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Disposition of Phenanthrene and Octachlorostyrene in Spiny Lobsters, *Panulirus argus*, After Intragastric Administration*

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Previously investigations from our laboratory have shown that subtropical mussles, clams, fishes and corals are accumulating hydrocarbons and chlorinated components from contaminated seawater (Knap et al. 1982; Solbakken et al. 1982 a, b; 1984; 1985).

Spiny lobster (Panulirus argus) is a commercial crustacean in Bermuda. It was therefore of interest to study the fate of xenobiotics in the species as very little attention has been paid to toxicological studies with spiny lobsters. We have earlier found that the temperate crustacean, Nephrops norvegicus (Norway lobster) had the ability to accumulate and eliminate phenanthrene (Palmork and Solbakken 1980; Solbakken and Palmork 1981). The aim of this investigation was to gain a better understanding of the fate of xenobiotics in crustaceans under different environmental conditions, and to compare the polycyclic aromatic hydrocarbon, phenenthrene, with the more environmentally presistent chlorinated compound octachlorostyrene, a by-product of magnesium metal production.

MATERIALS AND METHODS

Spiny lobster (Panulirus argus) of both sexes were collected around Bermuda and acclimatised for about a week prior to dosing. They were fed thawed frozen squid (Loligo opalasen) every second day during the entire experimental period. The mean weight, number of organisms and source of chemicals used are given in Table 1.

Approximately the same dose of ^{14}C-labelled phenanthrene and octachlorostyrene was administered intragastrically in the two experiments. The experimental conditions are shown in Table 1. The material, dissolved in 100 µl dimethyl sulphoxide (DMSO), was introduced orally to the crustaceans using a modified 100 µl syringe affixed to a teflon tube. A copper tube was temporarily inserted into the mouth to prevent damage of the teflon tube by the jaws.

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Three lobsters were kept in each of 75 L glass tanks (flow rate 2 L min^{-1}, 23°C, salinity 36 o/oo). Plastic tubes (100 mm diameter) were used as shelters. At the appropriate times, the organisms were frozen and maintained at -20°C until required. Samples were taken from hepatopancreas, green gland, gonads, heart, muscle (from the tail) and gills. Duplicate samples of approx. 100 mg were taken, except for the heart in which the entire organ was analysed. Standard methods using Soluene-350 and Dimilume-30 (Packard Instrument Co.) were employed in the scintillation counting. The samples were analysed on a Packard 300 CD Scintillation Counter (Solbakken et al. 1979; 1984).

Table 1. The specific activities of the compounds, the dose and the mean total weight of the lobsters.

Experiments	Specific activities (MBq $mmol^{-1}$)	Dose (nmol)	Mean weight (g + SD; n)
9-(^{14}C)Phenanthrene	714 (Amersham)	255	731 ± 252; 12
(^{14}C)Octachlorostyrene	321 (New England Nuclear)	237	861 ± 235; 12

In the biotransformation experiment two lobsters were each given 25 mg phenanthrene and dosed as earlier described. Two teflon tubes were inserted into the green glands and the green gland fluid was collected over a 24 h depuration period. The sample was treated and analysed for hydroxylated metabolites by using gas chromatography-mass spectrometry as described by Solbakken and Palmork (1981).

RESULTS AND DISCUSSION

Tables 2 and 3 show the distribution and elimination of labelled phenanthrene and octachlorostyrene in spiny lobster (*P. argus*). The highest amounts of radioactivity were recovered in hepatopancreas and thereafter the muscle. In the muscle and green glands approximately the same concentrations of octachlorostyrene and phenanthrene derived radioactivity were found. However, in gills and heart phenathrene derived radioactivity was dominant. The uptake of octachlorostyrene into hepatopancreas was much higher compared to phenanthrene. This was expected since the higher lipophility of octachlorostyrene favours stronger accumulation into lipid rich tissues such as hepatopancreas.

The high uptake of octachlorostyrene in hepatopancreas was in contrast to the uptake of the same component in coral tissue, *Diploria strigosa* Solbakken et al. (1984). However, the accumulation in gill tissue was similar to corals. A similar trend in the uptake of xenobiotics between coral tissue and gill tissue (mussels) is also reported by Solbakken et al. (1985).

Table 2. Distribution of radioactivity in organs of spiny lobster at various times following intragastric administration of (9-^{14}C)phenanthrene.

	Days		
	1	7	14
Organs			
Hepatopancreas	11.9* (4;0.9)**	10.8 (4;0.9)	5.0 (4;1.5)
Muscle	6.2 (4;1.0)	3.9 (4;1.1)	3.8 (4;0.9)
Gills	4.2 (4;1.5)	3.5 4;0.5)	2.2 (3;0.4)
Heart	0.8 (4;0.2)	0.6 (4;0.2)	0.5 (4;0.2)
Gonads	0.4 (4;0.2)	0.1 (4;0.03)	1.4 (4;1.1)
Green gland	0.2 (4;0.05)	0.09 (4;0.01)	0.07 (4;0.03)

* mean value, % of given dose
** number of animals; standard error of mean

Crustaceans have been found to metabolize phenanthrene (Solbakken and Palmork 1981), and biotransformation of phenanthrene results in more rapid elimination from hepatopancreas. In spiny lobsters we found that more than twice as much phenanthrene than metabolites was excreted during the first day. The main metabolic pathway was in the 9, 10 - position of the molecule (K-region) and in accordance to that found with N. norvegicus (Solbakken and Palmork (1981). N. norvegicus showed the ability to excrete the parent compound phenanthrene without being metabolized, and Solbakken and Palmork (1981) concluded that this characteristic was responsible for the efficient elimination in spite of a low metabolic rate.

In spiny lobster there was a lower uptake of phenanthrene compared to the temperate crustacean N. norvegicus (Palmork and Solbakken 1980). The higher environmental temperature in the study using P. argus should result in higher uptake. The doses were nearly the same in the two experiments (56 and 63 mg/g respectively in the N. norvegicus and P. argus experiments). The reason for the conflicting results is not clear, but it seems to be species differences rather than differences in environmental conditions.

Table 3. Distribution of radioactivity in organs of spiny lobster at various times following intragastric administration of (^{14}C)octachlorostyrene.

Organs	Days 1	7	14
Hepatopancreas	57.3* (4;4.5)**	31.9 (4;5.5)	24.1 (4;3.0)
Muscle	5.0 (3;0.4)	5.6 (4;0.8)	3.6 (4;0.6)
Gills	0.7 (4;0.2)	0.9 (4;0.2)	0.8 (4;0.3)
Heart	0.2 (4;0.06)	0.1 (4;0.05)	0.03 (3;0.01)
Gonads	0.5 (4;0.3)	1.0 (4;0.9)	0.5 (3;0.3)
Green gland	0.1 (4;0.03)	0.07 (3;0.02)	0.04 (4;0.01)

* mean value, % of given dose
** number of animals, standard error of mean

The lowest concentrations of radioactivity were found in the muscle tissue. However, since approximately 40% of the total weight was muscle, the amounts of radioactivity in the muscle were high. The lipid content in the tail muscle was 3%. In both experiments high concentraions of radioactivity were found in vital organs such as heart and female gonads which may result in toxic effects. Two weeks after dosing half of the radioactivity still remained in most tissues including the muscle.

The high persistance of phenanthrene-derived components was unexpected and in contrast to that found with N. norvegicus (Palmork and Solbakken 1980) and other subtropical organisms (Solbakken et al 1982a, b; 1983; 1984).

Spiny lobsters are commercially distributed around the world and a propensity to store xenobiotics is unfavourable. However, this characteristic may be helpful in chosing a tropichal organism to be used in monitoring of environmental pollutants.

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