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# Distribution of Trace Metals in the Pacific Oyster, *Crassostrea gigas,* and Crabs from the East Coast of Kyushu Island, Japan

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Oysters are known to be exceptional accumulators of Zn and Cu, and their tissue concentrations appear to reflect contamination of metals (Bryan *et al.* 1985). According to Lauenstein and Dolvin (1992), oysters clearly have a greater affinity for Ag, Cu and Zn than do mussels, while mussels have greater affinity for Cr and Pb. Oysters have been considered to be potential bioindicators for monitoring metallic pollution in marine environments (Hung *et al.* 1981; Goldberg *et al.* 1983; Presley *et al.* 1990; Paez-Osuna and Marmolejo-Rivas 1990; Paez-Osuna *et al.* 1993; Vazquez et al. 1993; Ikuta 1991; Lauenstein *et al.* 1990; Lauenstein and Dolvin 1992). Extensive investigations of oysters from the east coast of Kyushu Island, Japan, have been performed by Ikuta (1972, 1988, 1991), Ikuta and Morikawa (1988, 1991), Ikuta and Tokudome ( 1988) and Ikuta *et al.* (1990a, b).

The aim of the study was to examine spatial differences in metal concentrations in soft tissues of the Pacific oyster *(Crassostrea gigas)* and whole bodies (soft tissues with shells) of the crabs *Goetice depressa* and *Leptodius exaratus* inhabiting the Japanese coastal region of the Pacific.

## MATERIALS AND METHODS

Three-hundred specimens of the Pacific oyster *(Crassomstrea gigas)* and 61 specimens of crabs *[Goetice depressa* (de Haan), Grapsidae and *Leptodius exaratus* (H. Milne Edwards), Xanthidae] were collected from rocky shores in the inter-tidal zones around the sea areas of Urashiro, Akamizu and Saganoseki along the east coast of Kyushu Island, Japan, during low water of the spring tide in April 1994. The sampling sites shown in Figure 1 were selected according to different degrees of their exposure to pollution. A metal refinery (Saganoseki Refinery of Nipponkougyo Industry) is located in Saganoseki while a fiber factory (Asahikasei Industry in Nobeoka) in Akamizu, Urashiro is situated a far distance from metallic pollution sources and is considered a reference site.

Living specimens of *Crassostrea gigas, Goetice depressa* and *Leptodius exaratus* were transported immediately to the laboratory and kept in seawater in an aquarium for 24 hr to clean the alimentary canals. Five groups of oysters were prepared, in which soft tissues of twenty individuals were pooled for each to obtain mean averages

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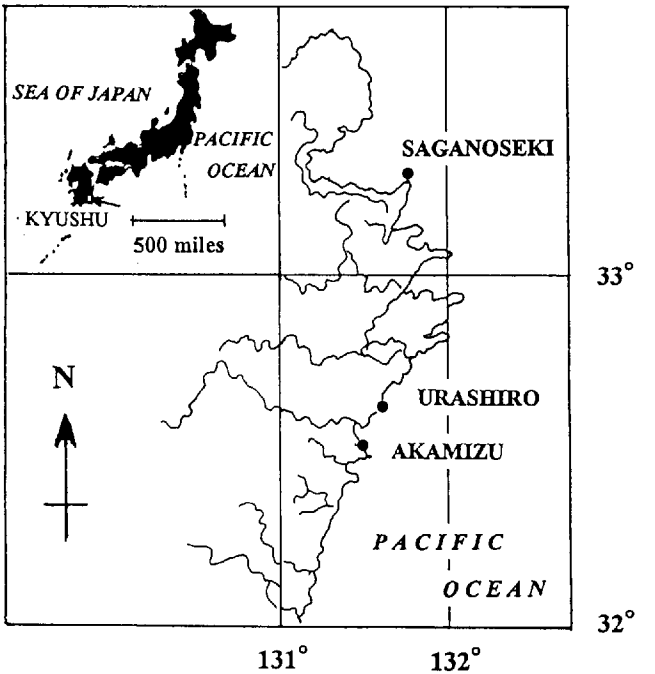


**Figure 1**. Location of the sampling stations for the collection of oysters and crabs in the areas of the east of Kyushu Island

of the samples, taking individual variations in trace element concentrations into consideration. The total number of crabs collected was not sufficient to prepare five pooled samples for each size group. As for oysters, the wet soft tissue was isolated from the shell of each specimen. All pooled samples were weighed and dried at 105°C to a constant weight and homogenized in a porcelain mortar. Three (crabs) to five (oysters) replicate subsamples of each were then prepared.

After weighing, dried materials were digested in an Automatic Microwave Digestion System (MLS 1200) using concentrated $HNO_3$ Suprapur® "Merck" and triple distilled water (obtained in apparatus Destamat® "Heareus Quarzglas"). Cadmium, Cu, Zn, Pb, Ag, Cr, Co, Ni Mn and Fe concentrations were determined by AAS method (Philips PU 9100 and VIDEO 11 E Atomic Absorption Spectrophotometers) using deuterium background correction. The quality of the method used was checked and confirmed in a separate comparative study of metals with a standard reference material, i.e., Fish Flesh MA-B-3/TM IAEA, Monaco. The agreement between the analytical results for the reference material and their certified values was satisfactory, i.e., the recovery and the standard deviation were >87% and <10%, respectively. To check for contamination, blanks were analyzed using this procedure after every 5 samples.

## RESULTS AND DISCUSSION

*Crassostrea gigas* from Saganoseki contained, on the average, considerably higher concentrations of tissue Cu (5,110 µg $g^{-1}$ d.w. ), Cd (19.6 µg $g^{-1}$ d.w.), Ag (46.3 µg $g^{-1}$ d.w.), Pb (14.5 µg $g^{-1}$ d.w.) and Fe (146 µg $g^{-1}$ d.w.) than those from Urashiro (216, 1.63, 5.13, 1.20 and 19.9 µg $g^{-1}$ d.w., respectively) (Fig. 2). The Saganoseki values of Cu, Cd, Ag and Pb were higher as compared with those reported for *Crassostrea gigas* from the other geographical regions, namely Restronguet Creek (lower), Menai Strait, Poole Harbour (Brownsea) and Knysna (S. Africa), Pipeclay Lagoon (Thomson 1983; Bryan *et al.* 1985); therefore, the Saganoseki area appears to be one of the most metal-contaminated regions of the world.

As for interspecies differences in accumulation of selected trace elements in Japanese oysters, the concentration of Cu in the Pacific oyster *(Crassostrea gigas)* from Urashiro and Akamizu were two orders of magnitude greater than those in the pearl oyster *(Pinctada fucata martensii)* from the same sites (Ikuta *et al.* 1990b). Concentrations of Zn, Mn and Fe were comparable in these two species, while pearl oysters from Urashiro concentrated ~ 7 times more Cd (0.619 µg $g^{-1}$ wet wt) than Pacific oysters from Urashiro (0.082 µg $g^{-1}$ wet wt). According to Ikuta *et al.* (1990b), the tissue concentrations of Cd in two species from Akamizu were similar, amounting to 0.536 µg $g^{-1}$ (pearl oyster) and 0.319 µg $g^{-1}$ wet wt (Pacific oyster).

Bearing in mind that the Pacific oyster is intensively cultivated in the Seto Inland Sea, the Sendai Bay and other coastal areas along the Japanese Islands, it is a very important commercial food product. The excretion phenomenon of metallic toxicants taken up in soft tissue as well as their bioaccumulation, are very important factors determining the quality of oysters as a potential food for man. To estimate depuration periods for Cu, Cd and Zn in *Crassostrea gigas* under field conditions, specimens with high levels of the selected metals from a polluted region, Akamizu, were transplanted into the Urashiro area where native oysters contain low levels of the metals (Ikuta and Morikawa 1991). Duration in days for the depuration of these metals to attain levels similar to the Urashiro native oysters was longer than a year, namely 488 (Cu), 458 (Cd) and 370 (Zn) days. These inter-elemental differences in the depuration period could be explained by the differences in physiological responses and biochemical reaction of these metals in diminution processes, i.e., there were differences in metal-liberating strength as an inverse role against metal-binding strength of proteins in oyster tissues (Ikuta and Morikawa 1991 ).

As for crabs, *Goetice depressa* from Saganoseki concentrated considerably higher concentration of Pb, Cd and Cu than those from Urashiro (Fig. 3). Average concentrations of Pb, Cu, Zn, Ag, Cr, Co, Mn and Fe in *Leptodius exaratus* from Akamizu were 2.94, 59.9, 55.9, 0.55, 3.72, 0.38, 98.7 and 521 $\mu g^{-1}$g dry wt.; hence *Leptodius exaratus* had higher concentrations of Pb and Fe than *Goetice depressa* from the same site.

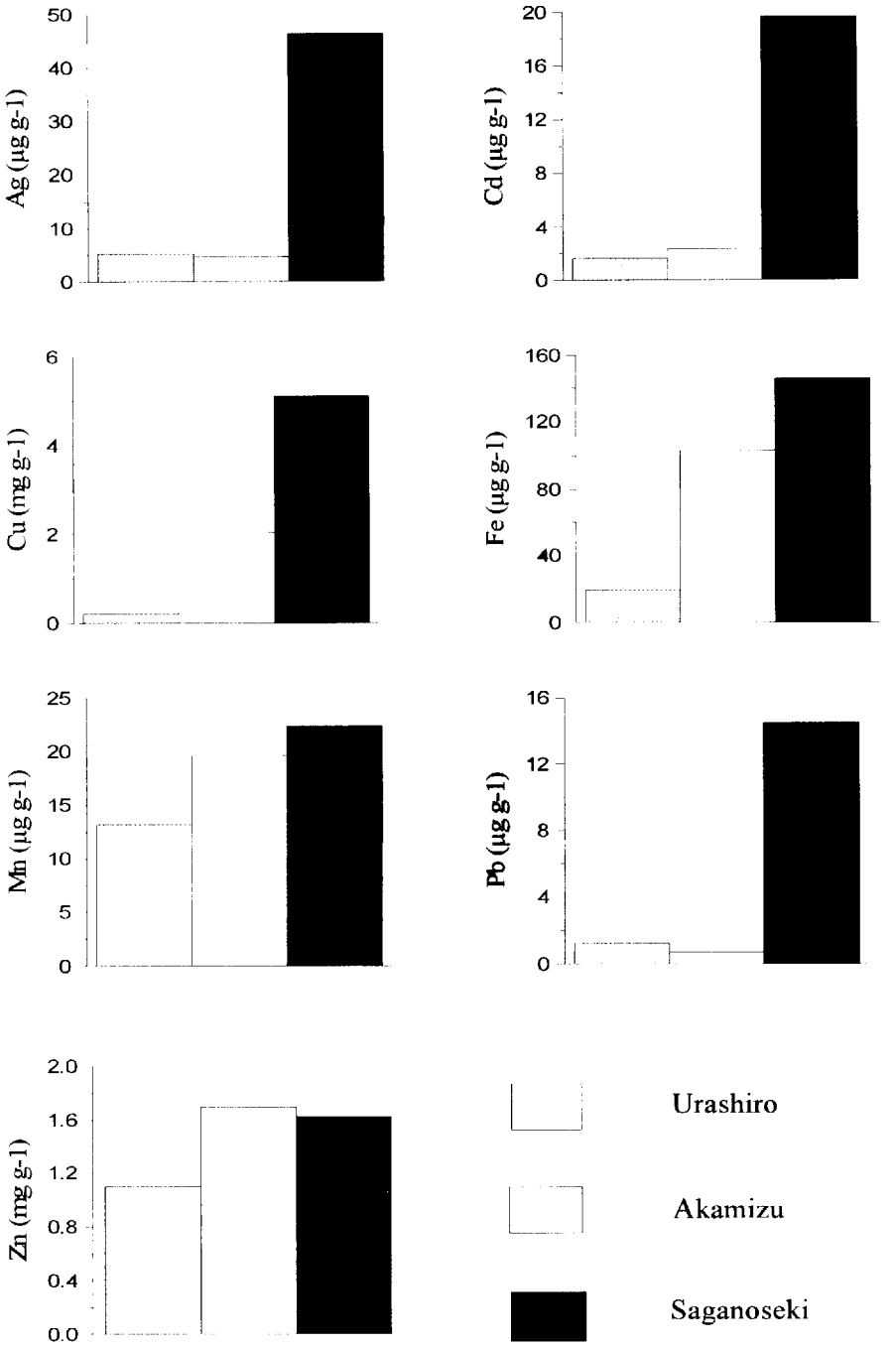


**Figure 2.** Spatial distribution of selected metals in the soil tissue of Pacific oyster, *Crassostrea gigas*

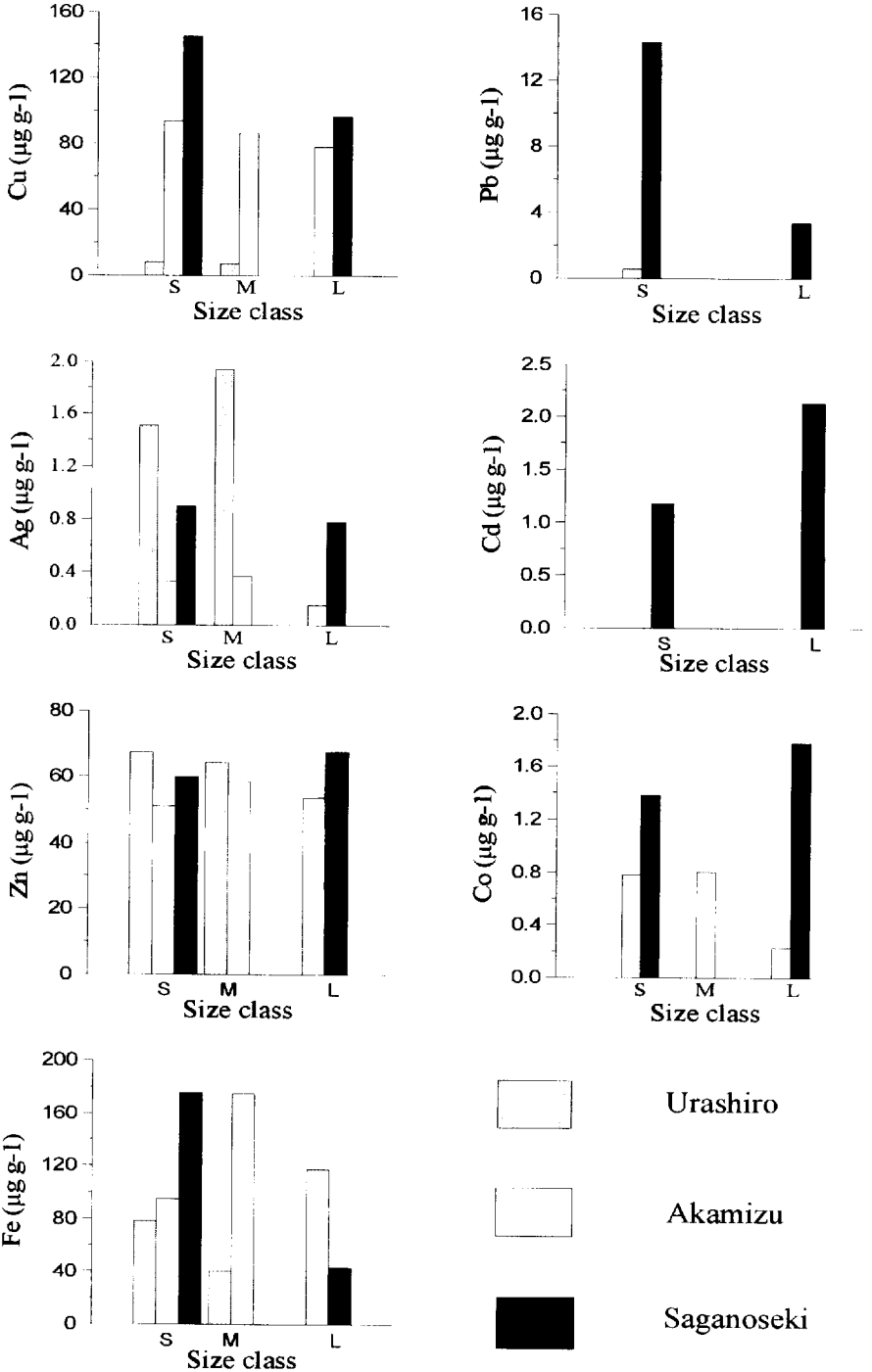


**Figure 3**. Spatial distribution of selected metals in whole body of crab *Goetice depressa* (S - small; M - middle; L - large)

The elevated concentrations of Pb, Cd, Ag and Cu in the soft tissue of *Crassostrea gigas* as well as Pb, Cd and Cu in the whole body of *Goetice depressus* inhabiting the Saganoseki area are attributed to the anthropogenic emissions from a metal refinery located there. Higher levels of Cu in both groups of benthic organisms from Akamizu as compared to Urashiro can be explained by the fact that the former area is exposed to Cu compounds released from an artificial fiber factory.

The data obtained in the present study and those reported by Ikuta (1988, 1991) and Ikuta et al. (1990b) show that the soft tissue of *Crassostrea gigas* is a good bioindicator for identification of coastal areas exposed to the influx of some metallic toxicants.

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