Bull. Environ. Contam. Toxicol. (1990) 45:538–544

Bulletin of Environmental Contamination and Toxicology

Trace Metals in Tropical Coastal Lagoon Bivalves, *Crassostrea corteziensis*

F. Páez-Osuna and C. Marmolejo-Rivas

Institute of Marine Sciences and Limnology Mazatlán, Marine Station, National Autonomous University of Mexico, P.O. Box 811, Mazatlán, Sinaloa, Mexico

The concentrations of trace metals in bivalves such as mussels and oysters provide information about their levels and availability in seawater. This concept has been developed through programs (NAS, 1980; Farrington et al; 1983), which recommend the use of filter-feeder molluscs as indicator of pollution. However, little is known about the relationship between trace metal concentrations in seawater and in oyster tissue.

The mangrove oyster Crassostrea corteziensis (Hertlein, 1901), is a brackish species which is geographically distributed from the Gulf of California to the North of Perú (Keen, 1971). In Mexico and particularly in the Pacific Coast, this mollusc and the rock oyster (S. iridescens) are widely utilized for human consumption, having consequently, an important commercial value, though no trace metal data are available to establish natural background levels.

The present study reports the accumulation of nine trace metals (Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn) from lagoonal water by the oyster C. corteziensis during a twelve-month period from the Port of Mazatlan, Mexico. The regression relationship which has the highest correlation coefficient between cobalt, chrome, nickel and lead concentrations in the particulate of water and in oysters is given.

MATERIALS AND METHODS

A population of Crassostrea corteziensis and lagoonal water samples were collected at regular intervals between August 1985 and July 1986, in the Port of Mazatlan (northwest coast of Mexico), which is a small coastal lagoon (16 Km^2) "barred inner shelf" type (Lankford, 1977).

Metal concentrations in the organisms sampled (by hand from mangrove roots) from the intertidal zone at the selected site (Fig. 1), were determined for total flesh; composite samples of 25

Send reprint requests to F. Páez-Osuna at the above address.

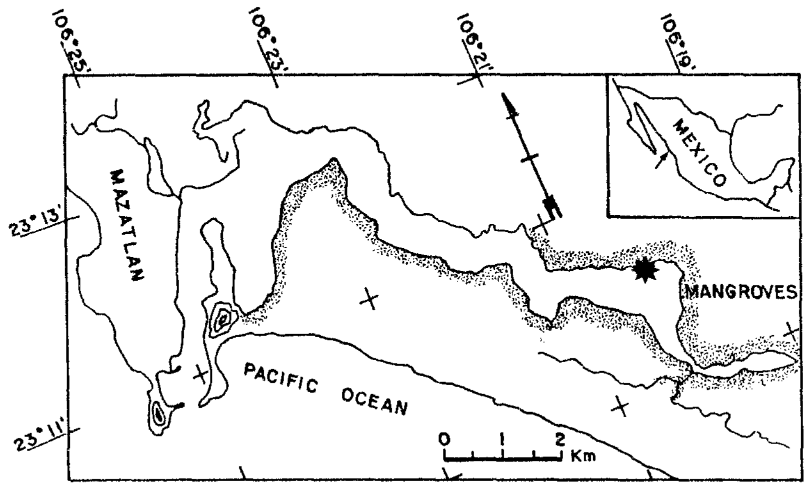

Fig. 1. Study area showing the location of sampling site (✱).

individuals were analysed using the procedure described earlier (Páez-Osuna and Marmolejo-Rivas, 1990). Specimen size was maintained between 40 and 50 mm (the longest each month) throughout the work to reduce variation due to size and age and assure that sexually mature specimenes were used in this study.

The water samples were taken (0.5 m of depth) at the same time as the oysters, using previously acid-washed polyethylene bottles. They were filtered as soon as possible after collection (< 12 h) through acid rinsed 0.45 µm Millipore (Type HA) filters. Filtrates were acidified with distilled HNO_3 and HCl in a teflon decomposition manifold system (Breder, 1982). An IAEA sediment standard SDN-½ (IAEA, 1985), treated in the same way as the samples, was used to ensure the accuracy of the analysis. The concentrations of "soluble" trace metals were analysed also following the earlier procedures (Páez-Osuna *et al*, 1987).

RESULTS AND DISCUSSION

The results of the analysis are summarized in Table 1 and Fig. 2. Zinc and Copper shows in a similar way the highest concentration in October. The levels of iron, manganese, cadmium and chromium were relatively constant, while that nickel, cobalt and lead simultaneously show an enrichment in the months of autumn-winter, when the temperatures of seawater in the locality decrease from 30-32°C to 22-24°C (Alvarez-León, 1980). The relationships between some metals in the oyster C. *corteziensis* were significant. For zinc and copper, the r-value (linear correlation coeficient; n=12) was 0.85, for manganese-iron, r=0.61, cobalt-chromium, r=0.80, cadmium-nickel, r=0.71, cobalt-nickel, r=0.92 and nickel-lead, r=0.70. Seasonal fluctuations with highest values in autumn-winter months have been found in other species of bivalves suchs as the marine oyster S. *iridescens* (Páez-Osuna and Marmolejo-Rivas, 1990), or the mussel M. *edulis* (Amiard *et al*, 1986).

Table 1. Port of Mazatlán. Salinity, suspended matter and dissolved and particulate metal concentrations ($\mu g.L^{-1}$).

Month	Salinity (°/₀₀)	suspended matter ($mg.L^{-1}$)	(Dissolved / Particulate) 10^{-2}								
			Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn
Oct	25.756	44	-/6	35/56	-/79	139/173	481/122	92/3500	336/93	92/200	3610/317
Nov	35.016	65	-/15	42/97	-/114	75/266	308/131	21/5050	278/218	57/377	5400/875
Dec	32.226	76	-/30	-/114	-/102	-/389	-/131	-/5050	-/218	-/551	-/827
Jan	37.942	30	-/13	16/24	-/29	63/79	63/56	14/960	206/55	42/135	840/74
Feb	36.426	48	-/5	20/26	-/42	90/105	181/113	9/2560	163/76	34/171	5690/477
Mar	37.004	38	-/6	65/34	-/53	140/87	384/91	19/1760	353/74	126/176	1900/508
Ap	37.140	47	-/-	32/25	-/61	124/62	272/81	12/1940	203/75	54/125	7080/88
May	37.395	54	-/5	25/56	-/70	163/144	515/133	15/3270	261/127	46/225	5120/403
Jun	37.869	35	-/2	36/6	-/35	204/70	1464/71	42/2560	250/58	107/164	3970/187
Jul	38.449	38	-/4	15/33	-/51	84/82	158/89	15/4160	109/80	45/166	-/231

- not available

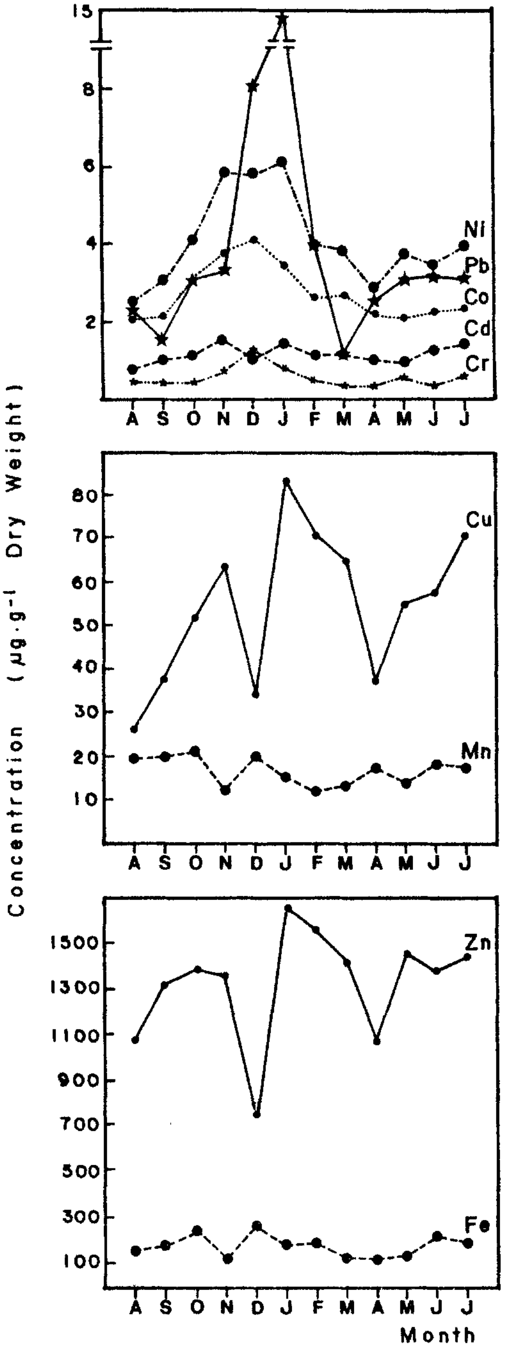

Figure 2. Temporal fluctuations of Cd, Cr, Co, Pb, Ni, Cu, Mn, Fe and Zn in the oyster C. corteziensis from Port of Mazatlan, Mexico, 1985-1986.

The causes of seasonal fluctuations have been the source of different proposals, such as the food supply (associated with an increase of productivity), changes in run-off of particulate metal to the sea consequent to high precipitations (Fowler and Oregioni, 1976), variations in the metal levels in somatic and gonadal tissues, related to the reproductive cycle (Latouche and Mix, 1981), or simply to seasonal size changes against a metal content during the year (Páez-Osuna and Marmolejo-Rivas, 1990).

In oyster C. corteziensis no correlations with the levels of dissolved metals were observed in the lagoonal water (salinity between 25.756 and 38.449 °/₀₀) nor with the level of metals in the particulate fraction (or both together) corresponding to the same collection time. However, when alternatively the levels of the trace metals of the oyster are correlated with those in the particulate fraction of the month immediately preceding, a significant relationship is obtained for four of the nine metals analysed.

For cobalt, chromium, nickel and lead, the relationship in oysters C. corteziensis (46±6 mm, long) is described by a simple linear function

$$Y = aX + b \qquad (1)$$

where, Y is the level of these metals in the oyster and X in the particulate fraction of the lagoonal water of the one-month precedent (Fig. 3).

This correlation suggest indirectly that copper, chromium, nickel and lead, have a biological half-live in C. corteziensis for approximatly one month, but in other metals (Cd, Cu, Fe, Zn, and Mn) the turn-over rates are probably very different, or the levels in the soft tissue of the lagoonal oyster is not understandable in function of particulate or/and dissolved metal in monthly measurements.

From equation (1) and using a wet-to-dry-weight ratio of 7.5 (conversion factor, calculated with water content), it follows that, in order to prevent the oysters sampled between August 1985 and July 1986 from exceding the maximum lead level permitted, for example by the National Health and Medical Research Council food standards (Anonymous, 1981); 2.5 $mg.kg^{-1}$ wet weight the concentration of lead in the particulate fraction of the lagoonal water, should not exceed 7.48 $\mu g.L^{-1}$. This concentration is close to that found during December (Table 1) and gives a concentration factor of 2507. Lead in oysters sampled in December was 14.2 $\mu g.g^{-1}$ dry weight which is lower than the critical value of 18.75 $\mu g.g^{-1}$ dry weight.

It should be pointed out, than the r-values for power curves of lead, nickel, cobalt and chromium were 0.79, 0.62, 0.63 and 0.58 respectively. Eq. (1) was chosen as the best description because

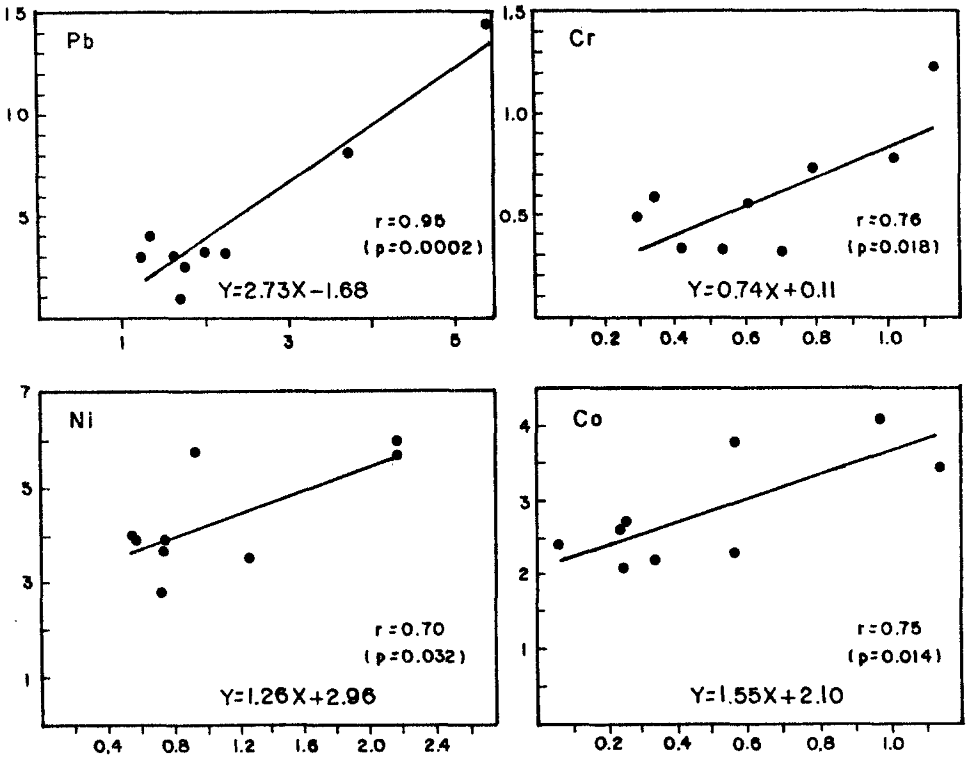

Figure 3. Concentration of trace metals in C. corteziensis Vs trace metal content of the particulate fraction (one-month preceding) in the Port of Mazatlan, Mexico.

it could predict most closely the values actually determined at the selected site for the population of oysters studied here.

These results are in concordance with these obtained by Talbot (1987) in Australia (Port Phillip Bay and Western Port), where a significant equilibrium relationship was found between total and direct recoverable lead in seawater and its concentrations in the mussel Mytilus edulis. Nevertheless, Talbot found that the best relationship is described by a power function.

The results of the present work together with those of Talbot (1987) and Marmolejo-Rivas and Páez-Osuna (submitted), show that the relationships found are valuable because it is possible to estimate the concentration factor and the concentration of metals in water (particulate or total) which is likely to cause the elements to accumulate in bivalves (Oysters or Mussels) to undesirable concentrations.

Acknowledgments. The author gratefully acknowledge the financial support of Consejo Nacional de Ciencias y Tecnología de México, for the investigations carried out in this area (Proyecto PCCBBNA 021995) and thanks Jeanette Wolf for reviewing the English manuscript.

REFERENCES

Alvarez-León (1980) Hidrología y Zooplancton de tres esteros adyacentes a Mazatlán, Sinaloa, México. An. Centro Cienc del Mar y Limnol UNAM 7: 177-196

Amiard JC, Amiard-Triquet C, Berthet B, Metayer C (1986) Contribution to the ecotoxicological study of cadmium, lead, copper and zinc in the mussel Mytilus edulis. Mar Biol 90: 425-431

Anonymous (1981) Report on revised standars for metals in food. Canberra

Breder R (1982) Optimization studies for reliable trace metal analysis in sediments by atomic absorption spectrometric methods Fres Z Anal Chem 313: 395-402

Farrington JW, Goldberg E, Risebrough RW, Martin JH, Bowen VT (1983) U.S. "Mussel Watch" 1976-1978: An overview of the trace metal, DDE, PCB, Hydrocarbon and artificial radionuclide data Environ Sci Technol 17: 490-496

Fowler SW, Oregioni B (1976) Trace metals in mussels from the NW Mediterranean. Mar Pollut Bull 7: 26-29

IAEA, International Atomic Energy Agency (1985) Intercomparison of trace element measurements in marine sediment sample SD-N-$\frac{1}{2}$ Report No. 24, Mónaco

Keen M (1971) Sea shells of tropical west America: Marine mollusks from Baja California to Perú. Stanford Univ Press, Stanford

Lankford RR (1977) Coastal lagoons of Mexico. Their origin and classification. In: Wiley M (ed) Estuarine Processes, Academic Press, New York, pp 182-215

Latouche YD, Mix MC (1981) Seasonal variation in soft tissue weights and trace metal burdens in the Bay Mussel, Mytilus edulis Bull Environ Contam Toxicol 27: 821-828

Marmolejo-Rivas C, Páez-Osuna F (submitted) Trace Metals in Tropical Coastal Lagoon Bivalves: Mytella strigata. Bull Environ Contam Toxicol

NAS National Academy of Sciences (1980) The international mussel watch. Office of Publications, Washington, DC

Páez-Osuna F, Marmolejo-Rivas C (1990) Ocurrence and seasonal variation of heavy metals in the oysters Saccrostrea iridescens. Bull Environ Contam Toxicol 44: 129-134

Páez-Osuna F, Valdez-Lozano S, Alexander HM, Fernandez H (1987) Trace metals in the fluvial system of terminos lagoon, Mexico. Mar Pollut Bull 18: 294-297

Talbot V (1987) Relationship between lead concentration in seawater and in the mussel Mytilus edulis: a water-quality criterion. Mar Biol 94: 557-560

Received October 16, 1989; accepted February 8, 1990.