Internal Inorganic Carbon Pool of *Chlamydomonas reinhardtii*—Commentary

Badger MR, Kaplan A, Berry JA (1980) Internal inorganic carbon pool of *Chlamydomonas reinhardtii*. Evidence for a carbon dioxide-concentrating mechanism. Plant Physiol **66:** 407–413

The affinity of the carboxylation enzyme Rubisco for CO_2 in green algae is usually lower than the CO_2 concentration in water equilibrated with air. Therefore, if CO_2 diffuses from the environment to the carboxylation site as it does in C_3 higher plants, the rate of photosynthesis at ambient CO_2 concentration should be negligible and limited by CO_2. In contrast to this prediction, the rate of photosynthesis of green algae is saturated by CO_2 at low CO_2 concentrations, whereas their rate of photorespiration is low and consequently their CO_2 compensation point is also low. These characteristics resemble those of C_4 higher plants. However, carbon fixation with the aid of auxiliary carboxylation in a C_4 mechanism has been found only in a few algal species, whereas high photosynthetic capability at low CO_2 concentrations is widespread among the algae. The occurrence of these phenomena was also attributed to the induction of enzymes such as carbonic anhydrase that equilibrates the concentrations of CO_2 and HCO_3^- or glycolate dehydrogenase that allows reassimilation of glycolate via the photorespiratory pathway. However, the presence of these enzymes, although they play a role in acclimation of algae to low CO_2 concentrations, cannot elucidate the discrepancy between the high rate of photosynthesis at ambient CO_2 and the high $K_m(CO_2)$ of Rubisco. The breakthrough in understanding of this enigma happened when Joe Berry and his postdoctoral fellows, at that time Aaron Kaplan and Murray Badger, realized that the C_4 characteristics of algal photosynthesis result primarily from increase in the CO_2 concentration at the carboxylation site. To prove this hypothesis, they developed a technique for determination of the intracellular inorganic carbon concentration, measured it in the unicellular green alga *Chlamydomonas reinhardtii* and in the cyanobacterium *Anabaena variabilis*, and indeed found that illuminated cells concentrate CO_2 by active uptake of inorganic carbon. Elevation of the CO_2 concentration at the carboxylation site raises the rate of carboxylation and decreases that of oxygenation. Consequently, algal photosynthesis is not limited by availability of inorganic carbon.

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