Palaeogeography, Palaeoclimatology, Palaeoecology 505 (2018) 398–409

Contents lists available at ScienceDirect

Palaeogeography, Palaeoclimatology, Palaeoecology

journal homepage: www.elsevier.com/locate/palaeo

Leukoma antiqua (Bivalvia) - A high-resolution marine paleoclimate archive for southern South America?

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ARTICLE INFO

Keywords:
Bivalve sclerochronology
Paleotemperature
Oxygen isotopes
Patagonian Sea
Disequilibrium

ABSTRACT

The Patagonian Sea in the SW Atlantic is one of the most productive marine ecosystems worldwide. Besides its economic relevance, this shelf sea serves as a major sink for atmospheric CO_2 and thus plays a major role in global climate. Despite that, the marine climate dynamics in that region remain barely known. Instrumental records only cover the last 30 years or so and high-resolution climate archives are currently not available. Here, we explore the possibility to obtain seasonally to inter-annually resolved paleotemperature data from shells of the bivalve mollusk, *Leukoma antiqua* collected alive from the shallow subtidal zone of the San Jorge Gulf. Results demonstrate that this species grows during summer and – at least at slow rate – during winter at this locality and records nearly the full seasonal temperature amplitude (monthly averages) in the form of $\delta^{18}O_{shell}$. Furthermore, isotope-based climate reconstructions will be limited to the first 15 years of life, because growth rates are sharply reduced afterward which aggravates sampling. The oldest studied specimen attained an age of 34 years. Annual, fortnightly and lunar daily increments can potentially be used to determine the timing and rate of seasonal shell growth and help placing the shell record into precise temporal context. However, due to interferences with the shell microstructure, sub-annual growth patterns were only occasionally well developed. In this study, the temporal alignment of the growth record was therefore largely achieved by forcing $T_{\delta 18O}$ to match the shape of the instrumental temperature curve. In some years it was possible to validate such temporal alignments with fortnight increments. Shell growth rate is strongly linked to primary production which attains a maximum in spring. For yet unexplained reasons, shell formation occurs with an offset of almost −1‰ (−0.9 ± 0.3‰) from expected oxygen isotopic equilibrium with the ambient water. When this offset is adjusted for, $\delta^{18}O_{shell}$ can be used to compute past water temperature. Given the individual variability regarding $\delta^{18}O_{shell}$, it is advised to study a sufficient number coeval specimens to obtain more reliable information on the seasonal temperature range. Presumably, the overall life history and the isotopic offset is similar for *L. antiqua* specimens at other localities in southern South America. Since *L. antiqua* not only dominates modern nearshore benthic assemblages, but also occurs abundantly in Quaternary deposits along the Argentine Patagonian coast, this species can significantly contribute to a better understanding of natural baseline conditions and past climate dynamics in southern South America.

1. Introduction

The Patagonian Sea in the SW Atlantic Ocean is one of the most productive marine ecosystems and one of the largest continental shelves (e.g., Longhurst et al., 1995; Carreto et al., 2007; Fernández et al., 2007; Dogliotti et al., 2014; Paparazzo et al., 2017; Fig. 1). Besides its economic relevance, this region serves as a major sink for atmospheric CO_2 with one of the highest uptake rates (Bianchi et al., 2005, 2009; Kahl et al., 2017; Orselli et al., 2018). Primary production in the Patagonian Sea is particularly strong near the numerous oceanic fronts at which water masses of different properties meet (Acha et al., 2004). From West to East, Carreto et al. (1995) distinguishes (1) the coastal

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https://doi.org/10.1016/j.palaeo.2018.06.024
Received 3 April 2018; Received in revised form 12 June 2018; Accepted 13 June 2018
Available online 18 June 2018
0031-0182/