Aquat. Sci. 68 (2006) 142–153
1015-1621/06/020142-12
DOI 10.1007/s00027-006-0818-5

Aquatic Sciences

Research Article

Can algal photosynthetic inorganic carbon isotope fractionation be predicted in lakes using existing models?

Darren L. Bade[1,3,*], Michael L. Pace[2], Jonathan J. Cole[2] and Stephen R. Carpenter[1]

[1] Center for Limnology, University of Wisconsin-Madison, USA
[2] Institute of Ecosystem Studies, Millbrook, NY, USA
[3] Present address: Institute of Ecosystem Studies, PO Box AB (65 Sharon Turnpike), Millbrook, NY 12545, USA

Received: 30 June 2005; revised manuscript accepted: 7 December 2005

Abstract. Differential fractionation of inorganic carbon stable isotopes during photosynthesis is an important cause of variability in algal carbon isotope signatures. Several physiological models have been proposed to explain algal photosynthetic fractionation factors (ε_p). These models generally consider CO_2 concentration, growth rate, or cell morphometry and have been supported by empirical evidence from laboratory cultures. Here, we explore the applicability of these models to a broad range of lakes with mixed phytoplankton communities. Understanding this fractionation is necessary for using carbon stable isotopes for studies ranging from food webs to paleolimnology. In our largest comparative study, values of δ^{13}C-POC ranged from –35.1‰ to –21.3‰. Using several methods to obtain an algal isotopic signature, we found high variability in fractionation among lakes. There was no relationship between ε_p and one of the most important predictors in existing models, pCO_2. A whole-lake inorganic ^{13}C addition was used to create distinct algal isotope signatures to aid in examining ε_p. Measurements and a statistical model from the isotope addition revealed that algal fractionation was often low (0 – 15‰).

Key words. Photosynthetic fractionation; carbon stable isotopes; algae; particulate organic carbon; lakes.