Tracing of geographic origin of fish by Pb isotopes in fish bones

*Hinako Nishimura[1], Keiji Horikawa[2], Ki-Cheol Shin[3]

1. Graduate School of Science and Engineering, University of Toyama, 2. Graduate School of Science and Engineering for Research, University of Toyama, 3. Research Institute of Humanity and Nature

Introduction

Ongoing marine environment changes is considered to disturb migration patterns of fishes. To use aquatic resources continuously, it will be required to comprehend migration patterns of fishes. Methods for tracing the migration of fish include mark-and-recapture method (Harden-Jones, 1968), biologging, and isotope ratio analysis. Recently, since neodymium (Nd) isotope ratios have characteristic in each oceanic region, Nd of fishes have been measured to test whether or not it makes possible to trace a migration pattern of fish. Like Nd in the ocean, the average residence time of Pb in the ocean is also short (about 10 to 100 years), and thus lead (Pb) also has characteristic isotope ratios in each oceanic region (Pinedo-gonzalez et al., 2018; Zurbrick et al., 2017; Chien et al., 2017; Lee et al., 2015) that are determined by natural and anthropogenic Pb inputs. Further, Pb is highly accumulated in fish bones up to several ppm, allowing us to measure Pb isotopes with a small amount of the bone samples. Therefore, there is a possibly that Pb isotope ratio in fish bones will be new and complementary method to trace migration patterns and/or to determine geographic origin. At this point, Pb isotopes of fish bones are not yet published, and therefore, we started to investigate the Pb isotope ratios of fish bones for many types of (river and marine) fishes collected from many types of oceanic regions, in the Japan Sea, East China Sea, western North Pacific, and North Atlantic. We also analyzed concentration of heavy metals in fish bones, and evaluated the difference in heavy metal content collected from different oceanic regions.

Materials and Methods

We have mainly measured seawater fish, such as Mackerel and Horse mackerel that inhabited in the Japan Sea, East China Sea, western North Pacific, and North Atlantic. The collected fish samples were divided into various parts such as back bone and muscle. These sample were freeze-dried and decomposed with nitric acid using a microwave (Mars6, CEM). The concentration of trace elements (Al, Cr, Mn, Fe, Cu, Zn, As, Cd, Pb) in fish bone samples were measured by a ICP-MS (Agilent 7700x, Agilent). Pb was separated using Sr resin (Eichron), and then Pb isotopes were measured by a MC-ICP-MS (NEPTUNE, Thermo Scientific), RIHN.

Results and Discussion

The $^{207}Pb/^{206}Pb$ and $^{208}Pb/^{206}Pb$ ratios of Blue mackerel, *Scomber australasicus* (n=12) (lived in the ocean near Japan) ranged from 0.8493 to 0.8543 and 2.0809 to 2.1028, respectively. In contrast, Atlantic mackerel, *Scomber scombrus* (n=5) (lived in the ocean near north Atlantic Ocean) ranged from 0.8520 to 0.8601 and 2.1003 to 2.1085, respectively. The t-test showed that the average values of Pb isotope ratios of these two species were significantly different. These data suggest that the geographic origin of mackerels could be identified by Pb isotopes of fish bones. Average concentrations of heavy metals in fish which lived in the ocean near Japan represented Zn> Mn> As> Fe> Al> Pb> Cd> Cu> Cr. Comparison with the previously published data (Gu et al., 2017) in the ocean near south china showed that the Zn concentration of fish bones in the ocean near Japan was about four times higher, and other elements tended to be lower values.

Keywords: Pb isotopes, Heavy metals, Fish bones, Tracing of geographic origin

