Size Variation of River Catfish (Mystus sp.) and It’s Relationship to Cadmium (Cd) Heavy Metal and pH in Blanakan River, Subang

I C Anjani, N D Takarina
Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Indonesia
E-mail: noverita.dian@sci.ui.ac.id

Abstract. The Blanakan River is the habitat for many fish species, including river catfish (Mystus sp.). River catfish is a freshwater fish that can survive in the polluted aquatic environment. This fish is also consumed by people living near the river. The Blankan river is polluted by human activities such as agriculture, transportation, and mining. These activities make heavy metals may expose the waters. Correspondingly, this study aims to determine the size variation of river catfish and its relationship with Cadmium (Cd) and pH parameter in water. Water and fish samples are collected from two stations. The pH was measured directly from water as well as the length and weight of fish. The concentration of Cadmium (Cd) in water was analyzed using AAS (Atomic Absorption Spectrophotometer). The result showed that the value of pH and Cd concentration was 5.78 – 6.64 and 0.03 ppm – 0.10 ppm, respectively. While the ranges for fish length and weight were 13.20 cm – 13.59 cm and 30.69 gr – 34.7 gr. To conclude, the increase in pH can increase the size of fish. In contrast, the increase in Cd reduces the size of fish.

1. Introduction
One of the most critical factors affecting fish in the aquatic environment is hydrogen ion concentration (pH). The hydrogen ion concentration of a solution can affect the survival, growth, reproduction, and distribution of aquatic animals [1]—high concentration of hydrogen ions indicating acidic waters. Alkaline waters show higher concentrations of hydroxyl (OH) ions rather than hydrogen ion [2]. A very low pH can increase the mobility of various heavy metal compounds, which will undoubtedly threaten the survival of aquatic organisms. While high pH will disturb a balance between ammonium and ammonia in water and the rise of pH above neutral will increase the concentration of ammonia which is very toxic to the organism. The pH value of 6.5 – 8 of the water is a safe limit for aquatic organisms. Variation of pH range or treatment positively affects the growth rate of fish affects the length and weight of fish. Several factors can indirectly alter pH values, such as temperature, salinity, and CO₂ content [3].

River catfish (Mystus sp.) is the most common freshwater catfishes distributed in the water bodies of India, Bangladesh, Pakistan, Nepal, Sri Lanka, Thailand, and Myanmar [4]. Mystus sp. is also available in Indonesia, especially in Sumatra, Java, and Kalimantan water. Mystus sp. is generally classified in the Siluriformes order and Ariidae family [5]. This fish is usually found in freshwater and is mostly available in rivers. River catfish have been consumed by people who live near the river due to good protein content in its flesh. Mystus sp. can be used as an alternative commodity to fulfill nutritional needs and improve the economics of fishing communities [6].
Fishes are also profoundly affected by many pollutants in their aquatic environment. One of the current environment serious problems is aquatic pollution through heavy metal ions. As heavy metals cannot be degraded, they continuously contaminate the water and enrich the water with mineral organic substances instead. Cadmium (Cd) is a non-essential heavy metal and the most toxic heavy metal pollutants that tend to accumulate in the organism and enter the food supply [7]. Cadmium (Cd) results from volcanic eruptions, forest fires, sea-salt aerosols, and many anthropogenic sources such as mining and refining, manufacture and application of fertilizers, and fossil fuel combustion [8]. Cd in fish can damage the kidney and produced signs of chronic toxicity, including impaired reproductive capacity and kidney function, hypertension, and hepatic dysfunction. Moreover, if humans consume cd, it will also cause physiological damage to human metabolism [9].

In the Blanakan river, Mystus sp. is local commodities and economical fish that people consume. However, information about the Mystus sp. biometry (weight and length) with the environmental parameters (pH) and Cd is still limited. Hence, this study aims to determine the size variation of river catfish and its relationship with Cd and pH parameters in water used as primary information to support the fishery practices of this species. Most of the current researches focus only on the morphology of fish like measurement of length and weight. Nonetheless, the novelty of this research is that we study the environmental factors that causing the variation of the length and weight of Mystus sp. Those studied environmental factors are pH and heavy metal.

![Figure 1. Mystus sp. collected from Blanakan river](Personal Documentation)

2. Methods

2.1 Study site

The Blanakan river is located in Subang district, West Java province. The station geocoordinates were from upstream at lat: -6.277444, long: 107.6599 to downstream (river mouth) lat: -6.240083, long: 107.667472 (Figure 2). The width of the Blanakan river is varied from 60 m near the river mouth to 11 m in the upstream. In upstream, the river was surrounded by settlements and paddy field, in midstream was transition area from paddy field to fish pond and downstream was dominated by the fish pond and revegetated by mangrove. The Mystus sp. samples were collected from the Blanakan river in stations 1 and 3.
2.2 pH sampling and measurement
Water in each sampling station was collected in the bottle sample, and pH was measured directly by using PH-meter. The pH 7.0 standard solution was collected in a beaker, and an electrode that rinsed with distilled water was placed in the beaker, then pH meter was allowed to read. The water samples were also collected in a beaker and treated the same way as the standard. The buffer solutions were measured in between every measurement [10].

2.3 Cd sampling and measurement
The Cd in water samples were taken using a 250 ml bottle and inserted into the cooler box. Furthermore, the samples were then preserved by 70% alcohol and dried for 2-3 hours at 105 °C. Dry samples destructed by 4 ml HNO3 and 2 ml HClO4 (aquaria) solutions. Then the sample was heated by using a hot plate until the solution volume shrank to 1-3 ml. Then the sample can be moved to another bottle and ready for the heavy metals content analysis by Atomic Absorption Spectrophotometry using AAnalyst 800[11].

2.4 Measurement of catfish length and weight
River catfishes were captured at each sampling station by using nets and were taxonomically identified by using the identification book. The length was measured to the nearest centimeter (cm), and body weight was recorded in the nearest gram (g). The total length was measured from the tip of the snout to the extended tip of the caudal fin using a measuring board. [12]

3. Result
Table 1 shows that the pH range in the Blanakan river ranging from 5.78 – 6.84. pH parameter was taken at two different stations, the first station was located in the river mouth, while the other stations were in the river. The pH value in the river mouth is suitable for the aquatic biota, while the pH value in the river is relatively low because the optimal pH value ranged from 6.5 – 8 [17]. The pH value in the water is related to mineral content. As the pH increases, it will also increase the mineral content in water [18].
Table 1. The comparable pH data with other locations

| Value/Range | Location                        |
|-------------|---------------------------------|
| 5.78 – 6.64 | Blanakan river (this study)     |
| 7.11 – 7.58 | Cisadane river [13]             |
| 6.8 – 7.2   | Bengawan Solo river [14]        |
| 5.9 – 8.4   | Bengkalis river [15]            |
| 6.57 – 7.41 | Sebalo river [16]               |

Table 2 shows that the concentration of Cd in water samples ranged from 0.03 to 0.10 mg/l. The obtained result shows that the Cd in water has exceeded the maximum standard. Heavy metals are usually found in a tiny amount in water naturally, which is less than one µg/l, and the maximum permissible limit for Cd in water is 0.01 mg/l. Usually, Cd in water is 0.00011 mg/l. In all water samples collected, the Cd was recorded above the permissible limit, and the water samples in Blanakan have the highest Cd concentration.

Table 2. The comparable Cd data (mg/l) with other locations

| Value/Range       | Location                                      |
|-------------------|-----------------------------------------------|
| 0.03 – 0.10       | Blanakan river (this study)                   |
| 0.0002 – 0.0005   | Rote island coast [19]                        |
| 0.005 – 0.01      | Jakarta bay [20]                              |
| 0.003 – 0.01      | Citarum Hulu river [21]                       |
| 0.008-0.057       | Banyuasin river [22]                         |

The concentration of heavy metals is increasing when natural erosion occurs or wastes that contain heavy metals enter the water. This waste is coming from human activities such as dumping of ships, mining activity, and agricultural activity. Some metals are usually more dominant than other metals. The type of water, such as freshwater, brackish water, and seawater, can affect the concentration of heavy metal in its content [23]. The pH of water bodies controls the solubility of metal elements and heavy metals in water bodies, types and concentrations of metals and chelates, the state of oxidized mineral components, and redox environment systems [24].

Based on figure 3 shows the correlation of pH value with body length and weight of Mystus sp. As the pH decreased from 6.64 in river mouth to 5.78 in the river, it reduced Mystus sp. from 13.59 to 13.20 cm. Likewise, it also reduced the weight of Mystus sp. from 34.67 to 30.69 gr. Hence, there was a positive correlation between the pH and length and weight of Mystus sp.

Table 3. The comparable length and weight of Mystus sp. with other locations

| Length          | Weight | Location                                      |
|-----------------|--------|-----------------------------------------------|
| 13.20 – 13.59   | 30.69 – 34.7 | Blanakan, Subang                             |
| 12.5 – 29.2     | na     | Delta Cimanuk Pabein Ilir, Indramayu [25]     |
| 2.00 – 14.00    | 5.00 – 30.00 | Siak river [26]                             |

Based on figure 4 shows that there were negative relationships between fish sizes and metal levels in the water. As the Cd decreased from 0.10 in the river to 0.03 mg/l in the river mouth, it increased the length of Mystus sp. from 13.20 to 13.59 cm. The same pattern was also observed for weight. The weight of Mystus sp. increased from 30.69 to 34.7 gr when the Cd decreased.
Figure 3. The correlation of pH with length (left) and weight (right) of Mystus sp.

Figure 4. The correlation of Cd (mg/l) with length (left) and weight (right) of Mystus sp.

4. Discussion
The pH value and concentration of Cd in water vary in each sampling station. In the river, variation of pH caused by many factors such as terrestrial runoff, river flow volume, spring water input, and availability of dissolvable bedrock along the channel. Near the river mouth, pH may be modified by mixing river water and seawater, with a pH that ranges between 7.5 and 8.4 [27]. The pH value in the water varies from the direction from the river until it reaches the sea. As close to the sea, the value of pH will be increased [13]. The pH range in the Blanakan river was relatively low compared to other locations (Table 1). That happens because the location of the Blanakan river was far from the ocean area; hence the pH was low.

The Cd in the Blanakan river was found higher than other similar locations such as Jakarta bay, Citarum river, and Banyuasin river mouth (Table 2). That happens because the Blanakan river carries water containing industrial and household wastes that can become potential pollutants and can contaminate this area with heavy metals [28]. The level of Cd in the Blanakan river was higher than the river's mouth because the river was near the transportation and agricultural activities that may
pollute the water with Cd [29]. The pH value may also affect heavy metal concentrations because the toxicity of heavy metals is high, as pH is high. That happens because insoluble metals can cause sedimentation in the bottom of the waters [30].

Based on the result, the size variation of Mystus sp. depends on pH value. In Figure 3, a bigger Mystus sp was found in the river mouth with a higher pH. Meanwhile, smaller fishes were found in the river with a lower pH. It relates to the relationship between pH and the growth rate of fish. The previous study showed that the optimum pH range for the best growth is between 6 and 7. Extreme pH will reduce growth rate and reproduction that may affect fish biometry (length and weight) [31].

Besides pH value, the size distribution of Mystus sp. also depends on Cd ranges. Figure 4 shows the negative relationship between fish size and Cd content. The negative relationships between heavy-metal levels in the water and fish sizes were generally in contrast with some literature. In some literature, the positive relationships were found only between zinc (Zn) and lead (Pb) [32]. In contrast, another previous research showed a negative relationship between fish size and Cd content. The phenomena may happen because the size of the fish is affected by the heavy-metal levels in fish tissue. Although metal concentrations in the surrounding water are high, there is a probability of dilution metal concentration in the tissue associated with growth and lowered metabolic activity in older fish. One of the evidence of dilution is when metal accumulation in fish reaches a steady state after a certain age. In this case, if the dilution factor is higher than the metal concentration factor in water, it may cause a smaller size of fish even though they live in water with high Cd concentration [33]. For comparison with other results, fish samples collected from the Malwathu Oya river, Sri Lanka, have a smaller size when the Cd content is high [34].

5. Conclusion
The pH and the presence of heavy metals (Cd) in the water influencing Mystus sp. length, and weight. The increase in pH will increase the length and weight. In contrast, the increase in Cd will decrease the length and weight.

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