Journal of Sustainability Science and Management
Volume 8 *Number* 2, December 2013: 207-211
ISSN: 1823-8556

CD AND ZN IN *NERITA LINEATA* COLLECTED FROM SELECTED AREAS OF THE SOUTH WEST COAST OF PENINSULAR MALAYSIA

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Abstract: The concentrations of Cd and Zn were determined in *Nerita lineata* snails and sediments collected from Johore and Klang between May 2010 and April 2011. This study found variations of heavy metal accumulations in the shells, opercula and soft tissues. The mean concentrations (µg/g dry weight) of Cd and Zn were 5.42 and 8.11 for shells; 5.60 and 14.26 for opercula; 3.08 and 110.90 for soft tissues, respectively. The mean concentrations (µg/g dry weight) of Cd and Zn for surface sediments were 1.76 and 88.78, respectively. Generally the results of this study were comparable with those of previous reports on the same species.

KEYWORDS: Heavy metals, *Nerita lineata*, cadmium, zinc.

Introduction

Anthropogenic sources, such as industrial activities (petro-chemical power plants and chemical factories) and shipping activities, are mainly concentrated on the west of Peninsular Malaysia (Abdullah *et al.,* 1999; Yap *et al.,* 2002a). This has resulted in excessive inputs of metals such as Cd and Zn into the marine environment. Cadmium has been identified as a very environmentally toxic element which is used in the production of plastics, paints and batteries (Lidén *et al.,* 2011). Zinc on the other hand, is an essential metal but it may be toxic to marine organisms if the concentration is high (Osipenko *et al.,* 1992). Hence, numerous biomonitoring studies on these metals were reported in this part of the Peninsular (Yap *et al.,* 2003; Ali 2004; Agusa *et al.,* 2005; Amin *et al.*, 2008; Alkarkhi *et al.,* 2009; Yap *et al.,* 2010a).

The *N. lineata* are common mangrove snails that are found in abundance in this region. Previous studies by Yap *et al.* (2009), had given a positive recommendation on this snail as a good biomonitor but a detailed study on this topic is still lacking. In this study, *N. lineata* was employed as a potential biomonitor to assess Cd and Zn pollution in selected sites of the west coast of Peninsular Malaysia. The focus of this study were mainly on polluted sites of ports and industrial areas as compared to the previous studies (Yap *et al.,* 2009) where samples were collected randomly along the west coast of Peninsular Malaysia. Therefore, the purpose of this study is to compare the Cd and Zn levels in the sediments and snails between this study and the previous study as part of the monitoring work and to reflect the utility of the snails as a good biomonitor for these metals.

Materials and Methods

Sample Preparation

Snail samples and sediments were collected from Selangor, Negeri Sembilan and Johore states of Peninsular Malaysia (Figure 1). The snails were dissected into three parts namely shells, opercula and soft tissues. The snails and sediments were dried in an oven at 60 ˚C to constant dry weights. The snails were then kept for extraction while the sediments were sifted through a 63µm stainless steel aperture before digestion. The snails were not depurated of the gut as this showed no effect on the metal levels in the snails (Yap *et al.,* 2010b).

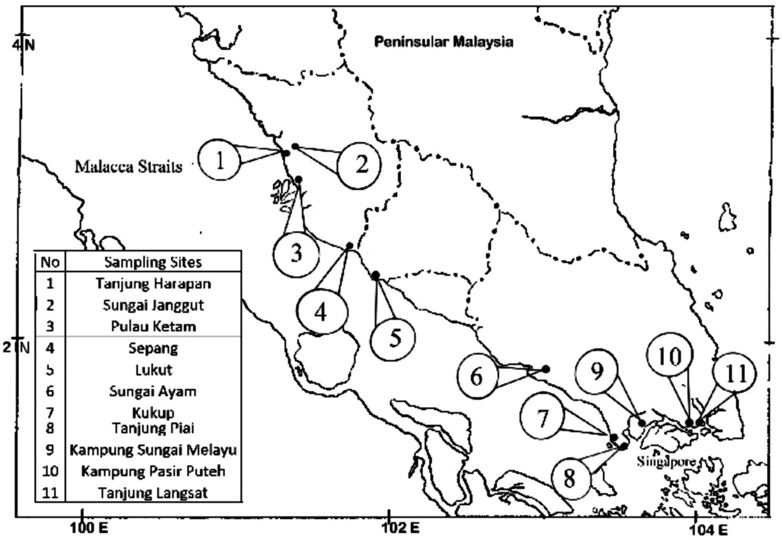

Figure 1: Map of Sampling Sites.

Digestion of Samples

Triplicates of each dried tissues (shell, operculum and soft tissues) were digested in concentrated nitric acid (AnalaR grade, BDH 69%) based on the procedures by Yap *et al.,* 2009a. The sediments were digested and the sequential extraction technique was applied to obtain the geochemical fractions of the sediments (Yap *et al.,* 2002b). All digested samples were diluted and filtered through Whatman No1 filter papers into acid washed pill boxes and stored for metal determinations.

Metal Analysis

Digested samples were analyzed for Cd and Zn by using an air-acetylene Perkin-Elmer™ flame Atomic Absorption Spectrophotometer (AAS) Model Analyst 800. Standard solutions were prepared from 1000 ppm stock solutions provided by MERCK Titrisol for Cd and Zn. All glasswares and equipment used were acid-washed to avoid contamination. Percentages of recoveries between 92% - 106% were acquired for all metals to check the accuracy of the analysis. The analytical procedures were checked with Certified Reference Material (CRM) for dogfish liver (DOLT-3, National Research Council Canada) and soil (International Atomic Energy Agency, Soil-5, Vienna, Austria). The recoveries obtained were satisfactory (dogfish liver: Cd=98.88%, Zn=110.77%; soil: Cd=111.76%, Zn=88.36%).

In this study, the snails' (shells, opercula and soft tissues) data were correlated with the sediment data by Pearson's correlation coefficient using statistical software (IBM SPSS 19.0 for windows).

Results and Discussion

The mean concentrations (µg/g dry weight) (Table 1 and 2) of the snails collected from eleven sampling sites ranged from 3.11 – 7.45 and 1.85 – 5.21, in the shells; 3.62 - 7.33 and 5.29 - 30.08, in the opercula; 0.69 – 6.25 and 102.74 - 130.66, in the soft tissues for Cd and Zn respectively. The mean concentrations (µg/g dry weight) for sediments were 5.17 – 92.63 and 12463.25 – 49935.55 for Cd and Zn, respectively.

The concentrations of heavy metals varied between the shells, opercula and soft tissues of *N. lineata*. The highest concentrations of Cd were generally recorded in the opercula followed by shells and soft tissues. The highest concentrations of Zn were recorded in the soft tissues followed by opercula and shells. This was in line with previous findings that essential metals

Table 1: Heavy Metal Concentrations (mean ± standard error µg/g) of Shells of *N. lineata* collected from Klang and Johore. (N=11)

	Cd									Zn								
	Shells			Opercula			Soft Tissues			Shells			Opercula			Soft Tissues		
Kpg. Pasir Puteh	3.11	±	0.55	3.94	±	0.14	0.69	±	0.17	3.67	±	0.54	8.19	±	1.02	108.62	±	0.92
Sg. Ayam	4.67	±	0.31	6.48	±	0.26	3.12	±	0.35	1.95	±	0.22	10.44	±	0.2	107.09	±	3.62
Sg. Janggut	7.16	±	0.97	6.12	±	0.3	3.82	±	0.17	1.85	±	0.03	30.08	±	1.82	106.45	±	2.17
Kpg. Sg. Melayu	7.42	±	0.53	6.45	±	0.38	3.61	±	0.12	4.3	±	0.17	16.8	±	0.93	106.8	±	3.11
Kukup	6.65	±	0.56	6.97	±	0.35	4.61	±	0.53	2.7	±	0.49	17.02	±	0.96	108.75	±	2.68
Tj. Langsat	6.6	±	0.18	6.34	±	0.37	3.43	±	0.26	5.21	±	0.16	23.21	±	3.01	130.66	±	3.98
Lukut	7.45	±	0.5	7.33	±	0.57	6.25	±	0.23	4.84	±	0.39	13.76	±	0.31	108.67	±	1.98
Tj. Harapan	4.79	±	0.02	6.46	±	0.28	2.06	±	0.18	4.1	±	0.32	8.93	±	0.49	106.37	±	2.13
Jetty to P. Ketam	3.49	±	0.55	4.57	±	0.32	3.52	±	0.41	2.6	±	0.1	15.47	±	0.93	123.11	±	8.02
Sepang	4.3	±	0.27	4.12	±	0.23	0.72	±	0.12	3.61	±	0.26	7.65	±	0.67	102.74	±	2.66
Tj. Piai	4.44	±	0.45	3.62	±	0.18	2.02	±	0.47	2.07	±	0.3	5.29	±	0.75	110.61	±	2.07

Table 2: Heavy Metal Concentrations (mean ± standard error µg/g) of Sediments Collected from Klang and Johore. (N=10)

Sites	Cd			Zn		
Kpg. Pasir Puteh	1.11	±	0.15	130.34	±	1.54
Sg. Ayam	1.97	±	0.23	124.49	±	1.93
Sg. Janggut	1.15	±	0.14	29.35	±	0.37
Kpg. Sg. Melayu	1.13	±	0.05	73.58	±	1.38
Kukup	1.66	±	0.17	68.95	±	0.08
Tg. Langsat	1.74	±	0.10	72.71	±	0.49
Lukut	2.00	±	0.35	64.10	±	1.81
Tg. Harapan	1.95	±	0.50	109.13	±	1.53
Jetty to P. Ketam	1.75	±	0.02	107	±	4.01
Sepang	1.60	±	0.10	35.14	±	1.50

Table 3: Correlation Coefficients of Heavy Metal Concentrations (Cd, Cu, Fe, Ni, Pb and Zn) in Soft Tissues, Opercula and Shells of *N. lineata* with SET Fractions of SET. (N= 11)

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed)

	SET Fractions				
	Aqua Regia	EFLE	Acid-reducible	Oxdisable-organic	Resistant
Cd					
Shells	-0.031	-.461*	0.283	0.121	.403*
Opercula	0.183	-0.246	.419*	0.055	.515**
Soft tissues	0.005	-0.015	-0.237	-0.204	-0.021
Zn					
Shells	-.389*	-0.217	-0.293	-.435*	-.397*
Opercula	-.521**	0.177	-.686**	-.489**	-.427*
Soft tissues	0.121	0.144	-0.23	0.167	0.225

(Zn in this study) were mainly accumulated in the soft tissues while non essential metals (Cd in this study) were accumulated in the shells (Yap *et al.,* 2008; Yap *et al.,* 2009a and 2010; Amin *et al.,* 2006 and 2008). Basically, the major source of heavy metals uptake by gastropods is from the dietary (Wang, 2002; Rainbow, 2007), which in this case the *N. lineata* accumulates the metals while grazing on microalgae from the environment. As the metals enter the body, they will either be channeled to sites where they will play an essential role, e.g. Zn in the enzyme carbonic anhydrase as suggested by Rainbow (2007), or bind to the detoxifying enzyme, metallothionein if the level of the particular metals are elevated (Ng *et al.*, 2007). The shells of molluscs are known to be a deposition site of unwanted metals (Yap *et al.,* 2009). Metals are accumulated into the shells through biomineralization process which built the shells (Jordaens, 2005). This explains the higher levels of Cd found in the shells of this study.

As for sediments, the concentrations of Cd (Table 2) were relatively low and showed little variations among the 10 collection sites which were in accordance with those reported by Yap *et al.,* (2003). The concentrations of Zn (Table 2) in the sediments collected from Kpg. Pasir Puteh (130.34 µg/g dry weight), Sg. Ayam (124.49 µg/g dry weight), Tj. Harapan (109.13 µg/g dry weight) and Jetty to P. Ketam (107 µg/g dry weight) were higher when compared to the other sites. This could possibly be due to the shipping and heavy industrial activities at these sites. As for the other sites, they are fishing villages with some aquacultural activities. However, all the tissues (shells, opercula and soft tissues) in *N. lineata* from the present study showed higher concentrations of Cd and Zn compared to those reported by Yap *et al.,* (2009a) except for Zn in the shells. The Cd and Zn concentrations in the sediments did not show significant differences between the present study and a previous study (Yap *et al.,* 2009) which showed a static level of these metals in Malaysia.

However, there were no positive correlations ($p>0.05$) between the three tissues of the snails (shells, opercula and soft tissues) and the aqua regia as well as the geochemical fractions of the sediments (Table 3). This showed that *N. lineata* is a good indicator of Cd and Zn but it may not be a good biomonitoring agent for these two metals.

Conclusion

This study indicated the ability of the *N. lineata* to accumulate heavy metals. The heavy metal accumulations were recorded in a decreasing pattern of soft tissues>opercula>shells for the essential metal Zn while for the non-essential metal Cd it was in the decreasing order of shells>opercula> soft tissues. The metal levels of the present and the previous study were in comparable range. However, there were no significant correlations ($p>0.05$) were found between the snails and the sediments of the present study. Further studies should be conducted in order to prove the use of *N. lineata* as a biomonitor for Cd and Zn.

Acknowledgements

The authors wish to acknowledge the financial support via the Research Grant Scheme (RUGS) (Vote no. 91986) provided by Universiti Putra Malaysia.

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