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AN INTEGRATING LIGHT METER FOR  
ECOLOGICAL RESEARCH

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# AN INTEGRATING LIGHT METER FOR ECOLOGICAL RESEARCH

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In many ecological studies, the measurement of light is of major importance. In the past, ecologists have had to use instruments which were not entirely satisfactory. Two types of instruments frequently used were the pyrhelio-meter and exposure meter. Both of these instruments have the disadvantage of recording light received on a flat surface only whereas plants are affected by light received from any direction. The main disadvantage of the pyrhelio-meter is that it is tedious to evaluate the continuous graphic record. It is, moreover an expensive instrument requiring a delicate recorder and an external source of electricity which make it unsuitable for many field studies. The exposure meter is an easy instrument to use in the field, but the readings obtained are subject to error in that they vary with the orientation of the meter. Perhaps the main weakness of the exposure meter is that it records illumination rather than quantity of light. Illumination measurements are sometimes difficult to work with because the illumination fluctuates widely in time, particularly under a forest canopy. The best way to cope with a varying illumination is to measure the total quantity of light received over a given period. The investigator usually wants a single average value with which to compare the relative light conditions in two environments, and to obtain such a value with an exposure meter would be a very tedious task. Under these circumstances, an instrument which records quantity of light directly is of great convenience.

The wave lengths having the greatest effect on plant functions are those in the visible portion of the spectrum, and for most work, it seems reasonable to use a meter sensitive to those wave lengths. A satisfactory meter for ecological use should be able to cope with a wide range of illumination, should be non-directional and integrate the light falling on a sphere from all directions (3), and should integrate and record in suitable units the light received during any given period of time. In addition to these requirements, the meter should be portable, rugged, and reasonably accurate.

A very promising light meter was built recently as a co-operative project between the National Research Council of Canada, and the Forestry Branch, Department of Northern Affairs and National Resources. It measures radiant energy in the visible spectrum in lumen-hours per square foot. It records the amount of light received on a spherical surface, which is an important feature because plants utilize light from any direction. The design was based on an instrument described by Sprague and Williams (1) and tested by Somers and Hamner (2). The electrical circuit is essentially the same, but the light-receiving section was completely re-designed by two officers of the National Research Council: W. E. K. Middleton, Head of the Photometry and Colorimetry Section, and George Klein, Head of the Engineering Section. Middleton has described the theory of the new design and the operation of the N.R.C.-type light meter in a recent paper (3).

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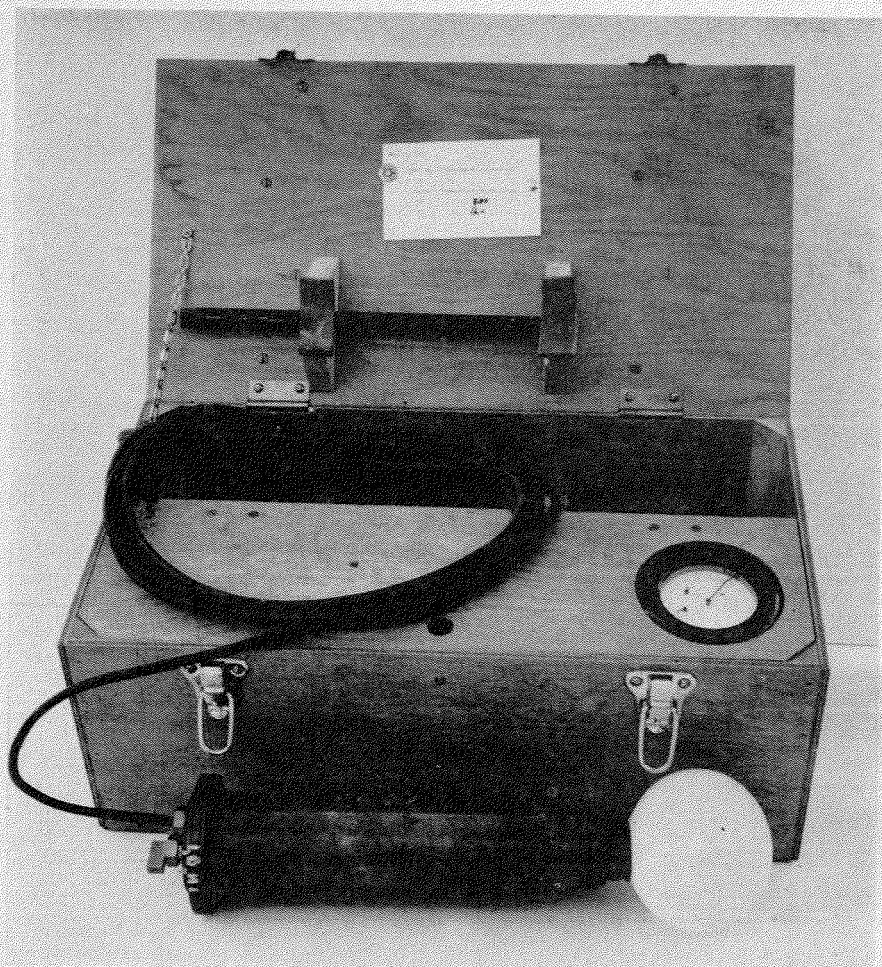


The meter consists of a brass tube which supports a spherical opal glass globe four inches in diameter and houses a photo-electric cell and other components. These components are connected by a 20-foot cable to the dry cell batteries, counter, and remaining parts which are mounted in a wooden box used to carry the meter (see Figure). Light striking the spherical globe is directed to the photo-electric cell and the current developed is used indirectly to operate the impulse-type counter. The quantity of light reaching the glass globe is determined by multiplying the counter reading by a calibration factor. For use in high values of illumination there is a manual switch on the meter which brings a larger capacitance into the circuit. Because there is a different calibration factor for high and low values of illumination, the operator must read the meter when switching from one circuit to the other.

The light meter was tested at the Petawawa Forest Experiment Station and found to be satisfactory. In practice, the meter is supported on an iron rod which screws into the base. It may be convenient to mount the instrument on a stand for observations at high levels; for studies at ground level, the supporting brass tube may be dug into the ground. The operator reads the counter at suitable intervals; in bright sunlight, the meter should be read at least twice a day because of the limited capacity of the counter. If relative light conditions in two environments are being studied, one meter may be set up in a clearing and used as a standard or control. The counters on both meters are then read simultaneously.

One feature of the meter which may limit its usefulness in some experiments is that recording is not automatic. The observer must be present to take readings at the beginning and end of the period. Another disadvantage of the meter is that it must be switched manually from the high scale to the low when illumination drops below a certain level; cost of an automatic switch is prohibitive. However, this limitation is not too serious in experiments where a worker is always present, or if weather conditions are such that the meter can be left on one scale.

The main feature of the meter is that it measures the total visible radiation received on a spherical surface during any period of time. The meter may be used in both low and high illuminations, and it is water-proof under normal conditions. The design of the meter makes it a useful and flexible instrument for a wide range of ecological experiments.



The N.R.C.-type light meter.



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