EFFECTS OF ENVIRONMENTAL FACTORS ON 5'-MONODEIODINASE ACTIVITY IN THE GILLS AND LIVER OF JUVENILE SALMONIDS

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In all teleost fishes examined to date, the thyroid gland secretes *L*-thyroxine (T_4) which is subsequently deiodinated in peripheral tissues to triiodo-*L*-thyronine (T_3). Based on increased receptor affinities and greater physiological efficacy, T_3 is considered to be the active form of the hormone. Furthermore, the enzyme 5'-monodeiodinase which removes an iodine atom from the outer ring of the L-thyroxine molecule is found in many tissues, including the liver, gills, kidney and muscle, all of which possess nuclear receptors for T_3. The liver tissue probably represents the most important site of deiodination, generating most of the circulating levels of T_3 as well as that for hepatic nuclear receptors. Gill tissue, on the other hand, seems to be somewhat independent of hepatic deiodination processes in that greater than 75% of the T_3 bound to the nucleus is deiodinated intracellularly.

Due to the importance of thyroid hormone(s) in metabolism, development and growth, regulation of the 5'-monodeiodination of T_4 to T_3 is of great significance. Various components of the environment, including diet, season, temperature, and salinity were examined for their influence on the activity of this enzyme, and the resulting thyroid hormone status, in juvenile rainbow trout (*Oncorhynchus mykiss*) and coho salmon (*O. kisutch*). These factors were examined because they represent natural and inherent variations in the environment and, furthermore, are faced by most fish on a regular basis.

Both starvation and rationing of juvenile rainbow trout led to rapid and significant decreases in the activity of the hepatic 5'-monodeiodinase system, followed by a decrease in plasma T_3 concentration. Sequential rationing of rainbow trout led to step-wise decreases in enzyme activity, suggesting a direct relationship with nutrient intake. Subsequent re-feeding returned both the enzyme and circulating T_3 levels to pre-starvation values, but previous nutritional status also played a role in the level of recovery. The starvation-induced reductions in hepatic 5'-monodeiodinase activity were seen achieved both by reductions in V_{max} (quantity of active enzyme) and increases in K_m (enzyme-substrate affinity).

To follow seasonal and/or developmental changes, juvenile coho salmon were examined on a bi-weekly or weekly basis in 1992 (January to July) and again in 1993 (January to January). The results from both years showed significant decreases in both hepatic and branchial 5'-MD activity during late spring and early summer, with a subsequent return to previous levels. These reductions were achieved (in hepatic tissue) by reductions in V_{max} without significant changes in K_m. Plasma T_3 levels also declined during the decrease in hepatic 5'-monodeiodinase activity in both years, but significant correlations were only observed in the 1993 study. The timing of these decreases suggest a strong association with the parr-smolt transformation, rather than to environmental factors such as increasing photoperiod and/or temperature. The lack of significant alterations in tissue 5'-monodeiodinase activity or plasma T_3 concentration associated with decreases in photoperiod or water temperature in the autumn and winter months further supports the smoltification hypothesis.

In the 1993 study, the effect of 24 hr seawater challenges (30 ppt) were also examined over the course of the year. Exposure to salinity did not affect hepatic or gill 5'-monodeiodinase activity levels at any time in the study except for a 3 week period late in smoltification, during which hepatic 5'-monodeiodinase levels (V_{max}) were significantly elevated over freshwater controls. On the other hand, significant decreases in circulating T_3 concentrations were observed subsequent to 24 hr of salinity challenge throughout the study, perhaps an indication of increased uptake and/or clearance.

The results are discussed in terms of the overall growth and development of the fish, and how these external parameters act to influence the activity of thyroid hormone(s) status.