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Occurrence and Seasonal Variation of Heavy Metals in the Oyster *Saccrostrea iridescens*

F. Páez-Osuna and C. Marmolejo-Rivas

Institute of Marine Sciences and Limnology, Mazatlan Marine Station, National Autonomous University of Mexico, P.O. Box 811, Mazatlan Sinaloa, 82000 Mexico

The oyster Saccrostrea iridescens (naley, 1854) is a marine species which is geographically distributed from the Gulf of California to the North of Perú (Keen, 1971). In México and particularly in The Pacific coast, this mollusc is widely utilized for human consumption, having consequently, an important commercial value, though no heavy metal data are available to establish natural background levels.

In the present study the analysis of the concentration of heavy metals (Fe, Mn, Ni, Pb, Cu, Co, Cr, Zn and Cd) in soft tissues of S. iridescens of the Mexican nortwest coast (a rural, uncontaminated site), during a period of ten months, allows us to suggest the relative importance that the seasonal variation and size (age) of bivalve have in the accumulation of these elements. Additionally, the observed levels have been compared with those in other areas.

MATERIALS AND METHODS

The oysters were collected monthly in the nortwest coast of México (Southern Gulf of California) (Fig. 1), between August 1985 and May 1986. Metal concentrations in the organisms sampled by divers from a depth of 2–10 m, were determined for total flesh; composite samples of 19–22 individuals were dried at 90°C and treated carefully with concentrated and distilled nitric acid (Goldberg et al, 1983; PNUMA, 1983). The digests were slowly evaporated to dryness on a hotplate (110°C) and the residues were dissolved in 25 ml of 1M nitric acid. Samples were placed in acid-washed polyethylene bottles (Moody and Lindstrom, 1977) and analysed by the flame spectroscopy using a Shimadzu AA-630. The accuracy of the Method used was established using MA-M-2/TM Mussel Tissue (IAEA, 1985). Analysis gave the following results (Table 1):

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

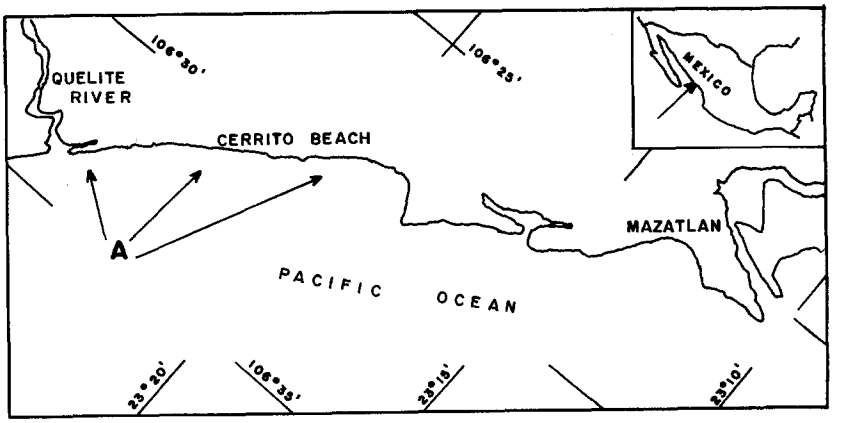

Figure 1. Study area showing the location of sampling site (A).

Table 1. Concentration values of elements in MA-M-2/TM reference material.

Metal	Confidence interval (significance level 0.05) ($ug.g^{-1}$)	Class of Results (a)	Concentration Found (n=6) ($ug.g^{-1}$)
Cd	1.16-1.54	A	1.63 ± 0.04
Co	0.75-1.07	B	2.37 ± 0.10
Cr	0.95-1.62	B	1.23 ± 0.04
Cu	7.35-8.44	A	9.32 ± 3.11
Ni	0.89-2.04	C	2.13 ± 0.03
Pb	1.53-2.50	C	3.70 ± 0.65
Zn	152.8-166.7	B	140.5 ± 6.8

(a) Certified with satisfactory (Class A) or acceptable (Class B) degree of confidence. Values non-certified (Class C).

Apparently, cobalt and lead are over estimated with this method, because of this, such elements are not included in the comparison with other areas (Table 2).

RESULTS AND DISCUSSION

The results of the analysis are presented in Figs. 2-4. Zinc and copper shows in a similar way the highest concentration in October and the lowest in April (r=0.88, P=0.01; linear regression). Chrome and manganese with little fluctuation, their patron is very similar (r=0.84, P=0.01). With exception of one month, the levels of cadmium and iron in the rest of months were relatively constant, while the cobalt, nickel and lead simultaneously show a light enrichment in the months of autumn-winter, when the temperatures of seawater in the locality decrease from 29-34°C to 23-25°C (Mee et al, 1985).

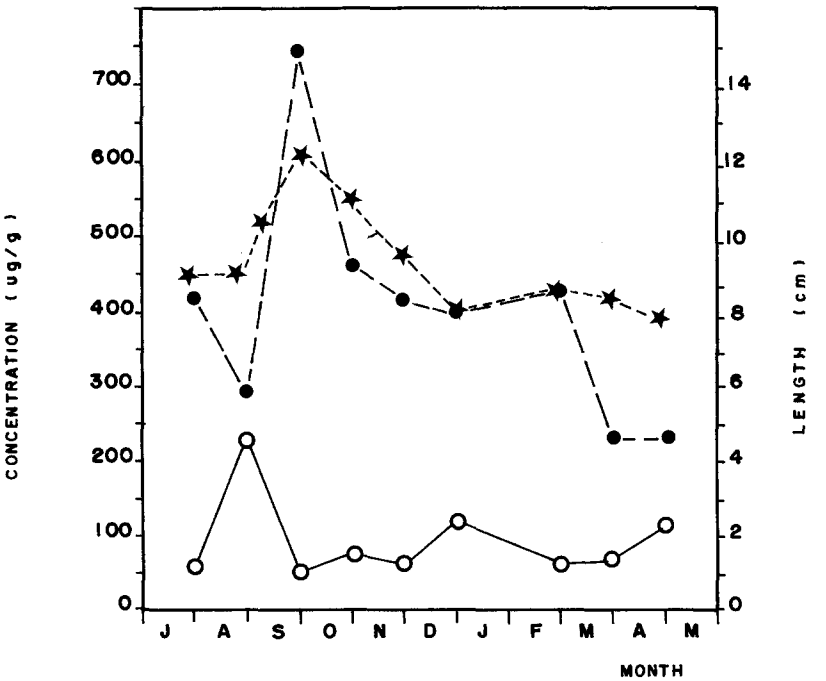

Figure 2. Temporal fluctuations of Fe (○), Zn (●), and length (★) in the oyster S. iridescens from northwest coast, México, 1985 and 1986.

There are several possible reasons for temporal fluctuations in concentrations of the heavy metals in the bivalves; changes in biological or biochemical activity or changes in the environmental concentrations, forms or chemical species of the elements in question, (Farrington et al, 1983). The results of this study are due, at least in part, to variation of the size (age) of the oyster depending on the season. The seasonal fluctuations in concentrations of copper (6.6-41.8 $ug.g^{-1}$), zinc (226-745 $ug.g^{-1}$) chrome (0.41-0.85 $ug.g^{-1}$) and manganese (7.2-11.2 $ug.g^{-1}$) found here are due (at least in part) to variation of the size (as length, 8.12 cm) of the oyster S. iridescens depending on the season. Copper and zinc were positively correlated with size ($r=0.78$, $P=0.05$; $r=0.80$, $P=0.01$), while chrome and manganese were negatively correlated ($r=0.82$, $P=0.01$; $r=0.89$, $P=0.01$). In the present study, samples having seasonally high size (as length) are found to have seasonally low concentrations of chrome and manganese (and high for copper and zinc) and vice versa.

Table 2, shows the average metal concentrations in oysters from different areas. Although, there is evidence of problems with the intercomparison of data, the levels reported in this study are comparable to oysters as C. gigas (Walting and Walting, 1976; Hwang et al, 1986), and C. comercialis (Phillips and Muttarasin,

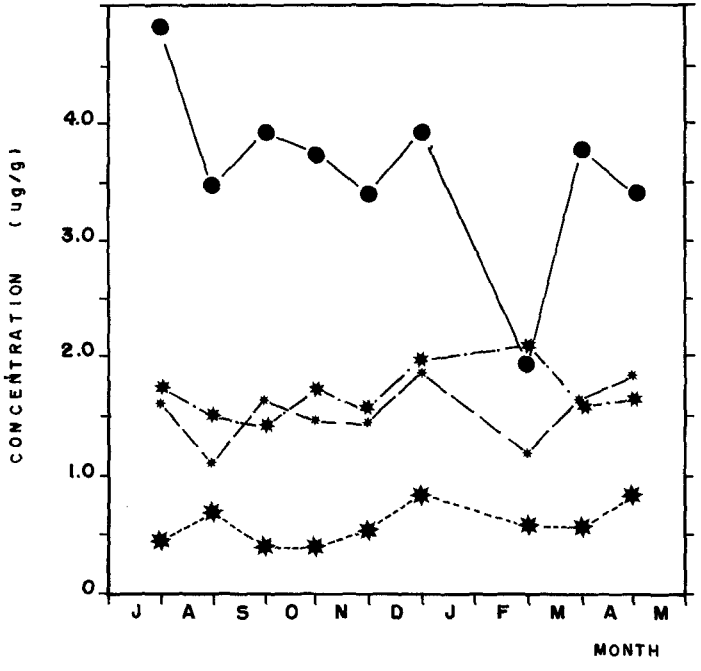

Figure 3. Temporal fluctuations of Cd (●), Co (*), Ni (✱) and Cr (✱) in the oyster S. iridescens from northwest coast, México, 1985 and 1986.

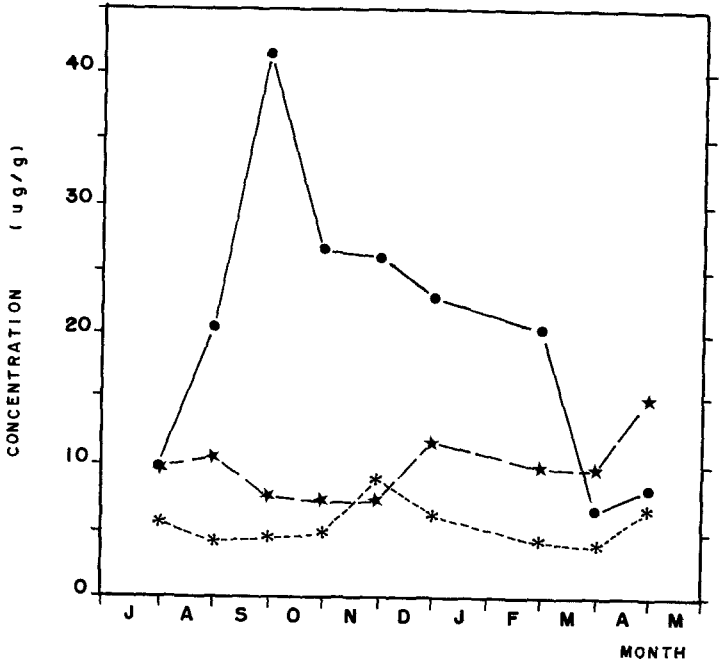

Figure 4. Temporal fluctuations of Mn (★), Cu (•) and Pb (*) in the oyster S. iridescens from northwest coast, México, 1985 and 1986.

Table 2. Average heavy metal concentrations in oysters from different areas. Concentrations are expressed in ($ug.g^{-1}$) dry weight.-

Oyster	Area	($ug.g^{-1}$)						Reference
		Cd	Cu	Fe	Mn	Ni	Zn	
S. iridescens	Northwest cost (México)	3.6	20.4	93	9.4	1.7	402	(1)
C. gigas	Knysna Estuary (South Africa)	3.7	52	128	16	1.6	396	(2)
C. gigas	Hansan-Koje Bay (Corea)	2.7	30.8	-	-	-	543	(3)
C. comercialis	Thailand Gulf (Thailand)	3.2	100	124	-	0.8	571	(4)
C. corteziensis	Mazatlán Harbour (México)	0.4	53.8	202	12.3	2.8	1068	(5)
C. virginica	Atlantic coast (U.S.A.)	-	220	-	-	4.2	4060	(6)

(1) This study; (2) Watling and Watling (1976); (3) Hwang et al (1986); (4) Phillips and Muttarasin (1985); (5) Páez Osuna et al (1988); (6) Goldberg et al (1978).

1985) from uncontaminated sites. In contrast the concentrations of Cu, Ni and Zn are low in comparison to oysters from Mazatlán Harbour (Páez-Osuna et al, 1988) or from the Atlantic coast of the USA (Goldberg et al, 1978).

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REFERENCES

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

Goldberg ED, Bowen VT, Farrington JW, Harvey G, Martin JH, Parker PL, Risebrough RW, Robertson W, Schneider E, Gamble E (1978) The Mussel Watch. Environ Cons 5:101-125

Goldberg ED, Koide M, Hodge V, Russel AF, Martin JH (1983) U.S. Mussel Watch: 1977-1978. Results on trace metals and radionuclides. Estuar Coast Shelf Sci 16:69-95

Hwang GC, Kim SJ, Song KC, Wi CH, Park JH (1986) Heavy metal concentration in oyster Crassostrea gigas and Blue Mussel Mytilus edulis in Hansan-Koje Bay. Bull Fish Res Dev Agency 37:201-209

IAEA. International Atomic Energy Agency (1985) Intercalibration of analytical methods on marine environmental samples: Trace elements measurements on mussel homogenate. Report No. 26, Mónaco

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

Mee LD, Ramírez-Flores A, Flores-Verdugo F, González-Farías F (1985) Coastal upwelling and fertility of the southern Gulf of California: Impact of the 1982-1983. ENSO Event Trop Ocean-Atm New 13:9-10

Moody JR, Lindstrom PM (1977) Selection and cleaning of plastic containers for storage of trace element samples. Anal Chem 49:2264-2267

Páez-Osuna F, Izaguirre-Fierro G, Godoy Meza RI, González-Farías F, Osuna-López JI (1988) Metales pesados en cuatro especies de organismos filtradores de la región costera de Mazatlán: Técnicaas de extracción y niveles de concentración. Cont Amb 4: 31-39

Phillips DJH, Muttarasin K (1985) Trace metals in bivalve molluscs from Thailand. Mar Environ Res 16:281-300

PNUMA. Programa de las Naciones Unidas para el Medio Ambiente (1983) Determination of total cadmium, zinc, lead and copper in selected marine organisms by Atomic Absorption spectrophotometry. Reference Methods for Marine Pollution Studies. París

Watling HR, Watling RJ (1976) Trace metals in Oysters from Knysna Estuary. Mar Pollut Bull 7:45-48

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