BivCRS2 - Time dependence of thermal tolerance in marine bivalves: extant fauna and implications for palaeo-analogues

Prof. Dr. Hans-Otto Pörtner

Summary

The relevance of physiology in studies of climate change effects on marine ectotherms and ecosystems is currently constrained by limited availability of quantitative links between physiological phenomena and ecosystem level processes. Such evidence is still scarce for the present, and even more so for the deep past. The proposed project BivCRS2 wants to fill this gap by identifying the quantitative contribution of those mechanisms that shape and limit the time dependent survival under extreme conditions. Clearly, an understanding of mechanisms can only be derived from extant fauna, assuming that those mechanisms are still in place that have shaped the fate of fauna in the deep past, explaining the patterns and irreversibility of faunal losses under progressive environmental change. A limited number of studies have in fact established clear links between, on the one hand, field studies reporting a climate-induced effect on species at ecosystem level and, on the other hand, laboratory studies establishing the reasons for such an effect. In addition to the effects of temperature and its extremes, laboratory studies and consecutive meta-analyses have revealed vulnerability of marine fauna to extreme hypoxia and ocean acidification, with extreme hypoxia having an effect as strong as temperature at extremes outside of the thermal range of species. Temperature and hypoxia extremes are thus candidates to cause short term lethal impacts, however, they also have combined effects. The main goal of BivCRS2 within phase 2 is to increase predictive power for characterizing unifying principles of species responses to climatic changes and to quantify the mechanisms underpinning different and specific vulnerabilities of species groups. In the context of palaeo-patterns research in BivCRS2 will therefore address why and how species are specialized on limited but different temperature ranges, why and at what temperatures they are sensitive to accumulating CO2 and along the same lines, how they deal with ambient oxygen deficiency. Phase 1 compares/d the capacities of oysters and scallops to sustain fitness actively. Phase 2 will address their passive tolerance capacity, the set of mechanisms underpinning such capacity, with a view on the implications for the time limitation of tolerance to environmental extremes. The focus is on how, beyond pejus limits of the thermal window, interactions of warming, acidification, and hypoxia (“deadly trio“) may shift limits and capacities of tolerances, e.g. through metabolic depression, shifting acid-base parameters, and exploitation of antioxidative defence, energy reserves and mode, and capacity of anaerobic metabolism. Reduced functional scope may cause a narrowing of active thermal tolerance with the potential benefit of expressed and extended passive tolerance.