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Research Article

A Preliminary Study of Heavy Metals in *Thais gradata* Collected from Kuala Sungai Ayam and Pantai Lido, Peninsular Malaysia

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Abstract

This study determined the levels of Cd, Cu, Fe, Ni, and Zn in the soft tissues, operculum and shells Thais gradata between Kuala Sungai Ayam and Pantai Lido, Peninsular Malaysia, collected in 2008. The metal concentrations (µg/g dry weight) in the soft tissues of T. gradata collected from the two sites in Peninsular Malaysia ranged from 3.01-4.72 for Cd, 83.96-124 for Cu, 345-365 for Fe, 6.80-14.8 for Ni, and 2916-4361 for Zn. Overall, this preliminary baseline data can be used for regular ecological monitoring for the effective management of the coastal area in Malaysia.

Keywords: Barnacles, heavy metals, coastal waters of Peninsular Malaysia.

Introduction

Thais gradata (Family: Muricidae) is a predatory snail. It was reported that *T. gradata* fed on barnacles only even though it is offered with clams and mussels, however, it showed preference for black mussel as well (Rilov *et al.*, 2002). This snail species is widely distributed in Indo-Malaysia, Indo-China, Western Pacific (Oceania), and in Australia. It lives in mangrove areas and on rocky shore (Tan, 1999.).

The snail *T. gradata* has been used a potential biomonitor of heavy metal pollution on the coastal since it fulfil some of the important criteria incuding wide geographical distribution, sedentary, easy to identify, long lived, available for sampling throughout the year, and large enough to provide sufficient tissue for metal analysis. The use of biomonitors to indicate the bioavailability of heavy metals has been wide established since 1990s (Rainbow *et al.*, 1995). Several papers on the similar topic have been published in the literature

(Ruelas-Inzunza and Páez-Osuna, 2000; Yap *et al.*, 2009; Yap, 2018).

Sorya *et al.* (2016) studied the metal levels in the soft tissues of shells of *Indothais gradata* collected from Sungai Brunei estuarine system. The distribution of snail *T. gradata* has been reported in Singapore coastal waters (Tan, 1999; Cuong *et al.*, 2005) and the Straits of Johore (Cuong *et al.*, 2005). Trace metals in *T. clavigera* along coastal waters of the east coast of Peninsular Malaysia has been reported by Miskon *et al.* (2014). However, the metal levels in *T. gradata* is still lacking in the literature. Therefore, the objective of this study is to determine the levels of heavy metals in the soft tissues, operculum and shells of *T. gradata* collected Kuala Sungai Ayam (KSA) and Pantai Lido (PL), in Peninsular Malaysia. Thus, the data presented in this paper can serve as simple baseline data for future reference.

Materials and Methods

The samples of snail *T. gradata* and surface sediments were collected from KSA (01°45.316' N 102°55.842' E) on the 2 May 2008 while PL (01°28.001′ N 103°43.618 E) on 3 May 2008 (Figure 1).

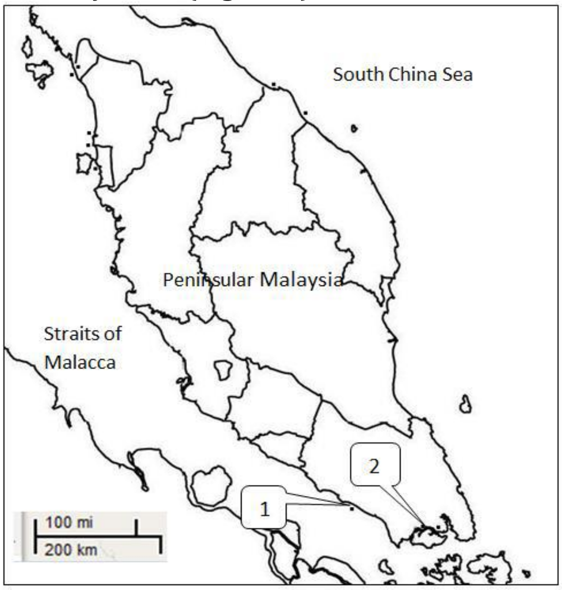


Figure (1): The sampling sites for *Thais gradata* in Peninsular Malaysia (1= Kuala Sungai Ayam; 2= Pantai Lido).

Based on observation during our sampling, KSA is a fishing jetty and a mangrove area while PL is small jetty and potentially receiving domestic discharges.

For KSA, the selected snails analyzed in the present study were 2.80 ± 0.12 g for total body wet weight, 2.42 ± 0.03 cm for shell width and 2.55 ± 0.85 cm for shell length. For PL, the selected snails analyzed in the present study were 5.00 ± 0. 72 g for total body wet weight, 3.01 ± 0.03 cm for shell width and 1.94 ± 0.02 cm for shell length.

For KSA, the surface water (0-10cm) parameters recorded *in situ* during sampling time were 32.5 ± 0.03°C, 23041 ± 304 µs/cm for conductivity, 13.1 ± 0.19 g/L for total dissolved solids and for 11.90 ± 0.18 for salinity. For PL, the surface water (0-10cm) parameters recorded *In-situ* during sampling time were 30.9 ± 0.01°C, 34570 ± 37.04 µs/cm for conductivity, 20.2 ± 0.02 g/L for total dissolved solids and for 19.2 ± 0.02 for salinity.

After transportation in the laboratory in UPM in a cool box, the snails were dissected and pooled into total soft tissues, operculum and shells. They were dried in 60°C for 72 hours in an oven until constant dry weights. Dried samples were weighed for 0.5g and triplicates were analysed for each pooled sample. They were digested with 10 ml concentrated HNO_3 (AnalaR grade, BDH 69%) in a hot-block digester first at low temperature (40°C) for 1 hour and were completely digested at a high temperature (140°C) for 3 hours (Yap *et al.*, 2002). The digested samples were diluted up to 40 ml with DDW and filtered with Whatman filtered paper No. 1 into acid-washed polyethene bottles.

The collected surface sediments were oven-dried and were sieved using 63 µm mesh size. For the surface sediment samples, the geochemical fractions of easily, freely, exchangeable or leachable (EFLE), acid-reducible (AR), oxidisable-organic (OO) and resistant (Res) were fractionated by sequential extraction technique as suggested by Badri and Aston (1983).

The concentrations of Cd, Cu, Fe, Ni and Zn were determined by an air-acetylene flame Atomic Absorption

Spectrophotometer (AAS) Perkin-Elmer Model AAnalyst 800. The data were presented in µg/g dry weight. Multiple-level calibration standards were analysed to generate calibration curves against which sample concentrations were calculated. Standard solutions for each metal were prepared from 1000 mg/L per stock solution of each metal (MERCK Titrisol®).

For quality control, all the glassware and equipment used were acid-washed with 10% diluted nitric acid solution for one night long. Procedural blanks were prepared for every digestion made for standardization. Quality control samples made from standard solution for Cd, Cu, Fe, Ni and Zn were analysed after five to ten samples to check for accuracy of the samples. The recoveries percentages were acceptable at 80-110% for each of the heavy metal analyses. The blank samples were subtracted from the results to avoid the contamination possibility. The analytical procedures for the samples were checked with the Certified Reference Material (CRM) for dogfish liver (DOLT-3, National Research Council Canada) (Table 1).

Table (1): Analytical results for the certified reference material (DOLT-3 Dogfish liver) and the measured values for each metal (µg/g dry weight)

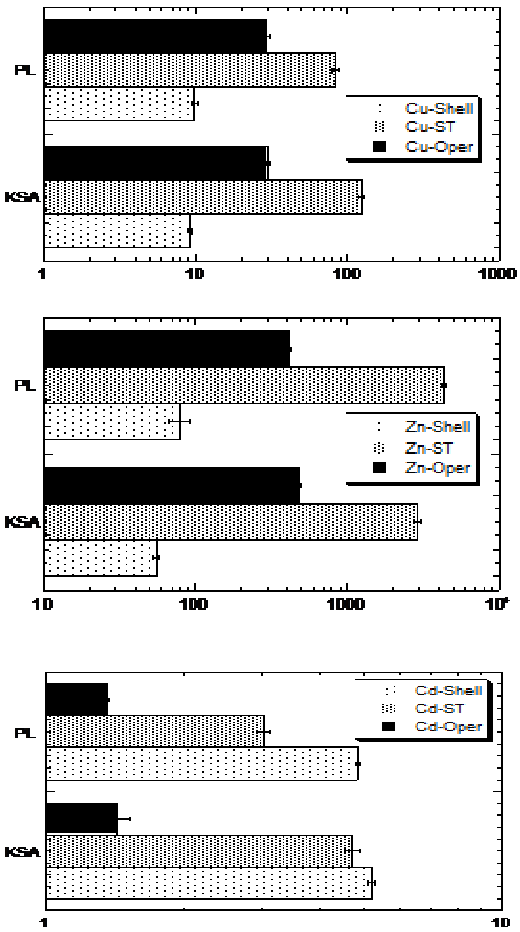
Metals	Certified reference material (CRM)	Measured value	Percentage of recovery (%)
Cd	19.7	19.4	101.7
Cu	32.3	31.2	103.6
Fe	1322	1484	89.1
Ni	3.95	2.72	145
Zn	86.7	86.6	100.2

To compare the metal levels between the two sampling sites, T-test results were performed by analyzing the data by using STATISTICA (99 Version) software.

Results and Discussion

The metal concentrations (µg/g dry weight) in the soft tissues of the snails collected from the two sites in Peninsular Malaysia ranged from 3.01-4.72 for Cd, 83.96-124 for Cu, 345-365 for Fe, 6.80-14.8 for Ni, and 2916-4361 for Zn (Figure 2). Cuong *et al.* (2005) reported the concentrations (mg/kg dry weight) for Cd (0.37-0.47), Cu (52-110), Ni (2.4-5.4) and Zn (65-140) in the soft tissues *of T. gradata* collected from the mangrove area of Singapore. Therefore, the present levels of the five metals from KSA and PL are higher than those reported by Cuong *et al.* (2005).

The metal concentrations (µg/g dry weight) in the shells of the snails collected from the two sites in Peninsular Malaysia ranged from 4.83-5.17 for Cd, 9.14-9.87 for Cu, 182-211 for Fe, 21.4-21.5 for Ni, and 55.3-79.0 for Zn (Figure 2).



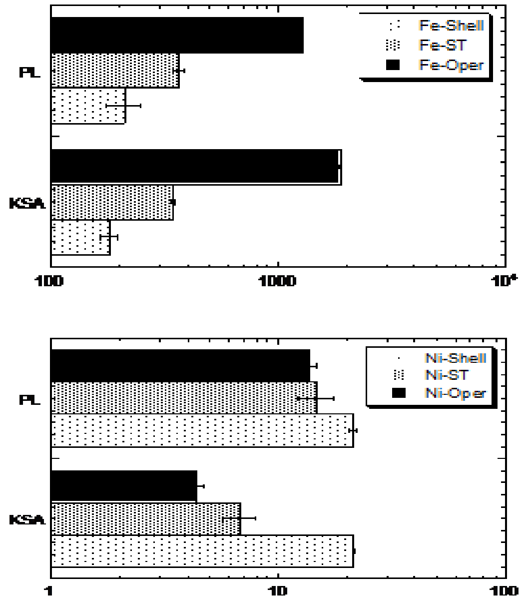


Figure (2): Heavy metals concentrations (mean µg/g dry weight ± SE) in different parts of *Thais gradata* collected from Kuala Sungai Ayam and Pantai Lido.

The metal concentrations (µg/g dry weight) in the operculums of the snails collected from the two sites in Peninsular Malaysia ranged from 1.36-1.43 for Cd, 29.3-30.1 for Cu, 1280-1887 for Fe, 4.37-13.7 for Ni, and 421-483 for Zn (Figure 2).

The heavy metals concentrations in the three parts of *T. gradata* from KSA and PL are presented in Figure 2. For Cu and Cd levels in shells and operculums of snails, there are not significant difference (P> 0.05) between KSA ad PL. However, the Cu and Cd levels in the soft tissues of the snails are signficantly (P< 0.05) higher in the KSA populations than those in PL population. For Zn levels, the soft tissues and shells of the snails are significantly (P< 0.05) higher in PL than those in KSA. For Ni levels, the soft tissues and operculums of the snails are significantly (P< 0.05) higher in PL than those in KSA. For Fe levels, the operculums of the snails are significantly (P< 0.05) higher in KSA than those in PL. Chen and Tang studied the levels of six trace elements in the muscle, liver, and gonad of the *T. gradata* collected from Dianbai areas in China. They reported that levels As, Cd, Cu, Ni, Pb, and Zn were higher than evaluation standard for Marine Organisms and Medical Standard for Human Consumption.

The metal levels in the four geochemical fractions of the surface sediments collected from the two sites are presented in Table 2.

Table (2): Concentrations (µg/g dry weight) of heavy metals in the four geochemical fractions of surface sediments collected from Kuala Sungai Ayam (KSA) and Pantai Lido (PL).

	Site	Cd	Cu	Fe	Ni	Zn
EFLE	KSA	0.31	0.17	48.6	0.63	0.9
	PL	0.12	0.61	30.1	0.37	1.45
AR	KSA	0.67	0.33	34.1	1.35	0.74
	PL	0.12	0.35	474	1.12	15
OO	KSA	0.17	3.96	4185	8.14	45.3
	PL	0.1	11.1	6600	13.2	55.9
Res	KSA	0.79	20.3	22467	12.9	83.1
	PL	0.64	10.7	19059	7.59	47.8
SUM	KSA	1.93	24.8	26735	23	130
	PL	0.99	22.7	26163	22.3	120
Aqua-regia digestion	KSA	1.83	19.7	31818	26.9	115
	PL	0.96	25.9	32353	15.1	99.1
NonR(%)	KSA	59.3	17.9	15.9	43.9	36.1
	PL	34.7	53.1	27.2	65.9	60.3
Res (%)	KSA	40.7	82	84	56.1	63.9
	PL	65.3	46.9	72.9	34.1	39.7

Note: EFLE= Easily, free, leachable or exchangeable; AR= Acid-reducible; OO= Oxidisable-organic; Res= Resistant; SUM= Summation of all four geochemical fractions; NonR= Non-resistant consisting of EFLE, AR and OO fractions.

The levels of Cd, Fe and Ni in the EFLE fraction are significantly (P< 0.05) higher in KSA than those in PL. However, the levels of Cu and Zn in the EFLE fraction are significantly (P< 0.05) higher in KSA than those in PL. Overall, the percentage of non-resistant fractions for Cd is more than 50% (59.3%) in KSA, indicating the anthropogenic inputs of Cd at KSA. The percentages of non-resistant fractions for Cu, Ni and Zn are more than 50% (59.3%) in

PL, indicating the anthropogenic inputs of Cu, Ni and Zn at PL.

In general, there seems to have no clear relationships of metal levels between the snails and geochemical fractions of the surface sediments. Therefore, further studies are needed to understand the possible relationships of metal levels.

Conclusion

The present heavy metal levels in *T. gradata* can be used as a baseline of heavy metals against which future local changes can be assessed. This is highly recommended that further studies should be focused on the genetic structures on this potential *T. gradata* that can be established as a good biomonitor in this region in the future. Overall, this preliminary baseline data can be used for regular ecological monitoring for the effective management of the coastal area in Malaysia.

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