Commentary: biogeochemical analysis of ancient pacific cod bone suggests hg bioac...

Health & Medicine

A commentary on

Biogeochemical analysis of ancient Pacific Cod bone suggests Hg bioaccumulation was linked to Paleo sea level rise and climate change

by Murray, M. S., McRoy, C. P., Duffy, L. K., Hirons, A. C., Schaaf, J. M., Trocine, R. P., et al. (2015). Front. Environ. Sci. 3: 8. doi: 10. 3389/fenvs. 2015. 00008

Over the last 21, 000 years, continuous and pulsed sea level rises from its glacial minimum of ~120 m below the present sea level have affected the continental configuration of Earth's surface and thus land-sea interactions, materials exchanges and related biogeochemical processes. In this article, Murray and co-authors investigated total concentration of mercury (Hg) and stable carbon and nitrogen isotopes (δ^{13}C and δ^{15}N) in the bone collagen of archeologically recovered Pacific Cod (*Gadus macrocephalus*) and found high levels of total Hg in bones deposited during the early-mid Holocene interval. The authors suggested that the coastal flooding likely led to increased methylation of Hg in newly submerged terrestrial land and vegetation and thus high total Hg in bones. This study provides a clue that the coastal flooding due to future climate change may have the potential to enhance the amount of Hg significantly in marine food webs in the North Pacific region. Also of interest is the increase in methylmercury in receiving waters immediately following the flooding of previously dried wetlands, as occurred at the end of the last ice age on the continental shelves. It has been well-documented in the literature that flooding of wetlands leads to release of the sequestered methylmercury (and demonstrated

experimentally by Porvari and Verta, 1995); the authors have acknowledged that this is the logical explanation to the higher levels they found in the older bones. It is unfortunate, however, that the authors chose muscle tissue to analyze in modern fish for comparison with the fossil bones. Nevertheless, an understanding of historical trends in contamination is always welcome.

From stable isotopes point of view, it has been inferred based on increased carbon isotopic ratios since the mid-Holocene that shelf flooding due to sea level rise must have transferred the productivity regime from an oceanic to a shelf system. Furthermore, the authors suggested that the increase in $\delta^{13}C$ may have resulted to increased phytoplankton growth rates or a change from pelagic to benthic foraging regime. $\delta^{13}C$-values in both pelagic and benthic planktons are ranging roughly from −18 to −21‰ and if one includes all suspended particles, surface sediments and ice algae investigated during both summer and winter seasons in north-central Bering Sea, then $\delta^{13}C$ ranges from ca. −18 to −26‰ (Lovvorn et al., 2005). However, the range of $\delta^{13}C$ in Pacific Cod bones from archeological sites is always higher than above mentioned ranges, especially bones with the age of ≤1500 calendar years. Some bone collagen values are enriched and are around −12‰. These values are compatible with C_4 plants, indicating a C_4 dominated diet of Pacific Cod during the late Holocene. Fry (1977) observed 1. 6–6. 5‰ ^{13}C enrichments in Texas nearshore fishes and attributed such enrichment to isotopically heavy sea grass carbon entering in the food.

McConnaughey and McRoy (1979) suggested that biomagnification of ^{13}C

occurs as animals selectively respire light carbon (^{12}C) and therefore heavy carbon (^{13}C) undergoes modest biomagnifications in the food web. Since stable C and N isotopic values act as chemical tracers of animal diet and are widely used to study food web dynamics in inland seas, coastal oceans and opens seas, some of these reasons should be critically analyzed in future studies for a better understanding the carbon isotopic enrichment of archeological fish bones.

Funding

SK thanks the National Natural Science Foundation of China (41273083) and Shanhai Fund (2013SH012) for the financial support.

Conflict of Interest Statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

Fry, B. D. (1977). *Stable Carbon Isotope Ratios – A Tool for Tracing Food Webs* . M. A. thesis, University of Texas, Austin.

Lovvorn, J. R., Cooper, L. W., Brooks, M. L., De Ruyck, C. C., Bump, J. K., and Grebmeier, J. M. (2005). Organic matter pathways to zooplankton and benthos under pack ice in late winter and open water in late summer in the north-central Bering Sea. *Mar. Ecol. Prog. Ser* . 291, 135–150. doi: 10. 3354/meps291135

CrossRef Full Text | Google Scholar

McConnaughey, T., and McRoy, C. P. (1979). Food-web structure and the fractionation of carbon isotopes in the Bering Sea. *Mar. Biol* . 53, 257–262. doi: 10. 1007/BF00952434

CrossRef Full Text | Google Scholar

Porvari, P., and Verta, M. (1995). Methylmercury production in flooded soils: a laboratory study. *Water Air Soil Pollut* . 80, 765–773. doi: 10. 1007/BF01189728

CrossRef Full Text | Google Scholar