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Exploring the geochemistry and shell ultrastructure of bivalves as archives of past ocean acidification events: recent Mytilidae in a natural acidic setting in Ischia (Italy, Mediterranean Sea)

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This study assesses the impact of future ocean acidification on the biomineralization performance of calcitic and aragonitic bivalves by analysing past ocean acidification events. However, to accomplish this goal, an archive for recent bioperformance and calcification of bivalves is necessary. In a first approach we focus on recent Mytilus galloprovinciales specimen from naturally acidic seawater (mean pH 7.4) and normal conditions (mean pH 8.15) near the Island of Ischia. These mussels were transplanted from the port of Ischia into the different settings. Ischia [Mediterranean Sea (Thyrrenian Sea), Italy)] allows for an investigation of the effects of ocean acidification in a natural setting. These effects were investigated on various specimen of the benthic ecosystem like corals, sea grass, sea urchins, serpulid polychaetes, gastropods, bivalvia (Hall-Spencer et al., 2008) & (Cigliano et al., 2010), foraminifera (Dias et al., 2010) and bryozoans (Martin et al., 2008). Now we extend the findings in regard to bivalves, investigating the bivalve shell in more detail. Since, bivalves are sensitive recorders of environmental change in epeiric-neritic and coastal water masses. For the analysis of the bivalves, we use two methods for the quantification of bivalve calcification and bioperformance under acidic seawater conditions: (i) geochemistry and here mainly stable isotope systems (C, O, trace elements) that are affected by the bivalve bioperformance and (ii) shell ultrastructure analysis focussing in textural differences between shell material precipitated under 'normal' with such precipitated under acidic seawater conditions. The first results of the geochemical analyses of the carbon and oxygen isotope show, that these proxies illustrate both milieus and the sudden transition between them very well. Furthermore, by a specific and detailed sampling it was possible to prove, that the various components or layers of the shell have different isotope values. This contributes to the understanding of shell construction. The results of the shell ultrastructure analyses are very complex and it is yet not possible to distinguish the variable factors (pH, general milieu differences, etc.) and their individual influence on construction of the shell structure. Thus, it is possible to observe differences in the shell ultrastructure between the growth in the 'normal' milieu and in the 'acidic' milieu. For example one observable effect of the new acidic milieu around Ischia is the distinct thinning of the calcite layer by about $\sim$40% relative to normal shell growth. However, in all likelihood, this has nothing to do with the acidic milieu, but depends on the low nutrient supply or the individual for the shell completely altered habitat. These difficulties show the limits of a natural laboratory. The next steps are to use cultured bivalves to clearly distinguish between the individual and various effects like pH. Furthermore, the main goal is to obtain a basis for improving the interpretation of shell archives for environmental changes of the past. However, Mytilidae are generally bivalves that are particularly tolerant to less-than-normal marine aquatic environments. Thus, more work with more sensitive species may reveal a more pronounced effect of acidic seawater on bivalve metabolism and performance.