TEMPERATURE AND EMBRYONIC GROWTH IN BROWN TROUT

(*SALMO TRUTTA* L.)

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EXTENDED ABSTRACT ONLY – DO NOT CITE

Emergence from the gravel nest represents an important ontogenetic niche switch for salmonid fishes (Elliott, 1989). During this phase, juveniles should compete for territories, which provide profitable feeding positions and protection against predators. Larger body size would be advantageous by increasing the ability for territorial competition, and by reducing the vulnerability to predation. A recent study on Atlantic salmon have demonstrated that selection may favour larger body size and early emergence (Einum & Fleming, 2000). According to Atkinson's (1994) general rule for ectotherms, increased rearing temperature will increase both developmental and growth rates, but will reduce the size at a given ontogenetic stage. Thus, thermal environment during the embryonic development can be an influential factor affecting the whole life cycle of ectotherms. The aim of this study was to assess the effect of incubation temperature on embryo survival and growth during the endogenous feeding period in brown trout (*Salmo trutta* L.).

We fertilised the eggs from 6 females with the milt of 10 males, this process was repeated three times and the whole eggs (18 females, 180 families) were pooled. We selected eight constant incubation temperatures, 4, 6, 8, 10, 12, 14, 16 and 18 ºC, covering a wide range and trying to approach to the thermal limits for egg development. Development was monitored by taking samples of eight individuals at 350, 400, 450, 500, 550, 600 and 720 degree-days and an additional sample at the 50% hatching time for each temperature.

All the embryos died before hatching at 16 and 18 ºC, indicating a critical thermal maximum for embryonic development between 14 and 16 ºC which agrees with previously published values for northern populations of the species.

During the endogenous feeding period, increased temperature resulted in faster growth. At the end of this phase, a decrease in growth rate was evident at all incubation temperatures. At higher temperatures embryos hatched with smaller body weights but with relative more yolk. In fact, we found significant between-temperature differences in body length (ANOVA: $F_{5,77} = 39.49$; $p < 0.0001$), body dry weight (ANOVA: $F_{5,77} = 54.13$; $p < 0.0001$) and body dry weight percentage (ANOVA: $F_{5,77} = 49.64$; $p < 0.0001$). Since hatching took place at different degree-days from egg fertilisation at each incubation temperature, and the sampling schedule was based on equal numbers of degree-days, we recalculated the number for each sampling establishing the 50 % hatching as zero point. Body dry weight showed lineal relationships with the number of degree-days from hatch at all temperatures. The slopes of the regression lines for each temperature were not significantly different (ANCOVA: $F_{5,26} = 0.775$; $p = 0.577$). However we found between temperature differences in the intercept of the lines (ANCOVA: $F_{5,31} = 29.667$; $p < 0.0001$), being higher at lower temperatures.

Growth trajectories evidenced that the effect of incubation temperature on developmental rate translated in embryos reaching larger sizes earlier at higher incubation temperatures. Since embryonic development implies both cellular proliferation and tissue differentiation, it is not easy to separate growth from other ontogenetic processes (Atkinson, 1994; Fuiman & Higgs, 1997). Recognisable ontogenetic events, such as occurrence of certain structures, hatching or the onset of exogenous feeding, have been frequently considered to assess the effects of temperature on embryonic development. In this study we considered hatching because it represents an inflexion in development, with possible implications for subsequent growth (Kamler, 1992). The differences registered in size at hatching remained until the end of the yolk resorption, i.e. individuals incubated at low temperatures would be larger at the onset of exogenous feeding too. Size has been demonstrated to be a key issue for survival and competitive ability in this phase (Elliott, 1989; Einum & Fleming, 2000). Nevertheless, it should be necessary to take into account the time required to complete the embryonic development to assess the ecological and evolutionary implications of the temperature experienced during early life-history stages (Kamler, 1992; Atkinson, 1994).

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