

## TRACE ELEMENTS IN TWO RAS BEIRUT SHORE CRABS

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## ABSTRACT:

Two species of shore crabs, Eriphia verrucosa and Pachygrapsus transversus were collected along the coast of Ras Beirut, Lebanon and analysed for lead, cadmium, copper, nickel, iron, zinc and chromium. Metal levels were similar in the two species, but copper was slightly higher and zinc was considerably higher in E. verrucosa. Chromium was not detected in most samples analysed. Three molted specimens of P. transversus were also analysed and found to contain high levels of lead and zinc in contrast to the other samples.

## INTRODUCTION

The occurrence of heavy metals in marine shore crabs does not appear to have been extensively investigated, particularly in the eastern part of the Mediterranean Sea. It has been reported that some species may be poor biological indicators of coastal pollution since they are able to adapt to a wide range of environmental conditions (6). For instance, Pachygrapsus crassipes has been found in relative abundance near an untreated sewage outfall where the crabs were seen feeding on organic matter (7).

PEDEN et al. (9) reported considerably high cadmium le-

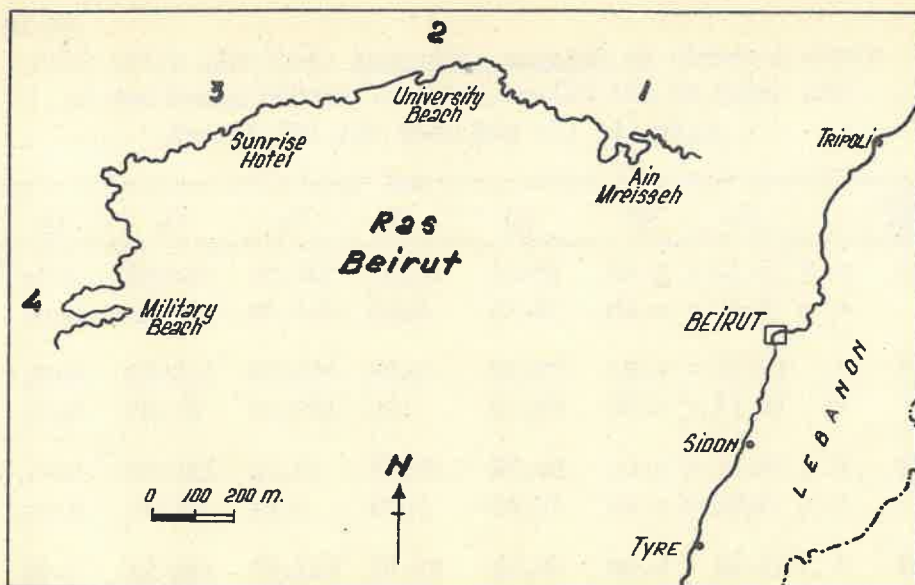
vels in limpets and crabs which feed on limpets, indicating that there may be a relationship between the metal levels in crabs and their diet. In an in vitro experiment, fiddler crabs, Pugettia producta (Randall), were fed nothing but one species of algae for a period of time. Results of metal analysis on both the crabs and the alga showed that the fecal material of the crabs concentrated higher levels of many metals than the alga contained (2). A few studies have also been done on the physiological effects of heavy metals on crabs. THURBERG et al. (12) exposed crabs to copper which resulted in normally hyperosmotic blood serum, eventually becoming isosmotic with the surrounding medium. Cadmium seems to interfere with normal respiration in certain crab species, which is probably due to the accumulation of the metal in the gill tissues (3; 8; 12).

The present work represents one in a series of short studies being conducted on the coast of Ras Beirut, Lebanon with regard to heavy metals in intertidal organisms. The two species of crabs used in this study were the rock crab Eriphia verrucosa (Forsk., 1775) and the smaller shore crab Pachygrapsus transversus (Gibbes, 1850), both of which occur quite abundantly. The identification of representative specimens was verified by Professor Jacques FOREST, Muséum National d'Histoire Naturelle, Laboratoire de Zoologie, Paris, France. Although E. verrucosa is not commonly used for food, it is occasionally eaten by some people in Lebanon.

#### COLLECTION AND ANALYSIS

The collections of thirty-two specimens were made at four locations, about 800 m apart from each other, on the rocky coast of Ras Beirut, Lebanon (Fig. 1). Two to three Eriphia verrucosa (average length: 32 mm; average width: 42 mm) and five Pachygrapsus transversus (average length: 16 mm; average width: 18 mm) were taken from each site. In addition, three molted P. transversus (average length: 16 mm; average width: 19 mm) were collected at site 2 and processed separately.

The crabs were measured, briefly rinsed in distilled water, and frozen at  $-5^{\circ}\text{C}$  to  $-2^{\circ}\text{C}$ . Samples of whole specimens were prepared for analysis according to the wet-ashing procedure



**Fig.1** - The coast of Lebanon with the blocked-in area enlarged to show the four collection sites in Ras Beirut from which crab specimens were taken.

described by FOWLER and OREGIONI (4). Analysis of the animals for metal content was performed at the Purdue University School of Civil Engineering in West Lafayette, Indiana, U.S.A. Concentrations of lead, cadmium, copper, nickel, iron, zinc and chromium were determined on a Perkin-Elmer Model 306 atomic absorption spectrophotometer with a flame consisting of a lean mixture of acetylene and air.

#### RESULTS AND DISCUSSION

The results of the analysis for heavy metals in the two crabs, Eriphia verrucosa and Pachygrapsus transversus are shown in Tables 1 and 2 respectively. In general, the metal concentrations, particularly of lead, were similar in the two species. This may not be unusual considering that the crabs inhabit the same eulittoral region and are probably exposed to nearly the same environmental factors. However, cadmium was a little higher in P.transversus and zinc was definitely higher in E.verrucosa. The

Table 1

Trace elements in Eriphia verrucosa (Forsk., 1775) from  
the coast of Ras Beirut, Lebanon. Values given are in  
 $\mu\text{g/g}$  dry (d) and  $\mu\text{g/g}$  wet (w) tissue.

Site #		Pb	Cd	Cu	Ni	Fe	Zn	Cr
(1)	d	< 13.12	< 0.68	86.25	15.94	517.97	118.88	n.d. <sup>x/</sup>
	w	< 5.39	< 0.28	35.45	6.55	212.89	48.86	n.d.
(2)	d	28.12	< 0.68	76.88	6.56	480.47	119.63	n.d.
	w	10.71	< 0.26	29.29	2.50	183.06	37.58	n.d.
(3)	d	< 13.12	< 0.68	50.53	15.94	11.72	131.63	n.d.
	w	< 4.49	< 0.23	17.28	5.45	4.01	45.02	n.d.
(4)	d	< 13.12	< 0.68	86.25	32.81	311.72	112.13	6.66
	w	< 7.01	< 0.36	46.06	17.52	166.46	59.88	3.55
Ave- rages	d	16.87	< 0.68	74.98	17.81	330.47	120.57	1.67
	w	6.90	< 0.28	32.02	8.01	141.61	47.84	0.89

x/ not detected

Table 2

Trace elements in Pachygrapsus transversus (Gibbes, 1850)  
from the coast of Ras Beirut, Lebanon. Values given are in  
 $\mu\text{g/g}$  dry (d) and  $\mu\text{g/g}$  wet (w) tissue. The metal content of  
three molted specimens taken from site # 2 is also  
included

Site #		Pb	Cd	Cu	Ni	Fe	Zn	Cr
(1)	d	28.12	2.93	80.63	49.69	311.72	79.13	n.d. <sup>x/</sup>
	w	7.85	0.82	22.49	13.86	86.97	22.08	n.c.
(2)	d	< 13.12	1.43	56.25	6.56	132.97	65.62	n.d.
	w	< 5.24	0.57	22.44	2.62	53.02	26.18	n.d.

(Table 2 suite)

Site #		Pb	Cd	Cu	Ni	Fe	Zn	Cr
(3)	d	< 13.12	< 0.68	56.25	< 3.65	593.00	65.62	n.d.
	w	< 6.00	< 0.31	25.71	< 1.67	271.00	29.99	n.d.
(4)	d	< 13.12	< 0.68	39.38	32.81	517.97	61.13	n.d.
	w	< 6.05	< 0.31	18.15	15.13	238.78	28.18	n.d.
Ave-rages	d	16.87	1.43	58.13	23.18	388.92	67.88	n.d.
	w	6.29	0.50	22.20	8.32	162.44	26.61	n.d.

Molted specimens:  
(taken at site # 2)

d	65.62	< 0.68	76.88	6.56	480.47	190.88	n.d.
2	16.27	< 0.17	19.07	1.63	119.16	47.34	n.d.

x/ not detected

fairly stable readings for copper, which was slightly higher in E. verrucosa, may support the suggestion that crustaceans might be able to regulate their body burden of copper (5). Similar copper values have been found in Maia squinado from the southwest coast of Spain and Portugal (10) and Carcinus maenas from the lower Medway estuary in Kent, England (13). It has been pointed out by Wharfe and Van den Broek (13) that the respiratory pigment haemocyanin might contribute to higher copper levels in crustaceans. The cadmium concentrations in these two crab species are lower than those reported in Carcinus maenas from the coast of West Norway (10), the northeast coast of England (14), and the lower Medway estuary (13). Nickel levels seem to be variable in both species, but more so in P. transversus. The concentrations of iron are quite similar in the two crabs, except for the very low reading for E. verrucosa at site # 3. There was one chromium reading in E. verrucosa at site # 4, but in all the other samples, chromium was below the detection limits of 0.03 mg/l set for the analytical instrument employed.

It is of interest to note the elevated lead and zinc le-

vels in the molted specimens of P. transversus. Perhaps in the molted state, some species of crustaceans take up and retain certain elements more readily. The consideration of such a possibility, however, requires more extensive study into metal levels in molted as opposed to unmolted specimens. According to a report by GESAMP (5), lead tends to be stored in the exoskeletons and digestive organs of crustaceans. BERTINE and GOLDBERG (1) have suggested that carbonate exoskeletons might act as "receptacles" for certain elements.

In a recent study of prawns (Palaemon elegans) from the coast of Ras Beirut (SHIBER J., 1978: Heavy metals in Ras Beirut prawns and sea urchin eggs. Submitted for Publication), nickel and cadmium levels were similar to those being reported here for the two crabs. Iron was quite a bit lower, however, and lead and copper were about twice as high in the prawns ( $\bar{x}$ : 33 g/g dry and 147 g/g dry, respectively). Lead concentrations were also much higher in algae sampled from this area in the same year (SHIBER J.G. and SHATILA T., 1978: Certain metals in three coastal algae from Ras Beirut waters. Hydrobiologia. In press) and cadmium was a little higher or about the same. The average concentration of these metals (except for zinc and chromium) in surface seawater taken at two different periods of time in 1977 from these same four locations are as follows (mg/l): Pb: 0.36, Cd: 0.02, Cu: 0.12, Ni: 0.22, and Fe: 1.72 (SHIBER J.).

Among the sources of heavy metals in this coastal area, one of the most prominent is the untreated domestic sewage and industrial waste which enters the sea in various outfalls and rivers. Pesticide and fertilizer residue input is also probably considerable since there is a great deal of farming (fruit, vegetable, and animal) done in Lebanon, and some even done in the Beirut area. Many of the chemicals used might well contain compounds of such metals as lead and cadmium. With regard to the study area in particular, there are at least two major outlets for sewage, one near site # 1 and the other between sites # 3 and # 4 (Fig. 1), plus several minor sewage outlets and innumerable stormwater outfalls. During the rainy season, stormwater runoff is frequently very heavy and is invariably mixed and over-flooded with sewage. In addition, raw garbage and debris is commonly dumped into

the sea by the local inhabitants. Since the heavily-travelled Corniche boulevard runs directly adjacent to the study area, the contribution of lead and possibly nickel emitted from motor vehicle exhaust is probably significant.

It would seem that further studies are needed in this area which should include the separate analysis of both soft and hard body parts of these and other intertidal organisms for heavy metal content. Also, the physiological needs and uses of various elements by individual species should be a major consideration in future work.

#### REFERENCES:

1. BERTINE K.K. and E.D.Goldberg, 1972 - Trace elements in clams, mussels, and shrimp. Limnol.Oceanogr., 17 (6): 877-884.
2. BOOTHE P. and G.Knauer, 1972 - The possible importance of fecal material in the biological amplification of trace and heavy metals. Limnol.Oceanogr., 17 (2): 270-274.
3. COLLIER R.S., MILLER J.E., DAWSON M.A. and F.P.THURBERG, 1973 - Physiological responses of the mud crab, Eurypanopeus depressus to cadmium. Bull.Envir.Contam. & Toxicol., 10 6: 378-382.
4. FOWLER S.W. and B.OREGIONI, 1976 - Trace metals in mussels from the northwest Mediterranean. Mar.Pollut.Bull., 7,2: 26-29.
5. GESAMP (Joint Group of Experts on the Scientific Aspects of Marine Pollution), 1976. Reports and Studies, No.2: Review of harmful substances. United Nations, New York.
6. JONES D.J., 1973 - Variation in the trophic structure and species composition of some invertebrate communities in polluted kelp forests in the North Sea. Mar.Biol., 20: 351-365.
7. LITTLER M.M. and S.N.MURRAY, 1975 - Impact of sewage on the distribution, abundance and community structure of rocky intertidal macro-organisms. Mar.Biol., 30: 277-291.

8. O'HARA J., 1973 - Cadmium uptake by fiddler crabs exposed to temperature and salinity stress. J.Fish.Res.Board Can., 30: 846-848.
9. PEDEN J.D., CROTHERS J.H., Waterfall C.E. and J.BEASLEY, 1973 Heavy metals in Somerset marine organisms. Mar.Pollut. Bull. 4 (1): 7-9.
10. STENNER R.D. and G.Nickless, 1974 - Distribution of some heavy metals in organisms in Hardangerfjord and Skjerstadfjord, Norway. Water, Air and Soil Pollution, 3: 279-291.
11. STENNER R.D. and G.NICKLESS, 1975 - Heavy metals in organisms of the Atlantic coast of S.W.Spain and Portugal. Mar. Pollut.Bull., 6, 6: 89-92.
12. THURBERG F.P., DAWSON M.A. and R.S.COLLIER, 1973 - Effects of copper and cadmium on osmoregulation and oxygen consumption in two species of estuarine crabs. Mar.Biol., 23: 171-175.
13. WHARFE J.R. and W.L.F. Van den Broek, 1977 - Heavy metals in macroinvertebrates and fish from the lower Medway estuary, Kent. Mar.Pollut.Bull., 8, 2: 31-34.
14. WRIGHT D.A., 1976 - Heavy metals in animals from the north east coast. Mar.Pollut.Bull., 7, 2: 36-38.