

## Metabolic rate, social status and life-history strategies in Atlantic salmon

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**Abstract.** An animal's relative social status has major short- and long-term consequences, yet its determinants are rarely known. Here a strong relationship between status and standard metabolic rate (SMR) in juvenile Atlantic salmon, *Salmo salar*, is demonstrated; the higher the SMR, the more dominant the fish. After controlling for SMR, the relative size, weight or date of first feeding of two opponents had no effect on the outcome of encounters. Moreover, these differences in SMR are not a consequence of experience in encounters, since it has previously been shown that the onset of aggressive behaviour occurs later. Since relative social status has a significant influence on subsequent developmental pathways in this species, these results indicate an indirect link between intraspecific variation in metabolic rates and life-history strategies.

There is an extensive literature documenting the long- and short-term consequences of differences in the relative social status of animals. Individuals of high status frequently obtain preferential access to resources, may become sexually mature at a younger age and have a higher survival rate than animals of lower rank (reviewed in Huntingford & Turner 1987). In species with indeterminate growth patterns, dominance status may also influence the life-history tactics adopted by individuals through its impact on competitive ability and hence on growth rate (e.g. Metcalfe 1989, 1991; Metcalfe et al. 1989). However, while the fitness consequences of differing social status are clearly considerable, the proximate factors determining status are poorly understood and cause and effect can be hard to disentangle. For example, are individuals dominant because they are large, or vice versa?

There has recently been much discussion as to whether metabolic rates should influence life-history strategies; the assertion that animals with relatively high metabolic rates should have more rapid development and shorter life spans (McNab 1980, 1986 and references therein) has been shown not to hold in birds and mammals in both inter- and intraspecific comparisons (Trevelyan et al. 1990; Harvey et al. 1991; Hayes et al. 1992).

Here we investigate the relationship between metabolic rate (SMR) and social status in juvenile Atlantic salmon, *Salmo salar*. It is already well

documented that social status influences the age at which salmon metamorphose into smolts and undertake the seaward migration (Metcalfe et al. 1989, 1990, 1992). Thus any factor that influences social status will potentially also cause substantial differences in life-history tactics.

## METHODS

### Fish

A batch of full-sibling eggs from sea-run salmon caught in the River Almond, Perthshire was incubated at the Scottish Office Agriculture & Fisheries Department Almondbank Salmon Rearing Unit. The hatched fish were transferred to the University Field Station, Loch Lomond, on 7 May 1991, shortly before the start of exogenous feeding. Relative date of first feeding has been shown to correlate with social status, with early-feeding fish being the more dominant (Metcalfe & Thorpe 1992). Therefore, on 8 May the fish were anaesthetized and divided into three groups of approximately equal size according to the amount of visible yolk still remaining. Those with virtually no yolk sac remaining ( $N=135$ ) were termed Early, since they would be the first to begin feeding, while the fish with the largest remaining yolk sacs ( $N=143$ ), which would be the last to begin feeding, were termed Late (see Metcalfe & Thorpe 1992 for illustrations of the different categories). Intermediate fish ( $N=142$ ) were excluded