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Physiological Basis of Seawater Inadaptability in a Landlocked Masu Salmon, Biwa Salmon

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Summary

The ability of anadromous salmon to adapt to seawater is an important phenotypic trait subjected to natural selection. Landlocking of salmon relaxes selective pressures on hypo-osmoregulatory ability (seawater adaptability) and may lead to the abandonment of its physiological system. Biwa salmon is a strain/subspecies of *Oncorhynchus masou* that has been landlocked in Lake Biwa for an exceptionally long period (about 500,000 years) and has low ability to adapt to seawater. We investigated the physiological basis of its seawater inadapatability.

We first compared gill Na^+,K^+-ATPase (NKA) activity of landlocked Biwa salmon (spring migrant) with those of anadromous masu (spring migrant) and amago (fall migrant) salmon during their downstream migration periods. The activity of gill NKA in masu and amago salmon increased during their migration periods while that in Biwa salmon remained low in spring, suggesting that Biwa salmon has no inherent seasonal rhythm of increased seawater adaptability. We next examined effects of exogenous growth hormone (GH) and cortisol on gill NKA activity and its subunit mRNA levels. Treatment with the exogenous hormones increased gill NKA activity both in Biwa and amago salmon, while *nka α1b*, a seawater subtype of NKA α-subunit, was unchanged in Biwa salmon. Cortisol was also improved the whole-body seawater adaptability of Biwa salmon. We further measured circulating levels of endogenous cortisol in Biwa and masu salmon during their downstream migration periods. Masu salmon showed a peak in circulating cortisol but endogenous cortisol levels remained low in Biwa salmon in spring.

The present results indicate that Biwa salmon can improve its seawater adaptability by exogenous hormonal treatment and hormone receptors are capable of responding the signals. However, secretion of endogenous hormone (cortisol) was not activated during downstream migration period, which explains, at least in part, their low ability to adapt to seawater.