Juvenile Chum Salmon in the Okhotsk Sea: Their Origins Estimated by Genetic and Otolith Marks

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Juvenile chum salmon (*Oncorhynchus keta*) are abundant in the Okhotsk Sea during the summer and fall (Ueno 1997; Melnikov et al. 1999a, 1999b; Lapko and Glebov 2001; Volvenko 2003). A genetic stock identification (GSI) study suggested that Japanese stocks dominated juvenile chum salmon catches in the southern Okhotsk Sea in the fall of 1993 (Urawa et al. 1998, 2001), while Russian stocks dominated in the southwestern water during the fall of 2000 (Urawa et al. 2003).

Thermal and dry markings of salmonid otoliths have been well developed as a reliable tool to determine the hatchery origin of salmon. In the spring of 2002, approximately 44 million thermally-marked chum salmon fry were released from 5 hatcheries in Japan (Kawana et al. 2002), and 18 million chum fry with dry or thermal marks were released from 5 Russian hatcheries along the Okhotsk Sea coast (Akinicheva and Rogatnykh 2002).

In the present study, the origins of juvenile chum salmon caught in the Okhotsk Sea in 2002 were determined by using genetic and otolith marks. Fish were caught at 27 stations (45–55ºN and 146–152ºE) by a surface trawl net (1 hour) of R/V *Torishima* in October 2002. The fork length, body weight and gonad weight of each fish were recorded, and scales were removed for the age determination. The sagittal otoliths, muscle, heart, and liver were collected from each fish. The sagittal otoliths were dried and kept in cell well plates until the detection of otolith makers. The other tissues (muscle, heart, and liver) were immediately frozen in -80°C freezer for genetic analysis.

Samples were examined for protein electrophoretic variation on horizontal starch gels using standard procedures described by Aebersold et al. (1987). Alleles were compared and standardized for 20 polymorphic loci. We used Asian baseline data set (43 stocks/20 loci) collected by Winans et al. (1994), Wilmot et al. (1998) and Urawa et al. (2003). Estimates of stock contributions were made with a conditional maximum likelihood algorithm (Pella and Milner 1987) using the Statistics Program for Analyzing Mixtures (SPAM version 3.5, Debevec et al. 2000). Standard deviations and 90% confidence intervals were estimated by 1000 bootstrap resamplings of the baseline and mixture samples. Estimates were made to individual stocks and then pooled to regional stock groups: Japan, Sakhalin, Premorye, Amur River, and northern Russia (Magadan/Kamchatka/Anadyre).

The left sagittal otoliths were mounted on slide glasses using thermoplastic cement, and then ground to expose the primordia. If the left sagittal otoliths were not available, the right sagittal otoliths were used. Otolith microstructures were observed under a light microscope, and the microstructure patterns were compared to the thermal mark patterns of voucher specimens collected from hatcheries before releases.

A total of 2,776 juvenile chum salmon were caught by 27 trawls. Fish were relatively abundant in waters between 50ºN and 53ºN, where the sea surface temperature (SST) ranged between 7ºC and 9ºC. The regional stock composition estimates of juvenile chum salmon was 37.6% Japan, 6.6% Sakhalin, 0.6% Premorye, 4.2% Amur River, and 49.7% northern Russian stocks. The estimated stock composition was apparently different among the catching locations. The percentage of Japanese stocks was high in southern water, but low in northern water. The northern Russian stocks showed the opposite trends in their distribution. Sakhalin and Amur River stocks appeared in the western water.

Nineteen otolith marked fish released from 3 Japanese (Chitose, Shizunai and Ichani in Hokkaido) and 3 Russian (Bereznykovsky and Sokolovsky in Sakhalin, and Ozerki in western Kamchatka) hatcheries were found from juvenile chum salmon caught in the Okhotsk Sea. Japanese marked fish (n=14) were widely distributed in the

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waters south of 53ºN. We are the first to document that Japanese chum salmon juveniles migrate even from the Pacific coast (Shizunai Hatchery) to the Okhotsk Sea. Four otolith marked fish released from two hatcheries in southern Sakhalin were caught in the western water near the island.

The Okhotsk Sea is indispensable for Asian chum salmon as a feeding ground during the early ocean life. It is important to continue the monitoring program for juvenile salmon in the Okhotsk Sea using stock identification and abundance estimate techniques in order to understand the population dynamics of Asian chum salmon.

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