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The Effects of Various Carbon Dioxide Concentrations on *Lemna minor*

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ABSTRACT

Pflanzen brauchen CO_2 zum Leben. Sie atmen es ein durch ihre Stomata, im Gleichgewicht dazu verlieren sie Wasser, wenn die Stomata geoeffnet sind. Der CO_2 Gehalt in unserer Umwelt ist ansteigend. Eine gute Frage ist es dann, ob Pflanzen den hoeheren CO_2 Gehalt nutzen koennen, besser und effizienter zu arbeiten, weniger Stomata offen zu haben und damit weniger Wasser zu verlieren. Diese Experiment untersucht den Effekt von verschiedenen CO_2 Konzentrationen auf die Stomataanzahl in *Lemna Minor.* Diese Pflanze wurde in drei verschiedenen CO_2 Konzentrationen aufwachsen gelassen. Die Stomataanzahl ist verschieden in allen Ergebnissen, aber nicht nur wegen der erhoehten oder erniedrigten CO_2 Konzentration, sondern auch wegen des unterschiedlichen Wachstumsstadiums der einzelnen Blaetter.

Plants require CO_2 to live. They take in the CO_2 through their stomata; similarly they lose water through the open stomata. Atmospheric levels of CO_2 have been increasing. It is an interesting question, therefore, whether plants are able to use less water and function more efficiently because of the higher CO_2. The purpose of this experiment was to determine the effects of various CO_2 concentrations on stomatal density in *Lemna minor.* These plants were grown under three different CO_2 concentrations; 250ppm, 350ppm and 700ppm. The stomatal density is not significantly different between treatments, particularly when the size to which the new leaves grew is taken into consideration.

Keywords: CO_2 concentrations, stomata, water, *Lemna minor*, environment

INTRODUCTION

The CO_2 concentration in our atmosphere is increasing, altering our climate and influencing both our lives and our environment. On the one hand, CO_2 is a byproduct of all living, respiring organisms, and of our industry.
On the other hand, CO_2 is an important ingredient in the metabolism of plants. Plants absorb CO_2 and convert it metabolically into sugar (Galston, et al., 1980). Often we only think of the negative side of CO_2; of the pollution of the environment, the destruction of the atmospheric ozone layer and of global warming due to the Greenhouse effect. Plants, however, need CO_2 to live. Since they provide the majority both of our nourishment and of animal feed, it is an important question to know how plants will respond to the increased CO_2 levels.
Plant leaves have small openings, called stomata. In normal land-plants, these stomata can be found on both the adaxial and abaxial sides of the leaves. Under extremely hot conditions, plants minimize the water losses due to transpiration by having stomata on only the underside of the leaf. Floating-leaved plants, conversely, are unable to exchange gases with the atmosphere through submerged underside of the leaf, and therefore typically have stomata only on the upper leaf surface. Stomata function primarily in a plant's gas exchange processes, photosynthesis and transpiration (Galston, et al., 1980). When CO_2 moves into the plant, water diffuses out. That is to say, the more stomata are open to allow CO_2 to enter, the more water leaves the plant (Drake, et al., 1996). Plants try to lose as little water as possible (Woodward et al., 1995). They endeavor to optimize the balance between CO_2 uptake and water loss. This balance, called the Water Use Efficiency (WUE) equals the transpiration rate divided by the rate of CO_2 uptake (Galston, et al., 1980).

The diffusive uptake of CO_2 can be described by Fick's equation:

$$J = -DA\ \partial C / \partial L$$

In order to increase the CO_2 uptake by the plant there are two possibilities: either increase the CO_2 concentration in the atmosphere or open more stomata (Farquhar, 1997). That is to say, if the atmospheric CO_2 concentration is high enough, the plant can obtain the same amount of CO_2 through fewer open stomata. Fewer open stomata also means that the plant will have a higher WUE, because it will lose less water (Farquhar, 1997). Plants react differently to elevated environmental CO_2 concentrations, taking one of several paths. The may grow more quickly, because they are able to take in more CO_2 , or they may grow at the same rate, but simply grow more efficiently (i.e. losing less water and requiring fewer stomata) (Saxe et al., 1997). Therefore I have investigated the following hypothesis, H_0: The number of stomata will not be different for leaves grown under an elevated CO_2 level.

MATERIALS AND METHODS

Individual plants of the duckweed *Lemna minor* (Carolina Biological Supply) were placed in 25x100mm glass culture tubes. Duckweed has a relatively short generation time, during which new daughter plants grow vegetatively from the mother plant. The new plants easily can be propagated, therefore, under altered environmental conditions. Each of 32 culture tubes was filled with 5ml of Hoagland's nutrient

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