Transfer of Radiostrontium and Radioiodine to Marine Organisms

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Abstract

A commercial large-scale nuclear fuel reprocessing plant in Rokkasho, Aomori Prefecture, Japan is now under final safety assessment by the Nuclear Regulation Authority. Radionuclides including radiostrontium and radioiodine are discharged by the normal operation of the plant. In order to assess the realistic impact of those radionuclides, it is important to understand the processes of their accumulation from seawater to marine organisms. In this research, we investigated the transfer of Sr and I from seawater and feed to bastard halibut (*Paralichthys olivaceus*), a commercially important fish found in the coastal waters of Aomori Prefecture.

In order to investigate transfer of radiostrontium ingested as feed to bastard halibut, white leg shrimp (*Litopenaeus vannamei*) and Japanese medaka (*Oryzias latipes*) were kept in water with enriched ^{86}Sr and ^{87}Sr as tracers, respectively. The organisms were lyophilized, powdered, and dispersed in gelatin glue derived from fish. The solidified glue was cut into a suitable size pieces and administered as feed to the halibut. The concentrations of tracer Sr isotopes in the muscle and vertebra in the halibut were increased depending on the dose.

To clarify the long-term excretion rate of Sr from the halibut, we transferred the halibut, which had been kept in seawater with enriched ^{86}Sr in advance, to normal seawater tanks. The fish were periodically collected up to 217 d after the transfer, and the concentrations of ^{86}Sr in their muscle and vertebra were measured. The ^{86}Sr concentration decrease in the muscle could be described by two exponential curves with half-times of 0.29 d and 1.7×10^2 d, while the decrease in the vertebra could be described by a curve with half-time of 2.2×10^2 d. The experiment will be continued in FY 2019, and all data obtained will be used for construction of a metabolic model of Sr in bastard halibut.

In FY 2018, we developed a short-term metabolism model of ^{125}I in bastard halibut using retention data after ingestion of ^{125}I incorporated into Japanese medaka, which had been kept for 7 d in water containing ^{125}I. Bastard halibuts aged >159 d after hatching were fed only ^{125}I labeled medaka once a day for 1-6 d. The radioactivity of ^{125}I in individual medaka was measured before feeding, and the medaka was given whole to the bastard halibut. Bastard halibuts were collected 24 h after the last feeding and dissected, followed by the measurement of radioactivity in their tissues. In addition, certain fish in the group fed medaka for 6 d were sampled 3 and 6 d after the last feeding. Using whole body retention data of ^{125}I excluding that in the gastro-intestinal (GI) tract, we constructed a single compartment model to simulate ^{125}I uptake and metabolism. The GI absorption ratio (f_1=0.41) and elimination rate constant from the whole body (k_{el}=0.010 h^{-1} corresponding to biological half-time of 2.9 d) were obtained using the least squares method. The model adequately simulated the short-term behavior of ^{125}I and indicated the rapid metabolism of radioiodine in bastard halibut.

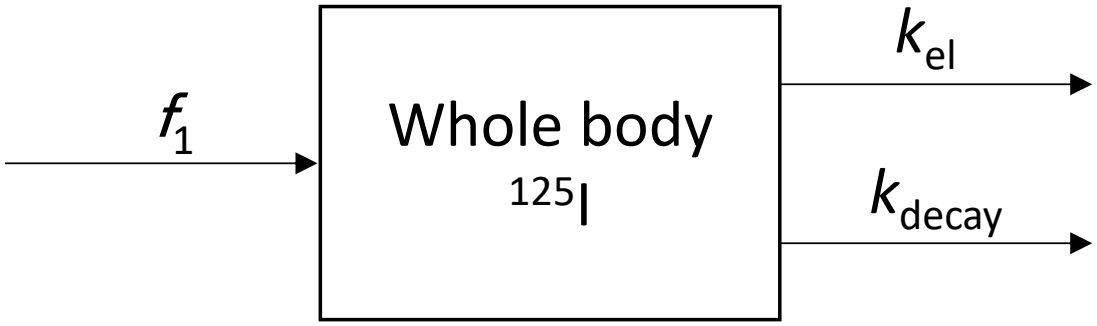

Fig. 1 Scheme of compartment model of ^{125}I ingested as biologically-incorporated ^{125}I in bastard halibut. f_1, GI absorption ratio; k_{el} (h^{-1}), elimination rate constant; k_{decay}, decay constant of 0.00019 h^{-1}.

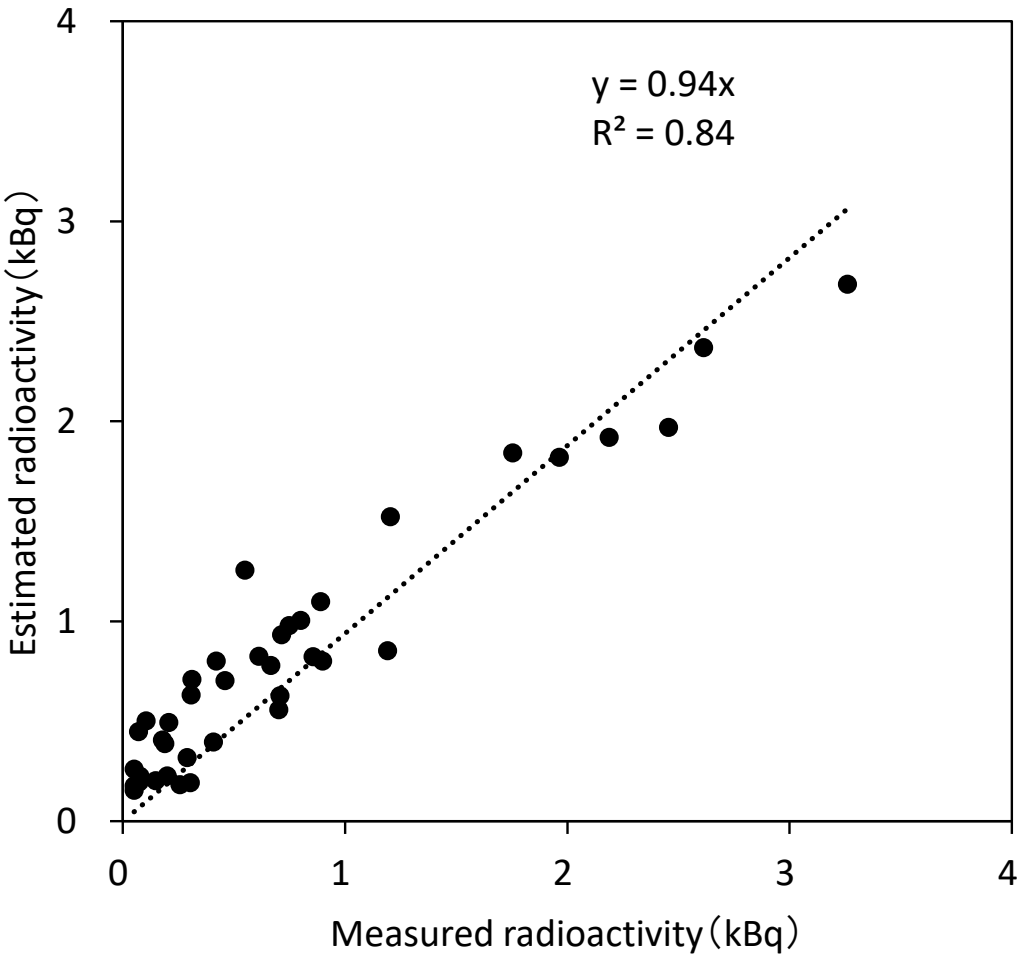

Fig. 2 Radioactivity of ^{125}I estimated with the compartment model against the measured one in bastard halibut after ingestion of biologically incorporated ^{125}I.