



Sclerochronology and geochemical variation in limpet shells (*Patella vulgata*): A new archive to reconstruct coastal sea surface temperature

Tracy Fenger and Donna Surge

Department of Geological Sciences, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina 27599, USA (donna64@unc.edu)

Bernd Schöne

Department of Paleontology, Increments Research Group, Institute of Geosciences, University of Mainz, Johann-Joachim-Becher-Weg 21, D-55128 Mainz, Germany

Nicky Milner

Department of Archaeology, University of York, The Kings Manor, York YO1 7EP, UK

[1] Climate archives contained in shells of the European limpet, *Patella vulgata*, accumulated in archaeological deposits can potentially provide much needed information about Holocene environmental change in midlatitude coastal areas. Before reconstructing climate information preserved in these zooarchaeological records, we studied the controls on oxygen and carbon isotope ratios ($\delta^{18}\text{O}$ and $\delta^{13}\text{C}$, respectively) in modern specimens. We tested the hypothesis that *P. vulgata* precipitates its shell in isotopic equilibrium with the ambient water by comparing $\delta^{18}\text{O}_{\text{SHELL}}$ with predicted values. Predicted $\delta^{18}\text{O}_{\text{SHELL}}$ was constructed using observed sea surface temperature (SST) records and the equilibrium fractionation equation for calcite and water. We assumed a constant $\delta^{18}\text{O}_{\text{WATER}}$ value of +0.10‰ (VSMOW) based on published regional measurements. Comparison of $\delta^{18}\text{O}_{\text{SHELL}}$ with predicted values revealed that $\delta^{18}\text{O}_{\text{SHELL}}$ values were higher than expected by $+1.01 \pm 0.21\text{‰}$. Consequently, estimated SST calculated from $\delta^{18}\text{O}_{\text{SHELL}}$ was $4.2 \pm 2.3^\circ\text{C}$ lower than observed SST. However, because of the relatively uniform offset between observed and expected $\delta^{18}\text{O}$, an adjustment can be made to account for this predictable vital effect. Thus past climate can be reliably reconstructed using this temperature proxy once the offset is taken into account. $\delta^{13}\text{C}$ values have a similar cyclicity to the $\delta^{18}\text{O}$ variation and therefore vary seasonally. However, $\delta^{13}\text{C}$ is slightly out of phase relative to $\delta^{18}\text{O}$. An overall negative shift in $\delta^{13}\text{C}_{\text{SHELL}}$ over the lifetime of the individual indicates a vital effect associated with ontogeny. Further study of environmental and ecological factors that influence shell $\delta^{13}\text{C}$ is required to evaluate fully the potential of carbon isotope ratios as a useful environmental proxy.

Components: 9679 words, 8 figures, 1 table.

Keywords: gastropoda; oxygen; carbon; climate; temperature proxy.

Index Terms: 4215 Oceanography: General: Climate and interannual variability (1616, 1635, 3305, 3309, 4513); 4825 Oceanography: Biological and Chemical: Geochemistry; 4217 Oceanography: General: Coastal processes; 4227 Oceanography: General: Diurnal, seasonal, and annual cycles (0438); 4870 Oceanography: Biological and Chemical: Stable isotopes (0454, 1041).

Received 21 September 2006; **Revised** 14 March 2007; **Accepted** 11 April 2007; **Published** 4 July 2007.