CHANGES OF THE CHLOROPHYLL-SPECTRUM IN LIVING CHLORELLA, IF THE PHOTOLYTE IS SPLIT BY LIGHT

Otto WARBURG, Edmund BIRKICHT, Günter KRIPPAHL and Günter PAHLKE
Max-Planck-Insitute for Cell Physiology, Berlin-Dahlem, Germany

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It has been shown by manometry [1, 2] that the photolyte of photosynthesis is a carbonic acid-chlorophyll compound. Light splits this compound into free chlorophyll, oxygen and reduced carbonic acid in the ratio 1:1:1. In the course of the catalysis, the resynthesis of the photolyte follows – a dark reaction, in which free chlorophyll and carbonic acid recombine to the photolyte.

It has been further shown [3] with the Aminco-Chance double beam spectrophotometer, that the chlorophyll spectrum in the living alga *Ulva lactuca* changes when the photolyte is synthesized.

In this note, we show that the chlorophyll spectrum in living *Chlorella pyrenoidosa* changes when the photolyte is split by light into free chlorophyll, oxygen and reduced carbonic acid. The wavelength of the splitting light was 680 mμ, the incident light intensity was about 300 mm^3 quanta per min. The wavelength of the light at which the chlorophyll spectrum was measured in the Aminco-Chance apparatus was 730 mμ, the incident intensity of which was 0.008 mm^3 quanta per minute.

The synthesis and the splitting of the photolyte was effected in two manometric vessels that were connected with two Aminco optical cuvettes by silicon tubes in a closed system, through which the *Chlorella* suspension was driven by a rotary pump. The cells were suspended in an acid culture medium (pH 4.3) [4]. The composition of the microelements is described in [4]. The total amount of circulating fluid was 50 ml, the concentration of the *Chlorella* cells in the fluid was 6 mm^3 cells per ml. Preparation of the cell suspension is described elsewhere [4].

This technique allowed the measurement of the transmission of the chlorophyll in living *Chlorella* when the photolyte was synthesized or split by light. Some of the results are shown in figs. 1 to 4. In each experiment prior to the elumination period there was a dark period of 30 min. The conditions of the medium in the two manometric vessels are given in the legends.

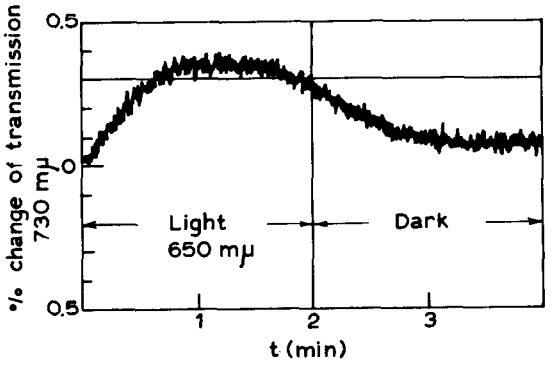

Fig. 1. 10% CO_2 in air against air. Medium + microelements.

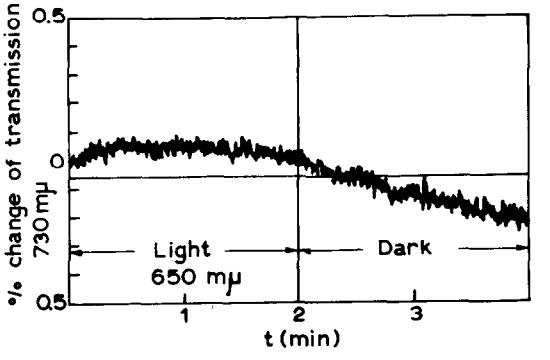

Fig. 2. 10% CO_2 in argon against air. Medium + microelements.

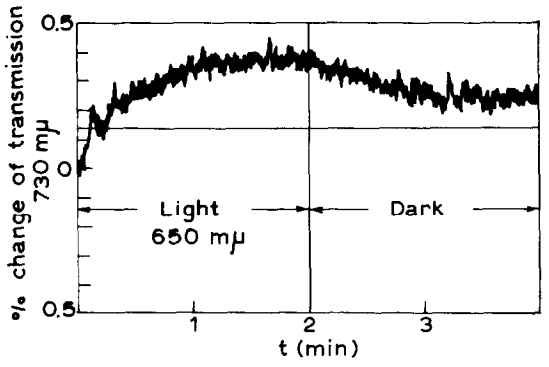

Fig. 3. 10% CO_2 in air against air. Medium without microelements.

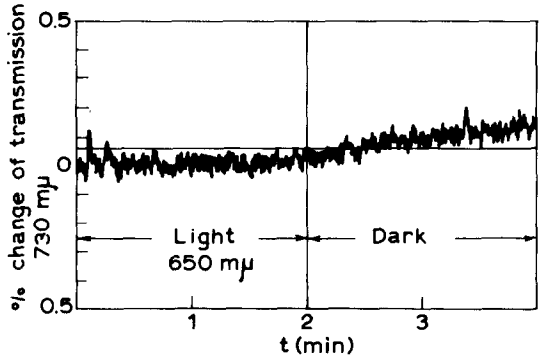

Fig. 4. 10% CO_2 in air against air. Medium without microelements, but with *o*-phenanthroline (1 mM).

The results of the experiments recorded in figs. 1 to 4 agree essentially with the results obtained with the manometric technique. However, in longer experiments, the optical response did not agree with the results of the manometry. Thus, optical changes exist which are not connected to manometric changes.

The experiments proved that the synthesis of the photolyte and the splitting of the photolyte occur inside the chlorophyll molecule. This means, that chlorophyll is the CO_2-splitting part of the photosynthetic enzymes, [1] in analogy to iron, the oxygen transferring part of the respiratory enzymes [5].

References

[1] Otto Warburg, G.Krippahl and A.Lehmann, Am. J. Botany 56 (1969) 961.
[2] Otto Warburg, G.Krippahl and A.Lehmann, Z. Naturforsch. 24 b (1969) 1533.
[3] Otto Warburg, E.Birkicht and G.Pahlke, Z. Naturforch. 25 b (1970) 112.
[4] Otto Warburg, (Georg Thieme, Stuttgart and Interscience, New York, 1962).
[5] Otto Warburg, Biochem. Z. 152 (1924) 479.