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Isotope Ratios in Marine Mollusk Shells after Prolonged Contact with Flowing Fresh Water

Abstract. *The ratios C^{13}/C^{12} and O^{18}/O^{16} in the calcium carbonate of shells of the marine mollusk,* Macoma calcarea, *appear unaltered after exposure for 4500 years to flowing fresh water of higher O^{16}/O^{18} ratio.*

The widespread use of carbon and oxygen isotopes as paleoenvironmental indicators in sedimentary geochemistry (*1*), for radiocarbon dating, and for paleotemperature determinations (*2*), depends to a large extent on the assumption that the original isotopic composition has not been altered by postdepositional, diagenetic processes (*3*). While oxygen isotope exchange in the calcium carbonate–water system proceeds relatively rapidly at high temperatures (*4*), it appears that original carbon isotope ratios may be preserved in calcitic limestones over very long periods of time, as indicated by consistent changes in the values of δC^{13} found in a regional study of isotope ratios in the Vanport limestone of Pennsylvanian age (*5*). Furthermore, in a study of over 500 marine and fresh water carbonates of Phanerozoic age (*6*), the original carbon isotope ratios appear to have remained unchanged since the Devonian—the earliest fresh-water limestone known to us is Devonian—because the expected difference in mean isotopic composition of marine and fresh-water limestones was confirmed. These samples, however, were mostly compact, dense limestones which were apparently not subjected to a significant flow of intrastratal solutions around grain boundaries.

Table 1. Carbon and oxygen isotope ratios of six individual shells of the marine mollusk, *Macoma calcarea*. The values, per mill, are relative to Chicago PDB-standard carbon dioxide.

δC^{13}	δO^{18}
−1.56	+.72
−1.64	−.58
−1.77	+.40
−1.47	+.98
−1.51	+.58
−1.37	−.43
Mean	
−1.55	+.28
S.D.	
.141	.636

* Collected by J. F. Schwietering, from north bank of Rivière du Sud, 1.6 Rm east of St. François, Montmagny county, Quebec, now 45 m above sea level.

Gross (*7*) reports that marine Pleistocene limestone from Bermuda and from the atolls, Bikini and Eniwetok, has been altered by the Ghyben-Herzberg lens of fresh water and by the precipitation of secondary calcite in a relatively short period of time so that C^{13}/C^{12} and O^{18}/O^{16} ratios approach those of fresh-water limestones. Unpublished data from this laboratory suggest that, if certain corals have contributed calcium carbonate to the calcareous sediments, some of these anomalous isotope ratios may, in fact, be the original ratios which obtained at the time of deposition.

Because of the importance of the preservation of the original isotopic record in carbonates, a collection of marine shells of the mollusk *Macoma calcarea* which were exposed to percolating freshwater for a known period of time, was made and analyzed for isotope ratios by standard techniques (*8*). After deposition in the bottom sediments of the Champlain Sea between 9500 and 9900 years ago (*9*), the mollusk shells have been elevated and subjected to the effects of percolating fresh water in the banks of Rivière du Sud, Quebec, for at least 4500 years. The isotopic composition, expressed as the difference in C^{13}/C^{12} or O^{18}/O^{16} ratio of the sample and the Chicago PDB standard carbon dioxide, in per mill, by the formula

$$\delta C^{13} = \left(\frac{C^{13}/C^{12}_{\text{sample}}}{C^{13}/C^{12}_{\text{std.}}} - 1 \right) 1000,$$

has been corrected for errors of measurement, such as capillary leaks and the presence of O^{17} (*10*), and is presented in Table 1. The results are well within the accepted range of marine carbonates (*11*), and indicate that under some conditions original isotope ratios may be unaltered or altered to an indetectable extent, after contact with flowing fresh water for as long as 4500 years.

The statement of Rubin and Taylor (*3*), that the degree of alteration can be determined by mass spectrometric studies of isotopes is not necessarily true, especially in the case of fresh-water mollusk shells, some of which originally exhibit a wide range in isotopic composition (*12*; *13*).

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Zinc Activation of a Coordinated Response in *Hydra*

Abstract. *In* Hydra littoralis, *the feeding response normally activated by reduced glutathione can be elicited by zinc ions under special experimental conditions: some calcium is necessary for the activation to be realized, but a high concentration of calcium inhibits the zinc-activated response. Zinc inhibits the normal feeding response induced by reduced glutathione.*

Zinc ions are known to have immediate physiological effects at several levels of biological organization. Vallee *et al.* showed that the addition of zinc to the apoenzyme of carboxypeptidase activates that enzyme (*1*). Isaacson and Sandow found that zinc potentiates the twitch of muscle (*2*). In this report we describe the activation by zinc of the feeding response in *Hydra littoralis*.

The feeding response of *Hydra* is normally activated by the ubiquitous