The Limiting Carbon Dioxide Concentration for Photosynthesis

MANY reports[1–5] indicate that plants in a closed system will reduce the concentration of carbon dioxide in the air to a minimum value between 50 and 100 p.p.m. Gabrielsen[2] postulates "there exists a threshold value for carbon dioxide in photosynthesis, which for elder leaves is about 0·0090 volume per cent. Below the threshold no assimilation takes place. Thus it seems that only about two-thirds of the atmospheric carbon dioxide is available for photosynthesis".

The equilibrium value between photosynthesis and respiration in a closed system varies with light intensity and temperature[5]. I have compared the equilibrium concentration of carbon dioxide for excised leaves of several species in a closed glass chamber at a constant light intensity of 7,000 ft. candles and temperature of 23° C. Carbon dioxide was monitored continuously with a Liston Becker infra-red gas analyser calibrated with standards of known concentration of carbon dioxide.

Striking differences were noted between species in the minimum level to which they could reduce the concentration of carbon dioxide in our system, as shown in Table 1. Under my conditions both corn and sugar cane reduced the concentration of carbon dioxide to less than 10 p.p.m. All other species tested came to an equilibrium at 60 p.p.m. carbon dioxide or greater. Orchard grass was in the latter group, indicating that the ability to scrub carbon dioxide from a system to very low levels is not a universal property of the grass family. The equilibrium for Norway maple leaves was an extremely high 145 p.p.m. carbon dioxide.

The constancy of the minimum level of carbon dioxide for a species was striking. I studied two corn and three tomato varieties over a period of six months at varying light intensity over 2,000 ft.-candles. The minimum concentration was characteristic of the species and varied by 5 p.p.m. or less.

The difference between species did not appear to be due entirely to high respiration relative to photosynthesis. The ratio of apparent photosynthesis at normal air concentration of carbon dioxide (P_{300}) to dark respiration (R) is shown in column two of Table 1. Although sugar cane had the lowest respiration relative to photosynthesis, corn was not different from tobacco or geranium. Orchard grass had a very high respiration relative to photosynthesis but the minimum level of carbon dioxide was the same as tobacco and geranium. However, tomato and Norway maple, which had high minimum levels of carbon dioxide, did have high respiration-rates compared to apparent photosynthesis. Actual respiration on a unit leaf basis was equal for sugar cane and geranium at a rate one half that of tobacco and corn. Leaf area was not determined for the other species.

Table 1. OBSERVATIONS OF PHOTOSYNTHESIS IN EXCISED SHOOTS UNDER 7,000 FOOT-CANDLES AT 23° C.

	Minimum CO_2 concentration (p.p.m.)	Ratio P_{300}/R	Ratio P_{100}/P_{300}
Corn (*Zea mays*)	9	3·9	0·63
Sugar cane (*Saccharum officinarum*)	7	6·2	0·67
Orchard grass (*Dactylis glomerata*)	60	1·5	0·22
Tobacco (*Nicotiana tabacum*)	60	4·4	0·33
Geranium (*Pelargonium* sp.)	65	4·4	0·33
Tomato (*Lycopersicon esculentum*)	75	2·0	0·31
Norway maple (*Acer platanoides*)	145	1·7	0·00

The different ability of plants to remove carbon dioxide to low levels would have great significance on the production of plants in an environment where carbon dioxide was limiting photosynthesis. Column 3 in Table 1 lists the ratio of photosynthesis at 100 p.p.m. carbon dioxide (P_{100}) to that at normal air concentration of 300 p.p.m. carbon dioxide (P_{300}). At this low concentration of carbon dioxide, the rate of assimilation of corn and sugar cane was two-thirds the normal rate while photosynthesis of tobacco, geranium, and tomato was only one-third the normal rate, orchard grass one-fifth the normal rate and the Norway maple was giving off carbon dioxide. Thus if carbon dioxide in the natural environment were low it would limit photosynthesis in Norway maple long before it would limit it in orchard grass or tobacco. Further low carbon dioxide would limit photosynthesis in orchard grass and tobacco before it would in the most effective species, corn and sugar cane.

When the supply of carbon dioxide is limiting photosynthesis, the rate of uptake of carbon dioxide by a leaf should be proportional to the gradient from the outside air to the cell surface in the sub-stomatal cavity. If the equilibrium concentration of carbon dioxide in a closed system reflects the concentration of carbon dioxide inside the leaf, then a larger gradient exists for corn and sugar cane than for many other species; this advantage would become relatively larger at lower concentrations of carbon dioxide and, perhaps, explains the difference in rate of photosynthesis I have observed between different species at these low levels of carbon dioxide. If plants are to be tested for air purification and low levels of carbon dioxide are desired, I suggest that the ability to reduce carbon dioxide to low values may be of importance not only in the efficiency of the photosynthetic process but also may be a useful phenomenon and important criterion for selecting material to be used in air purification for submarines or space platforms.

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Effect of Inhibition on the Presynaptic Nerve Terminal in the Neuromuscular Junction of the Crayfish

IN the crayfish muscle stimulation of the inhibitory axon results in two inhibitory effects: (1) The conductance of the muscle membrane is increased by the released inhibitory transmitter[1]; (2) The amount of transmitter released on stimulation from the excitatory nerve ending is reduced[2,3]. The second effect was named 'presynaptic inhibition'. In the present work the following hypothesis is tested: presynaptic inhibition is based on interference of the inhibitory transmitter with the action potential spreading into the nerve terminal.

When an extracellular microelectrode is placed at an isolated junctional area on a muscle fibre, a record of the current flowing into the postsynaptic fibre during an excitatory junctional potential is obtained[4]. Under favourable recording conditions