

Elimination of the heavy metals from coastal water by scallop cultivation

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Mutsu Bay in northern Japan is a semi-enclosed shallow water basin connected to Tsugaru channel between the Sea of Japan and Pacific Ocean. The problem of seawater eutrophication has not been appeared in Mutsu Bay because the human population density around the bay is relatively low. However, Mutsu Bay is one of Japan's most famous areas for the scallop cultivation, and about 100,000 tons of the scallops which took up inorganic substances in seawater are landed every year. For example, it is known that the mid-gut glands of scallops accumulate high levels of cadmium. We determined the nitrogen and carbon stable isotope ratios and the trace element concentrations of fish and measured the material cycles in Mutsu Bay and the Sea of Japan.

The Japanese whiting *Sillago japonica* were collected from the coastal areas (Mutsu Bay: 7 sites, the Sea of Japan: 10 sites) of Aomori Prefecture, northern Japan, in 2012 and 2013. We determined the nitrogen and carbon stable isotope ratios of their muscles by DELTA-plus Isotope Ratio Mass Spectrometer coupled with NC2500 Elemental Analyzer (Thermo Fisher Scientific), the levels of 25 elements (Li, Mg, Ca, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, As, Rb, Sr, Mo, Cd, In, Sn, Sb, Cs, Ba, Tl, Pb, Bi) in their livers by ICP-MS (Agilent, 7500cx), and the mercury levels in their livers by the cold vapor technique with an automatic mercury analyzer (Nippon Instruments Corporation, RA-3220A).

The carbon stable isotope ratios ($\delta^{13}\text{C}$) of Mutsu Bay specimens were higher than those of the Sea of Japan specimens. The nitrogen stable isotope ratios ($\delta^{15}\text{N}$) were not different in most of the sampling sites, but the ratios were obviously higher in the particular site of Mutsu Bay. It was considered that this phenomenon was locally caused by the unnatural nitrogen supply.

Moreover, the levels of 15 elements (Li, Mg, Ca, Mn, Fe, Co, Cu, Zn, Rb, Sr, Mo, Cd, Cs, Hg, Pb) in the livers of Mutsu Bay specimens were significantly lower ($p < 0.01$, U test) than those in the Sea of Japan specimens. Especially, the levels of cadmium and mercury for $\delta^{15}\text{N}$ values were obviously low in the Mutsu Bay specimens. This result suggested that some elements such as cadmium were brought out from Mutsu Bay by the landing of cultured scallops.

In Iwasaki fishing port (one of the sampling sites in the Sea of Japan), the levels of 8 elements (V, Fe, Co, Cu, Ga, Cd, Hg, Pb) of the specimens captured in 2012 were significantly higher ($p < 0.01$, U test) than those in 2013. In March 2012, a cargo ship was stranded nearby Iwasaki fishing port, and the oil spilled into the ocean.

Keywords: essential trace element, stable isotope, Japanese whiting, Japanese scallop, element elimination