

## *On the Production of Oxygen by Plant Cells in a Microspectrum.*

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*Engelmann was not the first to concern himself with the question of relative effectiveness of different portions of the spectrum in photosynthesis, and later workers improved on the quantitative precision of the determinations by equalizing the amounts of energy supplied at different wavelengths. But from the standpoint of sheer elegance of technique, this experiment will always excite admiration. Especially ingenious was Engelmann's use of light transmitted through the cell itself to correct for the absorption spectrum of chlorophyll.*

DURING THE PAST FALL and winter I have more closely investigated the dependence of oxygen production by green cells upon the wave length of the light by means of the bacterial method, utilizing for this purpose a microspectral apparatus designed to my specifications by Carl Zeiss. A brief report on this subject may be given here.

The apparatus, which is designed to throw a microscopically small spectrum in the plane of the object, is placed, when in use, in the position of the usual illuminating system of the microscope (mirror and diaphragm). It consists (1) of a plane mirror adjustable in any direction; (2) a double slit mechanism comprising (a) a bilaterally symmetrically movable slit, the width of which may be exactly adjusted between the limits of 0 and 2 mm to the nearest 0.001 mm by means of a micrometer screw; (b) two Gravesande blades movable at right angles to slit "a" for

regulation of the length of the light slit; (3) a collimator lens; (4) an erecting prism; (5) an objective system for perfecting the spectral image of the slit. Since it is desirable to be able to change the absolute size of the spectrum according to the nature of the object and the requisite light intensity, the objective system is not fixed but various objectives can be screwed in. For Zeiss objectives A, B, and C, which are sufficient for most purposes, the absolute distances between Fraunhofer lines a and E [7185 Å and 5270 Å] are respectively 0.236, 0.180, and 0.092 mm.

The clearness of the spectrum is such that when sunlight is used (even much weakened) and a slit width of 15  $\mu$  and less, several hundred Fraunhofer lines are clearly visible. The intensity of illumination is sufficient, even with the use of objective A with an ordinary gas flame as light source, for observation of bacteria under high magnification with

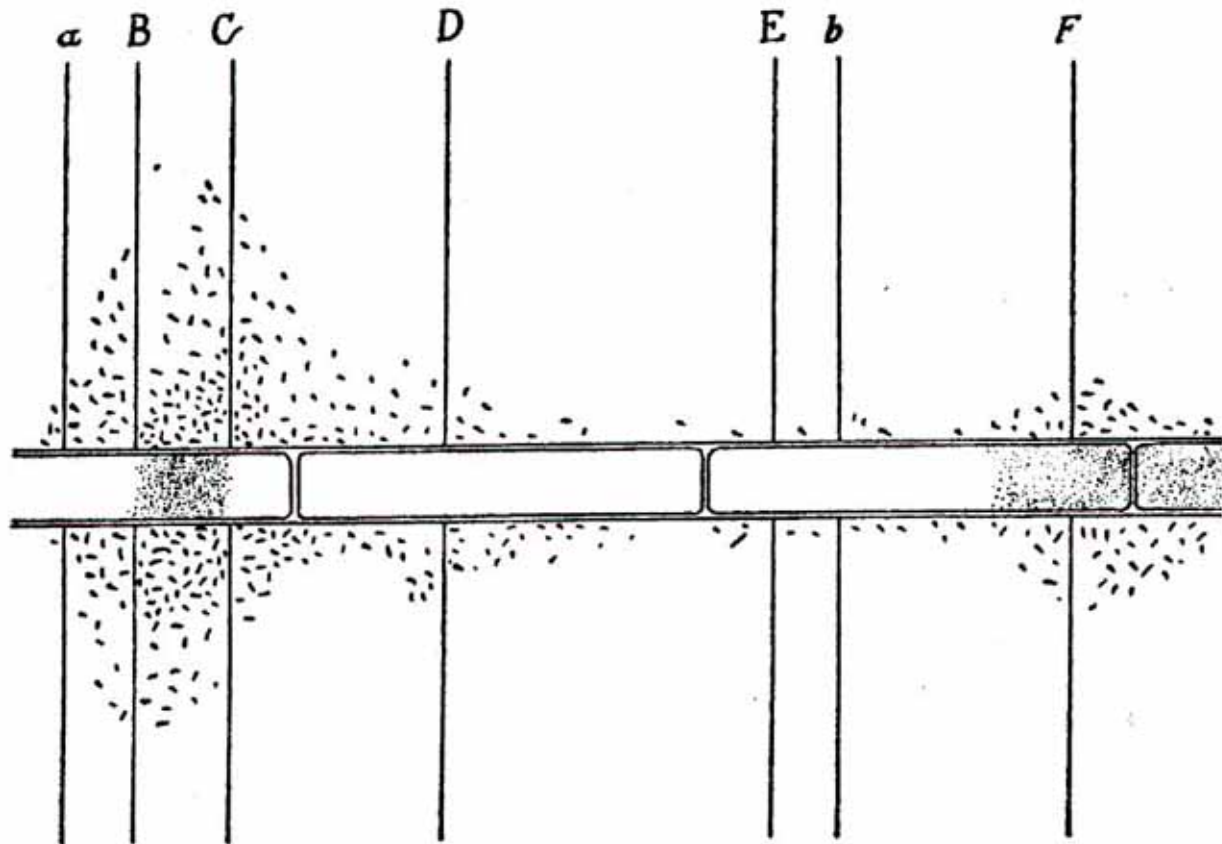


FIG. 1.—Portion of a *Cladophora* with swarming bacteria in a microspectrum of sunlight. The chloroplasts, which fill the cells uniformly, have been omitted. The absorption band between B and C, and the absorption at the violet end, beginning between b and F, are indicated (enlarged 200 X).