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*Research Article*

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# Fish diversity and heavy metal content mercury (Hg), arsenic (As) on the water and fish in Cikaniki river, Bogor regency

**Mia Azizah[1], Gladys Ayu Paramitha K.W[2]**

[1]Biology Study Program, Universitas Nusa Bangsa Bogor, Bogor, Indonesia
[2]Chemistry Study Program, Universitas Nusa Bangsa Bogor, Bogor, Indonesia
Email: miaazizah23@gmail.com*, gladys.paramita@gmail.com

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**ABSTRACT**

Organisms that live in waters are sensitive to changes in the water quality in which they live. The quality of the water in the Cikaniki River is threatened by the gold mining industry, illegal mining, agricultural activities, and settlements. One of the organisms that will be affected by these environmental changes is fish. This research aims to obtain a diversity index of fish species and to determine the content of heavy metals Mercury (Hg), Arsenic (As) on the water, and fish. Research on the diversity of fish in Cikaniki River, Bogor Regency, was carried out in January–March 2020. The research was conducted at five selected stations, and each station carried out three times the sampling of fish and water. The metal content test process is carried out at the Chemical Laboratory of the University of Nusa Bangsa. The research instrument used was the observation sheet for fish identification and heavy metal content. Fish identification was carried out at the Faculty of Mathematics and Natural Sciences Laboratory, University of Nusa Bangsa. Identification use characteristics observed included body shape, body length height, color pattern, muzzle shape, fin shape, number of fins, and tail shape. Calculation of heavy metals using an ICP–OES (Inductively Coupled Plasma) tool. This research found seven fish species in the Cikaniki river; based on its dominance, four types of fish dominate: *Nemacheilus chrysolaimos*, *Puntius bionotatus*, *Channa striata*, and *Glyptothorax platypogonides*. The content of heavy metal mercury (Hg) in water is still below the standard quality threshold, while the Hg content in fish is above the quality standard with a value range of 0.5 - 1.09 mg/kg. The content of heavy metal Arsenic (As) in water ranges from 0.02 - 0.6 mg/L, with the highest value found at stations 4 (irrigation canals), As in the highest fish at stations 1 and 2 with a value range of 1-1.1 mg/kg. The conclusion of this research is that there are seven species of fish and fish in the Cikaniki river which contain high Hg and As heavy metals.

**Keywords:** Diversity; fish; heavy metals; Cikaniki river; gold mining

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## INTRODUCTION

The river is a water source for the community, used for various purposes and activities, such as household needs, agriculture, industry, mineral resources, and other uses (Effendi, 2003). Current pollution, a problem for most water areas in Indonesia, including the river ecosystem, is a habitat for various aquatic biota whose existence is strongly influenced by the surrounding environment. These organisms include aquatic plants, such as fish, crustaceans, gastropods, benthos and plankton, and periphyton. One of the pollutants that can reduce and damage the river environment's carrying capacity is heavy metals. Heavy metals are dangerous pollutants because they are toxic if they are present in large quantities and affect various aspects of the waters, both biologically and ecologically.

The presence of heavy metals in the waters can come from multiple sources, including mining, household, agricultural and industrial waste (Mahardika et al., 2011). Whether legal or illegal, gold mining activities can produce waste as a source of heavy metal pollutants in Cikaniki River, Bogor Regency. Mount Halimun-Salak National Park (TNGHS) is a national park located in West Java with 113,357 ha. This area is a critical catchment area in the western part of West Java. More than 115 rivers and tributaries originate in the National Park area, including Cikaniki River, Cidurian River, and Ciberang River, which is part of the Ciujung River Basin. Cikaniki River, which empties into the Cisadane River, is located in Nanggung District, Bogor Regency, West Java.

The presence of heavy metals in the environment is considered dangerous because of their non - degradable nature. Still, they are often used in human activities so that their production is also increasing. There has been no research related to the content of heavy metals in water, sediment, and fish in the Cikanikiriver. The study results Azizah & Anen (2019), show that Cikaniki River watershed is polluted with light pollution levels. In 2004, Syawal &Yustiawati found that mercury (Hg) in the water had an average concentration of 35 times above the maximum limit set for Class III with a range of 0.0023 - 0.1743 mg / L), up to 2019 not yet. Some have reported the content of Arsenic (As) in water and fish.

The fish species that are most commonly found utilized are *Barbodes binotatus*. The impact of poor river quality is that it will reduce the amount of river biota and, in general, will further reduce the rate of river water in the downstream part, which then empties into the sea (Sundari et al., 2016). To reducethe negative impact on the surrounding community due to the value of pollution,it is necessary to researchthe analysis of metal content in water and fish along Cikaniki River. This study aims to know determine the content of heavy metals Hg and As in water and Barbodesbinotatus fish in the Cikaniki river flow and determine the distribution of rich metal content in water and *Barbodes binotatus* fish in the Cikaniki river.

## RESEARCH METHODS

This type of research is the method of a purposive sampling method. This research includes two stages: the first sampling of water and *Barbodes binotatus* at each station, the second stage of extraction, and heavy metal content analysis using ICP-OES. Water sampling was carried out at five predetermined stations. At each observation station, fish and water samples were taken three times from the riverbank to the opposite side. Station 1 is in the upper reaches of the Cikaniki River, and Station 2 is on the river where PETI activities. Station 3 in the river, which is flowed by mining waste from PT. Antam, Station 4 in the river body, which is used as an irrigation channel by residents, and Station 5 in the downstream area. The research was conducted for seven months, starting from January - March 2020, in Cikaniki River, which is included in the Mount Halimun Salak National Park (TNGHS), Nanggung District, Bogor Regency. The tools and materials used in this study include the Agilent 5100x

Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES).Water sampling was carried out based on SNI 6989.58: 2008. Samples were taken at three points with a depth of approximately 1.5 meters using a 5 L bucket, namely the middle, left, and right parts of the river, and then homogenized (composite). The total sample used was 20 fish, the sample that has been taken will be accommodated in a polyethylene bottle. Fish samples were taken from the Cikaniki river segment of Bogor district by taking sampling locations from upstream to downstream. The part of the fish that is taken is the meat part. The samples were taken five times sampling and two analysis repetitions.

The metal content test process is carried out at the Chemical Laboratory of the University of Nusa Bangsa. Fish identification was carried out at the Faculty of Mathematics and Natural Sciences Laboratory, University of Nusa Bangsa. Identification of fish using the identification book Kottelat et al. (1993). The characteristics observed included body shape, body length height, color pattern, muzzle shape, fin shape, number of fins, and tail shape.Data analysis was performed using descriptive methods. Metal data in water will be used to compare with data referring to the quality standard of Government Regulation No. 82 of 2001 concerning water quality treatment and class II water pollution control by Republic of Indonesia Government Regulation No. 82 of 2001 and Heavy metal content in fish use WHO regulations in 1989.

## FINDINGS AND DISCUSSION

During the research, a total of 135 fish were collected. These results were obtained from the identification results from upstream-downstream of the Cikanikiriver. Identification showed that seven species from 7 families were collected (see Table 1). The calculation of environmental factors and heavy metal content are shown in Table 2 and Table 3.

**Table 1. Diversity of Fish Species in Cikaniki River**

| No | Family | Species | Name | Stations | | | | | Count |
|---|---|---|---|---|---|---|---|---|---|
| | | | | St 1 | St 2 | St 3 | St 4 | St 5 | |
| 1 | Cyprinidae | *Puntius binotatus* | Benteur | 4 | 14 | 13 | 10 | 3 | 44 |
| 2 | Balitoridae | *Nemacheilus chrysolaimos* | Jeler kecil | 3 | 15 | 20 | 6 | 6 | 50 |
| 3 | Sisoridae | *Glyptothorax platypogonides* | Kehkel | 1 | 1 | 4 | 4 | 3 | 13 |
| 4 | Channidae | *Channa striata* | Gabus | 4 | 1 | 3 | 2 | 2 | 12 |
| 5 | Clariidae | *Clarias batrachus* | Lele | | | 8 | 1 | | 9 |
| 6 | Poecillidae | *Poecilia reticulata* | Bungkreung | 3 | | 1 | | | 4 |
| 7 | Synbranchidae | *Monopterus albus* | Belut | 1 | | 1 | | 1 | 3 |
| Number of Individuals | | | | 16 | 31 | 50 | 23 | 15 | 135 |

*St 1: Upstream, St 2: PETI, St 3: PT. Antam, St 4: Irrigation, St 5: Downstream

Observation station 3 is the place where the most number and types of fish are obtained. Fishis thought to be related to Observation Station 3, which is far from mining activities, close to settlements, and rice fields, so that food supplies are abundant. The most significant total number of individuals collected in the Cikaniki river along the pongkor gold mining concession is *Nemacheilus chrysolaimos* from the Balitoridae family, with as many as 50 individuals. They are followed by the type of *Puntiusbinotatus* from the family Cyprinidae, with 44 individuals. Then there are 13 types of *Glyptothorax platypogonides* from the Sisoridae family.

The results of field observations and identification in the laboratory found seven types of fish species divided into seven families along the Cikaniki river (Table 1), the number found was less than the research results Ridho et al. (2003), who saw nine types of fish families in the Cikaniki river.The decrease in the number of fish can be caused by habitat destruction, including those related to an increase in population, industrial activities, land use and management changes, economic policies in development, and high poverty levels (Wahyuni & Zakaria, 2018). The study results as a whole, the composition of the fish species found in Cikaniki River at station 3 was more diverse than other stations. The number of fish in station 1 (16 individuals), Station 2 there are 31 individuals. The number of fish caught at station 3 is 50 individuals consisting of 7 species and seven families, station 4 (23 individuals), and at station five, there are only 15 individuals. Station 1 and station 5, the upstream and downstream areas, have the least number of fish species caught than other stations. It can be because station one has experienced deforestation due to mining activities, and station 5 is under pressure from population activitiesin the downstream area. The number of fish species at station two and station 3 is the mining areas for Wild Mining (PETI) and PT. ANTAM has more species composition than other stations, presumably because the site is still natural with dense forest vegetation, so that it has a higher complexity of habitat structure. The complexity of habitat structure can maintain high species richness because it has more significant habitat heterogeneity (Nuryanto et al., 2017).

The catch during the study found that *Nemacheilus chrysolaimos, Barbodes binotatus, Glyptothorax platypogonides, Channa striata, Clarias batracus, Monopterus albus* are fish species native to Indonesia. Meanwhile, the *Poecilia reticulata* species are introduced fish originating from the United States, namely Venezuela, Barbados, Trinidad, Brazil (Ridho et al., 2003). *Barbodes binotatus* is a member of the Cyprinidae family, with its characteristics being that the scales have projections from the center to the edge like the spokes on a wheel, the spokes which are not curved towards the back; Young and sometimes adult fish have 2-4 round to oval spots in the center of the body. Changes in environmental conditions also affect food supplies changes and change fish's eating behaviour. Cyprinidaeis the most common freshwater fish found in various environmental conditions.

The data obtained is the result of direct field measurements (temperature, pH) and laboratory measurements (BOD, COD, DO) can be seen in Table 2.

**Table 2. Value of Cikaniki River Flow Environmental Factors**

| No | Environmental factor | Upstream | PETI | PT. ANTAM | Irrigation | Downstream | Quality Standards |
|---|---|---|---|---|---|---|---|
| 1. | Temperature(°C) | 27 | 27,5 | 31 | 32 | 30 | ± 30 |
| 2. | pH | 7,5 | 7,3 | 7,7 | 7,3 | 7,4 | 6-9 |
| 3. | BOD (mg/L) | 3,95 | 3,33 | 2,29 | 4,78 | 3,33 | 2 |
| 4. | COD (mg/L) | 29,9 | 27,8 | 28,1 | 39,8 | 27,8 | 10 |
| 5. | DO (mg/L) | 9,1 | 10,4 | 10 | 10 | 8,8 | 6 |

*St 1: Upstream, St 2: PETI, St 3: PT. Antam, St 4: Irrigation, St 5: Downstream

The composition and distribution of fish are strongly influenced by changes in physics, chemistry, and biology (Wahyuni & Zakaria, 2018). Measurement of environmental factors aims to see the effect of water conditions on aquatic resource communities. The results of measurements of physical and chemical characteristics in river water are compared with the quality standard according to PP No. 82 of 2001 for fish farming activities (class II). According to the Republic of Indonesia Government Regulation No. 82 of 2001, the pH value obtained during the study was in the optimum condition, namely 6-9. pH affects a chemical compound's toxicityat the observation station on Cikaniki River, ranging from 7,3 – 7,7. pH condition is following the statement (Andara et al., 2014), which states that river water pH ranges from 4 - 9. The pH range suitable foraquatic organisms is not the same, depending on the type of organism. The acidity of the water (pH) also affects water fertility because it affects microorganisms' lives. Acidic waters are less productive. They can even kill fish (Sutamihardja et al., 2018).Changes in pH are sensitive to most aquatic biota;aquatic organisms prefer a pH close to neutral pH; the degree of acidity controls the solubility and metal concentrations in water at low pH conditions, heavy metals tend to be dissolved (Siahaan et al., 2011).

BOD level is one of the parameters used as a benchmark for measuring the pollution load of waters. BOD inspection is critical to trace the flow of pollution because it can determine the pollution load due to wastewater and design a biological discharge system for polluted water (Wahyuni & Zakaria, 2018). Biochemical Oxygen Demand (BOD) is a characteristic that indicates the amount of dissolved oxygen required by microorganisms (usually bacteria) to break down or decompose organic matter under aerobic conditions. The distribution of BOD values in the Cikaniki River is 2.29 - 4.78 mg / L, and all these values are above the threshold value. As described (Andara et al., 2014), the greater the BOD value, the greater the degree of wastewater contamination. The highest BOD value at a resident irrigation channel at a station can happen because of residents' use of pesticides. The BOD value shows the number of organic pollutants in river waters.The results of testing the water sample levels of Chemical Oxygen Demand (COD) along Cikaniki river flow ranged from 27,8 – 39,8 mg / l.

The highest COD levels exceeding the BMA threshold were found at station four, namely 39,8 mg /l.COD value can be due to irrigation channels and many pesticides or other chemicals at this station (Abida, 2010). A lot of garbage is scattered, which causes a high chemical content at this station. The Dissolved Oxygen value along the Cikaniki river flow ranges from 8.8 to 9.4 mg / l.This figure is above the Water Quality Standard; according to Abida (2010), Dissolved oxygen is essential in the growth of phytoplankton in photosynthesis to increase primary productivity.The relatively high DO levels at the five research locations were due to the sampling process, which was not too far from the river surface. As stated, the highest dissolved oxygen concentration is in the water's surface layer. The most increased dissolved oxygen is due to sunlight in the surface layer of the observed waters. This condition can help the photosynthesis process supply oxygen to the waters. The phytoplankton that can carry out photosynthesis is also the highest on the surface. Dissolved oxygen concentration generally decreases with increasing depth.

**Table 3. Examination of Mercury (Hg) and Arsenic (As) Levels in Water and *Barbodes binotatus* Fish in the Cikaniki River, in the Upstream, Middle and Downstream Parts**

| Variable | St. 1 (mg/L) | St. 2 (mg/L) | St. 3 (mg/L) | St. 4 (mg/L) | St. 5 (mg/L) | Quality Standards |
|---|---|---|---|---|---|---|
| Mercury (Hg) | | | | | | |
| Water (mg / L) | 0.00012 | 0.00018 | 0.00051 | 0.00048 | 0.00056 | 0.001 |
| Fish (mg / Kg) | 0.655 | 0.630 | 1.029 | 0.914 | 0.795 | 0.5 |
| Arsenic | | | | | | |
| Water (mg / L) | <0.02 | <0.02 | 0.049 | 0.06 | 0.024 | 0.05 |
| Fish (mg / Kg) | 1.0 | 1.1 | <0.4 | <0.4 | <0.4 | 1 |

*St 1: Upstream, St 2: PETI, St 3: PT. Antam, St 4: Irrigation, St 5: Downstream

The observation results of heavy metal content in the water and fish of Cikaniki River are presented in Table 3. Mercury (Hg) or mercury is a metal that occurs naturally and is the only metal that is liquid at room temperature. Hg metal in water and soil mainly comes from natural deposits, industrial waste disposal, and volcanic activity. Apart from gold mining activities, Hg metal is also used to produce chlorine gas and caustic soda, thermometers, dental fillings, and batteries. Health problems that occur due to Hg metal poisoning are nervous system disorders, brain function damage, DNA and chromosomes, allergies, skin rashes, fatigue, and headaches. Besides that, it can also cause sperm damage, baby defects, and miscarriage (Kamarati et al., 2018).

Heavy metal concentrations can be affected by the entry of waste containing heavy metals such as industrial waste, domestic waste, and agricultural waste. The results of the measurement of the value of Hg content at all stations under 0.02 mg / L; although not far above the threshold, it is necessary to pay attention to the Cikaniki River flow, which has the potential for an increase in Pb metal content from the gold mining industry (Kamarati et al., 2018). Arsenic (As) or arsenic is found in groundwater. The results showed that the heavy metal content of As in the Cikaniki river flow was 0.02 - 0.06 mg / L as water content has increased at stations 3 and 4, which are gold mining industrial areas and community irrigation channels. Most of the arsenic in nature is a form of essential compounds, which are inorganic substances. Inorganic arsenic can dissolve in water or form a gas and is exposed to humans (Sundari et al., 2016). When humans consume fish containing Hg and Ascan cause health problems such as intestinal and stomach irritation, decreased productivity of white blood cells and red blood cells, skin changes, and lung irritation. Arsenic can also accelerate cancer development, causing infertility and miscarriage ingredients, As is a potent poison. The source of Arsenic pollution in more than 80,000 tons per year results from burning fossil fuels and various industrial activities (Munandar & Eurika, 2016).

Fish is one of the organisms that can be used as an indicator of heavy metal pollution. If the fish's body contains high levels of heavy metals and exceeds predetermined normal limits, it can indicatecorruption in the environment. The content of heavy metals in fish is closely related to industrial waste disposal around the fish's habitat, such as rivers, lakes, and seas. The number of heavy metalsthat are absorbed, distributed fish depends on the form of the compound and the concentration of pollutants, microorganisms' activity, the texture ofsediments, the types and elements of fish in the environment. Heavy metals enter the body tissues of living things in several ways, namely the respiratory tract, digestion, and penetration through the skin.

The results showed that the Hg content in the *Barbodes binotatus* fish ranged from 0.63 to 1.06 (Table 3) and exceeded the quality standard for fish's metal content. The highest Hg content is found at station three, which is a resident irrigation channel. The range of heavy metals in water systems, depending on the conditions of the water location, population density, environmental conditions around the waters, seasons, and local climates (Sofarini et al., 2011). According to Effendi (2003), if heavy metals accumulate in aquatic organisms, they will have a long residence time. The levels will continue to increase if the waters continue to be polluted. Even though the Cikaniki River is categorized as lightly contaminated, its status maygrow if there is still pollution (Azizah & Anen, 2019). Under anoxic conditions, microbial activity can form arsenic in methylate, solid, and enter the atmosphere (Istarani & Pandebesie, 2014). In the aquatic environment, the requirement under stress for arsenic oxidation from the mobility and absorption of pentavalent arsenic by soil sediments and minerals is dependent on the arsenic form.The presence of arsenic in nature (including the presence in rock (soil) and sediment, air, water, and biota), arsenic production in industry, use and sources of arsenic pollution in the environment (Sofarini et al., 2011).

Stations 1 and 2 are stations with the highest arsenic count because they are gold mining industrial areas. Istarani & Pandebesie (2014) said that arsenic in nature arsenic production from industry, use and sources of arsenic pollution in the environment arsenic content in fish Cikaniki River is 0.4 - 1.1 mg / L. According to the National Institute for Occupational Safety and Health (1975), inorganic arsenic is responsible for various chronic health problems, especially cancer. Arsenic can also damage the kidneys and is a potent poison (Ali, 2012). Arsenic can also damage the kidneys and is a potent poison.

Arsenic is known as a carcinogen or can cause cancer (Istarani & Pandebesie, 2014). Adding if a person is exposed to too much arsenic from drinking water is called arsenicosis. The arsenicosis victims will not impact the near future, but the effects will only be seen after a long time. Various products include skin pigmentation, gangrene, and keratosis, and it has only been seen for at least five years of accumulated arsenic exposure. Since arsenic poisoning is not immediately visible, the most likely course of action is preventive action (Maddusa et al., 2017).

## CONCLUSION

A total of 7 species were collected and each from a different family. Based on its dominance, four types of fish dominate: *Puntius bionotatus*, *Nemacheilus chrysolaimos*, and *Glyptothorax platypogonides*. The content of heavy metal mercury (Hg) in water is still below the standard quality threshold, while the Hg content in fish is above the quality standard with a value range of 0.5 - 1.09 mg/kg. The content of heavy metal Arsenic (As) in water ranges from 0.02 - 0.6 mg/L, with the highest value found at station 4 (irrigation canals), As in the highest fish at stations 1 and 2 with a value range of 1 - 1.1 mg/kg. The research results on the high content of Hg and As heavy metals in fish in Cikaniki River can provide input to the industry regarding the management of gold ore extraction wastewater. It is hoped that the surrounding community will no longer use Cikaniki River water for their daily activities.

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