the diverticulum. The author thus opines that in all probability the midges have a selective reflex action, not altogether mechanical, by which they can by closing or opening the valve of the diverticulum, divert a particular ingested fluid to a selected reservoir or reservoirs wherefrom they are regurgitated and absorbed when needed. It is quite likely that this closing of the diverticular valve by a reflex action takes place only at the time of a blood-meal by the actual penetration of the proboscis and the consequent folding in of the labium which is quite distinct from the "licking of free surface fluid" which, as the previous experiments show, diverts most of the ingested fluid to the diverticulum. The author also found that in the case of wild flies collected freshly fed in nature, blood was seldom found in the diverticulum and hence diverticulum, at least in these midges, cannot, in the true sense of the term, be called a food reservior. On the other hand, there are evidences of the presence of a colourless fluid in the diverticulum of wild-flies apparently, in the process of regurgitation. The author thus concludes that in nature the diverticulum of a blood-sucking *Psychodid* contains a fluid of lesser consistency than the blood traced in the mid-gut of a fly and that this fluid, at times, is regurgitated into the alimentary canal of the midge to restore or alter the physico-chemical properties of a blood-meal for a specific purpose.

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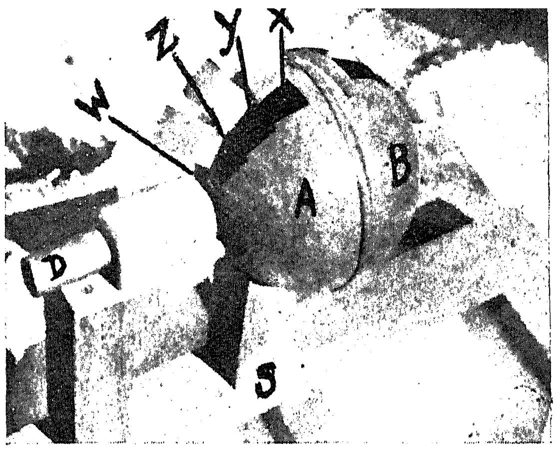
An Apparatus to Determine the Coefficient of Energy Absorbed by a Leaf.

THE problem of energetics of a leaf though very important has been dealt with by comparatively few workers. Brown and Escombe,[1] the premier workers in the field, have tried to establish a relation between the physiological activities of a leaf and the energy absorbed by it. In finding out the energy absorbed by a leaf they took for granted that the loss due to reflection from the surface of a leaf is neglegible. Jorgensen and Stiles[2] cast a doubt on this hypothesis and brought out the fact that even a black cloth reflects one per cent. of the incident energy.

Coblentz,[3] Shull[4] and others have made spectrometric measurements of light incident on, transmitted by and reflected from a leaf. They all agree that the reflected energy is about 10 per cent. of the total incident energy.

In the present state of our knowledge about the problem the author thought it desirable to construct an apparatus which would give an accurate idea of the amount of energy absorbed by a leaf. Fig. 1 gives a vertical section of the apparatus *in situ*, shown in the photograph.

A and B are two hemispheres, A fitting into B as shown in Fig. 1. The hemisphere A has an aperture at its apex to admit a beam of light coming through the tube D. A removable circular plate C is fitted in



A—Hemisphere receiving the light reflected from the surface of the leaf L. *B*—Hemisphere receiving the light transmitted by the leaf L. *D*—Tube admitting a beam of light incident on the leaf L. *X*, *Y* and *Z* areas cut on the surface of the hemisphere A on which the photronic cell is placed. *W*—Surface of the hemisphere, the energy falling on which cannot be measured directly. *S*—Support.

flush with the edge of the hemisphere A. The plate C has a circular aperture at its centre. This aperture is in line with the tube D and the aperture in the apex of the hemisphere A. The apparatus is supported on a wooden frame S (Fig. 1).

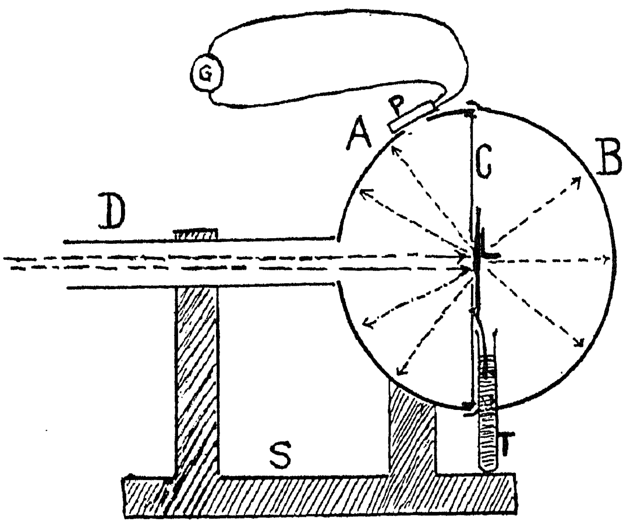


Fig. 1.

Vertical section of the apparatus *in situ*.

A—Hemisphere receiving the light reflected from the surface of the leaf. *B*—Hemisphere receiving the light transmitted by the leaf L. *C*—Circular plate with a hole at its centre fitting in flush with the edge of the hemisphere A. *D*—Tube admitting a beam of light incident on the leaf L. *G*—Galvanometer. *L*—Leaf fixed on the hole in the plate C. *P*—Weston's photronic cell placed on an area cut in the hemisphere A and connected with the Galvanometer G. *S*—Support. *T*—Tube containing water in which the petiola of the leaf L dips.

A beam of light admitted through the tube D passes through the aperture at the apex of the hemisphere A and falls on the leaf L fixed on the aperture in the plate C. The petiole of the leaf dips into a tube T containing water. A portion of the light incident on the leaf L is reflected back into the hemisphere A, another portion of the incident light is transmitted through the leaf into the hemisphere B and the remaining portion is absorbed. On account of the roughness of the surface of the leaf, both the reflected and transmitted portions of light are scattered in all directions and so fall on the inner surfaces of the hemispheres A and B respectively.

Suitable portions of each of the hemispheres are cut off along the longitudes of the hemispheres as seen in the photograph. The light falling on these areas is measured by placing on them a Weston's photronic cell P (Fig. 1), connected with a sensitive galvanometer G, and recording the deflection of the galvanometer. From these readings the total amounts of light reflected and transmitted by a leaf are calculated in the following manner.

It has been observed by the author in his preliminary experiments, that the reflected and transmitted energies are not uniformly distributed over the whole inner surfaces of the hemispheres A and B, but are distributed symmetrically round the axis of the hemispheres, which is perpendicular to the central plate C. Supposing the hemisphere A is rotated round its axis, the cut area x on its surface will describe a circular strip, say x'. Similarly, the areas y and z will describe circular strips y' and z' respectively. On account of the symmetrical distribution of the reflected and transmitted energies round the axis of the hemispheres, the intensity of light falling on the cut area x is the same as on a similar area on circular strip x'. In order to find out the amount of energy received on x' the reading of energy falling on the cut area x is multiplied by the factor

$$\frac{\text{area of the circular strip } x'}{\text{the cut area } x}.$$

In a similar manner the amounts of energy falling on y' and z' are found out.

The energy falling back on the aperture at the apex of the hemisphere, and also falling on the small strip w' bounding the aperture cannot be measured directly. It can only be estimated by the method of extrapolation. According to this method when we know the intensities of energy falling on the consecutive areas x, y and z the intensities of energy falling on the immediately next area (consisting of w' and the aperture at the apex of the hemisphere) can be estimated. From this intensity the amount of energy falling on this area can be estimated. The results of the amounts of energy falling on these different areas when added up, give the total energy reflected by the leaf.

In the case of transmitted energy readings of energy falling on areas of the hemisphere B, similar to x, y, z and one at the apex of the hemisphere B, are taken, and from these the total transmitted energy is calculated directly.

The total incident energy is determined by replacing the leaf by a screen of known transmissibility and collecting the light transmitted in the same manner.

The total time required for taking all the readings necessary to find out the coefficient of absorption of energy of a leaf, is never more than three minutes, and it may be presumed that the reflecting and transmitting power of the leaf with its petiole dipped in water, does not alter materially during this period.

Having found out the incident energy (I), the reflected energy (R) and the transmitted energy (T) the coefficient of absorption (C) can be found out by the equation

$$C = \frac{I - (R + T)}{I}.$$

A detailed study of the leaves of several species has been made with the help of the above apparatus and some interesting results have been noted. Further details of the apparatus and the results obtained with it will be published in due course.

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Soil Fertility and the Role of Trace Elements.

In recent years, a great number of papers have been published on soil fertility studies and in some of these, the factors that influence the plant growth are discussed. These experiments tend to show that some of the elements needed only in small quantities, *e.g.*, Mn, Ti, B, Zn, exercise marked influence on plant growth. Among the various workers who have contributed to this line of research mention may be made of Bertrand, Warrington, Sommer, Subrahmanyan, Dhar and Horner. The great importance of traces of Manganese for the plant has been demonstrated by McHargue, McLean, Kelley and Gerrestsen. Kelley, while studying the soils under cane cultivation in Hawaii, observed the presence of large quantities of Mn and Ti, while Gerrestsen believes that Manganese intensifies photosynthesis by accelerating the oxidation processes connected with the photochemical reactions in the leaf, shortage of Manganese resulting in retarded carbon dioxide assimilation. In carrying out a study of the physical and chemical properties of some typical soils from cane-growing areas, which were kindly supplied to the author by the Superintendent of the Government Agricultural Farm, Anakapalli, it was felt that valuable information might be obtained by the spectrographic examination of these soils, as it would enable one to detect and identify all the metallic elements contained in them without allowing even the rare ones to escape detection. The arc spectra of many representative soil samples have been photographed. Besides the elements Na, K, Cu, Mg, Ca, Al and Si which can be detected by chemical analysis as well, the trace elements Zn, Ti, Mn and B could be indubitably detected and identified, while Be is suspected. By comparing the spectra of these soil samples with those of a series of suitable ratio powders of known composition, attempts have been made to determine the proportion of the minor constituents. The Manganese content of the majority of the fertile soils was found to range from 0·04 to 0·15 per cent., while the value of Zinc ranged from 0·03 to 0·06 per cent. Though no very definite statement can be made as to the relative importance of the trace elements, the preliminary experiments tend to show that while these elements are needed only in small quantities, they may not be present in sufficient amounts in available form. An outstanding feature of this spectrographic examination is the predominating proportion of Manganese and Zinc in some fertile soils, while all the soils of the tract seem to be comparatively rich in Silicon. Further experiments are in progress.

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