Are Sediments a Source of Fukushima Radiocesium for Marine Fauna in Coastal Japan?

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The Fukushima nuclear power plant accident in 2011 resulted in the largest accidental release of artificial radionuclides into the world's oceans. Among the fission products released in large quantities, ^{137}Cs has the greatest potential for long-term impacts on marine biota and human consumers of seafood. Bottom dwelling fish near Fukushima had consistantly higher radiocesium (^{134}Cs and ^{137}Cs) levels than pelagic fish in the same area. We hypothesized that contaminated sediments have acted as a source of Cs for benthic fish and their invertebrate prey. The large temperature differences between surface and bottom waters off Fukushima may also affect the elimination rates of Cs in fish. We therefore assessed (a) the release of Cs from sediments to overlying waters, (b) the bioavailability of sediment-bound and dissolved Cs for deposit-feeding polychaetes, and its subsequent transfer to crabs and fish, and (c) the effects of water temperature on Cs retention in fish. We found that desorption of Cs from sediments to overlying seawater followed a concentration gradient, and bioturbation by polychaetes significantly increased the initial release rate of Cs to overlying seawater. The assimilation efficiency of ingested ^{137}Cs ranged from 16% in polychaetes ingesting sediments to 79% in fish ingesting worms. Efflux rate constants of ingested ^{137}Cs ranged from 5% d^{-1} for killifish to 40% d^{-1} for polychaetes. Uptake rate constants of dissolved ^{137}Cs ranged from 0.6 mL g^{-1} d^{-1} in killifish to 20 mL g^{-1} d^{-1} in polychaetes. Efflux rate constants following aqueous exposure ranged from 6% d^{-1} for killifish to 20% d^{-1} for polychaetes. Unlike dietary Cs, elimination of aqueous Cs in killifish is not affected by temperature in the range of 10-20 °C. Our results are consistent with the idea that sediments can be a continuous source of Cs for benthic food chains and help explain why bottom fish remained more contaminated than pelagic fish.