ABSTRACT

The Ontogeny of Physiological Adaptation in Larvae of the Palaemonid Shrimp *Macrobrachium rosenbergii* (de Man),

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Macrobrachium rosenbergii (de Man) is an important commercial species whose larvae develop through several stages in brackish water, after which they metamorphose and the postlarvae migrate into fresh water. Modelling the multiple factor interactions which may affect the ontogeny of physiological adaptation during larval development provides an opportunity to update Alderdice`s concept of the integral mobility of salinity-temperature response surfaces in identifying important underlying adaptive phases in the life of the animal.

Weight-specific oxygen consumption and nitrogen excretion were measured in up to 17 larval stages of *Macrobrachium rosenbergii*, reared in 12 combinations of salinity (10.1 to 17.1 ppt) and temperature (24 to 33 °C). Changes in net growth efficiencies (K_2) and O:N ratios were analyzed by polynomial regression and examination of the integral mobility of nonlinear three -dimensional response surfaces.

Larval growth is sigmoid and divided into three major phases each comprising several instars: a low or no-growth post embryonic phase, an exponential-growth phase and a slow-growth pre-metamorphosis phase. Low K_2 and O:N values during the low or no-growth phase indicate that growth is not the

priority and available energy from stored lipoprotein is channeled into programmed tissue reorganization. Tissue sections suggest that the focus is dedifferentiation and reconstruction of the hepatopancreas. A sharp discontinuity, rotation and translation of the oxygen consumption response surface suggests a physiological shift to the new attractor. This is the commissioning of the hepatopancreas and the changeover to reliance on an exogenous food supply.

In the exponential-growth phase increasing net growth efficiency and low O:N ratios show that anabolic processes predominate utilizing protein as the primary energy substrate. During the final pre-metamorphosis phase, net growth efficiency decreases but energy utilization remains high. Translation of oxygen and O:N response surface optima from about 14 ppt in Stage 1 larvae to 10 ppt in the last larval stage suggests that the physiological attractor is the formation of ion regulatory tissue. This may be a preparation for larval migration to freshwater. The change in optimal salinity and temperature conditions during larval development seems too small to be of benefit in improving commercial larval aquaculture.

Salinity tolerance in larval *M. rosenbergii* fits into the second of the four following categories along the continum of adaptation to fresh water known in the genus *Macrobrachium*: (1) Larvae that are euryhaline from about 8 to 35 ppt; (2) Larvae that are stenohaline and require brackish water conditions; (3) Larvae that are stenohaline and require fresh or low salinity water up to 10 ppt; (4) Non-free swimming larvae that develop entirely within the egg capsule in fresh water. This study proves that the integral mobility of response surfaces during

larval development can identify homoeostatic adjustments associated with the transition from one physiological attractor to another.