absence of any sexual stage, the genetical factors responsible for virulence in the rust. The results reported here are insufficient to make more than a very preliminary determination, but they are in accordance with the postulate that three factors for virulence in the rust genome are involved. The action of the factor postulated as conferring virulence to Heines VII is very distinct. The factor conferring virulence to Vilmorin 23 is distinct from the one conferring virulence to Cappelle, since *SSC* 4 gives a type IV reaction on Cappelle, but only a type I–II reaction on Vilmorin 23, in contrast to the type IV reaction given by race 2*B* and *SSC* 21, the other two isolates attacking Cappelle. The difference between these two reaction types is accepted as being highly significant[7]. If the absence of parasexual phenomena is assumed, the factor conferring virulence to Cappelle must be inherited as a dominant character; the evidence is insufficient to determine whether the other two factors are recessive or dominant.

R. LITTLE
J. G. MANNERS

Department of Botany,
University of Southampton.

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Juvenile Sterility in Male Ticks of *Ornithodoros tholozani*

DURING an investigation of the physiology of reproduction in ticks, we observed that young male ticks of *Ornithodoros tholozani* are temporarily sterile, although they may copulate.

Young unfed males of *O. tholozani*, *O. lahorensis* and *O. tartakovski* generally copulate at 4–6 days old[1], but they sometimes do so as soon as a few hours after ecdysis. To ascertain whether fertilization had taken place, the female was dissected after copulation and the uterus was inspected for the presence of a spermatophore. A spermatophore in the uterus was taken as an indication that fertilization had taken place. This conclusion should be modified, at least in the case of *O. tholozani*.

Our observations on the fertility of *O. tholozani* also showed that young unfed males are able to copulate. In our experiments some males began to copulate on the day after ecdysis and continued to do so at short intervals. Other males began to copulate later in their life. The presence of a spermatophore in the female's uterus does not, however, suffice to prove the ability of the male to fertilize a female.

Only microscopic examination of a spermatophore which has been dissected out of the uterus reveals the true contents of the spermatophore. The first spermatophores produced by a male generally do not contain sperm. They do, however, contain the sperm symbiotes *Adlerocystis ornithodori* which develop in one pair of the complex of accessory lobes of the male genital system which function as a mycetome[2] (Figs. 1 and 2).

Sterility is generally observed in young males of *O. tholozani* for 2 weeks after ecdysis. During this time a male may copulate up to five times, but all the spermatophores produced will contain no sperm. The entire process of copulation, as well as the spermatophore itself, is apparently normal, apart from the absence of sperm.

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