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High-resolution records of growth temperature and life history of two *Nacella* limpet species, Tierra del Fuego, Argentina

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ABSTRACT

Stable isotope ratios in patelloid limpets of the genus *Patella* have been established as proxies for coastal environmental change at sub-monthly resolution along the eastern North Atlantic and Mediterranean Sea. *Nacella deaurata* (Gmelin 1791) and *N. magellanica* (Gmelin 1791) are common intertidal species of patelloid limpets inhabiting the coast of Tierra del Fuego, Argentina/Chile and are commonly found in Holocene archaeological deposits. Here, we examine oxygen and carbon isotope ratios ($\delta^{18}O_{shell}$ and $\delta^{13}C_{shell}$, respectively) of modern specimens of *N. deaurata* and *N. magellanica* to test the hypotheses that: 1) they form their shells in isotopic equilibrium with ambient water; and 2) prominent growth lines form annually. Based on growth margin analysis of $\delta^{18}O_{shell}$ values, we identified a positive offset of 1.3 ± 0.4‰ (*N. deaurata*) and 1.3 ± 0.3‰ (*N. magellanica*) from expected equilibrium, similar to other patelloid limpets. Because the offset is relatively consistent between observed and expected values, it can be taken into account to reliably reconstruct growth temperature. Seawater temperature estimated from oxygen isotope time series data falls within the observed range. Thus, *N. deaurata* and *N. magellenica* shells serve as reliable proxy archives of seasonal variation in coastal seawater temperature. Time series of $\delta^{13}C_{shell}$ values do not vary seasonally in all shells; hence, the influence on its variation requires further study. The timing of prominent growth lines contextualized by the $\delta^{18}O_{shell}$ time series form twice a year and therefore cannot be used to estimate lifespan. Future isotopic analysis of archaeological *Nacella* shells can potentially provide much needed information about Holocene climate change at sub-monthly resolution from high-latitude South American locations, and contribute to our understanding of human behavior and human-climate interactions.

1. Introduction

Marine proxy archives are the foundation for extrapolating changes in oceanographic conditions beyond the bounds of the instrumental record. Currently, records of paleoclimate in the Southern Ocean are relatively scarce when compared to records of paleoclimate from other ocean basins. Many of the limited paleoclimate proxy records in the Southern Ocean are derived from ice, marine, or lake sediment cores (Borromei and Quattrocchio, 2001; Borromei et al., 2010; Mauquoy et al., 2004; Candel et al., 2009; Ponce et al., 2017). These records, while temporally extensive, focus on centennial to millennial time scales. Few of these proxy records capture changes to coastal environments, which are particularly sensitive to changing climate conditions. Even fewer paleoclimate data exist at decadal, annual, and seasonal time scales along coastlines in the Southern Ocean. Hence, a proxy record that can be resolved to sub-monthly resolution is necessary to understand seasonal variability in coastal environments from high southerly latitudes.

Stable isotopes in mollusc shells have been used to reconstruct paleoclimate records to sub-monthly resolution. Most molluscs form their shells in isotopic equilibrium with ambient water (Epstein et al., 1951, 1953; Craig, 1957; Grossman and Ku, 1986), but this is not always the

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