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Stock separation and environmental changes in chum salmon habitats using stable isotope contents in otoliths during 1997-1999

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Introduction

Stable isotope technique in matrine science is becoming powerful tool to reveal the environmental characteristics surrounding organisms during their past life histories. In general, the isotopic data can be used for estimations of habitat temperature, migratory patterns and habitat location, metabolic rates, and investigations of food chains (Kalish, 1991). Chum salmon (*Oncorhynchus keta*) constituted up to 50 % of the annual biomass of the seven species of Pacific salmon in the North Pacific Ocean. Its geographic distribution and migratory route is the widest and longest among salmon species (Bakkala, 1970). Especially, Asian chum salmon seem to have broader habitats to the eastern gyre area, and tagging experiments have been conducted to distinguish stocks in fishery science traditionally. In this paper, authors investigate the geographical distribution, stock separation and habitat characteristics of chum salmon in the North Pacific Ocean, and the stable isotopes $\delta^{18}O$ and $\delta^{13}C$ in otoliths were measured. Also, oceanographic characteristics of salmon habitats in 1997-1999 were investigated by comparing seawater temperature with stable isotopes $\delta^{18}O$.

Materials and methods

Salmon otoliths were obtained from four hatcheries in the eastern (Canada and USA) and western (Japan and Korea) North Pacific during 1997 and 1999 spawning seasons except otoliths of Japan salmon in 1999. Two pieces of sagittal otoliths were washed in distilled water after removal from head, and dried at 80℃ of drying oven for 1-2 days. Ten otoliths collected from each hatchery were sent to the Stable Isotope Laboratory of the University of Michigan for stable isotope

analysis ($\delta^{13}C$, and $\delta^{18}O$). Results from analysis are reported in notation relative to VPDB.

To compare the environmental conditions of salmon habitat with stable isotope contents during the high seas phase of chum salmon, seawater temperature data were analyzed. The data sets were downloaded from the website (NODC of NOAA: http://www.nodc.noaa.gov/GTSPP/gtspp-home.html). Seawater temperature data of 20-50 m depth during May-October of 1997 and 1998 were extracted assuming the residential depth of chum salmon in the water column is the lower part of the surface layer (Ogura, 1994), and the major increment of otolith happened in May-October.

Results

Statistical analysis with $\delta^{18}O$ and $\delta^{13}C$ isotopes indicated that they were largely separated into two groups: Asian and North American chum salmon. Oxygen stable isotopes of Asian salmon were higher values than those in North American ones. On the other hand, carbon stable isotopes appeared in the opposite pattern. Assuming $\delta^{18}O$ and $\delta^{13}C$ values are the indicatives for ocean temperature and productivity at salmon habitats, respectively, Asian salmon seem to reside in cooler temperature and more productive area compare to North American stocks. These results coincide generally the facts that the western gyre shows lower sea surface temperature and higher primary productivity compare to the eastern gyre in the North Pacific. There are interannual differences in stable isotope content of otolith during 1997-1999. The highest $\delta^{18}O$ were found from all otoliths collected in 1999, and the $\delta^{13}C$ and $\delta^{18}O$ values of Korea, USA, and Canada salmon were the lowest in 1998. The lower oxygen stable isotope in 1998, which represents warmer seawater temperature than in 1997 and 1999, may be related to changes of oceanic environment such as the strong El Nino in 1997/1998.

References

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