

CORTISOL AND THYROID HORMONES AT EARLY STAGES OF THE DEVELOPMENT OF THE RUSSIAN STURGEON *Acipenser gueldenstaedti* Brandt

N. E. BOIKO*, G. G. KORNIENKO, O. A. VOROBYEVA

Research Institute of the Azov Sea Fishery Problems, 21/2 Beregovaya Street, 344 007 Rostov-on-Don, Russia

E-mail: riasfp@icomm.ru

Abstract. A description is provided of tissue thyroxine (T_4), triiodothyronine (T_3) and cortisol concentrations in early-stage sturgeon larvae (prelarvae) *Acipenser gueldenstaedti* Brandt in fresh and brackish water. In fresh water cortisol profile was similar to that of thyroxine reaching maximum at stage 43. There was no significant change in the levels of T_3 during the entire period of study. In brackish water cortisol concentration increased slightly. Thiourea caused decrease in T_4 and T_3 levels in prelarvae placed into fresh and brackish water, with cortisol increased markedly attaining its peak levels at stage 41.

Keywords: sturgeon, larvae, thyroid hormones, cortisol, thiourea, saline adaptation.

AIMS AND BACKGROUND

The abundance of Russian sturgeon, one of the most valuable fishery species in the Azov and Black Sea Basin, is maintained only due to the artificial rearing. Physiological mechanisms responsible for the development of fish in their early ontogenesis should be studied to decrease the losses observed when rearing sturgeons and to create favourable conditions for their growth and formation of vital adaptive processes.

Sturgeons belong to species with indirect type of development and at the prelarvae stage they undergo certain structural and functional changes which allow them to adapt to the environment. The second half of the prelarvae development which is usually called the "critical period" is characterised by the activation of the thyroid tissue. It has been observed that one more endocrine organ, namely, the interrenal tissue, also functions in sturgeon prelarvae. The functional interaction between these endocrine systems in sturgeons has not been studied yet. Meanwhile, the study of peculiarities of "critical periods" in other representatives of the lower vertebrates (for example, metamorphosis in teleosts and amphibia) has shown a synchronous change in the activity of thyroxine and cortisol as well as the availability of the common mechanism of regulation, viz.

* For correspondence.

through hypothalamus¹. According to morphological data in the early ontogenesis the endocrine glands of sturgeons function unconnected with central structures which have not yet been fully differentiated by this stage². The aim of the work presented is to study the dynamics of cortisol and thyroid hormones, thyroxine and triiodothyronine, in early-stage sturgeon larvae in fresh water and placed into water of low salinity. The ability of sturgeon to tolerate the increase in the salinity is known to be one of the most important adaptive features of this species which ensures their survival in rivers with different hydrobiological regimes.

EXPERIMENTAL

The tests were performed under laboratory conditions with sturgeon prelarvae from the stage of hatching to their transition to active feeding (variants I-IV: I – control, II – salinity $S = 6\text{‰}$, III – thiourea 0.03%, IV – salinity $S = 6\text{‰}$, thiourea 0.025%). The levels of cortisol and thyroid hormones were determined by radioimmunoassay³.

RESULTS AND DISCUSSION

It was observed that between hatching (36th stage) and the transition to exogenous feeding the level of T_4 in sturgeon prelarvae increases greatly (more than twice). The most significant elevation was in the second half of the prelarvae development reaching maximum at stage 43. There was no significant change in the levels of T_3 during the entire period of study (Fig. 1a). The concentration of cortisol in tissues of developing prelarvae increased 5 times from hatching to stage 43. Thus, we see simultaneous rise in concentrations of T_4 and cortisol with maximum at stage 43. No sharp increase in both hormones at stage 43 was observed in the larvae placed into brackish water ($S = 6\text{‰}$) in a day after hatching (Fig. 1b). Thiourea caused a 16-26% decrease in T_4 and T_3 levels in prelarvae placed into fresh and brackish water. Cortisol increased markedly, attaining its peak levels at stage 41 (Figs 1a and 1b). Thiourea led to a one-day delay in the development, to anomalies in the digestive system in 18% and in olfactory organs affecting 30% of fish. Pigmentation disorders were observed in the larvae developing in brackish water (64% and 50% of fish in variants II and IV, respectively), and 100% of fish had underdeveloped fin edges.

The endocrine glands of sturgeons at early stages were thoroughly studied using light microscopy². According to morphological data the activity of the interrenal and thyroid glands manifests itself quite early: from the 4th day the thyroid follicles start intensively releasing the hormone. Our data evidence that at the same time (stage 40) the level of T_4 begins to rise. The level of T_3 has not one distinct peak and throughout the whole period of the development it re-

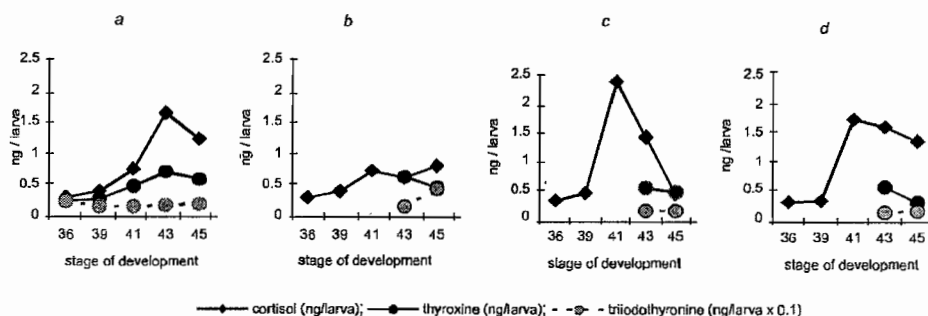


Fig. 1. Cortisol, thyroxine and triiodothyronine dynamics in early-stage sturgeon larvae (prelarvae) *Acipenser gueldenstaedti* Brandt in fresh and brackish water (a, b, c, d correspond to variants I-IV, respectively)

mains within the same limits. This allows one to assume that, on the one hand, there is a high need for T_3 which participates actively in the differentiation of tissues and, on the other, T_4 , not transforming into T_3 , exerts a specific effect in this period.

The role of the hormone cortisol which is secreted by interrenal tissue has been shown in many studies. This hormone affects positively the K-Na-ATPase activity and increase gill chloride cells number. It is assumed that cortisol somehow promotes the action of thyroid hormones increasing the number of binding receptors in the cell nuclei³. The observed increase in cortisol in the tissues of sturgeon larvae, may have some bearing on the transitions in intermediary metabolism associated with preparatory mechanisms for migration and seawater adaptation. The sturgeons are known to migrate to the brackish parts of the sea at the earliest stages, they are characterised by early development of hypoosmotic regulation. We have found that in the course of adaptation of the prelarvae to brackish water the hormone levels decrease. Obviously, this is associated with the active involvement of the hormones into formation of the organs. It is noteworthy that in such conditions the larvae do not exhibit any pathology in the development of the intestine which is the most important organ of osmoregulation in the sturgeons.

The simultaneous lowering of the cortisol and thyroxine levels accompanying adaptation of prelarvae to the brackish water confirms their common participation in the osmoregulation processes. T_3 decreases, as a rule, greater than T_4 (T_4 by 16-26% and T_3 by 15-75%). Cortisol is decreased by 63.5-34.5%. Probably, "excess" of cortisol and thyroxine at prelarvae stage not only ensures the processes of differentiation of organs, but it represents also a certain "safety factor" allowing the fish to survive in extreme conditions, one of which could be a too early change of habitat. One may assume that such specificity of the reaction in the hyperosmotic environment characterises only early stages of ontogenesis in

sturgeons when the hypothalamo-hypophysarous system of regulation has not yet been fully formed.

Thiourea did not lead to any significant lowering of the level of the thyroid hormones. However, the larvae exhibited a typical picture of hypothyreosis: they developed slower as against the controls, absorption of yolk sack was hampered, the digestive system and the olfactory organ remained underdeveloped. In this case the cortisol maximum occurred at earlier stages growing lower at the stage of active feeding. It is tempting to account for the above mentioned anomalies in sturgeon prelarvae by a disbalance between cortisol and thyroxine; while in spawning salmon species the total degeneration of the intestine resulting in death takes place against the background of substantial amounts of the cortisol in plasma⁴. The interaction between the thyroid hormones and cortisol at early stages of sturgeon requires further studies.

CONCLUSIONS

In normally developing sturgeon larvae the cortisol dynamics is similar to the dynamics of thyroxine, they both have maximum at the 43rd stage of development.

Thiourea caused decrease in T_4 and T_3 levels in prelarvae placed into fresh and brackish water, with cortisol increased markedly attaining its peak levels at stage 41.

The decrease in the level of the cortisol and the thyroid hormones during the adaptation of sturgeon to the brackish water (6‰) confirms their role in osmoregulation at the prelarva stage.

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