Geographic variation of stable isotope ratio and trace element level to the marine top pradetor in North Western Pacific Ocean

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Tracing of animal movement using chemical tag such as carbon and nitrogen stable isotope has been well developed for last decades. Although application of this approach to the marine predators has been challenging, various reports indicated usefulness of isoscape approach to tuna, and shark. Apart from traditional stable isotopes, trace element level and its stable isotope ratio are potentially useful as the ecological tracer since some essential micronutrients show distinctive geographical variation. However, understanding of the trophic transfer and metabolic cycle of trace elements are still not sufficient to extends trace elements variation to the isoscape approach. Here we show the comparison of trace element level and carbon/nitrogen stable isotope ratio of the muscle tissue of three species of cetaceans, harbor porpoise (HP: *Phocoena phocoena*, n=16), striped dolphin (SD: *Stenella coeruleoalba*, n=23), and Meron-headed whale (MW: *Peponocephala electra*, n=29) archived to the environmental specimen bank, Ehime University, to evaluate the link of trace element level to their geographical distribution. Liver and brain of SD (n=12 and 13) were also measured to assess metabolic cycle of each element.

Each tissue was freeze-dried, homogenized, then acid-digested by a microwave device. Trace element concentrations in the digested solution were measured by inductively coupled plasma mass spectrometer (ICP-MS). The carbon and nitrogen stable isotope ratios were measured by gas chromatography combustion type isotope ratio mass spectrometer (GC-C-IR-MS). All the statistical analysis was made using R software.

The variation of $\delta^{13}C$ in muscle of HP, SD, and MW were -19.0 to -17.2, -18.1 to -17.1, -17.0 to -16.7‰, respectively. Since HP inhabits coastal region around Hokkaido, largest variation plausibly reflected effect of local carbon sources. Higher $\delta^{13}C$ of MW than SD is consistent with latitudinal trend of baseline value, i.e. $\delta^{13}C$ increase toward higher latitude, since MW prefers tropical ocean more than SD. These results suggested that geographic variation of isotope signal can be partly retained in the top predator despite wide range migration of these species.

Trace element variations in muscle tissue were generally small for essential elements such as Fe, Mn, Zn, Cu, Co, and Se irrespective to the species. The relative standard deviation (RSD) of these elements were <30% except for the Co in HP. Since homeostatic regulation of the other elements seemed weak, environmental factors possibly control these levels. Body size dependence was significant for Co, Pb of HP, Al, Ca, Cr, Se, Sr of MW, and Co, Sn, Zn of SD, while the Ca, Cu, Mn in SD was negatively correlated. Principal component analysis (PCA) indicated that trace element profile was distinctively different in HP compare to the SD and MW. The difference is characterized by the higher Mn and Cu levels. Effect of terrestrial input of these elements can be a cause of this trend. The higher Fe level of SD and MW plausibly attributed to the high oxygen demand of these open sea dolphins. Significant positive correlation of Fe and Mn for all species suggested similar role of these elements in all the cetaceans. Comparison of trace element level among the tissue of SD indicated that most of the elements were the highest in liver, including V, Mn, Co, Cu, Zn, As, Se, Cd, Sn, and Pb.
From the results of this study, there were distict differences in both trace elements and stable isotope

ratios between HP and the other two species. This is probably due to habitual differences between coastal area and open ocean. Further study for chemical analysis of prey is necessary to clarify the factors controlling the trophic transfer of trace elements and its effect for isotope fractionation. In the presentation, the comparison with the fish data will also be shown to discuss the differences of accumulation feature of trace elments between mammal and fish.

Keywords: trace element, marine mammal, stable isotope

