they did not venture to name, consists of ripe sclerotia of the same species, and Thwaites 1013, *Tuber zeylanicum*, is another sclerotium. The latter is much larger, about one centimetre in diameter; it is quite common on rubbish heaps, and when planted in damp sand, it produces a white mycelium which runs along the top of the sand and forms sclerotia of the same size as those of *Sclerocystis coremioides*. It may, however, be a different species.

Up to the present it has not been possible to develop a fructification from these sclerotia: in pure sand, the larger develop a mycelium which produces the sclerotium stage again, while the smaller have not yet produced anything. It seems, however, worthy of record that the description of *Sclerocystis coremioides* was based on a complete misapprehension of the nature of the specimen sent from Ceylon by Thwaites, and that the genus *Sclerocystis*, as described, has no real existence.

Cesati established a new genus *Xenomyces*, on a similar production collected by Beccari in Sarawak. He states that it is 'Genus affine *Sclerocystidi* B. & Br., nec minus enigmaticum.' The description suggests that it is another sclerotium, if not the same species as Berkeley and Broome's.

PERADENIYA. T. PETCH.

THE CYTOLOGY OF RHOEO DISCOLOR.—At the suggestion of my teacher, Prof. Marcus Hartog, I made a preliminary study of the cytology of *Rhoeo discolor*, Hance (*Tradescantia discolor*, Hortt.), in 1905. Its inflorescence is a compact double scorpioid cyme, which facilitates the assemblage of sets of consecutive stages. Many fixatives were tried; but Tellyesniczky's mixture (potassium bichromate, 3 grms.; glacial acetic acid, 5 cc.; water to 100 cc.) proved most satisfactory.

Much preliminary work was done; but other duties make it probable that my complete results may long await publication. The two essential points of interest are (*a*) the small number of chromosomes (4–8); (*b*) the small size of the cells, which enables a considerable number in various stages to be seen in a single field under a magnification of 500 diameters. This may make the plant a very useful object to the cytologist—all the more as it is usually in flower all the year round, in hothouses.

W. J. GALLAGHER

(From the Biological Institute of Queen's College, Cork).

KUÁLA LUMPÚR, Federated Malay States,
May, 1907.

A PHOTOELECTRIC THEORY OF PHOTOSYNTHESIS.—The following is a preliminary abstract of an investigation into the nature and mode of formation of the primary products in photosynthesis which has been carried out in my laboratory at intervals during the past three years. Although the general hypothesis underlying this research was formulated some twelve years ago, various circumstances interfered with all but preliminary experiments until 1905, when the investigation was resumed.

The hypothesis I originally formulated to myself (and communicated verbally to my friend, Dr. J. Reynolds Green, F.R.S.) was, briefly, that the light rays absorbed by chlorophyll are transformed by it into electric energy, and that this transformed energy effects the decomposition of carbonic acid (H_2CO_3) in the cell, with the concomitant formation of an aldehyde and the evolution of oxygen.

To prove the validity of this hypothesis it would appear necessary to establish experimentally the truth of the following propositions:—

1. That an aldehyde is present, even though in very small quantity, in all actively photosynthetic tissues, and that the aldehyde is probably formaldehyde.

2. That the amount of formaldehyde present bears a definite relation to the intensity of illumination.

3. That formaldehyde may be synthetically produced from carbon dioxide in presence of water, with evolution of oxygen, by a feeble electric discharge.

4. That differences in electric potential of sufficient intensity occur in all photosynthetic tissues when adequately illuminated.

5. That the light rays absorbed by chlorophyll are those chiefly concerned in the generation of such electric currents.

Reserving complete details for a subsequent publication, in which I shall have the co-operation of my colleagues, Dr. A. W. Titherley, Lecturer on Organic Chemistry, and Dr. F. J. Brislee, Assistant Lecturer in Physical Chemistry, I may at present briefly indicate the results obtained as evidence in support of these five theses.

1. *Formaldehyde is present, though in very small quantity, in all actively photosynthetic tissues*:—

That formaldehyde is a primary product in photosynthesis was first suggested by Baeyer in 1870, and its presence in green tissues has been affirmed and denied by many investigators since his time. Curtius and Reinke (1897) asserted that an aldehyde appeared and disappeared according as the leaf was illuminated or not. In 1902 Pollacci affirmed the presence of formaldehyde in the leaf and reiterated this statement in 1904, but his latest results have been sceptically received.

The experimental proof of any theory that postulates formaldehyde as a primary product in photosynthesis must obviously depend on the existence of a delicate and reliable test for it. A test of this character has recently been published by Mulliken, Brown and French (1904) for a reference to which I am indebted to Dr. A. W. Titherley, who has latterly been associated with me in the chemistry of this problem. A knowledge of this test enabled me to proceed with my work in 1905. If a quite fresh and insolated leaf (e. g. *Tropaeolum*) be cut into small pieces and shaken up with water, the water extract, after filtration, may be shown to contain formaldehyde in the following way. To about 1 cc. of a 5 per cent. solution of gallic acid in absolute alcohol add about 3 cc. of pure concentrated sulphuric acid so that the two layers do not mix, and afterwards allow a small quantity of the filtrate to stream down the side of the test tube. If the proper precautions be taken, the presence of formaldehyde will be indicated by the appearance of a blue-green ring at the zone of contact of the upper and lower liquids. This test has been carefully investigated by Dr. Titherley, and we are quite convinced both of its delicacy and of its reliability.

2. *The amount of formaldehyde present in the leaf bears a definite relation to the intensity of illumination.*

If water extracts be made of leaves (in the way above described) at different hours of the day or after exposure to different intensities of sunlight, other conditions remaining constant, the depth of the colour zone in the above test varies, being most intense when the leaves have been exposed to diffuse light, and feeble or absent when the leaves have been placed either in very weak or very intense light. These results are quite in accord with those obtained by previous investigators and especially by Pantanelli (1904), who found that the optimum decomposition of carbon dioxide took place when the light intensity amounted to one quarter of that of direct sunlight, but that as the light intensity increased photosynthesis decreased, other conditions remaining constant.

3. *Formaldehyde may be synthesized from carbon dioxide in presence of water by feeble electric discharge.*

In my first experiments I used the simple method of saturating distilled water with carbon dioxide gas and passing a current from a dry cell through the solution, using platinum or copper electrodes. In some cases, I thought I was able to detect minute traces of formaldehyde, but notwithstanding several modifications in my apparatus I failed to convince myself of its constant occurrence. My colleague, Dr. F. J. Brislee, directed my attention to Loeb's paper (Zeit. f. Elektrochemie, 1906), and by employing his apparatus and a silent electric discharge, the presence of formaldehyde could be demonstrated with the gallic-sulphuric test in every case. Loeb, in discussing the bearing of his results on photosynthesis, holds that formaldehyde becomes by polymerization glycolaldehyde, which readily undergoes transformation into a sugar, but holds that the function of the chlorophyll is to remove the oxygen and at the same time to absorb the carbon dioxide, acting physiologically in an analogous but reverse manner to haemoglobin.

4. *Electric discharges of sufficient intensity occur in photosynthetic tissues when adequately illuminated.*

The researches of Kunkel (1882), Haake (1892) and others have demonstrated the existence of electric currents in green plant-organs, and Klein's (1898) investigations have shown that these currents are subject to regular variations according to the degree of illumination to which the parts are subjected. It would seem, however, that Klein considers the electric currents as something apart from the light and merely influenced by it; according to the theory here proposed the electric currents are the expression of the transformation of the rays absorbed by the chlorophyll.

5. *The light rays absorbed by chlorophyll are those specially concerned in the generation of the electric currents demonstrable in photosynthetic tissues.*

Nagamatsz (1886) and, more recently, Griffon (1900) have shown that no photosynthesis takes place in a leaf illuminated by light which has passed through other leaves (indicated in their experiments by absence of starch). I have confirmed this by other methods and found that no formaldehyde can be demonstrated in an extract of a leaf which has been exposed to light which has passed through another, although the upper leaf shows the presence of formaldehyde quite distinctly.

Again, if a leaf be illuminated by light which has passed through another leaf, the current at once ceases, reappears if illuminated by blue-violet light, and becomes nearly as great when illuminated by red light as it is when illuminated by white light.

Meldola in his Presidential Address to the Chemical Society (1906) says:—'From formaldehyde to fructose the laboratory evidence is fairly complete. It remains only to connect formaldehyde with carbonic acid by some photolytic method which may be regarded as above suspicion—and the discovery of such a method may be looked for sooner or later—in order to say that the chain of chemical evidence is quite complete.'

In our forthcoming paper the detailed evidence will be given on which we believe that we are justified in claiming that our work fills the gap indicated by Prof. Meldola in the sentences quoted; the present note is merely an outline of the chain of evidence and does not touch on various collateral problems which have arisen in the course of the investigation.

R. J. HARVEY GIBSON.

UNIVERSITY OF LIVERPOOL.