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Glycymeris pilosa (Bivalvia) – A high-potential geochemical archive of the environmental variability in the Adriatic Sea

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ABSTRACT

Due to its outstanding longevity (decades), the shallow-water bivalve *Glycmeris pilosa* represents a prime target for sclerochronological research in the Mediterranean Sea. In the present study, we analyzed the microgrowth patterns and the stable carbon ($\delta^{13}C_{shell}$) and oxygen ($\delta^{18}O_{shell}$) isotopes of the outer shell layer of live-collected *G. pilosa* specimens from four different sites along the Croatian coast, middle Adriatic Sea. Combined analysis of shell growth patterns and temporally aligned $\delta^{18}O_{shell}$ data indicated that the main growing season lasts from April to December, with fastest growth rates occurring during July and August when seawater temperatures exceeded 22 °C. Slow growth in the cold season (< 12 °C) coincided with the formation of winter growth lines on the outer shell surface. The growth cessation occurred in winter, but on the outer shell surface the brown summer bands are more pronounced than the winter lines. Mutvei-staining of cross-sections facilitated the recognition of the growth lines. $\delta^{13}C_{shell}$ values reflect ontogenetic changes in physiology as well as seasonal changes in primary production and salinity.

1. Introduction

Bivalves of the genus *Glycymeris* represent an important sclerochronological archive for climate dynamics in the late Holocene (Brocas et al., 2013; Reynolds et al., 2013, 2017a, b; Royer et al., 2013; Featherstone et al., 2017) and the more distant geological past (Crippa et al., 2016; Walliser et al., 2015, 2016, 2017). Actually, the fossil record of glycymeridids extends back to the Cretaceous, and from an evolutionary point of view, they are a conservative group (Thomas, 1975). It can therefore be assumed that fossil glycymeridids recorded environmental variables as faithfully as their modern relatives. Some representatives of this highly diverse and cosmopolitan (Huber, 2010) species-group can live for up to 200 years as documented by distinct annual shell growth patterns (e.g., Reynolds et al., 2013; Walliser et al., 2016). Most importantly, changes of environmental conditions are recorded in their shells in the form of variable increment widths and geochemical properties (e.g., Ramsay et al., 2001; Brocas et al., 2013; Royer et al., 2013; Walliser et al., 2015; Featherstone et al., 2017; Reynolds et al., 2017a, b; Markulin et al., 2019). Environmental drivers of Glycymeridae growth include seawater temperature (Brocas et al., 2013; Royer et al., 2013; Walliser et al., 2015; Reynolds et al., 2017b), salinity (Featherstone et al., 2017), food availability and quality (Brocas et al., 2013; Royer et al., 2013; Featherstone et al., 2017; Reynolds et al., 2017a; Markulin et al., 2019), climate oscillation (Brocas et al., 2013; Reynolds et al., 2017b; Markulin et al., 2019), fresh water inflow (Featherstone et al., 2017), and bottom quality (Ramsay et al., 2001). The broad biogeographic distribution and large species diversity of glycymeridids offers great potential for combining proxy data from different *Glycymeris* specimens and species living in different regions under different environmental and climate conditions. A 'glycymeridid data-network' would provide a picture of spatial climate variability and thus, greatly contribute to climate reconstruction efforts.

In the North Atlantic, stable isotopes and growth patterns of *G. glycymeris* shells have been used to reconstruct seawater temperatures and decadal climate variability (Brocas et al., 2013; Royer et al., 2013; Reynolds et al., 2013, 2017a, b; Featherstone et al., 2017). Similar studies are also possible in the Mediterranean Sea as demonstrated, e.g., by Peharda et al. (2016, 2018) using *G. pilosa* from the Adriatic Sea. Since this semi-enclosed basin is strongly impacted by human activity (Ramírez et al., 2018), data on past environmental conditions can

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