Migration routes of pelagic crucian carp "*Carassius auratus grandoculis*" endemic to Lake Biwa revealed by otolith Sr stable isotopes.

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1. Introduction

Paddy Fields have a function for the place as fish spawning and as fish juvenile growing. Therefore, it is positioned as an important habitat for conserving biodiversity of fish communities. Cyprinid fish are dominant species in the paddy field. Many fish species dependent on paddy field are threatened with extinction due to declined spawning habitat such as reed bed and lagoon and, disconnected paddy field and Lake. The information of history on the habitat of these fish is indispensable to restore the resource amount of these fish and conserve the habitat.

In recent study, analysis of otolith chemical composition such as Strontium isotope is often used to trace about the habitat use and conditioned behaviors of individuals (Kennedy et al., 2001). Strontium (Sr) stable isotope ratio ($^{87}Sr/^{86}Sr$) of fish otolith varies depending on environmental condition of habitat water. In addition, Nakano et al., 2008 reported that river water qualities around lake Biwa are reflected geological specificity, and are significant spatial variation in the elemental composition and $^{87}Sr/^{86}Sr$. In this study, we tried to trace migration history of fish spawning at paddy filed, using $^{87}Sr/^{86}Sr$ of otolith and fish habitat water around Lake Biwa.

2. Material and Method

At Lake Biwa watershed, fish and habitat water sampling were conducted at paddy field and canal. This study focused on Nigorobuna *Carassius auratus grandoclis*. This fish is endemic subspecies in Lake Biwa, and is known to migrate between lake, paddy field and lagoon. In Shiga prefecture, as a resource growing project, Nigorobuna juveniles are stocked utilizing paddy field. In addition, a follow-up survey of juvenile is conducted. Juveniles were marked its otolith with alizarin complexone, and released into paddy field. In this study, we analyzed trace elements of otolith (lapillus), for marked individuals and for wild individuals collected at paddy fields and water way. Otolith samples are embedded by epoxy resin and grinded to make slice sections. Micro core samples were collected to drill 80μm depth from otolith sections, from the center part (core) to margin along the ring pattern at intervals about 100 μm using micro sampling device (MicroMill, Electro Scientific Industries). Powder samples collected with micro sampling device were dissolved with distilled nitric acid. After measuring trace element of habitat water samples and micro-core samples using ICP-MS, $^{87}Sr/^{86}Sr$ was measured with thermal ionization mass spectrometry.

3. result and discussion.

The mean value (5 individuals) for $^{87}Sr/^{86}Sr$ of the otolith core for marked individuals was 0.71112± 0.00003SD. They were sampled at place where they were released. The $^{87}Sr/^{86}Sr$ value of the otolith core showed similar $^{87}Sr/^{86}Sr$ value (0.71108) in the lake water collected from the sampling site. Additionally, from the center part to the edge part of the otolith, $^{87}Sr/^{86}Sr$ values showed similarity to the $^{87}Sr/^{86}Sr$ value of the lake water collected from the sampling site. These results suggest that the marked individuals migrated around released-place and returned to spawn at sampling site without migration to the north part of the lake. This was confirmed because there were no signals detected from the otoliths that could

indicate they migrated to the north part of the lake. For wild individuals, the mean value (three individuals) for $^{87}Sr/^{86}Sr$ of the otolith core is 0.71184±0.00009 which is also within the range $^{87}Sr/^{86}Sr$ values of the paddy field. $^{87}Sr/^{86}Sr$ values of otolith edge (0.71217-0.71236) was close to the $^{87}Sr/^{86}Sr$ values of south part (0.71221) and north part (0.71250) of the lake. These results suggest that the wild individuals return to the paddy field to spawn after migrating from the coast of Lake Biwa. The results of these preliminary analyses suggest the potential of the method using $^{87}Sr/^{86}Sr$ of the otolith micro-core in tracing migration history of freshwater fish.

Keywords: fish migration, Strontium isotope ratio, Lake Biwa, otolith, paddy field ecosystem

