Correlation of Lead and Zinc Contents in Sediments and *Faunus Ater* Against *Faunus Ater* Density in Reuleung River, Leupung, Aceh Besar

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Abstract

Purpose – The purpose of this research is to investigate the relationship of lead (Pb) and zinc (Zn) contents in sediment of Faunus ater (*F. ater*) population density and to analyze the relationship between Pb and Zn accumulation in *F. ater* with *F. ater* density in Reuleng River, Leupung, Aceh Besar.

Design/Methodology/Approach – Sampling was conducted in November 2016 until January 2017. Density of *F. ater* was analyzed by density formula while its relationship to Pb and Zn in sediments and *F. ater* was conducted by correlation analysis method.

Findings – The results showed that correlation between Pb and Zn in sediments and in *F. ater* varies at each locations on every month of sampling. Pb and Zn content in sediments found a fluctuating relationship in each month of sampling with density of *F. ater*. Correlation of Pb content in sediments with *F. ater* density showed a medium correlation in January 2017 with r-value = 0.665. Zn in sediment has a very strong correlation to *F. ater* density in November 2016 with r-value = 0.891. Pb in *F. ater* has a medium correlation to

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F. ater density in January 2017 with *r*-value = 0.436. Furthermore, accumulation of Zn in *F. ater* to its density does show some apparent correlation in each month of sampling.

Research Limitation/Implications – This research gives information about the relationship of Pb and Zn contents in sediment to density of *F. ater* and to analyze correlation of Pb and Zn in *F. ater* to density of *F. ater* in Reuleng River, Leupung, Aceh Besar district.

Originality/Value – This is the first time research is conducted about on the correlation between lead and zinc to obtain the density of *F. ater*.

Keywords Heavy metal, lead and zinc, *Faunus ater*

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1. Introduction

The Reuleung river lies in Leupung, Aceh Besar that crossed several villages in the area of Leupung. Land use around this river are for agriculture and human settlements, while the water is utilized for irrigation, fishery, and car washing. The Reuleng river is very meaningful to the people along watershed area; they are very much dependent on this river to meet their daily needs for water supply and agricultural irrigation. The Reuleung river is also rich with many biota, such as freshwater fish, shellfish, snails, and a number of other macrozobentos.

Faunus ater is a black snail found in this river (Figure 1). People use these snails as an additional food and sources of their income, sold in many traditional market because it can be consumed and contains high level of protein. *F. ater* is a mollusc of antrophoda phylum. They play significant roles in the public and veterinary health and thus need to be

Figure 1.
Faunus ater

scientifically explored more extensively (Supian and Ikhwanuddin, 2002; Abd El-Wakeil *et al.*, 2013).

Heavy metals in certain concentrations will become dangerous pollutants when entering the water (Suhendrayatna and Gultom, 2011). Heavy metals even affect the function of enzymes and fertility of aquatic species, such as organotin compounds. Pb will affect aquatic biota even at low concentrations (Svavarsson *et al.*, 2001). Heavy metals will settle into sediment, so that the heavy metal content in sediment is greater than in water.

2. Materials and Methods

Sample of sediment and *F. ater* were taken from the Reuleung river. Samples were taken from November 2016 to January 2017. The sampling sites were divided into three stations: Station 1 at the upper river; Station 2 at the watershed; and Station 3 at the mouth of the river (Figure 2). Each station was divided into three plots of sampling measuring 1 m^2 each. Sample of sediment and *F. ater* were taken directly from the bottom of river, then placed into a sample bottle that has been labeled according to the station of observation, and transported to laboratory for analysis.

Pb and Zn in *F. ater* and sediments were examined using atomic absorption spectrophotometer, Shimadzu AA 630 (APHA, 2005) after constructed with toxicity characteristic leaching procedure (US-EPA, 1989). The measurement data from each station were collected in the form of tables and graphs, and discussed descriptively. Hypotheses were analyzed using the Statistical Package for Social Science (SPSS) program. Individual density level was analyzed using the following formula (Brower *et al.*, 1989):

$$D = \frac{Ni}{A}$$

where D is the number of individuals per unit area (individual/m^2), Ni the number of individuals in quadratic transect, and A the area of square transect (m^2). Correlations of Pb

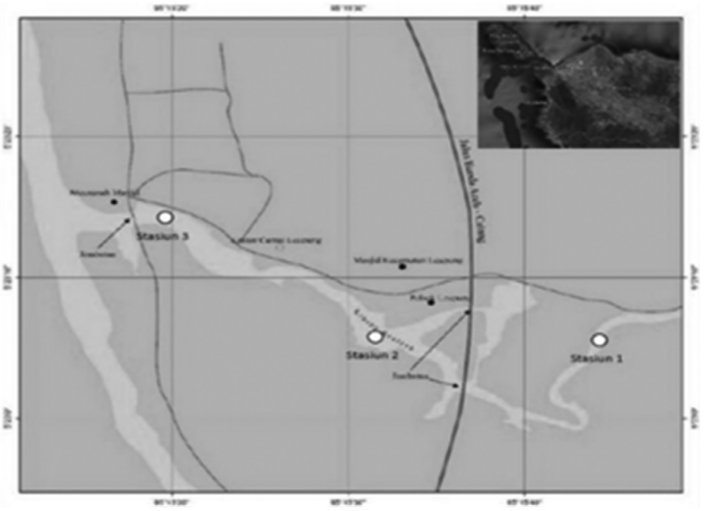

Figure 2.
Location of Research

and Zn in *F. ater* and sediment to *F. ater* density were analyzed by using correlation analysis (Steel, 1989), while its data processing was supported by SPSS 14.0 program. The correlation coefficient was calculated by using the following formula:

$$r_{XY} = \frac{\sum xy}{\sqrt{\left(\sum x^2 y^2\right)}}$$

where r is the average coefficient of correlation, $\sum xy$ the distribution of observed values x and y, and $\sum x^2$ the diversity of values.

3. Results and discussion

3.1. Pb and Zn Contents in the reuleung river

During three months of observation, Pb and Zn in the sediments were found to be 0–60.732 mg-Pb/kg and 53.61–205.3 mg-Zn/kg respectively (Table 1). Pb and Zn in *F. ater* were found to be 0–9.651 mg-Pb/kg and 16.428–147.90 mg-Zn/kg respectively. Pb in the sediments and *F. ater* in November and December sampling indicates that the metal content of both the sediments and the *F. ater* was too small. Analysis in January showed a very significant increase, wherein Pb in sediment was found to be 60.732 mg-Pb/kg (Station 1), 51.096 mg-Pb/kg (Station 2), and 60.097 mg-Pb/kg (Station 3) (Table 1).

This difference happened in the research areas because of the ecological conditions in November and December marked by occurrence of several extreme storms resulting in unstable water currents. This condition affects the accumulation of Pb and Zn in sediments and *F. ater*, in contrast to Zn, which is found both in sediments and *F. ater* at each observation station. In the first sampling on November and the second on December 2016, Pb content was found to be very low. This condition can occur due to weather and conditions of the river such as velocity of water currents and strong winds. The observation result at the time of sampling hold (in November and December) reported that weather condition was in extreme status.

3.2. Density level of F. ater

F. ater density in the Reuleng river varies in each station. Figure 3 shows that the density level at each station fluctuates every month. The highest density of *F. ater* was found at Station 3 and the lowest was in Station 2. This is because Station 3 is a rocky area which a

Table 1.
Pb and Zn in sediment and *F. ater* at the Reuleng River

		Pb and Zn (mg/kg)					
		November		December		January	
Observation Station	Sample	Pb	Zn	Pb	Zn	Pb	Zn
Station 1	Sediment	nt	53.61	nt	205.30	60.732	169.082
	F. ater	nt	147.90	nt	111.71	6.049	28.169
Station 2	Sediment	nt	71.90	nt	103.60	51.096	89.184
	F. ater	nt	82.71	nt	28.59	8.926	36.074
Station 3	Sediment	nt	103.75	nt	137.14	60.097	90.741
	F. ater	nt	66.81	nt	52.82	9.651	16.429

Note: nt, not detected.

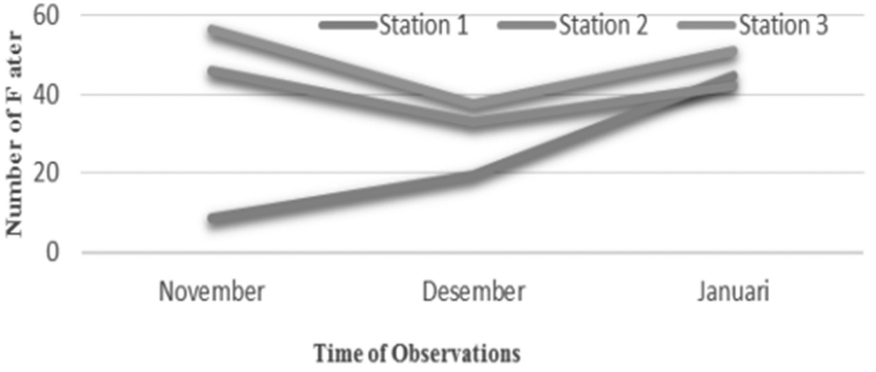

Figure 3.
Density of *F. ater*

favorite habitat. This snail attached to the rocks because of many bentos on it, which is one of the food sources. So the density of *F. ater* in Station 3 was higher than in Stations 1 and 2.

3.3. Correlation between Pb and Zn in sediments with F. ater *density*

Figure 4 shows Pb in sediments in January 2017. Based on statistical test results, the correlation of Pb accumulated in *F. ater* with *F. ater* density in January was $r = 0.665$. This value indicates a strong correlation between Pb content in sediment with *F. ater* density (criteria 0.60–0.799 has a strong correlation). The correlation of Zn accumulated in *F. ater* with *F. ater* density in November was $r = 0.891$. This means that Zn in sediment greatly affects *F. ater* density (Figure 5). The correlation of Zn content in sediments with *F. ater* density on December was $r = -0.838$. This number indicates a negative correlation, the correlation was very weak, meaning that Zn in the sediment does not affect the *F. ater* density (Figure 6). The correlation of Zn in *F. ater* with the density of *F. ater* in January was $r = -0.240$. this value also indicates a very weak correlation (Figure 7).

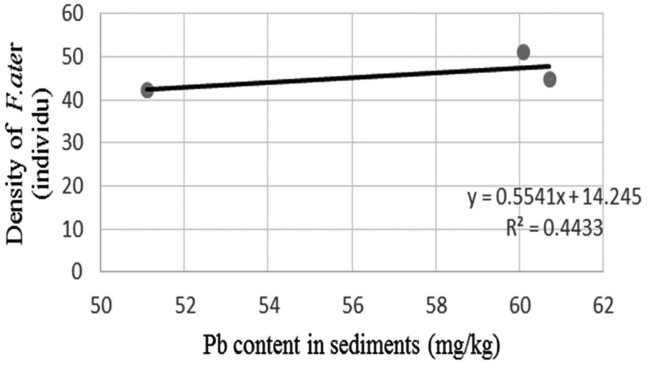

Figure 4.
Correlation Pb in Sediment with Density of *F. ater* on January 2017

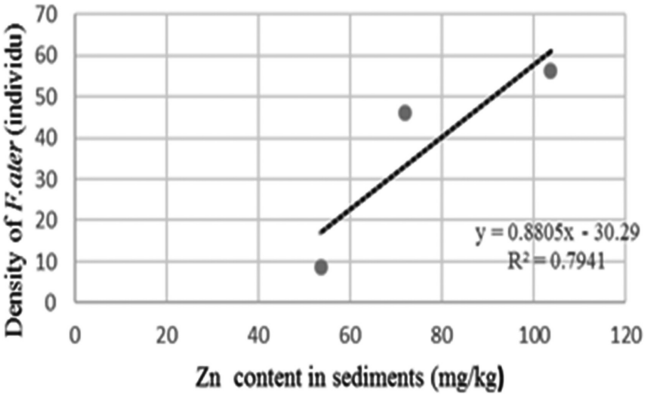

Figure 5.
Correlation Zn in Sediment with *F. ater* Density on November 2016

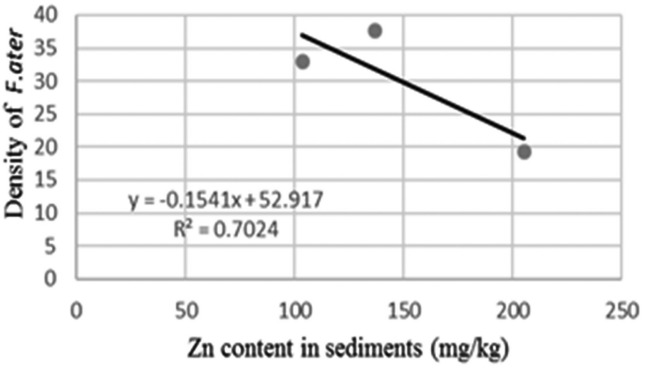

Figure 6.
Correlation Zn in Sediment with Density of *F. ater* on December 2016

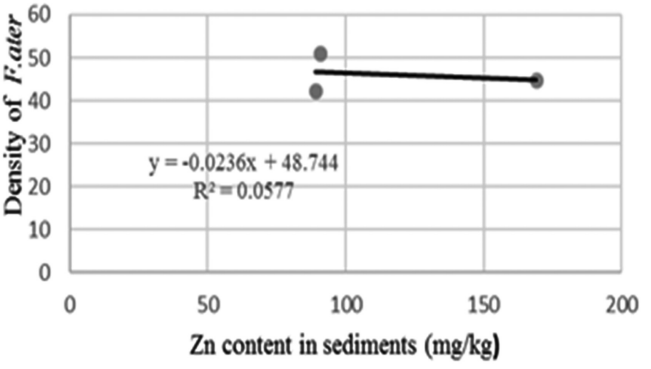

Figure 7.
Correlation Zn in Sediment with *F. ater* Density on January 2017

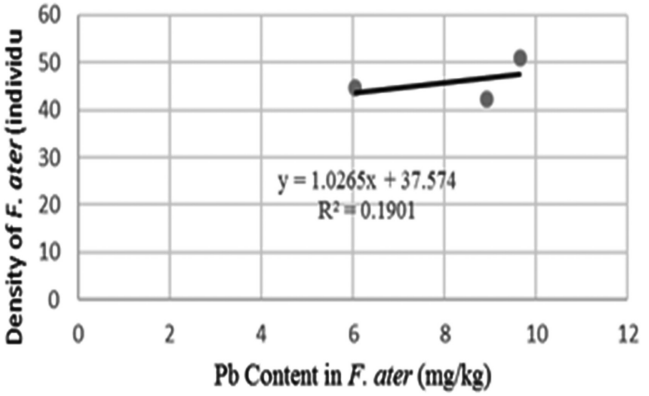

Figure 8.
Correlation Pb in *F. ater* with *F. ater* Density on January 2017

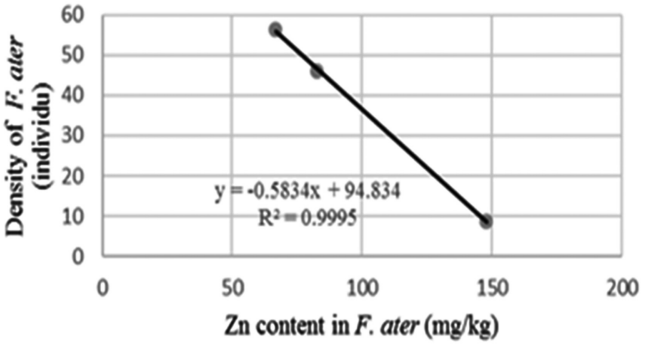

Figure 9.
Correlation Zn in *F. ater* with *F. ater* Density on November 2016

The correlation test between Pb and Zn in sediment with *F. ater* density showed significant relationship in January (for Pb) and November (for Zn), while for December and January only Zn affected the *F. ater* density. Figs. 4 and 5 showed that Pb and Zn in sediment does not cause a population decline of *F. ater*, while Figs. 6 and 7 showed that Zn content affects the *F. ater* population. This situation is caused by the habitat and conditions of the river at the time of sampling. *F. ater* if located in a favorable habitat, a muddy area, then the number of snails will be abundant because of abundant food (Niem *et al.*, 1998). The condition of the stream also affects the amount of Pb and Zn in sediment and *F. ater*. Differences in type, age, and physiology of *F. ater*, also play a role in the physical and chemical properties.

3.4. Correlation of Pb and Zn in F. ater *with density of* F. ater

Correlation of Pb in *F. ater* with density of *F. ater* on January was $r = 0.436$. This value indicates a positive correlation (criteria 0.40–0.599: middle correlation) which mean that Pb in *F. ater* affected the *F. ater* density (Figure 8). Correlation of Zn in *F. ater* with density of *F. ater* in November was $r = -0.999$. This value indicates that Zn in *F. ater* does not affect its density (Figure 9). Correlation of Zn in *F. ater* with its density in December was

$r = -0.860$, which means that, Zn concentration in *F. ater* does not affect the density level (Figure 10). Correlation of Zn in *F. ater* with its density in January was $r = -0.989$. This value indicates a very weak correlation (Figure 11).

4. Conclusions

(1) Pb and Zn in sediment showed a fluctuating relationship in each month of sampling with density of *F. ater*.

(2) The correlation of Pb in sediment with *F. ater* density showed a medium correlation in January 2017 with *r*-value = 0.665.

(3) The relationship of Zn in sediment in November 2016 greatly affects *F. ater* density with *r*-value = 0.891.

(4) The relationship of Pb accumulation in *F. ater* with *F. ater* density indicated a medium correlation in January 2017 with *r*-value = 0.436.

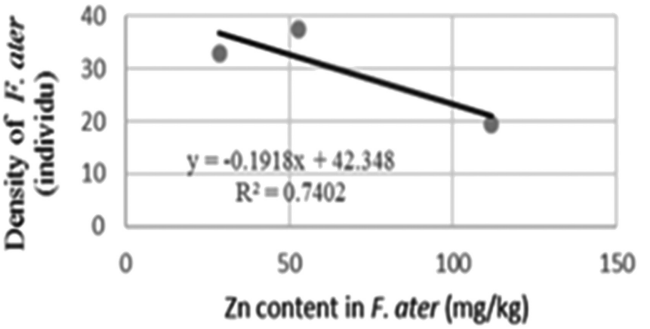

Figure 10.
Correlation Zn in *F. ater* with *F. ater* Density on December 2016

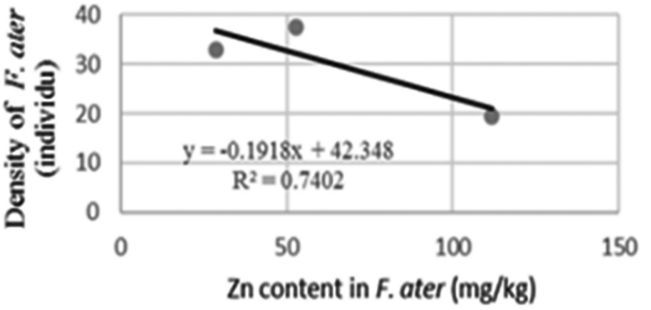

Figure 11.
Correlation Zn in *F. ater* with *F. ater* Density on January 2017

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