Accumulation and Loss of Selected Radionuclides by *Meganyctiphanes norvegica* M. Sars

by

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Abstract*

The diel vertical migration of certain planktonic and nektonic organisms is responsible for world-wide rhythmical translocation of a considerable biomass in the sea. To assess the possible role of vertically migrating organisms in spreading radionuclides, the accumulation and loss of ^{54}Mn, ^{57}Co, ^{59}Fe, ^{65}Zn, ^{106}Ru and ^{141}Ce was investigated in the euphausiid *Meganyctiphanes norvegica* M. Sars.

In laboratory experiments of 12 hours duration the accumulation of ^{59}Fe, ^{65}Zn, ^{106}Ru (Cl form), and ^{141}Ce showed an initial rapid uptake which gradually decreased with time. After 12 hours, the concentration ratio for ^{65}Zn was 85, that for ^{141}Ce was 65, and the ratios for ^{59}Fe and ^{106}Ru (Cl) were 30 and 20, respectively. Concentration ratio is defined as the activity per milligram live weight of euphausiid divided by activity per milliliter of water. ^{106}Ru (N form) was not accumulated strongly, and had a 12-hour concentration ratio of 3. The relatively strong accumulation of ^{141}Ce was not expected, as cerium is largely particulate in seawater and has no known biological function. The relatively low concentration ratio for ^{59}Fe is probably due to the unavailability of the isotope because of its physico-chemical form in seawater. Almost 90% of the ^{59}Fe in the water at 12 hours could be trapped on a filter of 0·45 μ nominal pore size.

Uptake of ^{54}Mn, ^{57}Co, ^{59}Fe and ^{65}Zn was followed in 5-day experiments in seawater. Equilibria of exchange were not reached with any of the isotopes in 5 days. Molting of the euphausiids' exoskeletons periodically lowered the total body burdens, showing that much of the radioactivity accumulated directly from the water is on the outer surfaces of the animals. Sometimes up to 70 % of the body burden was removed with the cast exoskeleton. ^{54}Mn, ^{57}Co and ^{59}Fe reached about 10 nanocuries/animal after 5 days, whereas ^{65}Zn averaged about 175 nanocuries/animal after the same time period. Animals were given equal activities of all four isotopes at the beginning of the experiment, so that ^{65}Zn clearly had the fastest net rate of accumulation.

Loss of ^{59}Fe, ^{65}Zn, ^{106}Ru(Cl), ^{106}Ru(N), and ^{141}Ce from euphausiids was followed for 12 hours in fresh, running seawater, after the 12 hour uptake period. Only 10 % of the ^{141}Ce body burden was lost after 12 hours, again a somewhat surprising result. About 25 % of the ^{65}Zn, 30 % of the ^{59}Fe and 35 % of both ^{106}Ru forms were lost in 12 hours, although there was much variation in the ^{59}Fe and ^{106}Ru data.

Loss of ^{54}Mn, ^{57}Co, ^{59}Fe and ^{65}Zn into non-running seawater (after 5-day uptake from seawater) was monitored for 48 days. The animals were fed non-radioactive *Artemia* nauplii during the loss experiments. Molting was responsible for the most drastic losses of isotope from the animals, indicating again

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that much of the radioactivity accumulated from seawater in 5 days was still associated with outer surfaces of the animals. The first molt after the initiation of the loss experiments was particularly effective in removing radioactivity. For example, about 7 days were required to remove 50 % of the initial body burden of ^{54}Mn by exchange mechanisms alone, but the first molt immediately removed another 35 %, on the average. All animals had molted by the 7th day in our experiments, and the average percentage of the initial ^{54}Mn activity that remained a after the 7th day was 15 %. With successive molts and continuing isotope exchange with the water, only 1 % of the initial ^{54}Mn body burden remained after 30 days. In the case of ^{57}Co, simple isotope exchange would have required 10 days before 50 % of initial body burden was reached, but with molting, only 7 % of the body burden actually remained after 7 days. Only 1 % remained after 17 days, on the average. With ^{65}Zn, exchange would have taken 10 days to bring about a 50 % reduction in initila activity, but with the occurrence of the first molt during this time the body burden was reduced to an average of 15 % of the initial activity in 6 days. Succeeding molts did not substantially reduce the ^{65}Zn body burden over and above that which could be accounted for by isotope exchange; thus, the 1 % level was not quite attained in the 48-hour duration of the experiment. This result suggests that zinc is mobilized away from exoskeletal surfaces and into body tissues more efficiently than the other isotopes tested. The results with ^{59}Fe were inconclusive and must be repeated.

In a final experiment, euphausiids accumulated ^{54}Mn, ^{57}Co, ^{59}Fe, and ^{65}Zn by feeding on labelled *Artemia salina*, and loss curves were developed after placing the euphausiids into seawater with non-radioactive *Artemia* for 65 days. When uptake was through the food chain, molting loss was insignificant and the loss curves were smooth. Only 7 days were required for 50 % loss of ^{65}Zn, but after 65 days 15 % of the initial ^{65}Zn activity still remained in the animals. With ^{54}Mn and ^{57}Co, 50 % loss was achievedin 3 days and 1 day, respectively, but about 1 % of the ^{54}Mn remained after 65 days and 1 % of the ^{57}Co was left after about 50 days. Loss of ^{59}Fe again depended on physico-chemical state of the isotope, and results were quite variable.