

# The Effect of the Heavy Metal Mercury (Hg) Concentration on the Growth Rate of *Pilsbryoconcha* spp Mussel

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## ABSTRACT

The purpose of this study was to determine the effect of heavy metal mercury (Hg) concentration on the growth rate of *Pilsbryoconcha* spp mussels and to compare the growth rates of *Pilsbryoconcha* spp mussels exposed to mercury at different concentrations. The type of research used is quantitative research with experimental methods. The study used a completely randomized design with 3 treatments and 6 repetitions. The treatments were different levels of mercury, namely P0, P1 and P2 (0, 0.5 and 1 ppm). Data were analyzed for variations using ANOVA. If there is a significant effect, then proceed with the Duncan Multiple Range Test (DMRT) with  $\alpha$  5%. The length growth rates in treatment P0, P1 and P2 (0, 0.5 and 1 ppm Hg) ranged from 0.12 to 0.22; 0.08-0.09 and 0.03-0.1 cm/observation or there is a decrease in the length growth rate from the control treatment of 0.16 cm/day to only 0.006 cm/day at P1 treatment, and the more decrease at P2 0.002 cm/day. The weight gain along observation is ranged from 0.071-0.349 g (P0), 0.031-0.077 at P1, and decreased at P2 reaching -0.03 to 0.006 g. The average daily length of mussel was 0.012; 0.006 and 0.004 cm/day in P0, P1 and P2 respectively. The average daily weight rate was 0.052 g/day in the P1 and -0.068 g/day in P2, while the control (P0) was 0.158 g/day. The average relative length of mussels was 0.02, 0.01 and 0.007 cm, whereas the average weight growth of mussel was 0.081; 0.024 and -0.035 g. Length and weight growth rate of mussels in P0 and P1 treatment are not different significantly, but significantly difference in P2 treatment. This shows that mercury is very dangerous for the life of *Pilsbryoconcha* spp and can reduce the weight and inhibit length growth mussel during maintenance.

**Keywords:** Mercury, Growth rate, *Pilsbryoconcha* spp Mussel.

## 1. INTRODUCTION

*Pilsbryoconcha* spp are a type of mussels belonging to the Unionidae family, the Bivalvian class of the Mollusca phylum. These mussels are widely consumed by people in Jambi Province as a source of animal protein which is cheap and easy to obtain, a source of feed for livestock and fish, and can be used as a bioindicator of environmental pollution. Similar mussels are also found in the Ogan Komerang River and the Enim River in South Sumatra, Sipin Lake, and the others river and have been studied with respect to reproductive aspects and cultivation [1][2].

Mercury is one of the heavy metals that are harmful to organisms. One of the heavy metals that can pollute rivers in several districts in Jambi Province is Mercury (Hg). BPLHD (2015) [3] states that gold mining in Jambi

Province is taking place intensively in three districts, namely Merangin, Bungo, and Sarolangun. Mercury is often used to bind gold core in unlicensed traditional gold mining (known as PETI) through the amalgamation process. The amalgamation technique has the potential to cause pollution in the environment, this is due to the accumulation of mercury in the ecosystem through the food chain. Mercury pollution in the environment can cause bioaccumulation in the food pyramid, starting from plants, aquatic animals, fish, and eventually accumulating in humans [4]. Mercury that accumulates in the environment will be oxidized to organic mercury called methyl mercury (MeHg) by biological systems. MeHg can penetrate the membranes of living things and cause poisoning in humans [5] [6]. Some research results show the successful use of freshwater mussels as a biofilter. Mussel is a filter feeder animal and is able to filter out particles of size between 0.1-50  $\mu$ m from water

bodies, then at particle sizes > 4.0 it can filter up to 100% [7]. Anodonta mussels are able to filter water up to 40 l/day and can extract colloidal organic matter, either suspended or particles, and can reduce the organic matter content in the waters by an average of 99.5%. According to Prihartini [8][9], another type of mussels, Pilsbryconcha spp can help in water purification efforts, utilizing food scraps that are not eaten by fish, as a biofilter because it has high survival and in large quantities it can be used to overcome water pollution due to pollutants including metals. weight. Some research results show the successful use of freshwater mussels as a biofilter and bioaccumulator of heavy metals including mercury, but little is known about how it affects the growth rate of Pilsbryconcha spp mussels. The purpose of this study was to determine the effect of the concentration of heavy metal mercury (Hg) on the growth rate of Pilsbryconcha spp mussels and to compare the growth rates of Pilsbryconcha spp mussels exposed to heavy metal mercury at different concentrations.

**2. METHODS**

**2.1. Research Location and Time**

The research was carried out in the Integrated Biology Education Laboratory of Jambi University from June to August 2020.

**2.2. Research Design**

The type of research used is quantitative research with experimental methods. The study used a completely randomized design (CRD) with 3 treatments and 6 repetitions in order to obtain 18 experimental units. The treatments were different levels of mercury, namely 0, 0.5 and 1 ppm.

P0 = Aquarium with 0 ppm mercury concentration with 15 Pilsbryconcha spp (control)

P1 = Aquarium with 0.5 ppm Hg concentration + 15 Pilsbryconcha spp

P2 = Aquarium with 1 ppm Hg concentration + 15 Pilsbryconcha spp

**2.3. Data Collection Techniques**

Growth measurements were carried out by measuring the increase in shell size every 2 weeks for 2 months of rearing exposed to different levels of Hg. The parameters of the study included daily growth rate and relative growth rate mussels.

**2.4. Data Analysis**

Data were analyzed for variations using ANOVA to see the effect between treatments. If there is a significant effect, then proceed with the Duncan Multiple Range Test (DMRT) with  $\alpha$  5%.

**2.5. Research Procedures**

The research began with the initial weighing and measurement of the mussels and the preparation of a mercury solution with various levels. Furthermore, the mussels was acclimatized for 1 week and the test animals used were 7-9 cm in size. Maintenance was carried out for 2 months and measurements were made of length and weight of mussels in every 2 weeks.

**3. RESULT**

Growth is the change in size, weight, length and volume in the rate of increasing time. There are two types of growth, namely absolute growth and relative growth. Absolute growth is the average measure at a certain age, while relative growth is the length or weight achieved in a certain period of time related to the initial length or weight of that period. Growth observations on Pilsbryconcha spp mussel were carried out for 2 months of maintenance which was carried out every 2 weeks. The growth rate of Pilsbryconcha spp mussels due to exposure to heavy metal mercury (Hg) at 3 different concentrations obtained data as in Tables 1-3.

**Table 1.** Result of Morphometric Measurement Every 2 Weeks Of Observation

Observation to	Length (cm/2 weeks)			Weight (gr/2 weeks)		
	P0	P1	P2	0	0,5	1
I	8,30	8,36	8,11	27,31	29,63	26,75
II	8,30	8,36	8,12	27,61	29,74	26,71
III	8,40	8,39	8,13	27,98	29,96	26,47
IV	8,41	8,41	8,14	29,17	30,20	26,06
V	8,46	8,44	8,16	29,54	30,34	25,81
Mean	<b>8,37</b>	<b>8,39</b>	<b>8,13</b>	<b>28,32</b>	<b>29,97</b>	<b>26,36</b>

The results of measurement of length growth of mussel for 2 months from observations 1 to 5 can be seen in Table 2. The length growth rates in treatment P0, P1 and P2 (0, 0.5 and 1 ppm Hg) ranged from 0.12 to 0.22; 0.08-0.09 and 0.03-0.1 cm/observation or there is a decrease

in the length growth rate from the control treatment of 0.16 cm/day to only 0.006 cm/day at P1 treatment (0.5 ppm Hg), and the more significant decrease at 1 ppm Hg of 0.002 cm/day.

**Table 2.** Average Length Growth of *Pilsbryconcha* spp. Mussel

Repetition	P0	P1	P2
1	8,23	8,37	7,92
2	8,34	8,41	8,00
3	8,21	8,43	8,05
4	8,35	8,36	8,19
5	8,50	8,37	8,19
6	8,60	8,39	8,45
<b>Mean</b>	<b>8,37<sup>a</sup></b>	<b>8,38<sup>a</sup></b>	<b>8,13<sup>b</sup></b>

Note: Data that are not followed by the same letter represent significant differences effect at the  $p > 0.05$  level

Table 3 shows the weight growth of the mussel in each aquarium with 3 treatments for 2 months of maintenance. The weight gain along observation with the level of mercury is ranged from 0.071-0.349 g (P0 = 0 ppm), 0.031-0.077 at P1 (0.5 ppm Hg) and decreased at P2 (1 ppm Hg) reaching -0.03 to 0.006 g. The results showed that mercury affected the length and weight growth rate mussels. Length and weight growth rate of mussels in P0 and P1 treatment are not different significantly, but significantly difference in P2 treatment than the others.

**Table 3.** Average Weight Growth *Pilsbryconcha* spp. Mussel

Repetition	P0	P1	P2
1	25,87	29,12	26,35
2	26,59	29,32	25,49
3	26,40	29,64	26,37
4	28,62	30,19	26,18
5	31,65	30,37	25,54
6	30,80	31,19	28,22
<b>Mean</b>	<b>28,32<sup>a</sup></b>	<b>29,97<sup>a</sup></b>	<b>26,36<sup>b</sup></b>

Note: Data that are not followed by the same letter represent significant differences effect at the  $p > 0.05$  level.

The average daily length of mussel was 0.012; 0.006 and 0.004 cm/day in P0, P1 and P2 respectively. The average daily weight rate was 0.052 g/day in the P1 treatment (0.5 ppm Hg) and -0.068 g / day in P2 (1 ppm Hg), while the control (P0) was 0.158 g/day. The results of further analysis showed that the increase in daily weight and length of *Pilsbryconcha* spp between mercury levels was very significant difference, especially between P2 treatment with the addition of 1 ppm from the other treatment, P0 and P1. This shows that mercury is very dangerous for the life of *Pilsbryconcha* spp and prolonged mercury exposure can reduce the growth rate of weight mussel during maintenance.

**Table 4.** Daily Growth Rate of Mussel

Repetition to	Length (cm)			Weight (gr)		
	0 ppm Hg (P0)	0,5 ppm Hg (P1)	1 ppm Hg (P2)	0 ppm Hg (P0)	0,5 ppm Hg (P1)	1 ppm Hg (P2)
1	0,016	0,006	0,004	0,137	0,047	0,006
2	0,009	0,006	0,003	0,094	0,062	-0,14
3	0,016	0,006	0,007	0,071	0,077	-0,03
4	0,010	0,006	0,002	0,174	0,048	-0,08
5	0,009	0,006	0,004	0,349	0,039	-0,09
6	0,012	0,006	0,003	0,131	0,031	-0,07
<b>Total</b>	<b>0,072</b>	<b>0,036</b>	<b>0,023</b>	<b>0,950</b>	<b>0,310</b>	<b>-0,404</b>
<b>Mean</b>	<b>0,012</b>	<b>0,006</b>	<b>0,004</b>	<b>0,158</b>	<b>0,052</b>	<b>-0,068</b>

The average relative length and weight growth in each treatment (P0, P1 and P2) shows in Table 5. The average relative length rate of mussels were 0.02, 0.01 and 0.007, whereas the average weight growth of mussel

were 0.081; 0.024 and -0.035 g/observation. The relative weight growth at 1 ppm with 0.5 ppm of mercury or between P1 and P2 was not different, but very different when compared to control.

**Table 5.** Relative Growth of Mussel

Repetition to	Length (cm)			Weight (gr)		
	Control	0,5 ppm	1 ppm	Control	0,5 ppm	1 ppm
1	0,027	0,010	0,006	0,076	0,022	0,003
2	0,014	0,009	0,005	0,050	0,030	-0,073
3	0,028	0,010	0,013	0,038	0,037	-0,015
4	0,016	0,009	0,004	0,090	0,022	-0,043
5	0,014	0,010	0,006	0,170	0,018	-0,048
6	0,019	0,009	0,005	0,061	0,014	-0,033
<b>Total</b>	<b>0,118</b>	<b>0,057</b>	<b>0,039</b>	<b>0,485</b>	<b>0,143</b>	<b>-0,209</b>
<b>Mean</b>	<b>0,020</b>	<b>0,010</b>	<b>0,007</b>	<b>0,081</b>	<b>0,024</b>	<b>-0,035</b>

#### 4. DISCUSSION

Heavy metal mercury that enters the aquatic environment will experience deposition, dilution and disperse [10][11][12]. Mercury waste that is produced from the gold management process will enter the river and marine ecosystems and can sink into the bottom of the water which is then concentrated in sediments [13]. This waste not only settles in the sediment, but part of the waste will enter and accumulate into the tissues of the biota in river waters, including bivalves. Based on the table, it can be seen that the higher the level of mercury application, the slower the growth of mussels. This means that mercury can disrupt the work of the kidneys and nerves, digestive and respiratory systems. Water containing the heavy metal mercury enters the respiratory and digestive systems. This results in disruption of the organ system and inhibition of the absorption of food juices so that growth, both absolute and relative growth, becomes slow. In line with the results of research by Pratiwi and Ariesyady [14], the effects of mercury poisoning can cause kidney and central nervous system disorders, memory loss, tremors, sensory disturbances and permanent damage to the brain and kidneys. Another effect that can be caused is in the form of disorders of the digestive and respiratory systems.

*Pilsbryconcha* spp is an animal that gets food by sucking water without selection so that it is classified as a filter feeder. Water enters the mantle through the bottom of the inhalant siphon and continues to flow toward the gills and out again through the top of the inhalant siphon. The food particles will join the water in the mucus, before being sent to the mouth. In this section the food particles will be selected. Small particles will pass into the esophagus, then into the intestine, while large particles will come out again with the water through the inhalant siphon [15][16]. The slow growth rate of mussel is caused by the entry of heavy metals into the shells in line with the absorption of water and nutrients through the filter feeder process. According to Puspasari [17] and Suryono [18], there are two kinds of mechanisms for the entry of heavy metals into an organism's body, namely directly and indirectly. The direct mechanism occurs through the absorption of dissolved heavy metals by organisms along with the absorption of water and nutrients into the body. In addition, heavy metal mercury can also enter indirectly through the food chain.

Nonessential metals (including heavy metals) will be detoxified by a mussels by synthesizing a protein called metallothionein [19] [20] [21]. *Pilsbryconcha* spp has the ability to bioaccumulate in absorbing mercury in polluted water, mussels also have limits on tolerance and endurance when in a polluted environment. This shows that mussel have limits on tolerance to mercury and limits to survival, and that exposure to heavy metal mercury in the water can decrease the growth rate and reduce the

weight of mussel, especially when exposed to mercury for a long time can cause death of mussel.

#### 5. CONCLUSION

1. There is an effect of mercury concentration on the growth of *Pilsbryconcha* spp
2. The growth rate of *Pilsbryconcha* spp produced was different, between the mercury concentration of 0 ppm (PO treatment) and 0.5 ppm (P1) was not significantly different, but was significantly different from the growth rate of shellfish at the mercury concentration of 1 ppm.

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