ON PLANTS AND CARBON

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About half of the dry matter of organisms consists of carbon (C). The biosphere contains roughly 700 billion tons of C, largely tied to cellulose, the most abundant biological substance on earth. Forests store almost 90% of the global biomass carbon reservoir. Carbon enters the biosphere by photosynthetic uptake of CO$_2$, and it leaves the biosphere by respiration of all non-green tissue and heterotrophic organisms. The balance between these fluxes was close to zero, before humans started to manage the planet. Now, humans release nearly 10 billion tons of carbon as CO$_2$ every year by burning fossil fuels and destroying forests, almost half of this CO$_2$ remains in the atmosphere, enhancing the green-house effect. Since plants can absorb CO$_2$ and store C, there is a debate on whether plants can mitigate atmospheric CO$_2$ enrichment. I will challenge these views, by recalling the basic rules of element ratios, the stoichiometry of life, and by emphasizing that fluxes of carbon (the carbon cycle) must not be confused with pools of carbon (carbon storage).

It needs about 25 chemical elements in the right proportion to build an healthy organism. Plants compete for most of these elements (for instance P, K, Mg, Mn, Mo) since they conquered land. Per unit land area, the availability of these elements is finite per unit land area. In contrast, the availability of CO$_2$ is theoretically infinite, and its acquisition is a matter of photosynthetic activity. Plants can absorb atmospheric CO$_2$ only to the extent, the availability of these other chemical elements permit. Only if the availability of all these elements is increasing in proportion to the rise of atmospheric CO$_2$ concentration, plants can capture more C. This explains, why experimental CO$_2$-enrichment of natural vegetation does not enhance plant growth and productivity, but it does, when applied together with a full nutrient solution or compound fertilizer or in very fertile soils, such as under horticultural conditions or in fast rotation tree plantations. Thus, there is no reason to expect a global CO$_2$-fertilization effect in the biosphere. This debate is also tied to the still widespread assumption that faster tree growth, for whatever reason, represents ‘carbon sequestration’, i.e. a mitigation of atmospheric CO$_2$ enrichment by permanent C storage in the biosphere. This is as if one assumed cash flow to represent capital in economy. Growth is a process, tied into the global carbon cycle. Growth at one place has to be balanced with mortality or harvest elsewhere, and only if these two parts of the carbon cycle differ, the biospheric carbon capital can rise or fall. Hence, carbon storage of an area is a matter of carbon residence time, of tree age distribution (tree demography), and globally, it is a function of land area covered by high stocking forest, irrespective of the rate at which C cycles through these forests. Quite commonly, very productive forests (e.g. plantations) store less carbon than slow growing old growth forests. So, there is no straightforward relationship between productivity and C storage. These rather basic aspects of the C cycle will be illustrated by empirical data.

**Christian Körner** received his academic education at the University of Innsbruck, and is professor of Botany, University of Basel, Switzerland since 1989. He has authored many publications in alpine plant ecology and alpine treeline research including books, *Alpine Plant Life and Alpine Treelines*, and is coauthor of a publication on botany, *Strasburger*. Professor Körner is also known for his pioneering CO2-enrichment experiments in natural vegetation of all climatic zones. He is a member of the German National Academy of Sciences Leopoldina, the Austrian Academy of Sciences, and an honorary member of the Ecological Society of America. For further information please visit: [https://plantecology.unibas.ch/koerner/index.shtml](https://plantecology.unibas.ch/koerner/index.shtml)