GROWTH HORMONE ENDOCRINOLOGY OF ATLANTIC SALMON

DURING PARR-SMOLT TRANSFORMATION

Thorleifur Ágústsson
Fish Endocrinology Laboratory, Department of Zoology, Göteborg University,
Box 463, S 405 30, Göteborg, Sweden.
e-mail: t.agustsson@zool.gu.se

Kristina Sundell[1], Tatsuya Sakamoto[2], Viktoria Johansson[1],
Ando Masaaki[2] and Björn Thrandur Björnsson[1]
[1]Fish Endocrinology Laboratory, Department of Zoology, Göteborg University,
Box 463, S 405 30, Göteborg, Sweden
[2]Hiroshima University, Faculty of Integrated Arts and Sciences, 1-7-1
Kagamiyama, Higashihiroshima, 739 Japan.

EXTENDED ABSTRACT ONLY – DO NOT CITE

Introduction

The parr-smolt transformation (smoltification) of anadromous salmonids involves both physiological and biochemical changes with enhanced seawater (SW) adaptability as one of the characteristics features. Growth hormone (GH) is considered one of the main regulators of this developmental process, improving hypoosmoregulatory ability, as well as regulating growth and behaviour (Björnsson, 1997). Plasma GH levels increase significantly during smoltification, concomitant with improved SW tolerance and increased gill Na^+, K^+-ATPase activity (McCormick *et al*., 1995). Insulin-like growth factor I (IGF-I) can improve SW tolerance and may thus mediate long-term actions of GH in SW acclimatisation (McCormick, 1996).

During the parr-smolt transformation of the Atlantic salmon, a frequently observed feature is that the plasma GH profile has two distinct peaks, and it has been speculated that this is due to interplay between GH secretion rate and the metabolic clearance rate of the hormone (Björnsson *et al*.2000), which have been shown to increase after SW transfer in coho salmon and rainbow trout (Sakamoto *et al*. 1991). Further, Yada *et al*. (1992) demonstrated that in amago salmon, that response of GH mRNA to seawater exposure is related to the

development of preparatory mechanisms for SW entry, thereby speculating that GH mRNA increases before SW entry.

In order to elucidate the endocrine mechanisms that are underlying these changes in plasma growth hormone (GH) levels during the parr-smolt transformation, Atlantic salmons were kept in outside tanks, under natural condition from early February until early July. Approximately three times a month, pituitaries and blood were sampled for *in vitro* GH secretion studies, GH mRNA expression, total pituitary GH content, plasma GH and IGF-I levels.

Results and Discussion

During the parr-smolt transformation of the Atlantic salmon, a concurrent assessment of pituitary GH gene expression, storage and secretion was made to establish the chain of events leading to the observed changes in plasma GH. In mid- to late April, an increased secretion rate caused the plasma GH levels to rise, without triggering new synthesis of GH or the amount of GH stored in the somatotrophs to drop. This indicates that the pituitaries are secreting stored GH. From mid-April to mid-May, the GH secretion increased, causing parallel rise in GH gene expression. As a consequence, there is a drop in the total pituitary GH content before increasing synthesis of GH replenishes this.

A likely explanation for the “split-peak” in plasma GH profile, often seen during salmon smoltification (Björnsson *et al*., 2000; McCormick *et al*., 1995), is an increased metabolic clearance rate of GH (Sakamoto *et al*., 1991). Towards the end of this study, there was a gradual rise in plasma GH levels, in spite of a concurrent decrease in both GH secretion and GH gene expression occurred. This indicates a decreased demand for GH, perhaps due to down-regulation of GH receptors and thereby lower metabolic clearance rate. In conclusion, the study demonstrates that there is a complex interplay between GH production, storage, secretion and plasma levels during the parr-smolt transformation of the Atlantic salmon.

References

Björnsson, B. Th. 1997. The biology of salmon growth hormone: from daylight to dominance. Fish Physiol. Biochem. 17: 9-24.

Björnsson, B. Th., Hemre, G. I., Björnevik, M. and Hansen, T. 2000. Photoperiod regulation of plasma growth hormone levels during induced smoltification of underyearling Atlantic salmon. Gen. Comp. Endocrinol. In press.

McCormick, S. D., Björnsson, B. Th., Sheridan, M., Eilertson, C., Carey, J. B. and O´dea, M. 1995. Increased daylength stimulates plasma growth hormone and gill Na^+,K^+-ATPase in Atlantic salmon (*Salmo salar*). J. Comp. Physiol. B 165:245-254.

McCromick, S. D. 1996. Effects of growth hormone and insulin-like growth factor I on salinity tolerance and gill Na^+,K^+-ATPase in atlantic salmon (*Salmo salar*): interaction with cortisol. Gen. Comp. Endocrinol. 101:3-11.

Sakamoto, T. and Hirano, T. 1991. Growth hormone receptors in the liver and osmoregulatory organs of rainbow trout: characterization and dynamics during adaptation to seawater. J. Endocrinol. 130: 425-433.

Yada, T., Kobayashi, T., Urano, A. and Hirano, T. 1992. Changes in growth hormone and prolactin messenger ribonucleic acid levels during seawater adaptation of amago salmon (*Oncorhynchus rhodurus*). J. Exp. Zool. 262