extreme instance of a plant like *Euphorbia Lathyris*, since, at any rate in seedlings, starch occurs under natural conditions in the same position as in this plant. Why more copious formation of starch cannot be induced under circumstances which succeed in other cases is not evident. One of Schimper's alternative explanations, viz. that the chlorophyll-corpuscles cannot form starch, must be rejected after what has just been described, as some of them evidently can and do form starch. It is however quite consistent with the present state of our knowledge to say that the chlorophyll-corpuscles of the assimilating tissue proper of the green leaves cannot or do not form starch.

The other alternative, that it is because the solution of glucose in the cell-sap is never sufficiently concentrated, seems rather doubtful, since, in the first place, from the quantity of glucose contained in the leaves the solution is probably at least as concentrated as almost anywhere in any plant; and secondly, because in isolated leaves and pieces of leaves placed under the various conditions mentioned above, as e.g. in highly concentrated glucose solution in a warm moist atmosphere, one would imagine the cell-sap to contain a sufficiently concentrated solution of glucose, if such were the necessary condition for formation of starch.

We can only say that for some reason or reasons unknown the onion almost invariably stores up the excess of carbohydrate formed as glucose instead of in the more usual form of starch. The habit of forming starch may have been for some purpose abandoned in the course of evolution, in which case it is interesting to note that it is in the seedlings that we get an intimation of the more general process of assimilation in which starch plays so conspicuous a part.

A. B. RENDLE, Cambridge.

A MODIFICATION OF PAGAN'S 'GROWING SLIDE.'—In the Journal of the Quekett Microscopical Club of last year[1] Mr. Spencer Smithson described an arrangement designed by the Rev. A. Pagan for growing on microscopical slides small organisms, such as Rotifers, Algae, &c., which live in water and require a frequent change of the medium. The results obtained with it were very remarkable; but in the original design the slide had always to be removed from the microscope and kept on a specially-constructed stage, and although in

[1] Ser. II. Vol. III. No. 18.

many cases this is of no importance, for instance when there is no difficulty in finding again the individual which has previously been under observation, or when it is not desired to observe constantly the same individual, yet it is a very great drawback in other cases. I have therefore devised an arrangement which allows of the slide being kept constantly on the stage of the microscope and thus of the continuous observation of the same individual[1] for weeks and even, under certain conditions to be mentioned later, for an indefinite period. Whilst it is based on the principle of Pagan's 'growing slide,' almost every detail is different in my arrangement, and its new features justify its publication. I have had it in use for the last six months, and I may say that the results which I have obtained in growing Algae were extremely satisfactory.

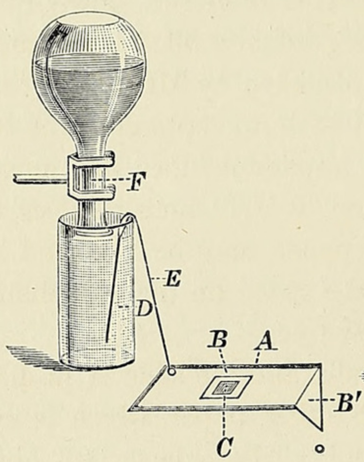

Fig. 12.

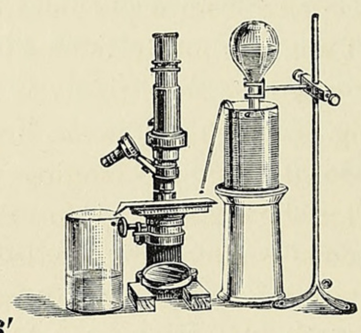

Fig. 13.

The arrangement which is represented on Figs. 12 and 13 requires very little explanation. Fig. 12 represents the essential parts of the apparatus. The slide, A, has the ordinary form, but is made slightly longer than the stage of the microscope, so as to project a little at both ends. On it is placed a piece of ordinary blotting paper, B, which just leaves the margins of the slide free; a hole is cut out in the centre of this paper, C, and at one end is a triangular prolongation, B', which is bent downwards close to the slide. Water is drawn from a tumbler, E, by means of a capillary tube, D, and drops on to the blotting paper. I usually make the tube just wide enough to allow a small drop of water to escape about every 20 seconds. The water is drained

[1] Of course only as long as it is in a non-mobile state.

off by the triangular prolongation of the blotting paper already mentioned. An inverted flask, F, filled with water, has its mouth just touching the surface of the water in the tumbler, E, and keeps the level of the water in the tumbler constant, thus ensuring the regular escape of drops from the capillary tube, D. The capillary tube has a thickened portion in the middle, which I find convenient to keep the tube steady. To be quite sure that the tube will work properly it is well to empty and refill it every 24 or 48 hours.

The object to be observed is placed on the slide within the central hole, C, cut in the blotting paper. It is covered with a coverslip slightly larger than the hole. The coverslip must not be put on in the usual manner, for in this way it is difficult to avoid having air-bubbles under it; but, when the paper is thoroughly saturated with water, the coverslip is placed beside the hole; it is then slid slowly over it, and the space between it and the slide is gradually filled with water.

Fig. 13, copied from a photograph taken by Mr. J. B. Farmer, and for which I am very much indebted to him, represents the apparatus in use. I may here state that the apparatus does not interfere with the drawing of an object, as the large vessel which receives the water dropping down from the blotting paper may be replaced by a very small one for some time, and thus the space on the right-hand side of the microscope is almost entirely left free.

As the water between the coverslip and the slide is in direct communication with the water in the blotting paper, which is constantly being renewed, it cannot become foul. I have never yet observed in my cultures (some of which lasted over a month) a strong growth of Bacteria, such as one would be sure to find in foul water. But in certain cases it may become desirable to have the water more rapidly renewed than is possible in the way above described. This is easily done by cutting a narrow channel (either straight or curved) from the central hole in the blotting paper to the place where the water drops down on the slide from the capillary tube. The strength of the current of water which one gets in this way may be regulated by a small piece of blotting paper which has been teased out with a needle.

With the arrangement described above it is only possible to use moderate powers (up to the combination of Zeiss' Ocular 5, Objective D). For many purposes this is quite sufficient. If higher powers are required, the paper may be removed and the object observed in the usual way, but of course it is then very difficult to continue the culture in the case of very minute objects. In some cases I have, however, succeeded in carrying the culture a little further by proceeding in the following manner:—The hole in the blotting paper was made slightly larger than the coverslip. The latter was thus allowed to come closer down on the slide than when it was supported by the paper. The portions of the paper surrounding the hole were then teased out by means of a needle, and the teased parts were made to touch the margin of the coverslip. This was sufficient to prevent the water under the coverslip from becoming foul, and at the same time it prevented drying up. After some days, however, the water usually flooded the coverslip more or less.

When the paper has been used for about 20 days it does not allow the water to pass through very freely, and it has therefore to be renewed. This is not very easily done, but I have almost invariably succeeded by proceeding in the following manner:—First of all an excess of water is brought on the paper. As soon as the coverslip begins to float it is removed. When this is done, as much water as possible is removed from around the object with a piece of fresh blotting paper, and then the blotting paper which has been used the whole time is carefully lifted and taken off, and a new piece of exactly the same size is put down in its place. When this has become thoroughly soaked with water, the hole is again covered with a coverslip in the manner already described. During this whole process the object is almost constantly kept under observation with a low power, so that it may not be lost even if it be slightly moved. As this process may be repeated any number of times, it is obvious that a culture may be kept in operation any length of time.

To make a culture successful, it is of course necessary to adapt it as much as possible to the needs of the organism which one wants to grow. It is not my purpose to discuss this point here in detail. I wish only to point out that the supply of light and of heat has to be carefully regulated. One ought, for instance, never to forget to turn away the mirror of the microscope after observation, so that concentrated light may not fall on the object for any length of time. Special attention has also to be paid to the fact that certain organisms will only grow in certain kinds of water, &c.

In order to show what results can be attained with this arrangement, I will shortly describe my last culture, which is still in progress to-day (July 5th). On the 2nd of June a culture of *Pediastrum Bory-*

anum Menegh., var. *granulatum* Rabh., was begun. It produced new colonies on June 6th. One of the latter was again selected for observation, the others not being removed. Its development could be studied with the greatest ease in all its stages, and on June 25th a third generation was produced, which is now developing, although I must say it does not seem to flourish. The first generation belonged distinctly to the above-mentioned variety of *P. Boryanum* ; its membranes were strongly 'granulated.' The second generation reached the same size as the former, and was in all respects like it, but its membranes were only slightly 'punctate.' It had therefore to be referred to the true *P. Boryanum* (*P. Boryanum*, Menegh., *a. genuinum*, Kirchner[1]), or at least to some variety which was not the var. *granulatum*. It was thus shown that these two rather extreme forms belong to one and the same species, and do not even deserve to be distinguished as varieties.

If nothing else could be gained with the arrangement I have described than to show to what extent Algae vary, and thus to reduce the confusing synonymy in this branch of Botany, it should recommend itself to all those interested in its study, but it is obvious that other and more important problems may be solved by its aid.

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