DISTRIBUTION OF HEAVY METALS IN THE NORTHERN SHRIMP *PANDALUS BOREALIS* FROM THE OSLOFJORD

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Studies on the distribution of heavy metals like copper, cadmium, zinc, lead and mercury in deep sea prawns *Pandalus borealis* in the Oslofjord region showed that those collected from inner and middle fjord contained higher levels of heavy metals than those from the outer fjord. Their content in the edible portions, *viz.*, tail muscle, was less compared to other organs. In terms of metal concentration copper and zinc are present in significant quantities in *Pandalus borealis*.

INTRODUCTION

Studies on the distribution of heavy metals such as copper, cadmium, lead, zinc and mercury in marine organisms have gained considerable importance in recent years as a result of widespread public concern over the levels of certain metals, particularly mercury, in food stuffs. Hence, such a base-line study was initiated in this laboratory to ascertain the naturally occurring concentrations of heavy metals in marine organisms (Andersen, Dommasnes & Hesthagan, 1973; Andersen & Neelakantan, 1974).

Pandalus borealis is a commercially important species of deep sea prawn fished in the Oslofjord. Little is known regarding the concentrations of trace metals in this species. The present study was undertaken as an attempt to determine the levels of copper, cadmium, lead, zinc and mercury in *Pandalus borealis* from different locations in the Oslofjord.

MATERIAL AND METHODS

Pandalus borealis were collected fresh from the commercial catches at six stations (Fig. 1) during the months January to

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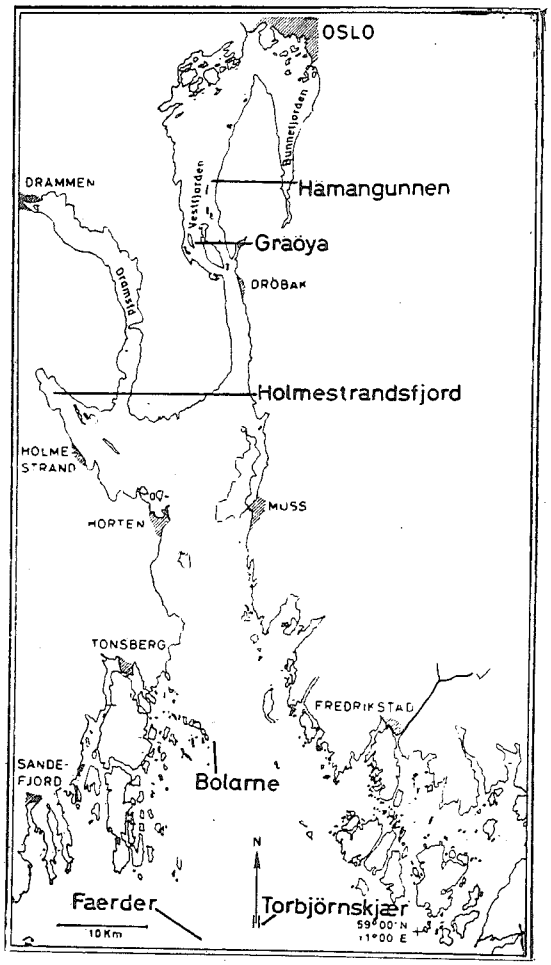

Fig. 1

Locations of the sampling stations in the Oslofjord

March 1973 and stored at -20°C until they were prepared for analysis. The samples were sorted on the basis of sex and again to different length groups. The total length was measured from the tip of the rostrum to the posterior edge of the telson. Fifteen individuals of the same size and sex group were selected to represent each sample. Whenever berried females were found in the samples, the eggs were separated and analysed for heavy metals. Approximately 100 shrimps from a bulk sample were dissected out and used for the determination of heavy metals.

All the samples were carefully dried to constant weight, homogenised, and 250 mg. was used for each analysis except for hepatopancreas, gills and eggs, in which case only 100 mg. was used. The concentrations of copper, cadmium, lead and zinc were measured using the method described by Andersen, Dommasnes and Heshtagan (1973) and mercury was estimated following the procedure described by Andersen & Neelakantan (1974).

Results and discussion

The concentrations of heavy metals in different length groups and sexes of one sample from Elle are given in Table I. Table II gives the concentrations of metals in whole prawns from different locations in the Oslofjord. The heavy metal levels in the different tissues and eggs of prawn sample collected at Holmestrandsfjord are given in Table III.

Copper

Table I shows that the sample of *P. borealis* from Elle did not show any apparent variation in copper content, either sex or size-wise. However, the samples from different places in the Oslofjord showed marked differences. The copper concentration ranged from 78μg./g. to 127μg./g. (Table II). The prawns from Holmstrandsfjord recorded the highest values of copper and the lowest were observed from Torbjornskjaer. The range of values obtained for *P. borealis* from the Oslofjord closely agree with the results of Halcrow, Mackay & Thornton (1973) for the related species *Pandalus montagui* from Firth of Clyde, and of

TABLE I

Concentrations of copper, cadmium, lead, zinc and mercury in the different length groups of *Pandalus borealis* from Station Elle.

Size group in mm.	Sex	% water content	Concentration in μg/g. dry material				
			Cu	Cd	Pb	Zn	Hg
90 – 100	male	75.5	92	1.1	4.1	127	0.3
101 – 110	male	76.1	89	1.1	3.0	120	0.4
111 – 120	male	78.5	87	1.2	5.4	132	0.3
130 – 155	female	75.1	82	1.3	2.6	164	0.5
130 – 140	female*	76.8	81	2.1	4.1	127	0.3

* with external eggs

TABLE II

Concentrations of Cu, Cd, Pb, Zn and Hg in *Pandalus borealis* from different locations in the Oslofjord

Place of collection	Length in mm.	Sex	% water content	Concentration in μg./g. dry material				
				Cu	Cd	Pb	Zn	Hg
Mokkalasene	100-110	male	80.2	106	1.7	5.4	155	0.7
Elle	130-155	female	75.1	82	1.3	2.6	164	0.5
Holmstrandsfjord	120-130	female	77.1	127	0.4	1.4	84	0.5
Bolarne	110-120	male	78.1	97	0.6	2.6	58	0.3
Torbjornskjaer	100-110	female*	75.5	78	0.8	2.3	75	0.5
Faerder	90-100	female	75.6	79	0.6	2.1	80	0.3
Average				95	0.9	2.7	103	0.4

*with external eggs

Bryan (1968) for decapod crustaceans from Plymouth area, which have copper in the range of 20 to 30μg./g. wet weight.

Among the different tissues, the hepatopancreas recorded the highest levels of copper (Table III). This indicates that the hepatopancreas is capable of concentrating and storing copper. Several studies have been made on the copper content of hepatopancreas of crustaceans (Kerkut, Moritz & Munday, 1961; Bryan, 1968 and Djangmah & Grove, 1970). Their results all indicated that the crustacean hepatopancreas is remarkably efficient in storing high amounts of copper. Apart from the hepatopancreas,

TABLE III

Concentrations of Cu, Cd, Pb, Zn and Hg in the tissues and eggs of *Pandalus borealis* from Holmestrandsfjord.

Tissue	% water content	Concentration in μg./g. dry material				
		Cu	Cd	Pb	Zn	Hg
Exoskeleton	60.9	66	0.4	1.2	39	0.2
Muscle	79.1	31	0.2	0.9	42	0.2
Gill	81.2	440	2.8	6.0	126	0.8
Hepatopancreas	55.0	565	3.0	4.2	264	1.3
Egg	84.4	26	3.4	2.6	114	0.2
Whole prawn	77.1	127	0.4	1.4	84	0.5

the gills also contain relatively high amounts of copper (Table III), and this is possibly due to the blood contained in the gills (Kerkut *et al.*, 1961). The exoskeleton and the abdominal flexor muscles have comparatively less copper similar to those found in *Crangon vulgaris* (Djangmah & Grove, 1970). Bryan (1968) believes that most of the copper present in the crustacean muscles is due to contamination by blood.

Cadmium

In the different sizes of shrimps, the cadmium concentration shows very little variation except in females with external eggs. The high content of cadmium in this group may be due to the external eggs, as these eggs contained an appreciable amount of cadmium (Table III). The samples from Mokkalasene recorded the highest values of cadmium when compared to other areas. The average concentration of cadmium (0.9μg./g.) obtained for *P. borealis* from the Oslofjord, is comparatively lower than *Crangon crangon* from British Channel as observed by Portman & Yardley (1972). The gills and hepatopancreas recorded higher amount of cadmium than the exoskeleton and muscles (Table III). Topping (1973) also has recorded high values of cadmium in the gills and hepatopancreas of the lobster, *Homarus vulgaris*, from Scottish waters. Muscles recorded the lowest concentration of cadmium.

Lead

The concentration of lead appears to vary in different size groups and sexes. Highest concentrations are observed in larger males (Table I). From various locations in the Oslofjord, the samples contain varying amounts of lead in the range of 1.4 to 5.4μg./g. with an average of 2.7μg /g., which is relatively lower than that of *Crangon vulgaris* from the coasts of England (Portman & Yardley, 1972). It is interesting to note that the lead concentration in the prawns gradually increases from the outermost station, i. e. Faerder towards the head of the Oslofjord. However, the lowest values are observed for prawns from Holmestrandsfjord (Table II). Gills contained the highest amount of lead, followed by hepatopan-

creas, exoskeleton and muscles. The lead content of the order of 0.9μg./g. for the tail muscles of *P. borealis* is comparable with that recorded (less than 0.2 p.p.m. wet weight) by Topping (1973) for the tail meat of lobsters from Scotland.

Zinc

Zinc is present in abundant quantities in the prawn, *P. borealis* (Table I). There appears to be wide variation in zinc content in different sizes of prawns. The samples from Elle and Mokkalasene are observed to contain very high concentration of zinc (Table II) which is about twice the levels found in samples from other stations. These high concentration of zinc in the samples from Mokkalasene and Elle (both lying in the innerfjord) may be related to high zinc values of sea water (Andersen *et al.* 1973). There is a uniformity in distribution of zinc in the samples from the last four stations, the samples from Bolarne recording the lowest value. The concentration of zinc in the tissues varies markedly (Table III). High concentrations are seen in the hepatopancreas and low concentrations in the gills. Bryan (1968) has also found high concentrations of zinc in the hepatopancreas of the lobster, *Homarus vulgaris* and this may be due to the ability of hepatopancreas to store excess zinc. Bryan (1968) has reported that the zinc content of hepatopancreas increased when the animal was exposed to sea water having high concentration of zinc. The occurrence of appreciable amounts of zinc in the gills may indicate that the gills are the possible sites of absorption and loss of zinc.

Mercury

The levels of mercury in different sizes and sexes do not show any significant variation (Table I). The samples from Mokkalasene lying in the innerfjord, which is closest to the city of Oslo, recorded highest concentration of mercury. Williams & Weiss (1973), working on the mercury content of pelagic food chain, found that the penaeid decapods from the depth of 600 m. off San Diego contained only about 0.3 p.p.m. mercury on dry weight. Similar values are also recorded in the present study for prawns from the outer Oslofjord. These results support the view that the animals from the coastal areas contain more trace metals than the ones from the open sea. Just like the other metals mercury is present in high concentrations in the hepatopancreas (Table III). Gills also recorded high values of mercury, and this indicates that the gills represent the principal organ of uptake and release of mercury in *P. borealis*. Similar role has been suggested for the gills of the marine crab, *Maia squinado* (Corner, 1959). The exoskeleton and the tail muscles recorded the lowest concentration of mercury.

The external eggs contain higher concentration of all the metals except copper. The cadmium and zinc values are as high as in the gills. Bryan (1968) has also reported high concentrations of zinc in the eggs of decapod crustaceans. The reason for the occurrence of high amounts of heavy metals in the eggs is not clear; it may be as a result of free exposure of eggs to the surrounding medium.

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