

that the single one of the pro-transformism arguments of the writer in *Le Pays* which remains in his memory is, that the best geologists of the United States believe in evolution. The Abbe justly remarks that the argument does not seem to him overwhelming. For, he adds, they and even most geologists of the English language and protestant faith are partisans of evolution because of their lack of philosophic and religious instruction.

V. L. K.

STANFORD UNIVERSITY, CAL.

A SIMPLE APPARATUS FOR ILLUSTRATING PHOTOSYNTHESIS

THE use of experiments, illustrating the various physiological processes in plants, are coming more and more into use in connection with the teaching of elementary botany in the secondary schools. Unfortunately the funds available for the purchase of apparatus are so limited in many of these schools that the teacher has to resort to the method of making the various experiments before the class, while the students make notes on the results, etc., to be written up in their laboratory notebooks later. Such a method as this is very good if nothing better is available, but of course the best results are obtained by the students themselves making as many of the experiments as possible. I devised the following simple apparatus for illustrating the necessity of carbon dioxide and light in photosynthesis. Since it has worked with success, I thought that a short account of it might be justified.

Ordinary bottle corks, about 2 cm. in diameter, and 1 cm. thick, should each have a hole cut through the flat side with a large cork borer. The holes should be about 1.5 cm. in diameter. Through one side of each of the cork rings thus formed, a small hole should be made for ventilating purposes. The large hole in each ring should now be covered on one side by cementing on a small piece of mica, or, if mica is not available, small round cover glasses will do, but will require more careful handling subsequently as the glass breaks more easily than the mica. A sufficient number of these discs should be made to provide

each student with six of them, two of which should be blackened to exclude the light.

In order to perform the experiment successfully a bright day should be selected, and only such plants should be used as have the stomata on the lower sides of the leaves. Plants with the stomata on both surfaces can be used, however, provided that the upper surfaces of the leaves used in the experiment are greased with cocoa butter or vaseline. The plant should be left in the dark long enough for the starch to be removed from the leaves before the experiment is started.

The cork discs, which have just been described, should be pinned to the leaves in pairs, one on the upper surface, and another on the lower surface opposite it so as to form small enclosed chambers in each instance. The blackened discs should constitute one pair so as to form a dark chamber. In order to exclude carbon dioxide the lower chamber of one of the other pairs of discs should contain small lumps of soda-lime, while the third pair will serve as a control to show that the presence of the discs themselves does not interfere with starch formation.

After the plant has stood in the sunlight for a few hours the leaves upon which the experiment is made should be removed, boiled in water, left in alcohol for a time and tested for starch in the usual way. If the experiment has been properly conducted, no starch will be present where carbon dioxide and light have been excluded, but it will be present in abundance under the discs used as a control. Groups of from two to four students can work together if the class is large and the number of discs limited.

It has been found that rather large-leaved plants with stiff petioles are better for use, in which case one leaf is sufficient for the three sets of discs. If plants with delicate leaves are used the discs can be supported by bending short lengths of soft iron wire at right angles near one end of each, and inserting the bent end in the side of one of the discs in each pair, while the other end of the wire is stuck into the soil below.

ALBAN STEWART

UNIVERSITY OF WISCONSIN