Introduction

Atmospheric CO₂ accumulation elicits climate change and associated impacts on marine ecosystems, emphasizing the need for an integrative understanding of the driving forces and their specific and synergistic effects. Besides indirectly inducing ocean warming, CO₂ directly causes ocean acidification, but the specific contribution of this process to ongoing ecosystem change is not yet clear. Learning about the principles involved can benefit from the observed organism and ecosystem responses to the warming trend. Understanding the specific effects of CO₂ and the synergisms with temperature requires the identification of sensitive physiological mechanisms.

3. Specific effects: Energy budget of fish gills

Working model for acid-base regulation under hypercapnia in the gills of the marine teleost, Notothenia rossii4. Red circles: gene expression during short-term hypercapnia (24 to 96 h), green circles: long-term response (4 weeks). Mitochondrial level: Mitochondrial capacities that generally are in excess of whole organism functional capacities and energy turnover are thermally less responsive under elevated PCO₂ in Antarctic fish gills and thereby contribute to an earlier onset of thermal stress.

Key references: