GEOLOGIC CONSEQUENCES

If changes in sea level such as herein suggested have taken place, an explanation is available for possible migration of flora and fauna in equatorial belts without the necessity of drifting continents or uplifting land bridges. Such alterations of sea level and ocean masses would also cause large changes in climates with resulting influence on life. It is, also, not beyond the realm of possibility that the internal changes necessitated during the adjustment of the solid earth might produce stresses which would result in orogenesis.

We have hesitated to present this hypothesis for some time because of its radical and highly speculative nature; but we have decided to advance it, though with much doubt in our own minds as to its validity, in order to invite criticism which might ultimately give rise to a satisfactory explanation. Also, we hope that discussion may focus attention on evidence of submergence in high latitudes and new data on submerged valleys.

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DECEMBER 31, 1935

SCIENTIFIC APPARATUS AND LABORATORY METHODS

MEASUREMENT OF THE AREA OF ATTACHED AND DETACHED LEAVES

IN various types of investigations it is often desirable to measure regular or irregular areas quickly and accurately. Especially is this true for attached or detached leaves of plants which differ in size, color and thickness. To facilitate such work a suitable apparatus has been devised. In principle the method consists in the use of a light source capable of producing a small amount of radiant flux, part of which passes through a condensing lens, two plates of glass, a second condensing lens and a diffusion screen, and finally onto a photoelectric cell attached to a meter by means of which a reading is taken. When it is desired to secure the area of any given objects, they are placed between the plates of glass, thus intercepting a portion of light and reducing the amount of radiant energy striking the photoelectric cell. The decrease in the electromotive force generated by the light-sensitive cell is proportional to the light intercepted by the objects, and the reduction indicated by means of a meter.

The various parts of the measuring device were fastened to a metal frame, Fig. 1 F. As a light source a twenty-one candle power automobile lamp was mounted by means of adjustable clamps to the metal frame, A. One condensing lens, twelve inches in diameter, was mounted in a metal ring and attached to the frame at a distance below the light approximately equal to the focal length of the lens, and another lens of the same size was attached at a lower position, B. Below the lower lens at a distance slightly less than its focal length a Weston Photronic cell, E, was attached to the frame with an adjustable clamp. A piece of acid etched glass, slightly larger in area than the photoelectric cell, was fastened about one inch above the cell and served as a diffusion screen, D. Finally, removable clamps supporting two pieces of window glass were fastened between the two lenses, C. The entire frame was then suspended by means

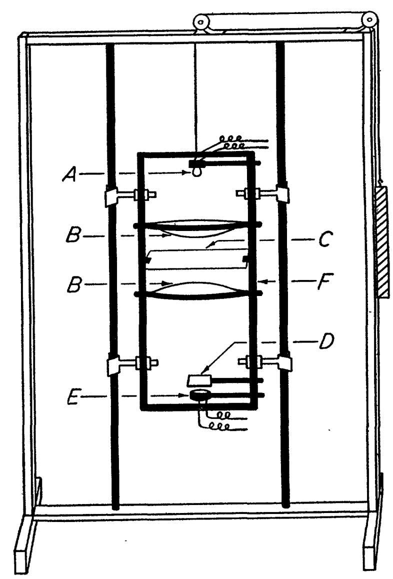

FIG. 1. Diagram of apparatus used to measure attached and detached leaves. A indicates a light source, B lenses, C glass plates, D diffusion screen, E photoelectric cell and F a metal frame.

of a cable between two vertical metal pipes in a larger wooden frame. It was therefore easily possible to adjust it to any level at which it was desired to secure a measurement.

In actual use, the distance between the upper and lower lenses was sufficient to allow for easy manipulation of the glass plates between which the leaves or other objects were placed in order to keep them flat and hold them in position. The distance between the photoelectric cell and the lower lens was finally adjusted so that the diameter of the light beam from the lenses was slightly less than the diameter of the light-sensitive surface of the cell. The lamp was energized by means of a six-volt storage battery. The photoelectric cell was connected to a microammeter, having an internal resistance of 63.5 ohms, and a sliding resistance of 44 ohms was shunted across the meter terminals to control the energy output of the photoelectric cell.

After placing the apparatus in a dimly illuminated room and protecting the cell from direct bright light, the shunt resistance was adjusted to give full deflection of the microammeter needle. Several adjustments were usually necessary during the following 15 to 20 minutes, while the electrical system reached equilibrium, but no difficulty was encountered thereafter. Calibration was effected by successively placing circular pieces of cardboard of various known sizes between the glass plates and in the path of the light beam, C, and noting the consequent reduction in the energy output of the photoelectric cell for each piece as indicated by the microammeter. The resultant calibration curve drawn from these observations is a straight line.

The area of a large leaf or a large number of small leaves which occupied most of the area covered by the light beam was determined when the two glass plates were held between the two lenses, C. The area of small leaves or a small number of them having an aggregate area of less than 45 cm² could be determined with accuracy only when the glass plates were held below the lower lens. In this position, even small leaves intercepted a large percentage of the concentrated light energy, and their areas were determined from a second calibration curve made with the glass plates in this position.

It is evident from the work of Withrow,[1] Gerdel and Saulter,[2] and others, that the amount of light energy intercepted from a beam of light by a leaf depends not only upon the size of the leaf but also upon its power to transmit and reflect light. They have also demonstrated that the amount of light transmitted or reflected varies with different types of leaves. In measuring leaves that vary in color and thickness by the methods described by these authors, it is necessary to correct the readings for errors caused by variations in the amount of light transmitted and reflected by different types of leaves.

By using the apparatus described above, however, providing the intensity of the light striking the surface of the leaf was less than about 15-foot candles, as measured by a Weston light meter, the radiant energy transmitted and reflected by leaves was not sufficient to cause significant errors in area measurements. Tests showed that identical areas cut from cardboard or leaves of different colors and thickness gave area readings which varied about 1 per cent. from the mean (Table 1). No appreciable error in area measurements resulted from the amount of light reflected from the surface of pieces of cardboard of different colors. When the light intensity at the leaf surface was greater than about 15-foot candles unreliable results were obtained. For this reason the glass plates used below the lower lens were not placed nearer than six inches to the photoelectric cell. If a light beam still smaller in diameter is required in measuring very small areas, then a light source which produces less radiant energy can be used and the glass plates moved nearer to the photoelectric cell.

TABLE 1
COMPARISON OF AREA READINGS USING EQUAL AREAS CUT FROM CARDBOARD AND LEAVES WHICH DIFFER IN COLOR AND THICKNESS

Leaf	No. of disks	Reading microamp.	Area cm²	Description of leaves
Cardboard ..	10	23.5	36.8	
Ficus	10	23.5	36.8	Thick, deep green
Coleus (yellow) ..	10	23.5	36.8	Thin, light green
Coleus (red)	10	23.4	36.1	Thin, red
Geranium ..	10	23.5	36.8	Thin, green
Codium	10	23.4	36.1	Thick, red
Pandanus ..	10	23.4	36.1	Thick, white
Ivy	10	23.4	36.1	Thin, green

Measurements were made to test the accuracy of results obtained by the method described by calculating the area of cardboard disks and comparing these areas and also those obtained through the use of a planimeter, with the areas of the disks as determined by the photoelectric method (Table 2). Measurements were made using cardboard disks of known areas and different colors and the results only varied about 1 per cent. from the mean. No significant differences in area readings resulted when the position of an object held between the glass plates was shifted, providing the object was kept completely within the boundary of the light beam. Finally the areas of attached leaves were measured, using the photoelectric method. These leaves were then removed from the plants and traced with a planimeter. Table 2 shows that leaf areas determined by means of the photoelectric method varied about 2 per cent., in the more extreme cases,

TABLE 2
COMPARISON OF RESULTS OBTAINED IN MEASURING THE AREA OF CARDBOARD DISKS AND LEAVES BY DIFFERENT METHODS

Object measured	No. of leaf or disk	Calculated area cm²	Area by photoelectric method cm²	Area by planimeter cm²
Cardboard disk ..	1	21.2	21.1	21.2
" ..	2	50.3	50.3	50.7
Coleus leaf (yellow)	3		23.4	23.2
"	4		22.4	22.2
"	5		20.9	20.4
"	6		20.9	20.5
Geranium leaf ..	7		49.2	48.7
"	8		50.0	50.5
"	9		35.6	35.3
"	10		41.2	40.8

[1] R. B. Withrow, *Jour. Agr. Res.*, 50: 637–643, 1935.
[2] R. W. Gerdel and R. M. Saulter, *Jour. Amer. Soc. Agron.*, 20: 635–643, 1928.

from areas of the same leaves obtained with a planimeter.

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A SIMPLE QUARTZ MERCURY ARC

THE small and inexpensive arc to be described has proved to be exceedingly useful for many laboratory purposes. It can be used conveniently with a monochromator or filters to obtain fairly intense visible and ultra-violet monochromatic radiations. In our laboratory it has been used for the following purposes: (1) In conjunction with a quartz monochromator and quartz microscope to make photomicrographs with visible and ultra-violet monochromatic radiation and to study the effects of these radiations on micro organisms.[1] (2) In conjunction with a microscope to make cinema films of micro organisms. (3) For dark field photomicrographs. (4) As a source of ultra-violet radiation for fluorescence microscopy. (5) With filters as a monochromatic light source for the polariscope. (6) As a light source for studying Raman spectra.

The arc can be made in practically any shape to meet specific experimental requirements. Two types which will satisfy most requirements, one having a vertical and one having a horizontal discharge tube, will be described.

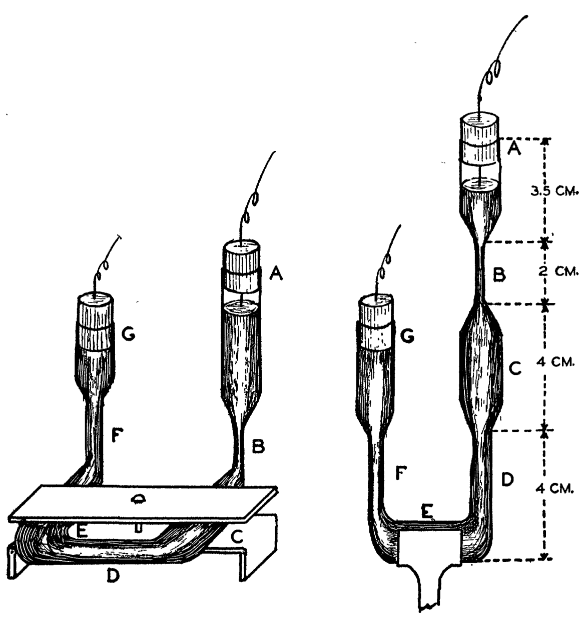

FIG. 1a. FIG. 1b.

Following are instructions for constructing the arc (see Fig. 1 (a) and (b)): A clear fused quartz tube 25 cm long with an approximate bore of 8 mm is pulled down to about 0.5 mm bore at B. This is done to prevent the arc from oscillating. The tube is then pulled down to 3–4 mm at D, which is the part in which the arc is maintained. The tube is also pulled down at F to a 1–2 mm bore. This constriction serves to diminish the heat conduction to G. The tube is then bent into the desired form; the horizontal type is shown in Fig. 1 (a) and the vertical type in Fig. 1 (b). The tube is then filled with very clean mercury and heated until all air bubbles are expelled by boiling. A tight-fitting cork stopper containing an iron electrode is inserted into G. A small flat head stove bolt serves admirably, for the nut can be turned up so as to expand the cork, causing a tight fit when the cork has been inserted into the tube. A loose-fitting stopper is inserted at A so as to allow air to escape when the mercury column is heated. The arc is operated from a 110 V. D.C. circuit in series with a 1.5 ampere 100 ohm variable resistance (a 150 watt lamp will often suffice). The arc is started by heating at D with the flame of a Bunsen burner until the mercury is separated by the vapor pressure of the mercury. When the arc is struck, about one ampere flows through the circuit. An inductance placed in series often improves the operation of the lamp. The portions C and E are made larger to provide more cooling surface. Part C of the vertical lamp tends to become too hot, causing the arc to migrate from D to C and it is sometimes necessary to wind copper wire about this part to cool it adequately. In the horizontal type a holder, made of $\frac{1}{8}''$ lead sheet, as indicated in Fig. 1 (a), provides adequate cooling surface to stabilize the arc. Lead is used on account of its flexibility and weight. For use with the microscope, the holder can be made so as to facilitate placing the arc just under the condenser and thus eliminate the use of a mirror. A fan can be used to prevent excess heating of the microscope.

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Dr. Ellice McDonald, Director

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