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Metal Concentrations in Oysters from the Southern African Coast

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South Africa has relatively few estuaries and lagoons along its coastline and, in these, there is likely to be an increasing amount of user conflict. Apparent benefits from industrial and harbour developments may, in the long term, be counter-balanced by the destruction of fish nursery grounds and/or the loss of local fisheries. It is important to have available an effective monitoring system whereby any development in estuarine areas can be assessed for its degree of pollution. Then in some cases, control measures may be introduced, the flora and fauna of the area preserved and the transfer to man of cumulative toxins prevented.

The general programme to monitor marine pollution along the coast of South Africa has been described in detail (CLOETE and WATLING 1981). The aims of this programme are to discover and monitor sources of marine pollution, to establish coastal monitoring stations and to institute a national data centre where all the information which is being collected can be collated most effectively.

Potential biological monitors for the South African marine environment have been discussed in general terms on the basis of the reported use of related species (DARRACOTT and WATLING 1975). The results of recent laboratory experiments on the accumulation of nine elements have led to the belief that the Cape oyster Crassostrea margaritacea is a suitable indicator organism (WATLING 1978a). The present survey of metal concentrations in C. margaritacea growing at 25 sites along a 500 km stretch of the South African coast was undertaken to provide data for the national marine pollution monitoring programme and to supplement data from sediment and water sampling surveys of the estuaries in this region.

MATERIALS AND METHODS

C. margaritacea were collected from sites along the South African south coast (Figure 1) during several surveys in the period July 1977 - August 1979. Living specimens were suspended in clean sea water for up to five days to allow them to purge their intestinal contents. The wet tissues were then removed from the shells and frozen inside glass vials.

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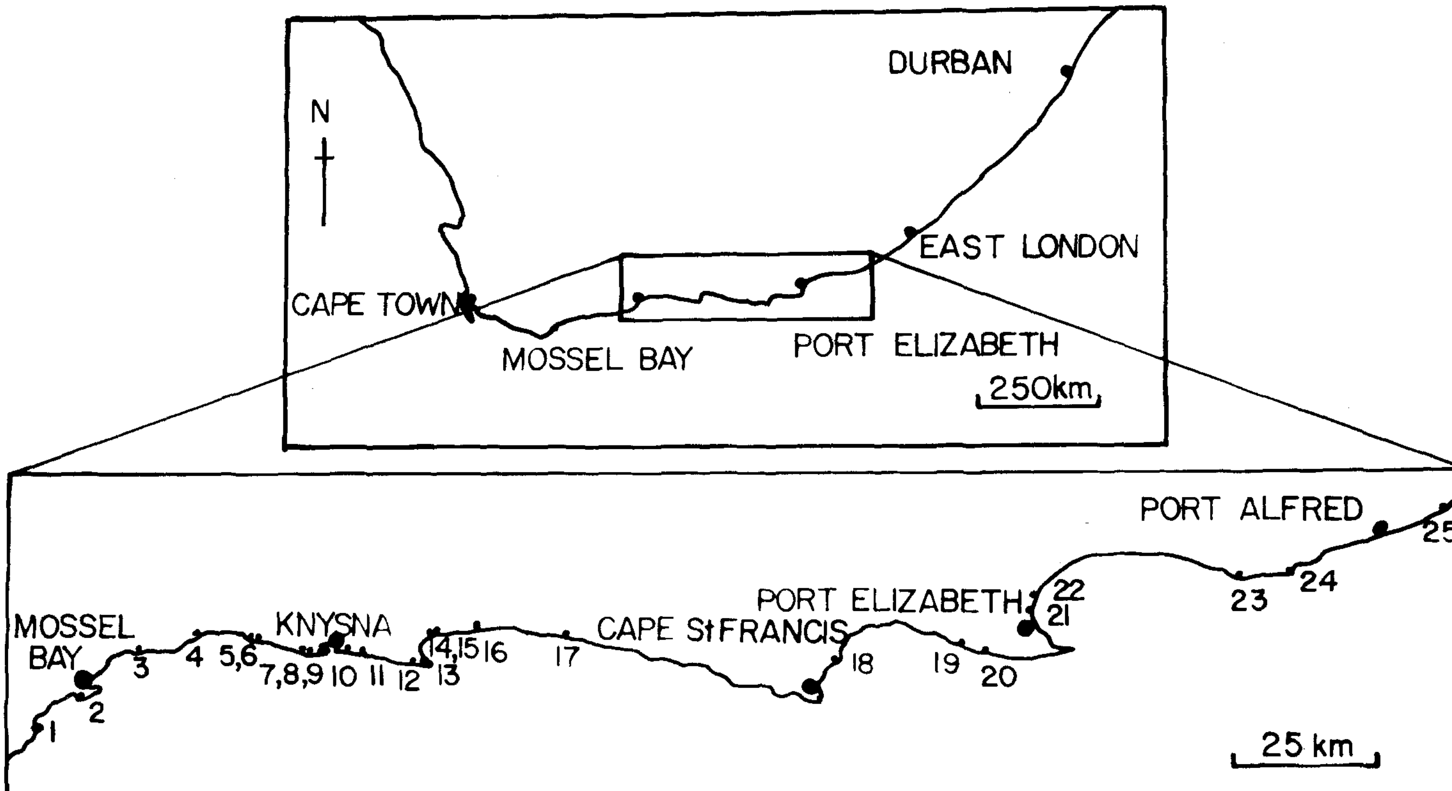

Fig.1 The sampling area and collection sites

The frozen specimens were thawed, weighed into clean dry flasks and oven-dried at 90°c for 24 h. The dried samples were reweighed dissolved in 25 ml of redistilled analar-grade nitric acid and the sample solution boiled and evaporated to near dryness. The residue was dissolved in 25 ml of a 4:1 nitric-perchloric acid mixture. This solution was fumed to dryness at about 120°C. The white residue was redissolved in 10 ml of 10% v/v nitric acid and the metal concentrations in this solution determined by atomic absorption spectrometry.

Composite standards containing zinc, cadmium, copper, lead, iron, manganese, nickel, cobalt and chromium in the range 0,1-20 μg/ml, in the presence of sodium, potassium, calcium and magnesium in the range 100-5000 μg/ml, were prepared in 10% v/v nitric acid. A Varian-Techtron AA5 with AA6 readout module and BC6 background corrector was used for all measurements. Background correction was applied to the determination of zinc, cadmium, lead, nickel and cobalt and the slotted tube (WATLING 1978b) was used to increase the sensitivity of the lead determination. The instrument was calibrated using the composite standards.

RESULTS AND DISCUSSION

Metal concentrations recorded for C. margaritacea are listed in Table 1. The major portion of the coast from which samples were collected is undeveloped and as would be expected, the metal concentrations recorded are low. As there is a lack of comparative data for C. margaritacea, it is possible to suggest that the metal concentrations quoted in Table 1 are generally low only by referring to results obtained for the Pacific oyster Crassostrea gigas.

C. gigas is grown and studied in many countries and comparative data on tissue-metal concentrations are available, particularly for locations where metal pollution is already a recognised problem. The metal concentrations in C. gigas cultivated and grown in Knysna estuary have been shown to be up to an order of magnitude lower than those reported for this species growing in seemingly unpolluted locations elsewhere (WATLING 1978a). These data, together with the results from comprehensive surveys of metal levels in water and sediment samples collected from the Knysna estuary, confirm that the area is unpolluted with respect to the study elements (WATLING and WATLING in press b). It is therefore suggested that C. margaritacea growing in the vicinity of Knysna estuary (Figure 1, sites 8-11) contain near background levels of these elements.

Closer examination of the data in Table 1 indicates that some contamination of the Victoria Bay (site 4) environment has occurred; oysters from this site have accumulated zinc, lead, nickel, chromium and possibly cobalt. It is reasonable to assume that these metals are being introduced into the marine environment from the relatively large holiday resort situated along the shore of the bay. Some elevated metal levels are observed in isolated samples, for

TABLE 1

Metal concentrations in Crassostrea margaritacea collected from sites on the South African coast

Sample Location	No		Wet mass (g)	Dry mass (g)	Zn	Cd	Cu	Pb	Fe	Mn	Ni	Co	Cr
					μg metal/g wet tissue								
1. Vlees Point	40	$\bar{x}$	4.44	0.78	202	1.4	4.2	0.01	25	0.9	0.03	0.01	0.2
		s	2.51	0.49	67	0.2	2.3	0.01	18	0.7	0.03	0.01	<0.1
2. Pinnacle Point	6	$\bar{x}$	6.47	1.01	190	2.1	8.5	0.01	13	0.7	0.03	0.01	0.4
		s	1.32	0.16	51	0.3	4.7	0.01	3	0.4	0.01	0.01	0.3
3. Glentana	40	$\bar{x}$	2.85	0.48	143	1.6	3.7	0.02	17	1.1	0.08	0.01	0.2
		s	1.02	0.16	28	0.4	1.3	0.01	9	0.5	0.06	0.01	<0.1
4. Victoria Bay	10	$\bar{x}$	1.94	0.32	723	2.8	1.8	0.53	52	1.0	0.84	0.10	2.9
		s	1.10	0.17	182	2.0	0.7	0.30	28	0.5	0.91	0.06	2.1
5. Gericke Point west	30	$\bar{x}$	3.71	0.47	141	0.5	0.6	0.03	7	0.1	0.02	0.01	0.1
		s	1.76	0.21	25	0.2	0.3	0.02	4	0.1	0.02	0.01	<0.1
6. Gericke Point east	30	$\bar{x}$	7.92	1.09	236	1.8	2.8	0.04	20	0.7	0.02	0.02	1.0
		s	2.78	0.42	106	0.6	2.1	0.02	11	0.4	0.03	0.01	0.2
7. Walker Point west	15	$\bar{x}$	3.34	0.35	249	1.3	2.9	–	50	0.8	–	0.04	0.7
		s	–	–	144	0.4	3.2	–	26	0.4	–	0.03	0.9
8. Walker Point east	10	$\bar{x}$	7.44	1.86	60	1.6	3.1	–	11	1.5	–	–	0.4
		s	–	–	15	0.3	0.6	–	2	1.5	–	–	0.4
9. Brenton-on-Sea	18	$\bar{x}$	2.12	0.38	118	1.9	5.3	0.06	34	0.7	0.05	0.02	0.5
		s	0.63	0.17	52	0.3	1.4	0.05	7	0.2	0.03	0.01	0.2
10. Knysna Heads	5	$\bar{x}$	3.55	0.52	329	2.4	3.7	0.08	42	0.9	0.32	0.06	0.4
		s	–	–	–	–	–	–	–	–	–	–	–
11. Noetzie	5	$\bar{x}$	2.40	0.44	23	2.6	11.9	0.12	40	0.8	0.21	0.05	1.1
		s	–	–	–	–	–	–	–	–	–	–	–
12. Cape Seal west	7	$\bar{x}$	3.04	0.41	228	1.6	11.4	0.01	23	0.7	0.10	0.02	0.7
		s	1.02	0.07	34	0.5	6.7	0.01	10	0.2	0.05	0.01	0.6
13. Cape Seal point	4	$\bar{x}$	4.54	0.72	251	1.5	7.5	0.05	17	0.8	0.07	0.01	0.8
		s	1.31	0.17	103	0.3	3.2	0.06	7	0.5	0.02	0.01	0.5

TABLE 1

Metal concentrations in *Crassostrea margaritacea* collected from sites on the South African coast

	Sample Location	No		Wet mass (g)	Dry mass (g)	Zn	Cd	Cu	Pb	Fe	Mn	Ni	Co	Cr
						µg metal/g wet tissue								
14.	Keurboomsrivierstrand	10	$\bar{x}$	3.19	0.48	141	1.5	3.3	0.02	18	0.8	0.06	0.01	0.3
	west		s	2.24	0.27	55	0.3	1.0	0.01	11	0.6	0.05	0.01	0.2
15.	Keurboomsrivierstrand	10	$\bar{x}$	1.91	0.33	127	2.3	4.2	0.01	24	0.7	0.07	0.01	0.2
	east		s	0.24	0.02	47	0.8	0.7	0.01	15	0.8	0.03	0.01	<0.1
16.	Nature's Valley	23	$\bar{x}$	4.44	0.63	182	2.1	1.6	0.01	17	0.5	0.03	0.01	0.4
			s	2.26	0.31	38	0.4	1.1	0.01	14	0.2	0.02	0.01	0.4
17.	Storms River	12	$\bar{x}$	8.18	1.46	173	0.4	11.2	0.04	27	1.5	0.09	0.02	0.1
			s	4.42	1.07	96	0.3	9.5	0.05	28	1.3	0.07	0.02	<0.1
18.	Jeffreys Bay	40	$\bar{x}$	2.31	0.47	94	1.1	5.1	0.01	39	0.7	0.12	0.01	0.3
			s	0.97	0.23	18	0.2	1.1	0.01	14	0.2	0.04	0.01	0.2
19.	Beach rocks	3	$\bar{x}$	1.32	0.28	173	1.8	2.3	0.09	28	1.1	0.03	0.28	0.3
			s	-	-	-	-	-	-	-	-	-	-	-
20.	Maitland River	30	$\bar{x}$	2.47	0.48	76	1.8	5.8	0.03	49	1.3	0.14	0.05	1.7
			s	1.40	0.27	22	0.6	1.7	0.01	21	0.5	0.06	0.02	1.0
21.	Papenkuils River	14	$\bar{x}$	1.03	0.19	1202	0.1	10.2	1.18	71	2.2	0.13	0.07	4.6
			s	0.26	0.02	571	<0.1	5.1	0.39	36	0.9	0.14	0.03	1.5
22.	Swartkops River	20	$\bar{x}$	6.45	1.05	905	0.3	5.6	0.20	29	1.0	0.19	0.05	0.5
			s	3.02	0.59	224	0.2	3.6	0.05	28	0.5	0.23	0.02	0.2
23.	Woody Cape	29	$\bar{x}$	4.59	0.86	249	1.0	2.7	0.13	21	1.7	0.17	0.07	0.4
			s	1.37	0.28	92	0.2	1.7	0.05	9	1.0	0.10	0.05	0.2
24.	Cannon Rocks	2	$\bar{x}$	9.01	1.11	157	0.4	1.3	0.03	12	0.3	0.12	0.03	1.4
			s	-	-	-	-	-	-	-	-	-	-	-
25.	Great Fish River	13	$\bar{x}$	2.82	0.40	199	0.9	13.8	0.21	54	2.5	0.13	0.08	1.9
			s	0.89	0.13	66	0.2	8.9	0.09	26	1.5	0.11	0.04	0.6

example copper in the samples from sites 11,12,13 and 17, cobalt in the sample from site 19 and chromium at site 24. No obvious common feature distinguishes these locations from the remaining survey sites, none of them being particularly near to urban developments, so that it must be assumed that these metals are being introduced into the marine environment from natural sources.

Oysters growing at the mouth of the Papenkuils River (site 21) have accumulated zinc, copper, lead and chromium. A recent pollution survey of this river (WATLING and EMMERSON 1981) has shown that considerable quantities of a number of metals, most notably zinc and chromium, but also lead, cadmium and mercury, are entering the river via the many drains which are to be found both in and above the canalized section. C. margaritacea growing at the mouth of the Swartkops River (site 22) are also found to contain considerably more zinc, copper and lead. Again the results of a survey in this river indicate the presence of four areas of contamination (WATLING and WATLING in press a). Oysters from the two extremes of Algoa Bay (sites 20 and 23) do not contain elevated metal concentrations which seems to indicate that the Bay as a whole is not polluted to any great extent. The results of a more detailed survey of the Bay indicate that the present level of industrialization and urbanization is not causing significant stress to the ecosystem, probably because there is considerable water movement (WATLING and WATLING 1981).

Copper, lead and chromium concentrations are elevated in C. margaritacea growing at the mouth of the Great Fish River (site 25). This result was unexpected as there are no urban or industrial developments along the river. It is therefore likely that these elements are derived from leaching of mineralized sequences in the catchment. In view of these results, a geochemical survey to establish the provenance of these metals will be undertaken in the near future.

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