Trends of Hormonal Levels in the Brain, Pituitary and Serum of Chum Salmon during Homing Migration

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In salmonids, at a particular stage of ocean growth, certain endocrinological changes cause the fish to shift from feeding migration to spawning migration. Previous reports indicate that this shift has been thought to coincide with the onset of gonadal maturation which in turn is regulated by brain-pituitary-gonadal axis (Urano et al. 1999). The hypothalamic decapeptide, gonadotropin-releasing hormone (GnRH) is secreted from axon terminals of GnRH neurons and carried to pituitary where it stimulates the release of gonadotropins (GTHs) from gonadotrophs into the blood stream (King and Millar 1992). GTHs control gametogenesis and production of gonadal steroid hormones (Nagahama 1994).

GnRH released from different regions of brain is considered to have functions not only as a hypophysiotropic hormone that controls reproductive functions but also as a neuromodulator that controls arousal states of various nervous actions in the animal (Oka 1997; Ishizaki et al. 2004). Kudo et al. (1996) investigated the changes in the levels of sGnRH mRNA in chum salmon (*Oncorhynchus keta*) during their migration and reported that a strong signals of sGnRH mRNA in olfactory bulb (OB) and the olfactory nerve were seen at the coastal sea, but these signals were not observed at the spawning ground. This could indicate that GnRH secreted in each brain region may have specific functions during upstream migration in salmonids. There are several reports which investigated changes in the levels of serum steroid hormones during spawning migration in salmonids (Ueda and Yamauchi 1995). However, very little is known about the changes in GnRH and GTHs, and their relationship with steroid hormone levels during homing migration. And, it would be very important to accumulate data on endocrinological changes during the spawning migration of chum salmon. Thus, in this study changes in salmon GnRH (sGnRH) in each brain region were examined for three years. Besides, other reproductive related hormones such as luteinizing hormone (LH) and follicle-stimulating hormone (FSH) in the pituitary, and steroids in serum were also measured.

Chum salmon were sampled in the Bering Sea from late-June to mid-July 2003, 2004 and 2005 during the cruise of RV *Wakatake-maru*. Besides, fish were caught at four to six points along their homing route from Ishikari Bay to their spawning ground in the Chitose River in Hokkaido from late-September to early-October of 2003, 2004 and 2005 for three years (Fig. 1). Blood samples were collected from caudal vasculature, temporarily kept on ice, centrifuged to obtain serum. Upon decapitation, brain and pituitary were removed, where brain was divided into three regions; olfactory bulb (OB), telencephalon (TE) and hypothalamus (HYP) and immediately frozen at ~-80°C until assayed. Steroids (estradiol 17-β (E2), 11-ketotestosterone (11-KT) and testosterone (T) and 17α, 20β-dihydroxy-4-pregnen-3- one (DHP)) from serum, sGnRH from OB, TE, HYP and pituitary; and GTHs from pituitary were measured by time-resolved fluoroimmunoassays (Yamada et al. 1997).

Fig. 1. Locations of sampling points. 1, the Bering Sea; 2, offshore of Ishikari Bay; 3, coastal sea; 4, estuary; 5, branch point of the Chitose River; 6, pre-spawning ground; 7, spawning ground.

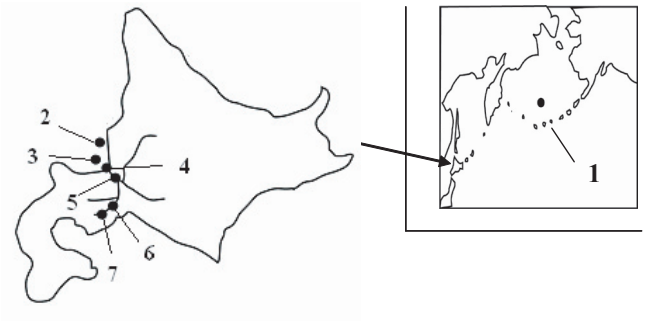

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Fig. 2. Changes in serum levels of steroid hormones in chum salmon during homing migration from 2003 to 2005. Each value represents the mean ± standard error.

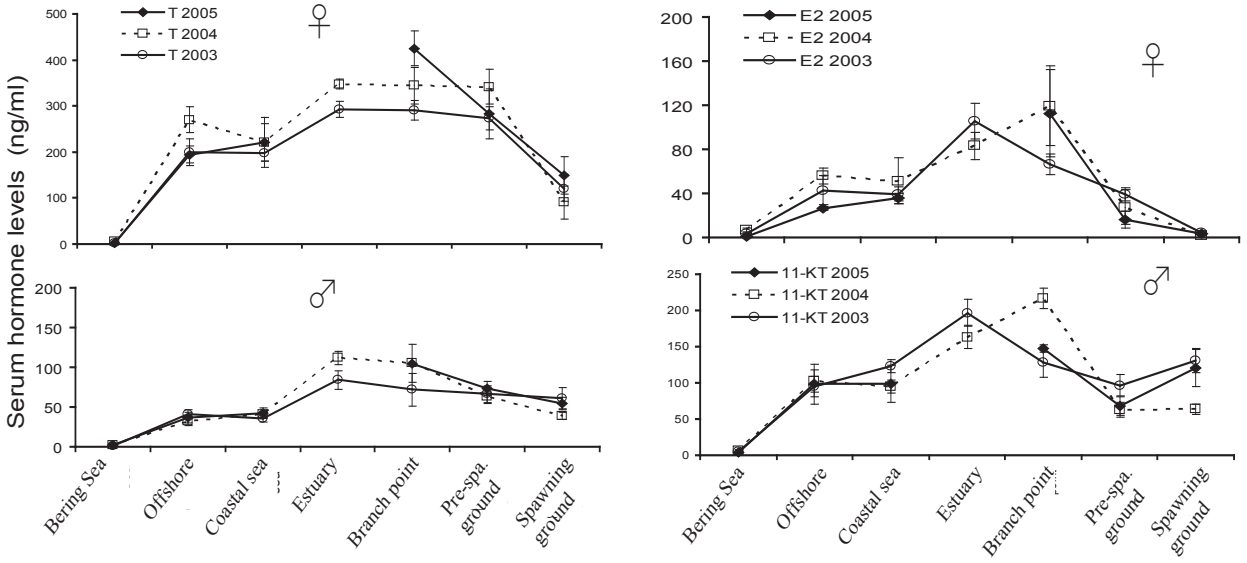
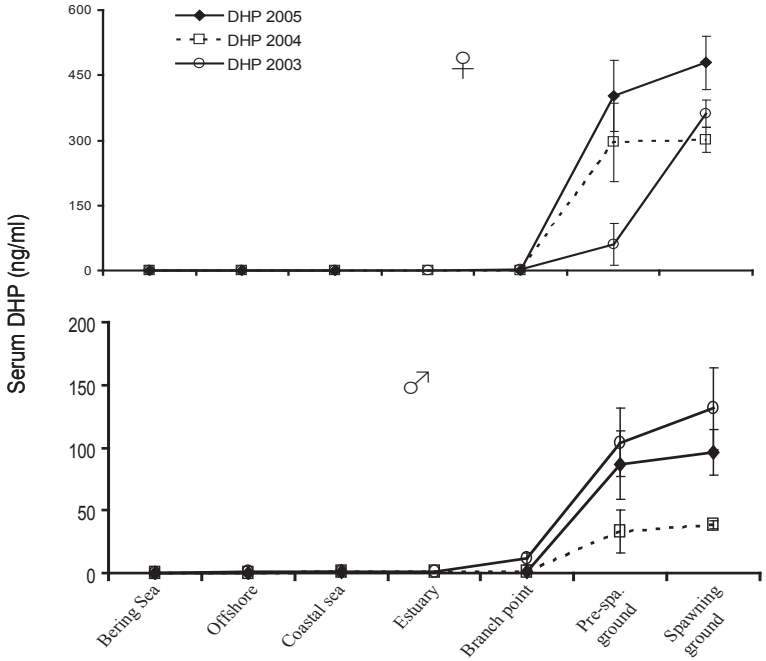


Fig. 3. Changes in serum levels of DHP in chum salmon during homing migration from 2003 to 2005. Each value represents the mean ± standard error.



In both sexes of the three years examined, serum levels of T and E2 were increased significantly at estuary and/or branch point of the Ishikari River from the Chitose River during the homing migration (Fig. 2). In males, serum 11-KT levels were elevated in the same manner as T (Fig. 2), whereas in females they showed an increasing tendency at the spawning ground (data not shown). On the other hand, serum DHP levels of both sexes of three years showed a surge increase in the pre- and spawning ground (Fig. 3). These results are quite similar to those of previous reports (Onuma et al. 2003).

Increased levels of sGnRH in the OB, TE and HYP were observed at offshore in 2004 and 2005, but sGnRH levels at the Bering Sea were similar to those at offshore of Ishikari Bay in 2003, indicating the involvement of BPG axis prior to the onset of spawning migration. Salmon GnRH levels in OB, TE and HYP showed peak values

either at estuary or branch point but the absolute values varied from year to year. In all years examined, LH levels in pituitary increased at the coastal and midway of the homing migration, whereas FSH levels increased at the coastal and showed a decreasing tendency at the spawning ground. Salmon GnRH levels in the pituitary showed similar pattern of changes with LH. There were year-to-year differences in the absolute amounts of serum steroids, brain sGnRH and pituitary GTHs though the general trend of hormonal changes was similar in the years examined. Further comparative approaches will be applied to investigate whether the oceanographic environment influenced the physiological data obtained in this study.

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