

Scientific Paper:

Polar Biol 28, 805-814, 2005

## **Thermal sensitivity of cellular energy budgets in some Antarctic fish hepatocytes**

F. C. Mark, T. Hirse, H. O. Pörtner

Alfred-Wegener-Institut für Polar- und Meeresforschung, Physiologie mariner Tiere, Postfach 12 01 61, 27515 Bremerhaven, Germany; Email: [fmark@awi-bremerhaven.de](mailto:fmark@awi-bremerhaven.de); Tel.: +49-471-48311015, Fax: +49-471-48311149

### **Abstract:**

Abstract Oxygen demand elicited by the main cellular energy consumers was examined in isolated hepatocytes of sub-Antarctic (*Lepidonotothen larseni*) and high-Antarctic notothenioids (*Trematomus eulepidotus*, *Trematomus pennellii*, *Trematomus lepidorhinus*, *Trematomus bernacchii*, *Artedidraco orianae*) and in a zoarcid (*Pachycara brachycephalum*) fish with respect to the role of cellular metabolism in co-defining thermal tolerance. The relative proportions of energy allocated to protein and RNA/DNA synthesis, ion regulation and ATP synthesis were quantified between 0°C and 15°C by analysis of inhibitor sensitive cellular respiration. In all the investigated species, protein synthesis constituted 25–37%, RNA synthesis 24–35%, Na<sup>+</sup>/K<sup>+</sup>-ATPase 40–45% and mitochondrial ATP synthesis 57–65% of total respiration. The sub-Antarctic nototheniid *L. larseni* displayed lower cellular protein synthesis rates but somewhat higher active ion regulation activities than its high-Antarctic confamilials, as is typical for more eurythermal species. Assumed thermal optima were mirrored in minimized overall cellular energy demand. In the sub-Antarctic *L. larseni* and *P. brachycephalum*, minima of oxygen consumption were located between 3°C and 6°C, indicating elevated energy turnover below and above these temperatures. In contrast, the high-Antarctic species displayed progressively rising respiration rates during warming with a cellular energetic minimum at 0°C. The sub-Antarctic nototheniid and the zoarcid showed signs of cold-eurythermy and appear to live close to their lower limit of thermal tolerance, while high-Antarctic notothenioids show high degrees of energetic efficiency at 0°C. All cellular preparations maintained energy budgets over a wide thermal range, supporting the recent concept that thermal limits are set by oxygen and associated energy limitations at the whole organism level.