behavior in the plant concerned. Therefore a study of pollen behavior, as far as possible, has been made in the field in certain cases for the sake of comparison with the laboratory experimentation. It is expected to extend this phase of the work.

Since my third paper on this topic I have increased the number of plants to 561. In all cases thus far the pollen has been tested in the various solutions referred to in my last paper. As yet no specimen has been found which for number of germ tubes produced is as prolific as *Malva crispa* referred to in my previous paper[1]. Some of the pollen reported in this paper refused to germinate under any of the laboratory conditions that were provided while in other cases germination occurred under precisely the same arrangements. In this last study no case of more than one pollen tube from a single grain has been observed. *Primula obconica* showed luxurious germination in most cases and under ordinary conditions is a favorable specimen for investigation. This was notable in as much as below and immediately above 10 per cent of cane sugar active germination was observed, but at 10 per cent none occurred in the specimens studied. This corroborates the findings heretofore brought out in certain other cases mentioned during these studies and it deserves further attention. There arises here also certain questions concerning the difference in the amount of time required for the commencement of germination aside from the influence of membranal variation. This I have found to be very different in the various pollens studied and constitutes a considerable problem in itself.

PROTOPLASMIC STREAMING.

F. M. ANDREWS, Indiana University.

The idea of this chemical study in *Rhizopus nigricans* was to ascertain the behavior of the plant when plasmolysed in different degrees and the response of the protoplasmic movements when in this condition. It is well known that some plants when plasmolysed by certain substances may remain living for only a short time while others will live for weeks in this condition[2]. It is the intention to carry out this study by using various representatives from the six groups of metals as well as certain organic substances such as sugar and glycerine.

In the first experiments a 20 per cent solution of cane sugar was used. In these experiments a rather sudden plasmolysis resulted, in the time it was maintained, in a slowing of the streaming from a speed of three mm. per minute to one-tenth mm. per minute. When the normal hydrostatic pressure was restored the normal velocity of protoplasmic streaming above mentioned in these specimens was finally restored. In the series of specimens experimented with in this way, however, three hours elapsed before the normal speed was regained. The question still remains as to whether or not a full cessation of streaming could be

[1] Andrews, F. M. Studies on pollen—III. Proc. Ind. Acad. Sci., 1920, p. 155-156.

[2] Pfeffer, W. Pflanzenphysiologie 2te Aug. 1904, Bd. II, p. 330.

produced in a very short time; the length of time maintainable and the various conditions surrounding complete recovery without plasmolysis being produced. These remarks apply not only to very young but also to older specimens where streaming is observable. The sudden transfer from solutions of different concentrations below the plasmolytic strength is also in need of study. In one other set of experiments sudden plasmolysis was produced by a 40 per cent solution of cane sugar and in 15 seconds streaming ceased. In this case the protoplasm was plasmolysed into several parts. However, at the expiration of 21 hours the filaments all presented the normal appearance of the controls and were streaming actively but somewhat less rapidly than at first. In certain filaments of Rhizopus a comparative study of hyptogen membranes constitutes a topic of special interest.

Experiments with glycerine of 25 per cent, as expected, allowed no growth. In 12½ per cent glycerine seven spores in each 100 germinated. In 6 per cent 30 spores in 100 grew and in 3 per cent glycerine 82 in each 100 germinated and grew well.

Potassium nitrate having a strength of 2 per cent permitted a germination of 37 spores for each 100. Above this strength growth and streaming soon ceased. Above isosmotic valuations growth and streaming were feeble or ceased altogether.[3] The specimens plasmolysed by potassium nitrate lived a much shorter time than those plasmolysed by cane sugar.

[3] Eschenhagen. Einfluss von Lösungen verscheidener Concentration Auf Schimmelpilze, 1889, p. 55.