The effect of organism size on the content of certain trace metals in marine zooplancton

by

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Interest in trace metal pollution has risen recently with the observation that ever increasing amounts of certain metal pollutants are entering coastal waters (directly from outfalls or dumping) as well as the open oceans (indirectly via atmospheric transport). These metals, if concentrated to a sufficiently high degree by biota in the food chain, could become toxic to both prey and consumer alike.

Zooplankton, by virtue of their large biomass and capacity to concentrate certain trace elements, may be an important vector for metal cycling in the marine waters. Therefore, measurements of tissue trace element concentrations may give some insight into the accumulation mechanisms involved as well as the ability of organisms to cycle these metals.

Individual species of euphausiids and pelagic shrimp, collected at the same time and place, were sorted into different size groups and analyzed for several biologically important trace metals by atomic absorption spectrophotometry and neutron activation. Other specimens from these samples were dissected into gross anatomical parts and analyzed in the same way. Molts collected from zooplankters maintained live in the laboratory were also analyzed for metals.

Results for the different size-group experiments showed that in general the concentrations of zinc, iron, and manganese were inversely correlated with dry body weight. Depending upon the crustacean species, metal concentrations in smaller individuals ranged from 1.2 to 4.1 times greater than those in larger individuals of the same species. Copper concentration on the other hand, tended to be a direct function of dry weight.

Concentrations of zinc, iron, and manganese were generally higher in molts and dissected exoskeletons than in muscle tissue, however, the opposite was true for copper. The amount of material shed by euphausiids in molting ranged from 4.7 to 10.9 % of dry body weight with smaller animals tending to lose a greater percentage of body weight than the larger specimens. These molts, in which ash accounted for about 40 - 50 % of the dry weight, contained 15 - 20, 19 - 45, 28 - 40, and 15 % of the total body zinc, iron, cobalt, and manganese, respectively. Only 5 % of the total body copper content was associated with the molt. In addition, molts from smaller crustaceans had higher concentrations of zinc and iron than those from larger species.

The findings for zinc, iron and manganese suggest the possibility that surface sorption phenomena play a role in the accumulation of these metals in planktonic crustacea. It is probable that some metals in the exoskeleton serve a metabolic function, since there is evidence that certain metalloenzymes are associated with the new shell of crustacea just before molt. However, the older, outermost layer of the chitinous exoskeleton usually lost by planktonic crustaceans is probably not metabolically active. Thus, a relatively large fraction of the animal's metal content is associated with the older inert chitin, indicating that much of the trace metal measured in small planktonic crustaceans is merely sorbed to the surface and is not physiologically necessary. In an ecological sense, the rapid molting frequency of these crustacea (every 4 - 10 days), the relatively high concentration of certain metals in the exuviae, and the slow breakdown of the chitinous molt, make the process of molting an important vector in the downward transport of metals in the sea.

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The direct relationship between copper content and body weight in *Pasiphaea* plus the fact that copper values were lower in molts than in muscle tissue of other crustaceans indicate that surface area is probably not of major importance in the concentration of this metal by planktonic crustacea. Copper is associated with the respiratory pigment haemocyanin, and perhaps a greater pigment concentration to facilitate more rapid gas exchange in larger carids might account for the relationship between copper and body size in *Pasiphaea*. Within the subclass Malacostraca haemocyanin has been found only in the order decapoda, thus the presence of copper in euphausiids can only be speculative at this point.

Recently, effort has been made to locate indicator organisms that can act as monitors of changes in environmental levels of certain pollutants. Increases in the external concentration of the pollutant are often reflected by only subtle changes in the levels in organisms. The results from the analyses of different sized crustaceans show that changes in metal content within one species can be due to size alone; therefore, care should be taken to consider organisms size when establishing baseline levels of metals in aquatic organisms.