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Mercury and Cadmium Content in Green Mussel, *Mytilus viridis* L. from Onrust Waters, Jakarta Bay

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Shellfish are known for their ability to accumulate trace metals from their environment (Goldberg 1975; Phillips (1976). The relatively small increase in ambient metal concentration due to pollution will be reflected in measureable increase in mussel metal concentration. Recently, Hutagalung (1987) found the high concentration of mercury in cockle, Anadara granosa, from Angke Estuary, Jakarta Bay. The abnormally high concentration of heavy metals in the surface water of Jakarta Bay was reported by Yatim et al. (1979). Moreover, they also reported that in some locations in Jakarta Bay, the concentration of heavy metals tends to increase, and in surface water around Onrust Island the mercury and cadmium concentration had reached upto 35 ppb and 450 ppb, respectively. The green mussel, Mytilus viridis L., was cultivated around Onrust Island, Jakarta Bay. So far, there is no available information on mercury and cadmium contents in marine organisms from the surrounding waters of Onrust Island. The present study reports the result of an observation of the total mercury and cadmium contents in the soft tissue of Mytilus viridis L. collected from Onrust Island waters.

MATERIALS AND METHODS

Mussel samples were collected biweekly by hand from Onrust waters, Jakarta Bay, during March to May 1983. Mussels were place in acid-washed plastic bags containing clean seawater for 24 hours to allow the voiding of gut content before dissection and analyses. The mussels were rinsed in distilled water, shell lengths were measured, and the whole soft tissue of the mussels carefully removed from the shell and weighed. The individual specimens were digested in 5 ml concentrated nitric acid and heated (<80°C) for 1 hour to minimize frothing. The samples were then cleared with a few drops of 30% H_2O_2, drying slowly by heating at 110 - 125°C and then dissolved in 5 ml concentrated nitric acid. The solution was then transferred to a cleaned polyethylene vial (Dalziel & Baker 1979). Several sample blanks were used to detect possible contamination during digestion and analyses. Water samples from the environments where the mussels were collected were analyzed for Hg and Cd content. Total mercury content in both mussels and water samples were determined by flameless AAS after reduction with $SnCl_2$, while air-acetylene flame AAS was used for cadmium determination.

RESULTS AND DISCUSSION

One hundred and five specimens of Mytilus viridis with shell lengths ranging from 2.10-12.18 cm were analyzed for both mercury and cadmium content. The results indicate that individual M. viridis from the same population accumulates varying concentrations (presented as percentage coefficient of variation) of the heavy metals (Table 1). High variability of the metals accumulation by molluscs has also been reported by Bryan (1973);Phillips (1976); Ayling (1974); Hung et al. (1981), and showed that the variability of metal accumulation by molluscs may be caused by individual variation factors such as shell length. In order to determine whether this individual variation existed, the mercury and cadmium concentrations were plotted against shell length on both linear ($Y=a+bX$) and power ($Y = cX^d$) regression analyses. The results showed that the relationship between Hg and Cd concentration with shell length has a strongly negative correlation to both linear and power regressions, but linear regression gave the highest correlation coefficients than that of power regression (Table 2). As shown in Table 2, the correlation coefficients of seven investigations were varied, but the concentration of Hg and Cd in the whole soft tissue of M. viridis always decreased significantly with increasing shell length. This means that the relatively highest concentration of Hg and Cd is present in the smallest mussels. Similarly, it was also found in other species of the family Mytilidae, i.e. Mytilus edulis (Boyden 1974; Phillips 1976); Mytilus galloprovincialis (Flower at al., 1978) and Choromytilus meridionalis (Watling and Watling 1976), and in Oyster, Crassostrea gigas (Ayling 1974); Saccostrea cucullata (Mackay et al. 1975) and Crassostrea virginica (Cunningham 1979). The above information suggests that the highest concentration of mercury and cadmium is always present in the smallest bivalves. The fact that the smaller bivalves accumulated higher concentration of Hg and Cd in most cases was probably a reflection of the more rapid metabolism which accompanies growth in these individuals. Dame (in Cunningham 1979) reported the instantaneous growth for intertidal Crassostrea virginica decreased with increasing body size. Presumably the more rapid growth in younger bivalves per-

Table 1. Concentration (range, $\bar{X}$, SD) and variability (CV) of Hg and Cd in _Mytilus viridis_ L. from Onrust Waters, Jakarta Bay.

Sampling date	range of shell length (cm)	N		concentration, ug/g Hg	Cd
March, 7.1983	2.10-10.25	15	range	0.264-3.663	0.058-4.175
			$\bar{X}$	1.850	1.627
			SD	1.055	0.670
			CV	57	64
21.1983	3.70-12.18	15	range	0.253-3.168	0.032-1.174
			$\bar{X}$	1.876	0.422
			SD	1.084	0.287
			CV	58	68
April, 4.1983	3.20-9.10	15	range	0.231-3.947	0.128-2.025
			$\bar{X}$	1.648	0.584
			SD	1.286	0.489
			CV	78	83
18.1983	2.90-7.90	15	range	0.096-2.974	0.745-11.748
			$\bar{X}$	1.242	4.085
			SD	1.052	3.868
			CV	85	95
May, 2.1983	3.05-8.00	15	range	0.011-2.627	1.015-12.001
			$\bar{X}$	0.916	5.090
			SD	0.774	3.983
			CV	85	78
16.1983	3.15-9.70	15	range	0.004-2.518	0.591-8.302
			$\bar{X}$	0.755	2.416
			SD	0.866	1.899
			CV	155	79
30.1983	2.90-7.05	15	range	0.055-1.900	1.297-8.588
			$\bar{X}$	0.742	3.901
			SD	0.467	2.314
			CV	63	59

N = number of samples SD = standard deviation CV = coefficient of variation (%)

mitted more rapid heavy metal accumulation in the tissue than older specimens. He suggests that the more rapid turnover of cellular material and the subsequent increase in body weight would dilute the metal concentration.

Table 2. Correlation coefficient for plot of shell length against metal concentrations on both linear and power regression.

*P = 0.05 **P = 0.01 ***P = 0,001

Sampling date	n	Hg linear	Hg power	Cd linear	Cd power
March 7, 1983	15	-0.91***	-0.85***	-0.71**	-0.62**
21, 1983	15	-0.91***	-0.90***	-0.81***	-0.66**
April 4, 1983	15	-0.89***	-0.91***	-0.80***	-0.64**
18, 1983	15	-0.88***	-0.85***	-0.98***	-0.90***
May, 2, 1983	15	-0.81***	-0.78***	-0.97***	-0.90***
16, 1983	15	-0.74***	-0.69**	-0.52*	-0.49**
30, 1983	15	-0.70**	-0.64**	-0.92***	-0.88***

Klumpp and Burdon-Jones (1982) reported that the uptake of Pb and Cd by the mollusc, Trichomya hirsuta, is directly proportional to the external concentrations of Pb and Cd in ambient water. Such conditions occured in the Onrust Waters where the concentrations of mercury and cadmium in the Mytilus viridis were higher than in the ambient waters (Fig. 1). The fluctuation of mercury and cadmium concentrations in Mytilus viridis follows the concentration of mercury and cadmium in the ambient waters. It is clear that the concentration of mercury and cadmium in Mytilus viridis were related to concentration of mercury and cadmium in sea water.

Thirty five specimens of large (shell length 6 cm) mussels have mercury and cadmium concentration ranging from 11-848 ppb ($\bar{X}$ = 320 ppb) and 627-2436 ppb ($\bar{X}$ = 990 ppb), respectively. Comparing the present data on mercury and cadmium in Mytilus viridis (shell length $>$ 6 cm) with those of other results is difficult because little data on this species are available. However, data reported on Mytilus edulis from different regions of the world are compared with data on Mytilus viridis as shown in Table 3. The results show that the values for both mercury and cadmium are much higher than those found in the other species of Mytilus i.e. M. edulis, M. smaragdinus and Perna viridis from different regions of the world.

The World Health Organization (WHO) recommended that the

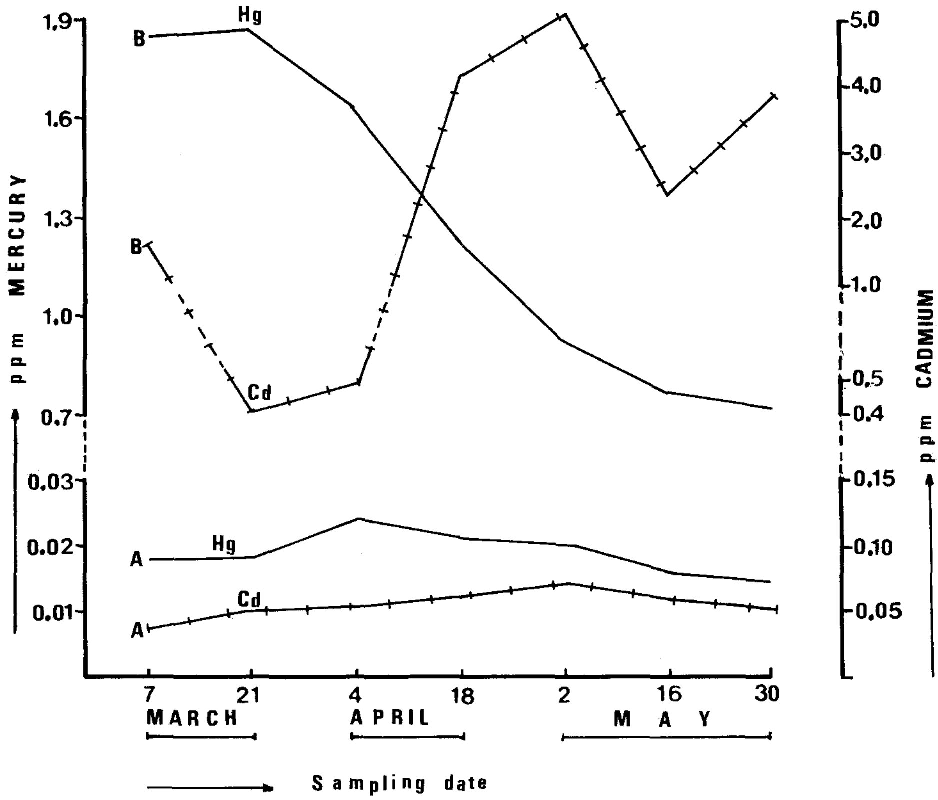

Figure 1. Mean values of total mercury and cadmium con- concentration in sea water (A) and in *Mytilus viridis* L. (B).

maximum concentration of mercury in marine food was 0.5 ppm. From the food safety point of view, specimens collected from Onrust Waters mostly have higher mercury concentration than those WHO's value. Most people living in Jakarta consume *Mytilus viridis* with shell length more than 6 cm. Based on this criteria only 11.4 % of large (> 6 cm) mussel exceeded the level recommended by WHO for mercury, therefore the potential hazard of M. viridis as food for human consumption is small. It should be noted that people living in Jakarta consume mussels very rarely and *M. viridis* can be considered as edible food resource from Jakarta Bay.

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Table 3. Mercury and cadmium content in Mytilidae collected from Onrust Waters and other areas, ppb wet weight.

Organisms	locations	Hg	Cd	references
Mytilus viridis	present study	11-848	627-2436	
M. edulis	Tallin Bay, Filand	20-30		Ott & Jatkovski 1980
M. smaragdinus	Shindai coastal, Taiwan	12-16		Hung *at al* 1981
M. edulis	Belgium	20-30	80-750	ICES 1984*
	Denmark	30-50	160-190	ICES 1984*
	France	20-50	100-130	ICES 1984*
	Puck Bay, Finland		540-1240	Szefer & Szefer 1985
Perna viridis	Northern Part of Malacca Straits,	20-70		Liong 1986

Notes : *International Council for the Exploration of the sea.

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