Coping with salinity and temperature changes: a focus on the gill response in European sea bass

Dicentrarchus labrax

Abstract
The European sea bass Dicentrarchus labrax undertakes seasonal migrations to estuaries and lagoons that are characterized by fluctuations in environmental conditions. It is unclear to what extent salinity acclimation mechanisms are affected at temperatures higher than in the sea, as usually encountered in transitional waters in spring and summer. In this study, juvenile sea bass were pre-acclimated to seawater (SW) at 18 °C (temperate) or 24 °C (warm) for two weeks and then transferred to either fresh water (FW) or SW at the considered temperatures. We have shown that sea bass are able to efficiently maintain blood osmolality at 24 °C at both salinities. However, temperature increase induced significant changes regarding several physiological traits related to osmoregulation, acid-base regulation, ammonia excretion and mucus production. This study showed that thermal acclimation at 24 °C affects gill morphology through gill remodeling and whole-organism ion balance. Plasma Na⁺ levels seemed to be particularly affected leading to decreased plasma Na⁺/Cl⁻ ratio in warm conditions, suggesting a blood acidosis. Following FW transfer, the major effects observed were a lower increase in the density of branchial ionocytes and in Na⁺/K⁺-ATPase activity at 24 °C compared to 18 °C. Moreover, several key ion transporters involved in ion uptake were not transcriptionally induced following FW transfer at 24 °C. These data suggest a less effective capacity to switch from hypo- to hyper-osmoregulation after FW transfer when fish are exposed to higher temperature. At the molecular level, the temperature increase affected the expression of several branchial transporters, notably in SW. At 24 °C, higher expression of transporters linked to H⁺ transport might be linked to an acid-base imbalance. Moreover, the induction of ammonia-transporting channels might also indicate increased need for nitrogen excretion, potentially due to enhanced metabolism in warm conditions. Molecular chaperones HSP90 expression was strongly affected by temperature increase and to a lesser extent by salinity decrease. Finally, gill goblet cells analysis suggested that mucus production is increased in response to thermal stress. This study and additional functional studies investigating different temperature regimes provide insights on the effect of increased temperatures on fish responses and may help to predict how teleost will face the consequences of global change.

Key-words
Ecophysiology, Temperature, Salinity, Dicentrarchus labrax, Gills, Ionocytes, Ion Transport, Mucus, Gene expression