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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**Project background**

The BIOACID-project is a national research initiative Biological will take the challenge to unfold the biological gaps in the understanding of the consequences of ocean acidification. Ocean acidification (OA) results from anthropogenic CO₂, slowly changing the carbonate system of the world oceans (Buesseler & Feely, 2008) and leads to a drop in seawater pH (Caldeira & Wickett, 2003). OA has significant consequences for marine life, particularly for those that build shells, bones and tests of bivalve calcium carbonate (Keller & Feely, 2008). This study assesses the impact of future ocean acidification on the biomineralization performance of calcite and aragonite by using modern and fossil events. The focus is on the textural differences between shell calcite and aragonite by using modern and fossil events. The focus is on the textural differences between shell calcite and aragonite by using modern and fossil events.

**Aims and projects of the approach**

In a first approach the focus lies on recent *Mytilus galloprovincialis* specimens from naturally occurring sites (B1 pH 7.25) and normal conditions (mean pH 8.07) near the Island of Ischia (Mediterranean Sea). The choice for this investigation of modern acidification in a coastal setting is because the biological system under study, sea grass, sea urchins and bivalves, are well known to be affected by OA (Cai et al., 2008). Furthermore, Immenhauser et al. (2005) described how shell morphology and shell chemistry are affected by OA. Most recent growth interval (1-7)

**Study Site - Ischia (Mediterranean Sea, Italy)**

Cultures of adult *Mytilus galloprovincialis* specimens were maintained in the part of the museum near the vent (B1 pH 7.25) and in normal pH (C) (see Figure 1). Our investigation on acidified with a mean pH of 7.25 and the control site C with a mean pH of 8.07. The culture experiment lasted from 28. September to 02. December 2009. Before the experiment started, a control experiment was established in collaboration with the Ludwig Maximilian University in Munich (Germany). The images (7-9) show data from three sites: B1 pH 7.25 and C pH 8.07. B1 is the transplantation environment (Bremen_5.1cm) of the mussel shell. B1 pH 7.25 is obtained from two different species of the mussel *Mytilus galloprovincialis* (Bremen_4.6cm) and C pH 8.07 (5.4cm). Inside of the shell the *Mytilus galloprovincialis* is less structured, characteristic pattern of the mussel *Mytilus galloprovincialis* (Bremen_5.6cm; very well structured, characteristic pattern of the mussel *Mytilus galloprovincialis* (Bremen_5.6cm; very well structured). The images (7-9) show data from three sites: B1 pH 7.25 and C pH 8.07.

**Geochemistry and bivalve metabolism**

Calcification and calcification under acidic seawater is assessed using the geochemistry of traditional carbon and oxygen isotopes and elemental abundances. Modern shell PFO has been shown to be influenced by seawater temperature, salinity and pH and therefore provides information on ambient conditions. Modern shell PFO has been shown to be related to most modern changes in fixed availability (Vander Putten et al., 2004). Magnesium and Ca isotopes in contrast may provide evidence for the metabolic activity of the bivalve (Immenhauser et al., 2005; Higham et al., 2009). Thus, Mg and Ca isotopes are one of the main tools in reconstructing present and past performance of shell and chemical changes under variable ancient seawater conditions.

**Shell Structure**

The focus is on the textural differences between shell calcite and aragonite precipitated under different pH conditions. This is the first approach in collaboration with the Ludwig Maximilian University in Munich (Germany). The images (7-9) show data from three sites: B1 pH 7.25 and C pH 8.07. B1 is the transplantation environment (Bremen_5.1cm) of the mussel shell. B1 pH 7.25 is obtained from two different species of the mussel *Mytilus galloprovincialis* (Bremen_4.6cm) and C pH 8.07 (5.4cm). Inside of the shell the *Mytilus galloprovincialis* is less structured, characteristic pattern of the mussel *Mytilus galloprovincialis* (Bremen_5.6cm; very well structured). The images (7-9) show data from three sites: B1 pH 7.25 and C pH 8.07.

**Discussion & Outlook**

While considering the two methods of analyses, the shell structures of *M. galloprovincialis* transferred from a natural pH setting to these cultured under acid conditions are significantly different. The geochemical analysis of *M. galloprovincialis* shows differences between the future environmental and the transplantation setting. The differences (8 & 9) are more pronounced in the bivalve shells implemented into the acidic environment. Ultrastructural analysis revealed differences both between the two *M. galloprovincialis* samples as well as the mussel *Mytilus galloprovincialis* of Ischia near the vents (Rudolfo-Metalpa & Feely, 2008). This because environmental changes tend to be more gradual as opposed to the abrupt change in this experiment.

**Next steps**

To obtain more precise evidence on the relative significance of individual or transoceanic factors, shell cores containing experiments kept under controlled environments and fixed availability settings will be analyzed. Furthermore, shells show variable texture and are indicative towards interstitial settings. Further studies should involve more respective bivalve species.