

WHY DO SALMONIDS NOT GROW FASTER?

- GROWTH HORMONE AND TROUT PERFORMANCE IN STREAMS

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Introduction

Fish and other animals are capable of catch-up growth after periods of starvation suggesting that growth rates normally are kept below the physiological maximum. This indicates that rapid growth may incur costs such as increased predation risk, reduced tolerance to starvation, reduced developmental stability or reduced immune capacity (Arendt, 1997). Growth hormone (GH) increases tissue growth by stimulating cell growth and cell differentiation. GH-treatment also induces increased competitive ability and reduced anti-predator responses similar to what has been observed in GH-transgenic fish (e.g. Abrahams and Sutterlin, 1999). Exogenous GH treatment is thus an excellent tool to simulate increased growth investment, which can be used to test growth rate trade-off hypotheses in general and to predict the impact of growth-enhanced (i.e. GH-transgenic) fish in the wild. In a series of field experiments we treated brown trout (*Salmo trutta*) either with GH or with sham-injections to study the effects of GH-mediated growth investment on performance in natural or near-natural streams.

Methods

Young brown trout (size range 5-40 g) were measured for weight and length, pit-tagged and simultaneously implanted with a sustained-release GH pellet (exp. I-IV) or a gel-like GH formulation (exp. V-VII). Control fish were sham-implanted. The trout were then released in the stream and recaptured by draining and netting (exp. I-V), or by electric fishing (exp. VI-VII). Recaptured trout were measured for weight, length and various other parameters reported

elsewhere (Johnsson et al., 1999; Johnsson et al., 2000). Experiments I-V were conducted in the experimental stream in Älvkarleby (see Johnsson et al., 1999) and experiments VI –VII were conducted in the Norumsån river.

Results and Conclusions

Mortality rates did not differ significantly between GH-treated and control fish. There was a general trend for increased mortality in GH-treated trout in the experimental stream in Älvkarleby, but not in river Norumsån (Table 1). These results do not strongly support the hypothesis that increased mortality selects against increased utilisation of GH in wild fish. Furthermore, GH-treatment increased weight and length growth rate in all stream experiments under a wide range of environmental conditions (Table 1). GH-treated trout in the experimental stream (exp. I-V) lost more energy reserves than control fish (Johnsson et al., 1999; 2000), but this effect was not significant in river Norumsån.

In summary, our field experiments do not reveal any clear fitness costs associated with increased growth rate and thus can not explain why the endocrine growth regulatory system of wild fish is not set at a higher level to promote faster growth. It is possible, however, that selection against increased GH-secretion is more intense at other life-history stages and/or during certain years with severe climate conditions. Our results also raise the concern that released or escaped growth-enhanced salmonids may compete successfully with resident fish in the wild. Faster growth may confer several size-related advantages such as reduced susceptibility to predation, increased fecundity and increased ability to compete for spawning sites and mates. A recent model by Muir and Howard (1999) suggests that increased mating success of large GH-transgenic males, in conjunction with reduced viability of their offspring, may result in rapid extinction of wild populations. Their results and our empirical findings indicate that the ecological risks associated with release of growth-enhanced fish should not be ignored.

Table 1. Summary of the effect of growth hormone treatment on mean growth rates (SGR) and mortality in control (C) and growth hormone treated (GH) brown trout in seven field experiments. Significant differences (P<0.05) are denoted by *. Mortality rates based on recapture by electro-fishing are denoted by °.

Experiment location	Time span	SGR weight		SGR length		Mortality (%)	
		C	GH	C	GH	C	GH
I Älvkarleby exp. stream	Feb-Mar	-0.11	-0.10	0.01 *	0.02	26	26
II Älvkarleby exp. stream	Mar-May	0.0	0.05	0.08 *	0.11	40	48
III Älvkarleby exp. stream	Jul-Aug	1.37	1.57	0.38	0.45	28	33
IV Älvkarleby exp. stream	Sep-Oct	1.95 *	2.15	0.70 *	0.84	25	30
V Älvkarleby exp. stream	Sep-Mar	0.22 *	0.28	0.05 *	0.08	36	48
VI Norumsån river	Aug-Mar	0.16	0.20	0.07 *	0.09	82°	82°
VII Norumsån river	Aug-Mar	0.20 *	0.25	0.08 *	0.09	83°	77°
Overall mean		0.54 *	0.63	0.20 *	0.24	46	49

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