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**EFFECTS OF TEMPERATURE AND SALINITY  
ON AEROBIC AND ANAEROBIC CAPACITIES OF ATLANTIC COD**

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Atlantic cod face many physical and chemical challenges in their natural environment. Not only are there major oceanic currents which they must occasionally swim against, but also they are a migratory species, which travel hundreds or even thousands of kilometers in search of prey or for reproduction. Their ability to migrate and their success at prey capture is then directly related to their swimming capabilities. Cod are subjected to a wide temperature variation in their environment as they travel from offshore to inshore locations following prey. They are also euryhaline species, and are able to live in water with salinity as low as 5‰.

In the present study, cod were forced to swim in a swimtunnel by increasing the velocity of the water flow, with a 0.5 h period between speed increments, until exhaustion. Swimming performance ( $U_{crit}$ ),  $O_2$  consumption rate, and blood chemistry were measured simultaneously, during swimming and during recovery from exhaustion (0-8 h post-exhaustion), at three different environmental conditions: (1) full strength seawater (31‰) and 15°C; (2) full strength seawater (31‰) and 2°C; (3) 1/3 strength seawater (11‰) and 15°C. The goal of this study is to understand how the swimming performance and aerobic/anaerobic capacities of cod are influenced by the extremes of temperature and salinity that they would encounter during offshore to inshore migration, and to predict the possible ecological consequence of these environmental factors on the migration and foraging success in this commercially important species. We chose 11‰ because this salinity results in an isotonic condition between the ambient water and the animal's body fluid, which has widely been hypothesized as having influence on the cost of osmoregulation, and therefore, on the metabolic rate and the growth rate of the fish.

Cod have an aerobic capacity only 1/5 of that of salmonids but have an anaerobic capacity comparable to salmonids. The anatomy and exercise physiology of cod indicate that they are selected naturally and possibly by human (fishing trawlers) for their anaerobic capacity rather than aerobic capacity. In an environment without the threatening of the predators, the fitness of cod is very much dependent upon their burst ability to catch preys (capelin and shrimp) and to escape from fishing trawlers, strong aerobic swimming ability for migration and a quick recovery from exhaustion are less critical. Though cod are less active than salmonids, the former have a higher maintenance metabolic rate than the latter, the explanations for this difference between cod and salmonids will be discussed.

Swimming performance and aerobic capacity are greatly reduced in cod at lower temperature. The anaerobic capacity is unaffected by the temperature change. Although cod at lower salinity start recruiting anaerobic energy at a lower swimming speed than their counterparts at higher temperature, the colder cod are able to correct their post-exercise acid-base disturbance at a much faster rate than the warmer cod. The limiting factors affecting the aerobic capacity and the mechanisms responsible for the more efficient acid-base regulation in the colder cod will be discussed.

Cod at isotonic salinity are able to swim equally well as their counterparts at full strength

seawater. The aerobic cost of swimming is much lower at 11‰ than at 31‰, which could be to a larger extent related to the reduced cost associated with the reduced osmotic gradient between the ambient water and the body fluid of the animal, and to a lesser extent related to decreased water density and viscosity. However, cod at isotonic salinity have a lower aerobic scope, and depend on more anaerobic energy to achieve the same swimming performance as cod at full strength seawater. The former cod therefore experience a much greater post-exhaustion acid-base disturbance and the recovery is a much slower process. The physiological, biochemical and anatomical adaptations in fish at different salinity will be discussed.

Concerning the optimal salinity for culturing cod, the present study suggests that, although cod at isotonic salinity save energy at routine activity, their scope for growth may be compromised due to their lower metabolic scope, and as a result they may be more sensitive to stress and stress-related diseases, which are important concerns in aquaculture.