Chemical Geology 526 (2019) 23–35

Contents lists available at ScienceDirect

Chemical Geology

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

Contrasting shell growth strategies in two Mediterranean bivalves revealed by oxygen-isotope ratio geochemistry: The case of *Pecten jacobaeus* and *Glycymeris pilosa*

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ARTICLE INFO

Keywords:
Sclerochronology
Mediterranean
Adriatic
Stable-isotope ratio geochemistry
Bivalve shells

ABSTRACT

High-resolution stable-isotope ratio data ($\delta^{18}O$, $\delta^{13}C$) were used to study growth strategies of two bivalve species, *Pecten jacobaeus* (calcitic shell) and *Glycymeris pilosa* (aragonitic shell) from the North Adriatic Sea. The principal objectives of this study were to identify the period of the year when the growth line is formed in the shell of two target species, to identify the main growing season of these two species, to identify the environmental drivers of shell growth, and to evaluate the potential applicability of $\delta^{18}O$ and $\delta^{13}C$ values for the reconstruction of environmental variability. Samples were collected from the North Adriatic Sea by commercial bean trawl (*P. jacobaeus*, December 2013 and January 2014, N = 4) and SCUBA diver (*Glycymeris pilosa*, March 2016, N = 3). Samples for the oxygen ($\delta^{18}O$) and carbon ($\delta^{13}C$) isotope composition of the calcium carbonate were collected by drilling the outer shell layer across several annual cycles. Temporal and spatial temperature and salinity values inside the investigated area were simulated using the 3D numerical ocean model - ROMS. The $\delta^{18}O$ cycles corresponded to the number of seasonal growth marks observed on the external shell surface of both target species, thereby confirming the annual periodicity of these growth patterns. In February 2012, extreme cooling of the water column accompanied by dense water formation occurred in the Adriatic Sea - an event recorded by *P. jacobaeus* shells. This study indicates that *P. jacobaeus* and *G. pilosa* have contrasting shell growth strategies. *Pecten jacobaeus* grows during winter and slows shell growth during the warmest part of the year, and thereby may be an interesting archive for winter conditions. Due to its longevity and continuous growth during the warmest part of the year, *G. pilosa* is a promising archive for the reconstruction of summer seawater temperatures.

1. Introduction

Over the past decade, the field of sclerochronology has been rapidly developing by investigating structural elements, as well as the geochemical composition of bivalve shells, with the objective of obtaining information on environmental conditions archived during the lifetime of an organism (Schöne and Gillikin, 2013). Analysis of oxygen-isotope ratios ($\delta^{18}O$) of mollusk shell carbonates has become a key tool for paleoclimate reconstruction as this data can be used to estimate the temperature of the ambient water at the time of shell formation, when $\delta^{18}O_{water}$ is known (Urey, 1947; Epstein et al., 1953; Grossman and Ku, 1986; Schöne and Surge, 2005; Gröcke and Gillikin, 2008; Oschmann, 2009; Wanamaker et al., 2011; Schöne and Gillikin, 2013; Butler and Schöne, 2017; Prendergast et al., 2017). Although the interpretation of $\delta^{13}C$ data is often less straightforward because of species-specific metabolic effects (Chauvaud et al., 2011; Marchais et al., 2015), stable carbon-isotope ratio signatures of mollusk shells may provide data on salinity and $\delta^{13}C_{DIC}$ values in estuarine environments (Gillikin et al., 2006; McConnaughey and Gillikin, 2008). These records can range from daily to sub-seasonal time-scales, depending on growth rate and longevity of the studied species, and can provide data for recent years and decades, as well as past centuries (e.g. Black et al., 2009; Butler

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http://dx.doi.org/10.1016/j.chemgeo.2017.09.029
Received 5 June 2017; Received in revised form 18 September 2017; Accepted 19 September 2017
Available online 22 September 2017