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# Uptake and Elimination of [9-$^{14}$C]Phenanthrene in the Turkey Wing Mussel (*Arca zebra*)*

Jan Erik Solbakken,[1] Anthony H. Knap,[2] Christine E. Searle,[2] and Karsten H. Palmork[1]

[1]*Institute of Marine Research, Nordnesparken 2, N-5011 Bergen, Norway, and* [2]*Bermuda Biological Station, 1-15 Ferry Reach, Bermuda*

Phenanthrene, a well known polycyclic aromatic hydrocarbon (PAH), is used as a model compound in our studies. In the series of experiments that we have undertaken, we try to elucidate differences in the uptake and elimination of this compound in various marine organisms.

The turkey wing, Arca zebra, is a bivalved mollusc inhabiting the shallow rocky areas surrounding Bermuda. We have shown in previous studies that the subtropical clam Macrocallista maculata has a more efficient elimination of phenanthrene than the temperate mussel Modiola modiolus (PALMORK & SOLBAKKEN 1981, SOLBAKKEN et al. 1982). In this experiment we therefore wanted to study the uptake and elimination of phenanthrene in a subtropical mollusc under the same laboratory conditions as in the previous studies. The higher temperature in subtropical areas may result in a more efficient elimination of xenobiotics. The results from the calico clam experiment were in agreement with this assumption. It was therefore decided to do a number of experiments using mussels from the same area as the calico clam in order to determine if a general trend is present in subtropical molluscs.

## EXPERIMENTAL

Organisms. Turkey wings Arca zebra of both sexes with a mean weight (meat + blood) of 21.2 ± 5.3 g (mean ± SD, n=25) were collected from Harrington Sound, Bermuda. The organisms were not fed during the duration of the experiment, and the behaviour was normal.

Treatment and maintenance. The organisms were dosed after a week-long acclimation period with [9-$^{14}$C]phenanthrene (714 MBq/mmol). They were transferred into 8 L of seawater containing 102 µg of labelled phenanthrene which was well mixed. Small air pumps were used to provide aeration during a 24-h dosing period. The 25 mussels were then placed into a tank of filtered seawater (73 L, 36°/00, 29°C, flowrate 2 L/min).

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Sample preparation. The concentration of radioactivity in the water was measured at the beginning of the dosing. Sampling of the mussels occurred at different time intervals after dosing. Groups of 5 were removed from the tank and frozen (-20°C) until required. After thawing, blood samples (2 mL aliquots) were taken. The tissues were then rinsed in methanol to remove surface radioactivity, and samples of the hepatopancreas, gills, and muscle were taken in replicates of approx. 100 mg. The samples were analyzed on a Packard 300 CD liquid scintillation counter using standard methods (Soluene-350 and Dimilume-30, Packard Instrument Co.) and an automatic quench correcting system. The test for comparison of the means was conducted using Student's t-test.

## RESULTS AND DISCUSSION

The concentrations of radioactivity in the various tissues are given in Table 1. The initial water concentration was found to be 9 µg/L, which corresponds to 70% of the total amount added. The tissues readily took up phenanthrene at different rates, and the highest concentration was found in the hepatopancreas, followed by the gills and muscle. The concentration of radioactivity found in the blood was low, but it follows the same pattern of elimination found in the other tissues sampled.

Table 1. Concentration of radioactivity in selected tissues of the turkey wing at various times following exposure to [9-$^{14}$C]phenanthrene in seawater (9 µg/L)

| | days | | | | |
|---|---|---|---|---|---|
| | 0 | 1 | 2 | 14 | 28 |
| Hepato-pancreas | 19.7[a] (5;1.8)[b] | 17.3 (5;2.9) | 14.8 (5;3.8) | 2.9[c] (5;0.9) | 2.3[c] (5;0.5) |
| Gills | 8.2 (5;1.5) | 8.5 (4;0.5) | 3.7 (5;0.4) | 1.1[c] (5;0.3) | 0.7[c] (5;0.2) |
| Muscle | 5.8 (5;0.7) | 3.1[c] (5;0.4) | 4.0 (5;1.3) | 0.8[c] (5;0,2) | 0.24[c] (5;0.08) |
| Blood | 1.9 (5;0.2) | 2.3 (4;0.5) | 1.6 (5;0.5) | 0.6[c] (5;0.5) | 0.2[c] (5;0.05) |

a) mean value, concentration of radioactivity (dpm/gx$10^{-3}$)

b) number of animals; standard error of mean

c) Significantly different ($P<0.002$) from corresponding values immediately after exposure

The accumulation of labelled phenanthrene in the turkey wing mussel was very low compared to that found in other species. In the hepatopancreas, the uptake of phenanthrene based on the water concentration was only 4% of the corresponding value found in the calico clam Macrocallista maculata inhabiting the same area (SOLBAKKEN et al. 1982). In comparison, the uptake of phenanthrene in a temperate mollusc such as the horse mussel Modiola modiolus (PALMORK & SOLBAKKEN 1981) was also considerably higher than in the turkey wing (approx. 4 times). It therefore seems likely that these differences are due to species variations rather than environmental variations between subtropical and temperate areas.

FOSSATO (1975) showed that the elimination of aliphatic hydrocarbons in mussels Mytilus galloprovincialis is dependent on the environmental temperature. From previous studies, we determined that phenanthrene was more readily excreted at high temperatures than in low temperatures in flounders Platichthys flesus (SOLBAKKEN & PALMORK 1983). In the present study the concentrations of radioactivity in the turkey wing tissues at day 28, had decreased to the same levels as the calico clam. The corresponding values in the temperate horse mussel were a factor of ten higher. However, when initial concentration values are compared with values obtained at day 28, there is approximately the same percentage left in the hepatopancreas of the two mussel species (turkey wing 12%, horse mussel 15%). In the calico clam less than 1% remains. The slow decrease of radioactivity in the tissues of turkey wing during the experimental period is due to the low uptake. The high capacity for these subtropical species to eliminate phenanthrene-derived radioactivity is an important characteristic for evaluation of the effects of polycyclic aromatic hydrocarbons in marine molluscs, and will also prevent a long term accumulation in the tissues.

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## REFERENCES

FOSSATO, V.U.: Mar. Pollut. Bull. 6, 7 (1975).

PALMORK, K.H., and J.E. SOLBAKKEN: Bull. Environm. Contam. Toxicol. 26, 196 (1981).

SOLBAKKEN, J.E., F.M.H. JEFFREY, A.H. KNAP, K.H. PALMORK: Bull. Environm. Contam. Toxicol. 28, 530 (1982).

SOLBAKKEN, J.E., and K.H. PALMORK: Accumulation and elimination of [9-$^{14}$C]phenanthrene in flounder (Platichthys flesus) at two temperatures. Can. Fish. Aquat. Sci., in review (1983).

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