

Small Research Grant Report

The affects of maternal steroids and spawning order on juvenile brown trout

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Background

Juvenile salmonids are characterised by a high degree of individual variation in several behavioural and physiological traits that influence life history strategies. For example, fish vary in their ability to acquire and defend profitable feeding sites when they emerge from their gravel nests. Success at this early stage can affect survival and dispersal, and may impact on growth rates, age at maturation and reproductive fitness. Factors influencing individual variation at the onset of feeding are not well understood.

Large quantities of maternal steroids are found in newly fertilised teleost eggs, and may play a role in the endocrine control of early development. I have found that experimental (physiological) elevations of egg steroid concentrations can affect developmental and juvenile metabolic and growth rates, sex ratios, and dominance behaviours. Having established that egg steroid levels can affect ecologically important traits, the next priority was to establish the extent of natural variation in egg steroid levels.

The small research grant awarded by the Fisheries Society of the British Isles enabled me to examine variation in steroid levels among and between the eggs of individual brown trout, and to investigate effects of spawning order on offspring physiology.

Methods

Intra-ovary variation in ovarian follicle size and steroid content in pre-ovulatory brown trout were assessed. As some females ovulated before they could be sampled, variation in egg size and steroid content in relation to post-ovulatory position within the body cavity was also assessed. Radioimmunoassay was used to measure egg steroid concentrations.

In a second experiment, pairs of wild brown trout were allowed to spawn naturally in an artificial stream, and the eggs were collected after each spawning. Many salmonids will spawn multiple times over a period of hours or days. A sample of eggs from each nest was taken for size and steroid content measurements, while remaining eggs were reared under hatchery conditions. The proportion of reared eggs that were viable at hatching was calculated. Just before complete yolk-sac absorption, the stress response of alevins from each nest was assessed using a standardised

handling and confinement stressor. The stress response was estimated by the increase in immunoreactive cortisol (IRC) in alevin homogenate (measured by radioimmunoassay).

Approximately 10 eggs from each nest were transferred to the University of Glasgow Field Station at Loch Lomond just before hatching, and were reared there in chemical and visual isolation from each other until 2 months after the onset of exogenous feeding. Juvenile growth and metabolic rates were assessed during these 2 months.

Results

Egg steroid content

I found a high degree of variation in egg steroid content between females. Within pre-ovulatory females, there was significant regional variation in follicle steroid content within ovaries. There were also significant differences in the steroid content of ovulated eggs resting in different regions of the body cavity prior to spawning. Finally, egg steroid content could vary between nests spawned by the same female, indicating post-ovulatory changes in egg steroid content.

Egg weight

Follicle weight, like steroid content, varied significantly within the ovaries of mature brown trout. However, there were no differences in egg weight within ovulated females. Consistent with the latter, there were no inter-nest differences in egg weight when fish were allowed to spawn naturally.

Effects of spawning order

There were indications that pre-hatching egg viability decreased with subsequent spawnings. There were significant inter-nest differences in the pre-and post stress IRC content of full-sibling alevins from several families, although there were no consistent patterns, and IRC levels did not correlate with steroid content of eggs from the same nests.

Spawning order had no apparent effect on juvenile growth or metabolic rates. However, tank effects confounded this phase of the experiment, and the results cannot be considered reliable.

Conclusion

These studies have established that there is considerable variation in egg steroid content both between and within females. It is therefore possible that natural variation in egg steroid content could lead to variation in individual physiology and behaviour both within and between families of brown trout. The effects of maternal environment on egg steroid content are currently being investigated. The experiments have also provided ecologically relevant and novel information on spawning physiology, and on inter-nest variation in egg viability and offspring physiology. Results may be of use in population management and conservation. This work should result in publication of three papers in peer-reviewed journals.

Expenditure

Total amount granted: £2859

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| Accommodation away from Glasgow | 650 |
| Transport away from Glasgow | 600 |
| Plastic consumables (bags, pipette tips, tubes, containers, etc...) | 250 |
| Spawning substrate and artificial nest materials | 160 |
| Chemicals and non-plastic consumables | 200 |
| Hormone analyses | 1000 |