Ship-board experiments to determine calcification rates of Mediterranean cold-water corals under variable pCO$_2$ conditions

Conny Maier (1,2), Markus Weinbauer (1,2), Pierre Watremez (3), Marco Taviani (4), Jean-Pierre Gattuso (1,2)

(1) Laboratoire d’Océanographie, CNRS, BP 28, F-06234 Villefranche sur mer, CEDEX, (2) Laboratoire d’Océanographie, Université Pierre et Marie Curie-Paris 6, BP 28, F-06234 Villefranche sur mer, CEDEX, (3) Agences des Aires Marines Protégées, France, (4) ISMAR, CNR, Via Gobetti, 101, 40129 Bologna, Italy

Global environmental change and the rise of CO$_2$ have been identified as a major threat to scleractinian corals and corals reefs. General predictions are that ocean acidification will be detrimental to reef growth and that 40 to 80 % of present-day reefs will decline during the next 50 years. Cold-water corals are thought to be even more affected by changes in ocean acidification due to the fact, that their distribution is confined to deep and/or cold waters where they are affected even sooner by the shallowing of the aragonite saturation horizon. While the impact of global change on reef-building, tropical corals has been intensely studied, not much is known on the response of cold-water corals. The Mediterranean Sea is an enclosed system and can be regarded as a miniature ocean that is expected to react faster to global change than the open ocean, which renders it a perfect study site. At three geographically distant sites, we therefore studied calcification rates of three species of Mediterranean cold-water scleractinian corals directly on board research vessels and immediately after collection. Corals were incubated directly onboard in vials using ambient seawater under ambient, reduced or enriched pCO$_2$ and calcification rates were determined by the TA anomaly technique. Calcification rates ranged from 0.008 % d$^{-1}$ for Desmophyllum sp. and 0.116 % d$^{-1}$ for Madrepora oculata. Lowest calcification rates were found for corals collected at a site south off Malta, in the Strait of Sicily, while corals collected at the canyon Lacaze Duthiers and the Gulf of Cassidaigne in the western Mediterranean were not significantly different in calcification rates. Calcification rates of corals under variable pCO$_2$ levels were on average 0.055 % d$^{-1}$ and were similar for ambient and elevated pCO$_2$ (404-867 µatm), while calcification rates were on average 0.1 % d$^{-1}$ for corals under reduced pCO$_2$. However, this difference was not statistically significant. Our results indicate that cold-water corals may be able to cope, at least for a short while, with elevated pCO$_2$ levels and maintain a normal calcification rate. We also proved evidence that on-board incubations are superior to study effects of climate change on cold-water coral calcification than long-term aquarium experiments. Cold-water corals appear to recover extremely fast from sampling stress if sampled carefully by ROV. Conducting experiments with freshly collected cold-water corals has the advantage that their response is close to in situ conditions and is not influenced by artificial aquarium conditions that may not reflect the natural environment with respect to feeding, current regimes, sedimentation and other potential factors influencing coral behavior. A systematic comparison of calcification rates from cold-water corals sampled over a large gradient with respect to geography, depth and seawater carbonate chemistry is more likely to provide reliable information on the potential response of cold-water corals to future changes in pCO$_2$ and aragonite saturation state than experiments conducted with corals maintained under artificial aquarium conditions.