areas under the two peaks were difficult to measure, we estimate that the α peak contains about 10% of the total area. The following values for the β peak were determined: at 0.96% myosin, $S'' = 0.7_4$ and $S'_{20,w} = 1.7$; at 0.48% myosin, $S'' = 1.0_0$ and $S'_{20,w} = 2.3$. This present finding of the heterogeneity in 5 M guanidine hydrochloride is in contrast with the conclusions of KIELLEY AND HARRINGTON[5], who deduce that myosin in this solvent dissociates into three identical subunits. Trial calculations show, however, that the heterogeneity will probably not greatly al er the weight-average molecular weight found by these authors.

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[1] O. SNELLMAN AND M. TENOW, *Biochim. Biophys. Acta*, 2 (1948) 650.
[2] T-C. TSAO, *Biochim. Biophys. Acta*, 11 (1953) 368.
[3] D. R. KOMLNZ, W. R. CARROLL, E. N. SMITH AND E. R. MITCHELL, *Arch. Biochem. Biophys.*, 79 (1959) 191.
[4] R. TRAUTMAN AND C. F. CRAMPTON, *J. Am. Chem. Soc.*, 81 (1959) 4036.
[5] W. W. KIELLEY AND W. F. HARRINGTON, to be published in *Biochim. Biophys. Acta.*

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Manganese content and changes in light absorption during photosynthesis in green algae

Studies on the effect of manganese deficiency on photoreduction and photosynthesis in green algae have led to the conclusion that manganese is specifically involved in photosynthetic O_2 evolution[1–4]. This assumption received further support from measurements of delayed light emission and fluorescence in manganese-deficient algae[5] and from work on the dependence of the HILL reaction on the manganese content of algae and higher plants[6]. In order to obtain further information concerning the role of manganese in photosynthesis, we have studied the effect of manganese deficiency on the changes in light absorption during illumination of green cells.

Four types of changes in light absorption have been observed during photosynthesis[7–10]. Those of Type 2 are obviously connected with the splitting of water. Their amplitude is independent of temperature, and they are not influenced by inhibition of the other basic processes of photosynthesis (*i.e.*, O_2 evolution, photosynthetic phosphorylation, and CO_2 reduction)[7,11].

Ankistrodesmus braunii (strain Marburg) was grown in culture media with and without addition of manganese[5]. After about 3 weeks, the photosynthetic activity of the manganese-deficient cells had dropped to one-fourth of that observed with normal algae. Fig. 1 shows that the changes in light absorption of Type 2, induced by short (10^{-4} sec) flashes of light[11], are not influenced at all by manganese deficiency.

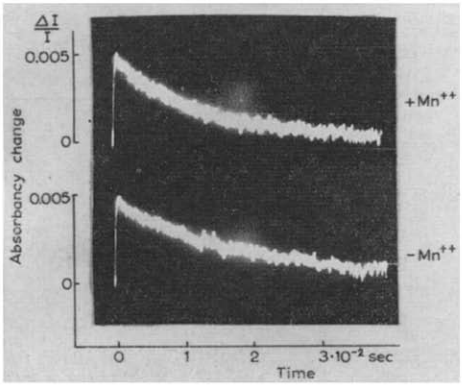

Fig. 1. Changes in light absorption of Type 2 at 515 mμ after illumination by short flashes of light (10^{-4} sec) in normal and in manganese-deficient cells. *Ankistrodesmus* suspended in phosphate buffer, pH 6.5; temp., 20°; light saturation.

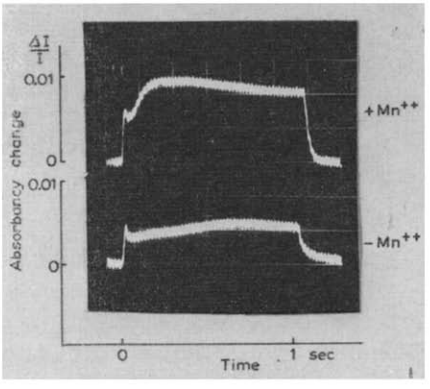

Fig. 2. Changes in light absorption of Type 2 at 515 mμ during 1 sec of illumination in normal and in manganese-deficient cells. *Ankistrodesmus* suspended in phosphate buffer, pH 6.5; temp., 20°; light saturation.

This again demonstrates that manganese does not serve as a catalyst in the water-splitting reaction of photosynthesis.

A considerable difference, however, can be observed in the second, slow phase of the changes in light absorption of Type 2, which occurs during longer periods of illumination (> 0.1 sec). This second phase disappears in manganese-deficient cells (Fig. 2), just as it does in normal cells at about 0° (see ref. 8, 11). After addition of manganese, both the second phase and the normal photosynthetic oxygen evolution are again observed. It should be stressed that the loss of the second phase is brought about directly by the manganese deficiency and not indirectly by the inhibition of photosynthesis resulting from it. This follows from the observation that the second phase remains unchanged when photosynthesis has been inhibited by lack of CO_2 or by poisoning with cyanide.

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1 E. KESSLER, *Arch. Biochem. Biophys.*, 59 (1955) 527.
2 E. KESSLER, *Research in Photosynthesis*, Interscience Publishers, New York, 1957, p. 243.
3 E. KESSLER, *Planta*, 49 (1957) 435.
4 A. PIRSON, *Trace Elements*, Academic Press Inc., New York and London, 1958, p. 81.
5 E. KESSLER, W. ARTHUR AND J. E. BRUGGER, *Arch. Biochem. Biophys.*, 71 (1957) 326.
6 C. EYSTER, T. E. BROWN, H. A. TANNER AND S. L. HOOD, *Plant Physiol.*, 33 (1958) 235.
7 H. T. WITT AND R. MORAW, *Z. physik. Chem.*, 20 (1959) 253.
8 H. T. WITT AND R. MORAW, *Z. physik. Chem.*, 20 (1959) 283.
9 H. T. WITT AND A. MÜLLER, *Z. physik. Chem.*, 21 (1959) 1.
10 H. T. WITT, R. MORAW, A. MÜLLER, B. RUMBERG AND G. ZIEGER, *Z. physik. Chem. (Frankfurt)*, 23 (1960) 133.
11 H. T. WITT, *Research in Photosynthesis*, Interscience Publishers, New York, 1957, p. 75.
12 H. T. WITT, R. MORAW AND A. MÜLLER, *Z. physik. Chem. (Frankfurt)*, 20 (1959) 193.

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