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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; 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^+/K^+-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.