Our experiments, which we consider as a proof of the above reaction mechanism, will be communicated in detail elsewhere.

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² J. Amer. Chem. Soc., 52, 3098 (1930).

³ J. Amer. Chem. Soc., 29, 1641 (1907).

⁴ Trans. Faraday Soc., 37, 566 (1941).

Are there Triflagellate Gametes in the Foraminifera?

THE great diversity of form shown by the gametes of the Protozoa is well known. Even among the Foraminifera they may be amoeboid, for example, *Patellina*¹, *Spirillina*²; or flagellate, at least at one stage. Of the latter, to mention only one feature, some may have but one flagellum as in *Gromia*³, but in the more typical Foraminifera they are usually represented as having two; for example, *Trichosphaerium*⁴, *Iridia*, *Planorbulina* and others⁵, *Polystomella* (*Elphidium*)⁶, *Tretomphalus*⁷ (perhaps, as Myers suggests, a pelagic phase of a species of *Discorbis*). In the case of *Discorbis* (*Discorbina*), we have the very convincing account by Foyn⁸ of a life-cycle for *D. vilardobona* which includes biflagellate gametes of a similar kind; but Myers⁹ has also described and figured triflagellate gametes in *D. patelliformis* in California. As he himself remarks, "three is a most unusual number" for the flagella of gametes of either plant or animal organisms; indeed it is unique.

There are other unusual features about these gametes in the living state: coloured inclusions suggestive of solid ingested food, "a slight notch, suggestive of a cytopharynx", and, most striking of all, their persistence in activity for periods up to 34 days in 'multiple tests' (that is, associated individuals enclosed in a common covering, a condition preceding sexual reproduction) collected from coralline pools and kept with the rest of the finer sediment washed off the weed, in finger-bowls of "sea water recently removed from the sea". While Dr. Myers was writing his paper at Plymouth in 1939, he very kindly showed me a preparation of these flagellates, including at least one of the specimens reproduced in his Pl. II, Fig. 16 of ref. 11, where, as he says, the "false cytopharynx does not show clearly". But, bearing in mind the old warning, sounded by Lister fifty years ago and recently emphasized by Kofoid and by Myers himself (see p. 223 of ref. 11), against careless acceptance of organisms observed in the tests of Foraminifera as stages in their life-history, I could not help noticing, when I had occasion the other day to look up some papers on marine flagellates, that there are records¹² of one or two species of free-living triflagellate salt-water organisms which agree well, so far as the very sketchy description goes, with Myers' 'gametes' of *Discorbis patelliformis*; and that these readily survive in the gathering and may be cultivated with ease. Two species of *Triflagellum*, collected in salt workings and salt lakes in various parts of the world, were cultivated in Holland, at Leyden, in the Botanical Institute of which the director, Prof. L. G. M. Baas-Becking, had previously found one at least at Marina in California. Does this observation solve the problem of the existence of these most peculiar triflagellate gametes in one species of *Discorbis* in California, while another species, in Europe, forms gametes of a more usual biflagellate kind?

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Nov. 28.

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² Myers, Earl H., *J. Roy. Micro. Soc.*, 56 (1936).

³ Lwoff, André, *Trav. Stat. Wimereux*, 9 (1925).

⁴ Jeppe, Margaret W., *Quart. J. Micr. Sci.*, 70 (1926).

⁵ Schaudinn, F., *Anh. Abh. K. Preuss. Akad. d. Wiss.* (1899); Schaudinn's "Arbeiten", 31.

⁶ le Calvez, Jean, *Arch. Zool. Exp. et Gén.*, 80 (1938).

⁷ Myers, Earl H., *Proc. Amer. Phil. Soc.*, 85 (1942).

⁸ Jeppe, Margaret W., *J. Mar. Biol. Assoc. U.K.*, 25 (1942).

⁹ Myers, Earl H., *Stanford Univ. Pub. Biol. Sci.*, 9, 1 (1943).

¹⁰ Foyn, Bjørn, *Bergens Mus. Arb. Naturv. Rekke*, 2 (1936).

¹¹ Myers, Earl H., *J. Mar. Biol. Assoc. U.K.*, 24 (1940).

¹² Ruinen, Jacoba, *Arch. J. Protistenk.*, 90 (1938).

Obligate Parasitism

THE phenomenon of obligate parasitism is well known among the fungi, particularly the rusts and the powdery mildews. That the rust derives its nutrients from the host has been accepted *a priori*, since no other source of food for the fungus was possible. Yet the fact that the nutrients from the soil were furnished to the fungus through the plant system has not been demonstrated. Radio-phosphorus, P^{32} , which is not changed by the plant, furnished a simple means of showing that the nutrient actually comes through the host plant.

Seeds of Little Club wheat were germinated on moist filter paper. When the first true leaf pierced the coleoptile, some seedlings were placed into Hoagland's nutrient solution and others into a similar solution in which the radioactive potassium dihydrogen phosphate has been substituted for the normal form P^{31} . The plants were inoculated with spores of *Puccinia graminis tritici* race 56, and incubated in a moist chamber for 36 hours. The wheat was grown under illumination of a 200-watt Mazda lamp and was kept at $20^\circ \pm 2^\circ$ C. during the entire experiment.

Rust spores were collected twelve days later and analyses made of the substrate, leaves and spores. The leaves and spores were prepared

for assay by first drying the samples to constant weight and then digesting them, the former in concentrated hydrochloric acid and the latter in *aqua regia*. 0.1 ml. samples were placed in the well of a depression slide and then dried at 50° C. Determinations of radioactive phosphorus were made by placing the slide under a Geiger tube and the counts were recorded. Three replicates were made for each determination, and all results in the accompanying table are an average of these values, and except where otherwise indicated, are reported as counts per gram of dry tissue. All determinations for radioactive phosphorus were made on the same day and the results were converted by means of a 'decay curve' to values for radio-phosphorus on the day samples were taken.

Results of the analyses show the presence of P^{32} in the nutrient solution (P^{32}), in the leaves of the wheat and in the spores of the rust collected from these plants. No radioactivity was found in wheat seedlings grown in the normal nutrient solution (P^{31}), nor in the spores obtained from them. Radiographs also revealed the presence of P^{32} in the leaves and in the spores collected from plants grown in the P^{32} nutrient solution.

PRESENCE OF PHOSPHORUS IN COMPONENTS OF OBLIGATE PARASITISM COMPLEX

Material analysed ¹	Counts of radioactivity per gram dry weight P^{32}
Nutrient solution (P^{31})	0
Nutrient solution (P^{32})	5,900 ²
Leaves (P^{31})	0
Non-inoculated leaves (P^{32})	20,400
Inoculated leaves (P^{32})	21,067
Spores (P^{32})	13,200

¹ Symbols P^{31} or P^{32} denote the type of phosphorus contained in the nutrient solution used for growing the host plant.

² Counts per ml. of nutrient solution.

Since no radioactivity was present in the check plants, grown in normal Hoagland's solution (P^{31}), all activity of the wheat grown in the P^{32} solution was due to the radio-phosphorus of the substrate. The presence of this tracer element in the plant and its subsequent appearance in the rust spores demonstrated that the fungus obtains this element from the host plant. Only one component in the chain is unaccounted for, the presence of the phosphorus in the vegetative mycelium of the fungus. The separation of this mycelium from the host tissue in amounts sufficient for analyses is almost impossible, and we can assume that since the spores contained radioactive phosphorus, that element must have been derived from a mycelium.

Thus it is apparent that in the parasitic relationship between the rust and the wheat plant the host absorbs the phosphate ions from the substrate, and transfers them to the leaves and other parts of the plant, from which they are absorbed by the hyphae and finally found present in the spores.

This study is not a regular station project of the Agricultural Experiment Station here, but represents our own interests in this field.

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Simple Photometric Method of Determining the Rate of Bacterial Growth

THE Rideal-Walker and other widely employed methods of evaluating disinfectants involve determining whether or not growth of bacteria occurs in sub-cultures taken from serial dilutions under defined conditions. They, therefore, necessitate a yes or no answer and are extremely inelastic, so that the data obtainable are strictly limited. Experiments have been designed to overcome these disadvantages and it is believed that the apparatus employed should be applicable to a number of problems in a considerably wider field.

A compensated photometric circuit has been devised for determining relative bacterial densities. It is modified from that of Libby¹ and is simpler than those of Pulvertaft² or Alper and Sterne³. Light from a 12-volt 24-watt projector bulb is rendered parallel by lenses and baffles, d_1 , d_2 , falls on an optically flat glass plate, m , which reflects a part of the beam on to a photocell, p_1 . The transmitted portion of the beam passes through the bacterial culture which is contained in a flow-through type of cell, c , having two optically flat facing sides, and thence reaches a second photocell, p_2 , the centre of which has been rendered inoperative by the use of a baffle having a diameter fractionally greater than the diameter of the parallel beam employed. By this means the undeflected light is prevented from reaching the sensitive surface of p_2 , which responds only to light scattered by the bacterial growth present in the culture under examination. The compensating nature of the electrical circuit is clear from the diagram, g being a reflecting galvanometer and pt a potentiometer calibrated 0-100.