Experimental Studies on Plutonium Kinetics in Marine Biota

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Laboratory experiments were undertaken to measure plutonium flux through marine organisms and to clarify the pathways by which this important element is cycled in the marine environment. The use of a specially prepared isotope, plutonium-237, allowed measurements to be made with standard NaI(Tl) scintillation techniques. Mussels, shrimp and worms were allowed to accumulate plutonium-237 from sea water for up to 25 days. Accumulation by shrimp was relatively slow and the degree of uptake was strongly influenced by moulting. Cast moults contained large fractions of the shrimps' plutonium content, indicating the high affinity of plutonium for surface areas. Only small amounts of the isotope in the moult are lost to water; hence, moulting is considered to be an important biological parameter in the biogeochemical cycling of plutonium. Mussels attained higher concentration factors than shrimp with most of the accumulated isotope (> 80%) located in the shell. Byssus threads often contained large fractions of the mussels' plutonium-237 content and reached concentration factors as high as 4100. Worms readily accumulated plutonium-237 in either the +4 or +6 state, reaching concentration factors of approximately 200. Retention studies indicated a relatively slow loss of plutonium-237 from all animals studied. In the case of mussels, a computed half-time for a large fraction of the animals' plutonium content was of the order of 2 years. The more rapid loss from shrimp ($Tb_{\frac{1}{2}}$ = 1.5 months) was due principally to the large fraction of plutonium lost at moult. Food chain studies with shrimp indicated that tissue build-up via plutonium ingestion would be a slow process. Total excretion was not entirely a result of passing contaminated food through the gut; approximately 15% of the ingested plutonium was removed from the contaminated food and subsequently excreted by processes other than defaecation of labelled food. Ratios of four different plutonium isotopes used in the experiments showed that when the isotopes were present together in the same physico-chemical form, no differences in isotopic behaviour were evident even in cases in which total mass of certain isotopes in the system differed by 10^3. It is concluded that plutonium-237, because of its relatively high specific activity, offers the best possible means for tracing plutonium biokinetics in aquatic systems in which the experimental design dictates that total plutonium concentrations approximate to those currently found in the environment.

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