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Spatial variations in Ba/Ca_{shell} fingerprints of *Glycymeris pilosa* along the eastern Adriatic Sea

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ABSTRACT

The long living *Glycymeris pilosa* bivalve is an interesting target species for the sclerochronological research in the Mediterranean Sea. In this study, Ba/Ca_{shell} and Mg/Ca_{shell} variations were studied along the coast of the eastern Adriatic Sea. Specimens were collected alive by SCUBA and skin diving during several occasions in 2014, 2015 and 2016 from five sites including Pag, Pašman Channel, Cetina, Živogošće and Drače. Element-to-Ca_{shell} ratios were measured by LA-ICP-MS in line scan mode in three specimens of each site, ranging in age from 7 to 21. In addition, chemical analysis was conducted on three ontogenetically older specimens (68-97 years-old) from Drače. Mg/Ca_{shell} and annual growth lines were used to place the Ba/Ca_{shell} data in temporal context. Published monthly *G. pilosa* shell growth data were used for transferring elemental data from distance to time scale. To enable a direct comparison of Ba/Ca_{shell} data between specimens and sites (different time-averaging), as well as a comparison with environmental data, monthly mean values were calculated (re-sampling). Results of this study show that Mg/Ca_{shell} values in *G. pilosa* increase through lifetime and variations occur with respect to amplitude and seasonal patterns. Detailed comparison of Mg/Ca_{shell} data between sites was not possible because specimens varied in ontogenetic age. Ba/Ca_{shell} values ranged between 0.03 μmol/mol and 14.18 μmol/mol, and time-series showed noncyclic sharp peaks, which differed between years. Values were rather synchronous among specimens from the same site. Specimens from Pašman, Živogošće and Drače contain more peaks than specimens from Pag and Cetina, and these peaks are less synchronous among the time-series. Three northern sites were characterised by lower Ba/Ca_{shell} values than the two southern sites. Comparison of monthly Ba/Ca_{shell} times-series with available environmental data revealed variability of environmental conditions. Long-term Ba/Ca_{shell} data of *G. pilosa* from Drače showed a lower baseline and amplitude during the 1950s and 1960s than from the mid-1970s onward. It is possible that these long-term changes are at least partially caused by anthropogenic factors, including changes of the river Neretva management and development of agriculture in its delta.

1. Introduction

Bivalve shells contain periodic growth patterns, i.e., growth lines and increments visible on the shell surface and in cross-sections (Richardson, 2001). These growth patterns can be used to assign time (e.g., calendar years) to corresponding shell portions. Geochemical properties of deposited shell material can yield temporally aligned proxy data of environmental conditions prior to instrumental recordings (e.g., Schöne et al., 2011; Royer et al., 2013; Schöne and Gillikin, 2013; Füllenbach et al., 2015; Reynolds et al., 2016; Prendergast et al., 2017; Markulin et al., 2019). Longevity of some bivalve species exceeds several decades (eg. *Tridacna gigas*; Elliot et al., 2009) and even centuries (eg. *Arctica islandica*; Schöne et al., 2005a; Wanamaker et al., 2008; Butler et al., 2013). Pairing with fossil specimens can enable reconstruction of environmental change in the more distant past (e.g. Scourse et al., 2006; Schöne et al., 2011; Butler et al., 2013). In the last two decades, the field of sclerochronology has been rapidly developing, relating variations in growth increments widths and geochemical composition of shell carbonate (e.g. Schöne et al., 2005b; McConnaughey and Gillikin, 2008; Black et al., 2009; Thébault et al., 2009; Reynolds et al., 2017; Tanabe

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