Acid-base regulation, calcification and tolerance to ocean acidification in echinoderms.

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The current increase of the atmospheric CO$_2$ concentration has two major consequences in the marine environment: an increased temperature of the surface waters and a decrease of the seawater pH. Consequently, the marine organisms have to acclimatize or adapt to these occurring changes in order to survive. Within the different groups of organisms, some of them are considered more sensitive than others. For instance, the echinoderms are considered “at risk” because they are hypometabolic calcifying (magnesium calcite) osmoconformers. The aim of this work was to characterize the acid-base physiology of the post-metamorphic echinoderms (juveniles and adults) of the different taxa in order to understand their response to ocean acidification. This hypothesis was tested by studying different species of sea urchins and sea cucumbers from different geographic locations and/or contrasted environments. Field measurements were carried out in parallel to measures in the laboratory to observe the changes in the acid-base balance of these organisms linked to a reduced seawater pH exposure. The data collected in this study compiled with those from the literature seem to indicate that only regular euechinoid sea urchins accumulate bicarbonate ions in the coelomic fluid (main extracellular fluid in echinoderms) to compensate for acidosis but this process has an important energetic cost, witnessed by the changes in resource allocation. On the contrary, cidaroid sea urchins are very tolerant to ocean acidification with no physiological response evidenced when they are submitted to an acidification of the water. In between those two extremes, the sea stars and the sea cucumbers are impacted by ocean acidification with a pronounced acidosis of the coelomic fluid for all the species studied to date. However, in those two groups, despite the acidosis of the extracellular fluid, no other process was impacted whether the metabolism, the regeneration capacities or the adhesion of tube feet. It is also interesting to note that the environment in which these organisms live does not seem to determine the tolerance of echinoderms to ocean acidification. However, more studies are required on irregular sea urchins, brittle stars and sea cucumbers to confirm the preliminary results, as well as on crinoids which have not been studied at all to date. Long-term experiments estimating the changes in the energetic budgets of these organisms are absolutely necessary.