

**THE ROLE OF SOCIAL RANK IN THE
DEVELOPMENT, PHYSIOLOGY AND
REPRODUCTIVE STRATEGIES IN SALMONIDS**

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..... **JEFFERSON MURUA**

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ABSTRACT

Salmonids naturally organise into social hierarchies both in the wild and aquaculture. This thesis investigates how social rank influences the physiology and development of salmonids with different life strategies using Atlantic salmon (*Salmo salar*) as a model. In broad terms two types of studies were conducted. Firstly osmoregulatory traits of freshwater parr prior to smolting, maturing or remaining immature were investigated using Na⁺ gill uptake kinetics. Highly distinct patterns emerged, especially for Na⁺ uptake affinity, between future alternative phenotypes, which could potentially be used as an identification tool in otherwise visually identical fish. Examination of Na⁺ uptake kinetics from a social status perspective revealed that first and intermediate ranked fish, which received less aggression and had lower cortisol, were better prepared for sea water entry. In the second batch of studies brain serotonergic activity (5-HIAA/5-HT), a key regulator of agonistic behaviour in vertebrates, was examined in a range of social conditions. First, the stability of social ranks was tested by food manipulation. The most dominant fish were able to retain their high status even after being kept in nutrient poor conditions. High status was associated with a high standard metabolic rate (SMR) and low brain 5-HIAA/5-HT. Secondly, studies on hierarchies with marked bimodal size asymmetries showed that upper modal group fish (UMG) became dominant. Despite being subordinate lower modal group (LMG) individuals showed similar growth rates, serotonin turnover and cortisol to UMG fish, possibly due to high aggression and fin injury sustained by high rank fish fighting for dominance. Thirdly, the association between social dominance and developmental pathway was examined in size-matched groups of immature parr and precocious parr, with the latter obtaining higher social positions and showing higher aggression. Brain serotonin turnover revealed higher 5-HIAA/5-HT in immature parr, a phenotypic distinction that was also identified in immature salmonids in aquaculture. Plasma samples from alternative life histories (immature parr, precocious parr and smolts) were also used for a preliminary investigation of potential metabolite signatures utilising metabolomic techniques.

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ABBREVIATIONS

ACTH Adenocorticotrophic hormone
CNS Central nervous system
CRF Corticotrophin releasing factor
DA Dopamine
DOPAC 3,4-dihydroxyphenylacetic acid
E Epinephrine
5-HIAA 5-hydroxyindoleacetic acid
HPA Hypothalamus-pituitary-adrenal (axis)
HPI Hypothalamus-pituitary-interrenal (axis)
HR High responders
5-HT 5-hydroxytryptamine, serotonin
5-HTP 5-hydroxytryptophan
LMG Lower modal group
LR Low responders
L-DOPA 3,4-dihydroxyphenylalanin
MAO Monoamine oxidase
MRC Mitochondria rich cell
Na⁺,K⁺-ATPase Sodium, potassium ATPase
NE Norepinephrine
PNA Peanut agglutinin binding
SMR Standard metabolic rate
TRP Tryptophan
UMG Upper modal group