

**THYROID HORMONES AND GROWTH IN WARM WATER
TELEOSTS: THE CHANNEL CATFISH AND THE RED DRUM**

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EXTENDED ABSTRACT ONLY- DO NOT CITE

Substantial data exist demonstrating that activation of thyroid hormone production accompanies periods of active growth in fish. Whereas this suggests that thyroid hormones function to promote growth in fish, clear evidence for their direct role in the cellular processes of fish growth remains elusive (Leatherland, 1994). Our objective has been to develop model warm water species in which to study the regulation and action of thyroid hormones during periods of rapid growth, in comparison to the extensive literature for cold water salmonids. We sought species which are used in aquaculture, but also exhibit rapid juvenile growth, elevated thyroid hormone levels, and the opportunity for controlled studies in the laboratory and under natural or semi-natural conditions. These traits are evident in two warm water teleost species, the channel catfish (*Ictalurus punctatus*), and the red drum (*Sciaenops ocellatus*). Whereas channel catfish are a fresh water siluriform species with extensive information on nutritive and environmental requirements for growth, red drum are an estuarine perciform species for which basic information on aquacultural requirements is currently accumulating.

In both species (red drum captured in the wild or channel catfish held in outdoor aquaculture ponds), the circulating thyroid hormones thyroxine (T4) and 3,5,3^o-triiodothyronine (T3) reach highest levels in the summer, when water temperatures are maximal and animals are feeding and growing most actively. As with other fish species (but not mammals, birds, or reptiles), circulating T3 is often found in equivalent, or greater, concentrations than T4 (MacKenzie *et al.*,

1989). This appears to be due to a combination of active peripheral deiodination of T4, enterohepatic cycling of T3, and enhanced T3 plasma protein binding. We have found that circulating T3 levels more accurately reflect the anabolic state of the fish, as they can be elevated (up to a maximal level) by increases in diet quantity or quality (MacKenzie *et al.*, 1993). These elevations of T3 are not consistently associated with increases in the activity of the primary hepatic outer ring deiodinase (ORD), but may reflect instead differences in blood protein thyroid hormone binding capacity between different nutritional states. Although experimental elevations of circulating T3 are capable of altering body composition and activity of the pituitary-thyroid axis, direct physiological actions of circulating T3 in these species has yet to be established.

In contrast to T3, T4 levels do not consistently reflect anabolic state. This may be due in part to the timing of blood sampling. We have found daily cycles in circulating levels of T4 in both species, with significant elevations in the late afternoon. In the red drum, these daily T4 cycles appear to be driven by a circadian oscillator, as they are maintained under constant illumination conditions (Leiner and MacKenzie, 2001). In both species, food deprivation results in a significant reduction in T4, suggesting that the amplitude of the oscillations is regulated by nutritional state.

These results suggest that the elevated levels of thyroid hormones that are observed during active periods of feeding and growth are due to both central mechanisms, via the hypothalamic-pituitary-thyroid axis to establish T4 oscillations, and peripheral mechanisms, through regulation of deiodination and transport of both T3 and T4. The basal production of thyroid hormones can thus be tuned to nutritive state, and possibly also growth status, via regulatory feedback of nutrients or hormones at both central and peripheral locations.

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