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Temporal variation of ^{137}Cs in zooplankton and its primary factor in the waters off Fukushima and nearby prefectures

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The East Japan earthquake on 11 March 2011 and the ensuing tsunami resulted in the release of large amounts of radionuclides from the accident of Fukushima Dai-ichi Nuclear Power Plant (FDNPP) into the surrounding environment. Cesium has similar chemical properties with potassium, which is the essential element for living organisms, and is easy to be incorporated into living organisms. The half-life of radioactive cesium (^{134}Cs and ^{137}Cs) is 2 and 30 years, respectively. For the relatively long half-life of ^{137}Cs compared with ^{134}Cs, continuous monitoring of the levels of ^{137}Cs contamination is indispensable.

Zooplankton play a key role in marine biogeochemical cycle as secondary producers in the marine food web because they are major food for fishes and organisms of higher trophic levels. Therefore it is important to have information on their ^{137}Cs concentration and behavior of ^{137}Cs between zooplankton and surrounding environment such as seawater, surface sediment, and suspended marine particle.

Methods

In this study, zooplankton samples were collected at seven to eight sampling locations in the waters off Fukushima and nearby prefectures during May 2012 to January 2014. The ^{137}Cs concentrations in the samples were measured with Ge detectors and the compositions of zooplankton species were analyzed by microscopic observation. The zooplankton samples were obtained by horizontal towing at a depth range of 0-80 m using a large ring net. Seawater and sediment samples were also collected at the corresponding locations with zooplankton samples.

Results

Concentrations of ^{137}Cs in zooplankton ranged from 0.26 to 184 (Bq/kg-dry) during the sampling period (May 2012-January 2014). The concentration peaks did not appear concurrently at each station. In January 2014, concentrations of ^{137}Cs in zooplankton ranged from 6.59-40.3 (Bq/kg-dry) and they were still one or two orders of magnitude larger than those detected before the accident of FDNPP (0.09-0.4 Bq/kg-dry, Kaeriyama et al., 2008). The taxonomic composition varied seasonally and geographically but Maxillopoda were generally dominant throughout the study.

^{137}Cs in zooplankton are thought to be derived from surrounding environment such as seawater, surface sediments, suspended particle, and food. Since the ^{137}Cs concentration in surface sediments has not decreased so fast as that in seawater with time, ^{137}Cs in surface sediments might be incorporated into zooplankton by resuspension of surface sediments. Assuming that aluminum in zooplankton is only derived from surface sediments, the contributions of surface sediments to ^{137}Cs in zooplankton were estimated as 10%. ^{137}Cs in zooplankton in unit volume of seawater (μBq/m^3) were not correlated with both of ^{137}Cs in ambient seawater (Bq/L) and zooplankton biomass (mg-dry/m^3). On the other hand, the timings of high relative abundance of Appendiculata, Osteichthyes and phytoplankton corresponded to the timings of relatively high concentrations of ^{137}Cs in zooplankton. Therefore it is implied that variability in ^{137}Cs concentrations in zooplankton attributed to the composition of plankton species rather than concentration of ^{137}Cs in surrounding environment and plankton biomass.

Acknowledgements

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Reference

Kaeriyama, H., Watabe, T., and Kusakabe, M. (2008). ^{137}Cs concentration in zooplankton and its relation to taxonomic composition in the western North Pacific Ocean. Journal of environmental radioactivity, 99(12), 1838-1845.

Keywords: Fukushima Dai-ichi Nuclear Power Plant accident, ^{137}Cs, Zooplankton, community composition