



**A History of Atmospheric CO<sub>2</sub> and Its Effects on Plants, Animals, and Ecosystems**, edited by J.R. Ehleringer, T.E. Cerling, and M.D. Dearing, 2005. Ecological Studies, Volume 177, Springer, New York, NY USA. xviii + 520 p. Hardcover USD149.00, ISBN 978-0-387-22069-7.

Atmospheric carbon dioxide ([CO<sub>2</sub>]) concentrations have varied considerably through time. Some estimates suggest extraordinarily high concentrations of atmospheric CO<sub>2</sub> (~4000–5000 ppm CO<sub>2</sub>) before 500 myr. Since that time, however, atmospheric CO<sub>2</sub> levels have declined, although not steadily, to a minimum of 180 ppm CO<sub>2</sub> during the Last Glacial Maximum. Since that time, atmospheric CO<sub>2</sub> again increased to ~270 ppm and remained constant until the onset of the Industrial Revolution. These large-scale fluctuations are the product of a suite of interactions between biological and physical factors that have shaped the Earth's biota and atmosphere. Today, we are faced with an alarming rate of increase in atmospheric CO<sub>2</sub> and an uncertainty of the effects of this increase on both biological and geochemical processes in the future. The examination of the responses of ancient biological and geochemical processes to past changes in atmospheric CO<sub>2</sub>, however, may allow for more accurate predictions of future consequences of the modern rapid increase in atmospheric CO<sub>2</sub>. With this goal in mind, Ehleringer and colleagues have compiled this edited volume in an effort to summarize how interactions between atmospheric CO<sub>2</sub> and biological and geochemical processes have influenced each other in altering Earth's biota and atmosphere.

The book's first section, which contains five chapters, summarizes atmospheric CO<sub>2</sub> from several hundred million years ago to modern times. This section also provides an adequate summary of methods employed to calculate these estimates of atmospheric CO<sub>2</sub>. One of the most notable contributions in this section ("The rise of trees and how they changed Paleozoic atmospheric CO<sub>2</sub>, climate, and geology," by R.A. Berner), details the rise of arborescence during the Paleozoic and the significant influence these large plants had on the rapid decrease in atmospheric CO<sub>2</sub> during this period, through uptake by photosynthesis and alterations in chemical weathering, which resulted in increased oceanic uptake of atmospheric CO<sub>2</sub>.

Section two, consisting of nine chapters, reports on the effects of biological responses to past changes in atmospheric CO<sub>2</sub> concentration. It is the breadth of this section that makes the book an extremely valuable resource for both readers with a peripheral interest in paleoecology and the researcher submersed in this type of work. Here several chapters examine the influence of atmospheric CO<sub>2</sub> on evolutionary processes in plants and how these responses dictated plant expansion. Particularly notable is "Evolutionary responses of land plants to atmospheric CO<sub>2</sub>" by D.J. Beerling, where the timing of the evolution of the C<sub>4</sub> photosynthetic pathway, CO<sub>2</sub>-induced

changes in stomatal density of ancient plants, and the influence of atmospheric CO<sub>2</sub> on plant speciation events are addressed. Other chapters discuss how changes in atmospheric CO<sub>2</sub> altered diets of African mammals ("Environmentally driven dietary adaptations in African mammals" by T.E. Cerling et al.) and North American horses ("Terrestrial mammalian herbivore response to declining level of atmospheric CO<sub>2</sub> during the Cenozoic: Evidence from North American fossil horses (family Equidae)" by B.J. MacFadden). Finally, the section culminates with an excellent chapter ("CO<sub>2</sub>, grasses, and human evolution" by N.J. van der Merwe) detailing the effects of atmospheric CO<sub>2</sub> on the relationship between the abundance of plants that use the C<sub>3</sub> photosynthetic pathway versus those that utilize the C<sub>4</sub> photosynthetic pathway and the effects of these differences in hominid evolution.

The book concludes with two sections that focus on the current state of knowledge on ecosystem functioning under elevated CO<sub>2</sub> and how these ecosystems may change with future increases in atmospheric CO<sub>2</sub>. For example, Chapter 18 ("Modern and future forests in a changing atmosphere" by R.J. Norby et al.) does an excellent job of synthesizing the large amount of work recently performed on the responses of forest ecosystems to elevated CO<sub>2</sub>. Chapter 20 ("Effects of CO<sub>2</sub> on plants at different timescales" by B.E. Medlyn and R.E. McMurtrie) provides a fresh perspective on the conclusions drawn from elevated CO<sub>2</sub> studies considered across different timescales. Other chapters within the book's final section examine changes in herbivory with increased CO<sub>2</sub> ("Herbivory in a world of elevated CO<sub>2</sub>" by R.L. Lindroth and M.D. Dearing) and the responses of semi-arid and arid ecosystems to rising CO<sub>2</sub> ("Modern and future semi-arid and arid ecosystems" by M.R. Shaw et al.)

Overall, Ehleringer and colleagues have provided an excellent addition to the Springer "Ecological Studies" series. The organization of the volume is extremely well done, allowing the reader to transition naturally from one chapter to the next. Each chapter is exceptionally well written by authors respected in their various fields of study. I highly recommend the book to both students and professionals alike.

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