UNIVERSITY OF CALIFORNIA, SAN DIEGO

The Physiological and Biochemical Responses of Fishes to Different Oxygen Concentrations and Feeding Conditions

A dissertation submitted in partial satisfaction of the
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in Marine Biology

by

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ABSTRACT OF THE DISSERTATION

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Organisms living in the ocean's oxygen minimum layer (OML) must endure low oxygen concentrations as well as several other depth-related habitat factors. How organisms respond and adapt to this environmental regimen is the concern of this thesis, which uses the comparative approach to examine OML adaptation from the molecular to the whole organism level. The subjects of this study are *Sebastolobus alascanus* which lives in the OML and the shallow-living confamilial species, *Scorpaena guttata*. To live in the OML, *S. alascanus* has a lower oxygen conusmption rate and a stronger ability to regulate this rate than *S. guttata*. *S. alascanus* has a higher blood oxygen affinity and its heart possesses a greater capacity to tolerate hypoxia. Unlike *S. guttata*, which has both A- and B-types of lactate dehydrogenase (LDH) isozymes expressed in its heart, *S. alascanus* has only LDH-A. The exclusive expression of LDH-A in *S. alascanus* heart is linked to reduced oxygen availability.

Fasting significantly reduced oxygen consumption rate, white muscle protein concentration, and the activities of energy metabolic enzymes in fish muscles. Differences in changes due to fasting were found among species, tissues, and proteins. Comparisons of these data revealed the relationship between the biochemical characteristics and the organisms' locomotory abilities and habitat properties. For example, the low metabolic rate and energy metabolism enzyme levels of field-collected *S. alascanus* correlate well with a low food availability and poor capability for sustained locomotion. The higher poise of anaerobic capacity in *S. alascanus* red muscle indicates a hypoxic habitat. Muscle protein concentration and activities of energy metabolism enzymes were positively correlated with weight-specific oxygen consumption rate. This relationship makes possible the use of biochemical measurements as indicators of oxygen consumption rate.

After long-term food deprivation for *S. guttata*, protein and mRNA concentrations for LDH significantly decreased, whereas actin and its mRNA did not change significantly. Compared to fed fish, fasted specimens had about half as much LDH activity but only 5% as much LDH mRNA. The studies suggest that protein synthesis is controlled at the transcriptional level.

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