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Liver histopathology of *baung* fish, *Hemibagrus nemurus* (Valenciennes, 1840) and the level of Pb in Siak River, Pekanbaru, Riau, Sumatra

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ABSTRAK

*Kadar Timbal (Pb) yang tinggi di perairan akan mempengaruhi struktur organ hati ikan. Penelitian ini bertujuan mengetahui perubahan struktur makroskopis dan mikroskopis organ hati ikan baung (*Hemibagrus nemurus*), serta kadar Pb di perairan Sungai Siak. Sampel ikan dan air sungai diambil dari lokasi 1 (Kecamatan Lima Puluh) dan lokasi 2 (Kecamatan Rumbai Pesisir). Pembuatan preparat histologis hati dengan metode parafin dan pewarnaan* Hematoksilin-Eosin *(HE). Kadar Pb menggunakan metode* Atomic Absorption Spectrophotometry *(AAS). Struktur makroskopis hati lokasi 1 berwarna merah kekuningan dan lokasi 2 berwarna merah kecokelatan. Rerata persentase kerusakan jaringan hati di lokasi 1 yaitu degenerasi parenkim (1,68%), degenerasi hidropik (1,46%), degenerasi melemak (30,77%), dan nekrosis (39,24%). Lokasi 2 yaitu degenerasi parenkim (1,20%), degenerasi hidropik (1,35%), degenerasi melemak (16%), dan nekrosis (21,70%). Kerusakan degenerasi melemak dan nekrosis di lokasi 2 bernilai 2 dengan kategori sedang dan kerusakan lainnya di 2 lokasi bernilai 1 dengan kategori sedikit. Kadar Pb Sungai Siak Kota Pekanbaru tahun 2024 bernilai 0,113 mg/L (lokasi 1) dan 0,072 mg/L (lokasi 2). Kadar Pb di air Sungai Siak di 2 lokasi telah melebihi batas baku Pb di perairan. Tingginya kadar Pb di Sungai Siak ternyata dapat merusak struktur jaringan hati ikan.*

Kata kunci: AAS, Kadar Pb, Metode Parafin, Kerusakan organ hati

ABSTRACT

*The high levels of Pb in the water will affect the structure of fish liver organs. This study aims to determine changes in the macroscopic and microscopic structure of the liver organ of baung fish (*Hemibagrus nemurus*), as well as Pb levels in Siak River. Fish and river water samples were taken from Lima Puluh and Rumbai Pesisir Subdistrict. Histological preparation using paraffin method and HE stain. Pb levels using the* Atomic Absorption Spectrophotometry *(AAS) method. The macroscopic structure of the liver in Location 1 was yellowish red and Location 2 was brownish red. The average percentage of liver tissue damage in Location 1 was parenchymal degeneration (1.68%), hydropic degeneration (1.46%), fatty degeneration (30.77%), and necrosis (39.24%). Location 2 was parenchymal degeneration (1.20%), hydropic degeneration (1.35%), fatty degeneration (16%), and necrosis (21.70%). Fatty degeneration and necrosis damage are medium, and other damage is slight. The Pb level of Siak River in Pekanbaru City in 2024 was 0.113 mg/L (Location 1) and 0.072 mg/L (Location 2). Pb levels in Siak River have exceeded the standard limit of Pb in waters. High levels of Pb in the Siak River can damage the structure of fish liver tissue.*

Keywords: AAS, Liver damaged, Paraffin method, Pb level

INTRODUCTION

Hemibagrus nemurus (Valenciennes, 1840); ***syn***. *Bagrus nemurus* Valenciennes in Cuvier & Valenciennes, 1840; *Bagrus sieboldii* Bleeker, 1846; *Mystus nemurus* (Valenciennes, 1840), locally known as *baung*, is a species of freshwater fish native to Indonesia, inhabiting regions such as Sumatra, Java, and Kalimantan. This species is commonly found in rivers, lakes, swamps, and reservoirs. Baung has high economic value due to its savory taste, low fat, and high protein content, making it a sought-after culinary ingredient (Sukendar et al., 2015). In Pekanbaru, Riau, Sumatra, *baung* is processed into various dishes, as evidenced by the numerous restaurants and eateries offering *baung* on their menus, such as spicy tamarind and coconut milk yellow curry (Khairuman & Amri, 2008).

One of the many freshwater habitats of *baung* in Riau is the Siak River, on which people do various activities such as water transportation, agriculture, fisheries, industry, and household activities. These activities strain the quality of Siak River water due to the large amounts of pollutants produced and disposed of into the river. High shipping activities and domestic waste from urban areas significantly degrade the quality of the Siak River waters. Domestic waste, if untreated, can pollute and poison the environment, containing harmful chemicals such as detergents, household pesticides, medicines, and cooking oil, as well as heavy metals like lead, mercury, cadmium, and zinc (Sitepu, 2024).

Research by Yuliati et al. (2017) found that during high and low tides in the Siak River, Pekanbaru City in 2016, the water contained heavy metal Pb at concentrations of 0.06 - 0.09 mg/L. These values exceed the quality standard set in PP No. 22 of 2021 concerning water quality management and pollution control, which is 0.03 mg/L. High Pb levels are attributed to human activities such as industrial operations and river transportation fuel. This heavy metal is difficult to break down and settles at the bottom of the waters, disturbing aquatic biota that live there (Amaliah et al., 2022).

Fish are aquatic organisms that can serve as indicators of pollution levels in water. Prolonged exposure to heavy metals can cause histological changes and damage to their organs. Heavy metals in water can enter fish bodies through the gills, meat, kidneys, and liver (Paundanan et al., 2020). Besides the gills, the liver is particularly prone to damage due to its role in metabolism and detoxification. Excessive exposure to toxic substances can damage liver tissue structure (Santo, 2020). Research by Rahmadani et al. (2014) on the liver structure of *Ompok hypophthalmus* (Bleeker, 1846), also known as *selais*, in the Siak River, Pekanbaru City, found the liver to be yellowish-red due to high fat content. Microscopic examination revealed fatty cells, congestion, cell swelling, and lysis. Histological preparations are used to observe structural changes in organs polluted with heavy metals. Research by Kusumadewi et al. (2015) found that heavy metal Pb in the Tukad Badung river exceeded normal standards, causing histopathological changes such as degeneration, necrosis, and fibrosis in the liver of *mujair* (*Oreochromis mossambicus*). Therefore, research on the liver structure of *baung* from the Siak River is necessary to assess the effects of pollution on liver organs.

The purpose of this study was to determine changes in the macroscopic and microscopic structure of the liver organ of *baung* in the polluted waters of the Siak River

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and to determine the levels of heavy metal lead (Pb) in the waters. This study aims to provide an overview of the liver structure of *baung* in the polluted waters of the Siak River and information on Pb levels in the river.

METHODOLOGY

Study location and species sampling

This research was conducted from December 2023 to March 2024. Fish and water samples were obtained from two locations: Lima Puluh and Rumbai Pesisir Subdistricts, Pekanbaru City, Riau Province. Samples in Rumbai Pesisir Subdistrict were taken from an area without residential areas but used as a passage route for ships, while samples in Lima Puluh Subdistrict were close to the port with shipping activities, trade, and residential areas around the Siak banks. Histology preparations of fish liver organs were conducted at the Microtechnical Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, Riau University.

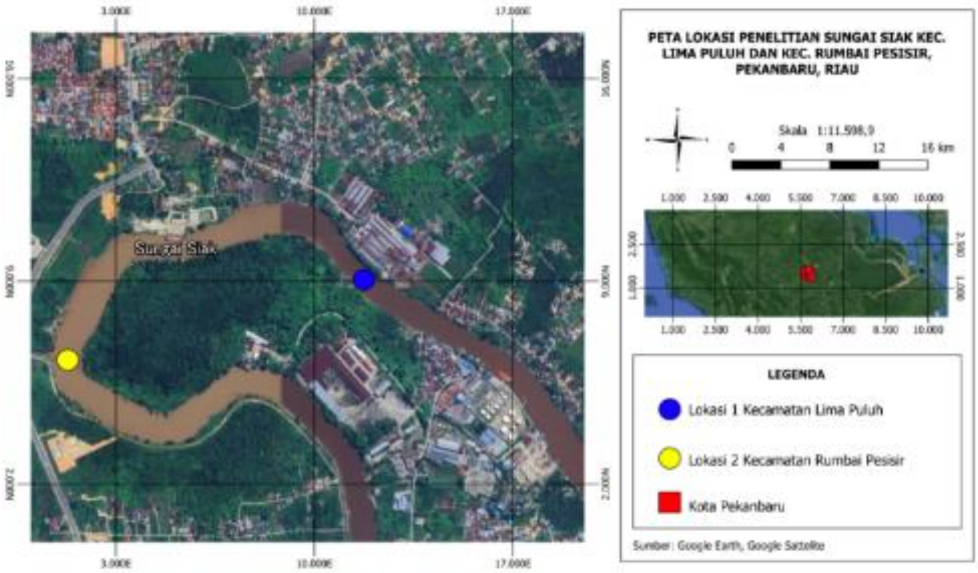

FIGURE 1. Map of the research location (Source: Google Earth)

Experimental design

This research uses several tools and materials in carrying out the stages in the experiment can be seen in **Table 1** and **Figure 2**.

TABLE 1. The tools and materials used in experiment

Tools	Material
Surgical tools, oven ruler, volume bottle, drop pipette, beaker glass, cover glass, measuring cup, light microscope, glass rod, obect glass, wooden block, tweezers, staining jar, analytical balance, rotary microtome, spiritus lamp, waterbath, high temperature oil bath model, photomicrographic microscope, embedding cassette, and *Atomic Absorption Spectrophotometry* (AAS)	2x2 cm cardboard boxes for embedding millimeter blocks, paraffin wax, 0.9% physiological saline, 10% Buffer Neutral Formalin (BNF), graded alcohol solutions (30%, 40%, 50%, 60%, 70%, 80%, 90%, 96%, absolute alcohol I and absolute II), distilled water, xylol I, II, and III, paraffin I and II, Hematoxylin- Eosin Y 1-2% dye, Canada balsam.

Baung were collected randomly with different body sizes and weights, with three fish from each location. River water was collected in the morning, with 100 ml taken from

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each location. Location 1 is densely populated, with a port called Sungai Duku Port, a docking place for ships. Location 2 is not densely populated and is usually used as fishing ground for the community.

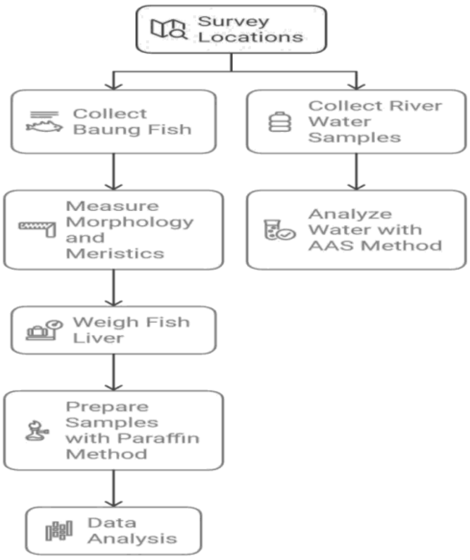

FIGURE 2. Experimental design

Research procedures

Collection of *baung*

Fish were collected once from each location. The fish were caught by fishermen in two locations in the Siak River: Lima Puluh (location 1) and Rumbai Pesisir (location 2) Subdistricts. Three live fish samples were taken from each location and further analyzed in the Zoology Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, Riau University.

Morphometric and meristic analysis of *baung* fish

Morphometric measurements and meristic observations of *baung* samples were carried out at the Zoology Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, Riau University. Morphometric measurements were taken using a ruler. Prior to the measurements, all fish samples were photographed for their full morphology. Each sample was measured for total length (PT), from the tip of the mouth to the tip of the tail. Meristic calculations were then carried out on the number of fish fins as a key identification of *baung* species.

Liver organ sampling of *baung* fish

Baung fish were dissected using a scalpel and surgical scissors. The fish sample was photographed to observe its anatomy. The fish liver was taken and placed into 0.9% NaCl. Preparations were then made on the liver organ.

Preparation of liver organ preparations of *baung* fish

The preparation of fish liver organs was carried out at the Microtechnical Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, Riau University. This histology preparation is based on the paraffin method of Sukarni et al.

DOI: 10.21009/bioma.v20i2.49655

(2012). The liver was washed with 0.9% physiological saline for 15 minutes, then fixed with 10% Buffer Neutral Formalin (BNF) solution for 24 hours. The next process was dehydration in graded alcohol (80%, 90%, 96%) for three hours each, followed by immersion in absolute alcohol solutions I, II, and III for one hour each. The clearing stage was carried out in xylol I, II, and III solutions for one hour each. Samples were inserted into paraffin I (60 minutes) and paraffin II (40 minutes) for the infiltration stage. Samples were then embedded in liquid paraffin in a cardboard box and cooled to harden in the freezer, forming paraffin blocks.

The liver organs in paraffin blocks were cut using a microtome with a thickness of 3-6 µm. Pieces of paraffin tape were glued to a glass slide and stored in a 38°C oven for two days before deparaffinization. The deparaffinization stage involved placing the preparations into xylol I, II, and III for two minutes each, followed by immersion in absolute alcohol, 96% alcohol, 90%, 80%, 70%, 60%, 50%, 40%, 30% for two minutes each, and distilled water for five minutes.

The preparations were then stained with Hematoxylin for seven minutes and soaked in tap water for 10 minutes, followed by five minutes in distilled water. The sample preparations were air-dried and then placed into Eosin staining solution for seven minutes, followed by dipping in 70%, 80%, 90% alcohol, absolute alcohol for two dips each, and xylol I, II, and III for two minutes each. The final stage involved mounting the sample with cover glass glued using entellan. Observation of the preparations was done under a microscope.

Water sampling and Pb determination

Water samples from the Siak River were collected 50 mL below the water surface using a container and tested for Pb heavy metal content using Atomic Absorption Spectrophotometry (AAS) at the Chemical Testing and Analysis Laboratory, Faculty of Engineering, Riau University, Pekanbaru. According to research conducted by Aphrodita et al. (2022), water samples were placed in an Erlenmeyer flask, and 10 mL of concentrated HNO3 was added. The sample solution was heated using a hot plate. Distilled water was then added until the volume reached 100 m. The sample filtrate was transferred to a 100 mL volumetric flask and topped up with distilled water to the mark. The sample solution was then analyzed using AAS.

Data analysis techniques

The research data obtained were both qualitative and quantitative. Qualitative data were analyzed descriptively, focusing on macroscopic changes in liver organs, such as changes in liver color and weight. The Hepatosomatic Index (HSI) is a quantitative parameter that describes the increase in liver weight relative to body weight (Akhmal et al., 2021). This HSI level can indicate changes occurring in the liver of fish.

$$HSI\ (\%) = \frac{Liver\ weight}{Total\ body\ weight}\ x\ 100\%$$

Microscopic changes in liver organs such as parenchymal degeneration, hydropic degeneration, fatty degeneration, and cell necrosis. Quantitative data in the form of values

DOI: 10.21009/bioma.v20i2.49655

of heavy metal levels in Siak River waters and the percentage of damage to liver cells are presented in tabular form. The formula for calculating the average percentage of changes in the structure of fish liver organs is (Lubis et al. 2014)

$$Percentage\ (\%) = \frac{Number\ of\ damaged\ cells}{Total\ cell\ count}\ x\ 100\%$$

The scoring parameters for the evaluation of cell damage in the liver (**Table 2**) were seen by observing 5 fields of view around the central vein.

TABLE 2. Scoring parameters of liver evaluation in 5 field of view around the central vein

Score	Percentage of Cell Damage	Description
0	0	No cell damage
1	< 25%	Light cell damage
2	25% - 50%	Moderate cell damage
3	50% - 75%	Moderately heavy cell damage
4	75% - 100%	Heavy cell damage

Source: Maftuch et al. (2015)

RESULTS AND DISCUSSION

Macroscopic structure of liver organ of *baung* fish

The mean total length of *baung* at Location 1 (Lima Puluh Subdistrict) was 22.73 cm with a mean liver weight of 1.36 grams. The mean total length of baung fish at location 2 (Rumbai Pesisir Subdistrict) was 18.13 cm with a mean liver weight of 0.69 grams. The mean length of *baung* obtained aligns with the morphometric characteristics of *baung* fish. The mean weight of female fish in location 1 was 200 grams, and in location 2, it was 130 grams. The HSI value in location 1 ranged from 5.98%, and in location 2, it ranged from 3.80% (**Table 3**). According to Morado et al. (2017), fish liver weight increases due to stress and damage in the microscopic structure of the liver organ caused by toxic substances in the water. Research by Zulfahmi et al. (2017) on the effect of liquid palm oil waste on the liver showed an increase in HSI value in the liver of tilapia fish due to increased exposure to liquid palm oil waste in waters.

TABLE 3. The mean total lenght and liver weight of *baung* and HSI level

	The mean Total Lenght (cm)	The mean Liver Weight (g)	HSI (%)
Location 1 (Lima Puluh subdistrict)	22.73	1.36	5.98
Location 2 (Rumbai Pesisir subdistrict)	18.13	0.69	3.80

The observations of the macroscopic structure of the liver organ of *baung* revealed that the liver is located posterior to the heart and has two lobes: the right lobe and the left lobe. In location 1 (Lima Puluh Subdistrict), the liver was yellowish-red, while in location 2 (Rumbai Pesisir Subdistrict), it was brownish red (**Figure 3**). A normal fish liver is red brown in colour. The change in liver colour to yellowish red is due to the amount of fat

DOI: 10.21009/bioma.v20i2.49655

stored (Rijal et al., 2023). Fat accumulation in the liver is for growth and preparation for gonad development (Azizi et al., 2022).

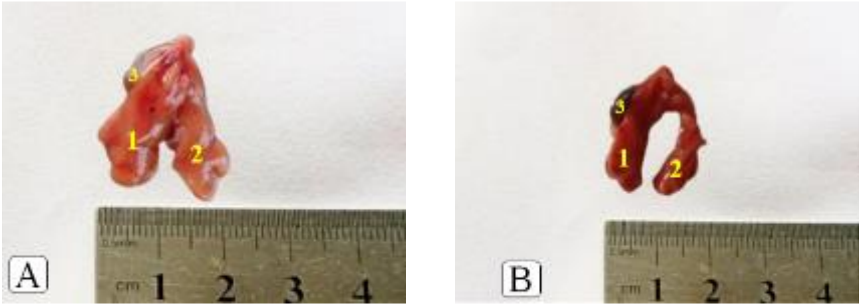

FIGURE 3. Liver morphology of baung fish from Siak River waters. A. Location 1 Lima Puluh subdistrict is yellowish red, B. Location 2 Rumbai Pesisir subdistrict is brownish red. (1). Left lobe, (2). Right lobe, (3). Gallbladder.

Microscopic structure of the liver organ of *baung* fish

The liver structure observed around the central vein in both locations showed cell changes characterized by parenchymal degeneration, hydropic degeneration, fatty degeneration, and necrosis. The central vein in location 1 experienced congestion, while location 2 did not. Based on observations with five fields of view on each preparation, the mean number and percentage of liver cell damage were obtained (**Tables 5** and **6**, **Figures 4** and **5**).

The average percentage of normal hepatocyte cells (**Table 6**) in location 1 was 26.85%, and in location 2, it was 59.75%. The mean percentage of liver cells that experienced the highest damage was necrosis, with a value of 39.24% in location 1 and 21.70% in location 2. The mean percentage of fatty degeneration damage was also high in location 1 at 30.77% and in location 2 at 16%. The lowest mean percentage of liver organ damage was hydropic degeneration at 1.4% in location 1 and parenchymal degeneration at 1.20% in location 2. Parenchymal degeneration in location 1 was 1.68%, and hydropic degeneration in location 2 was 1.35%.

TABLE 4. The mean of number of liver cell in *baung*

Location	Normal Cells	Parenchymal Degeneration	Hydropic Degeneration	Fatty Degeneration	Necrosis	Total of liver Cells
Location 1	3430	214	187	3930.5	5013.5	12775
Location 2	5760	115.5	130	1542	2092	9639.5

Notes: Location 1: Lima Puluh Subdistrict, Location 2: Rumbai Pesisir Subdistrict

TABLE 5. The mean percentage and scoring value of liver organs and histopathological of liver cell structure in *baung*

Location	Sample amount	Normal Cells (%)	Parenchymal Degeneration (%)	Hydropic Degeneration (%)	Fatty Degeneration (%)	Necrosis (%)
Location 1	3	26.85	1.68	1.46	30.77	39.24
Scoring value			1	1	2	2
Location 2	3	59.75	1.20	1.35	16.00	21.70
Scoring value			1	1	1	1

Notes: Location 1: Lima Puluh Subdistrict, Location 2: Rumbai Pesisir Subdistrict

DOI: 10.21009/bioma.v20i2.49655

Score value. 1= light, 2= moderate, 3= moderately heavy, 4= heavy

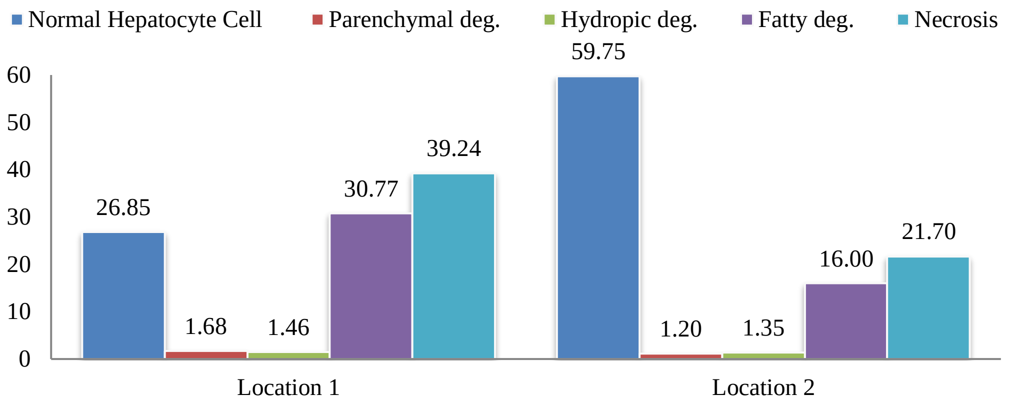

Figure 4. Mean percentage of the number of *baung* fish liver cells that have liver cell structure changes. The location 1 is Lima Puluh subdistrict and the location 2 is Rumbai Pesisir subdistrict.

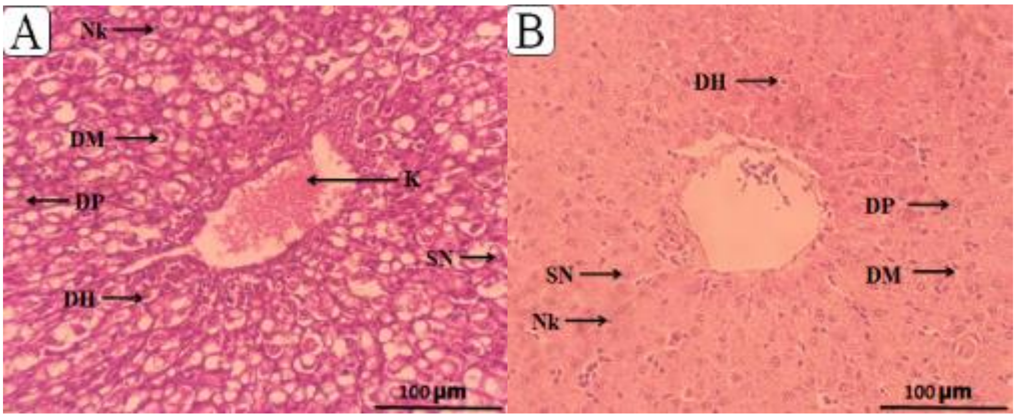

FIGURE 5. Microscopic structure of *baung* fish liver. A. Lima Puluh subdistrict, B. Rumbai Pesisir subdistrict. Magnification 40x. (Nk)= Necrosis, (DM)= Fatty degeneration, (DH)= Hydropic degeneration, (DP)= Parenchymal degeneration, (K)= Congestion, (SN)= Normal hepatocyte cells.

Normal liver organs have clear hepatocyte cells and sinusoids, with round nuclei and empty central veins (Wahyuni et al., 2020). The central vein is randomly distributed in the liver tissue, which exhibits a variety of shapes and sizes. Observations of this liver preparation were carried out around the central vein. According to Satria et al. (2021), the central vein is often damaged. The central vein functions to receive blood from the sinusoids. Blood carrying nutrients and a large amount of toxic substances passing through the central vein can cause damage to the surrounding tissues.

Changes in the liver structure of *baung* also showed that in location 1, there was damage in the form of congestion, while in location 2, there was no congestion in the central vein (**Figure 5**). Congestion is caused by the dilation of capillary blood vessels, resulting in increased blood volume. Congestion is characterized by the lumen of the blood vessels being filled with blood cells. It starts from the central vein and extends to the sinusoids, which are not regularly arranged, and there are erythrocytes due to the rupture of the sinusoid wall (Musada, 2022).

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The highest mean percentage of liver tissue damage in this study was necrosis. The average percentage of necrosis damage in location 1 is 39.24% with a scoring value of 2, indicating moderate liver cell damage, while in location 2, it is 21.70% with a scoring value of 1, indicating slight damage. Necrosis in cells is irreversible, where cells cannot return to their original state and will undergo cell death (Safitri et al., 2022). Necrosis is the final stage after cells degenerate. The signs of necrosis begin with a liver inflammation reaction in the form of cell swelling until death. Factors causing necrosis include environmental factors, pathogens, food, and other substances that enter the fish body.

Long exposure to toxic substances makes it difficult for liver cells to adapt, increasing necrosis in liver tissue. This occurs due to enzymatic disturbances in liver cell metabolism and molecules that can increase necrosis (Alif et al., 2021). Enzymes such as alanine aminotransferase (ALT) or serum glutamic pyruvic transaminase (SGPT), and aspartate aminotransferase (AST) or serum glutamic oxaloacetic transaminase (SGOT) are markers of impaired liver function because of their presence and normal levels in liver cells. Liver damage causes these enzymes to be released into the bloodstream, resulting in increased levels in the blood, indicating impaired liver function (Widarti & Nurqaidah, 2019; Parmono et al., 2024).

The stages of cell damage begin with cell swelling, followed by protein denaturation until cell death occurs. There are three types of cell death: pycnosis, karyorrhexis, and karyolysis. Pycnosis is characterized by the shrinking and darkening of the cell nucleus. Karyorrhexis involves the destruction of the cell nucleus and fragmentation of chromatin, which spreads in the cell. Karyolysis is characterized by the gradual disappearance of chromatin fragments, resulting in the absence of the cell nucleus (Maisaroh & Harjana, 2023).

Liver cell damage can also be sublethal (degenerative). Degenerative damage is reversible, where cells can return to normal if exposure to toxic substances is stopped (Safitri et al., 2022). In this study, there were three types of degeneration: parenchymal, hydropic, and fatty. The average percentage of fatty degeneration in location 1 is higher than in location 2. Fatty degeneration in location 1 has a scoring value of 2, indicating moderate damage, while in location 2, it has a scoring value of 1, indicating slight damage.

Fatty degeneration occurs due to the excessive accumulation of fat in the cytoplasm, resulting in fat vacuoles appearing in the cell. During the staining process of histological preparations, the part filled with fat appears empty with clear boundaries (Triadayani et al., 2010). Fat accumulation in the liver damages the rough endoplasmic reticulum, disrupting the process of lipoprotein formation in protein synthesis. Fat in the liver cannot bind to proteins to be transported out of the liver and taken to other parts of the body (Dewi et al., 2017).

Locations 1 and 2 exhibited parenchymal degeneration and hydropic degeneration with a scoring value of 1, indicating slight damage. Parenchymal degeneration, also called albuminous degeneration, is the mildest reversible damage characterized by cell swelling and a cloudy, granular cytoplasm. Parenchymal degeneration is caused by protein deposition, making the cells granular. Cells also swell due to the accumulation of water, as they are unable to eliminate water resulting from metabolites (Firdauzi, 2018).

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Hydropic degeneration is more severe than parenchymal degeneration. It is characterized by a vacuolized cytoplasm, where there is an increase in water entering the vacuole. The vacuole appears clear, and the nucleus is in the centre. Toxic substances damage hepatocyte cells by impairing the sodium-potassium pump in the cell membrane due to membrane lipid peroxidation, resulting in hypernatremia in the cell, causing water to enter the cell (Baskara et al., 2019).

Damage to the structure of *baung* liver organs can be influenced by several factors, including fish activity, adaptability to heavy metals, duration of exposure to heavy metals, and the age of the fish. The liver contains metallothionein protein compounds that can bind heavy metals. Metallothionein proteins limit the distribution of heavy metals to unwanted parts and protect against heavy metal toxicity (Nuraeni et al., 2021). Continuous exposure to toxic substances decreases liver metabolism, resulting in an ineffective detoxification process (Damayanti, 2010).

Lead (Pb) level of Siak river in Pekanbaru

The measurement results of lead (Pb) levels in the Siak River waters at location 1 and location 2 were 0.113 mg/L and 0.072 mg/L, respectively (**Figure 6**). Location 1 has higher Pb levels compared to location 2. The Pb levels in both locations have exceeded the quality standard limit for Pb levels in waters. The normal standard value for Pb levels in waters, based on PP No. 22 of 2021 concerning water quality management and pollution control, is 0.03 mg/L. The high Pb level in location 1 is due to the presence of boat docks and dense population settlements around the river flow. The Pb levels in location 2 have also exceeded the water quality standard limit, likely due to location 2 being a transportation route for large ships and fishing boats (Prasetyo et al., 2020).

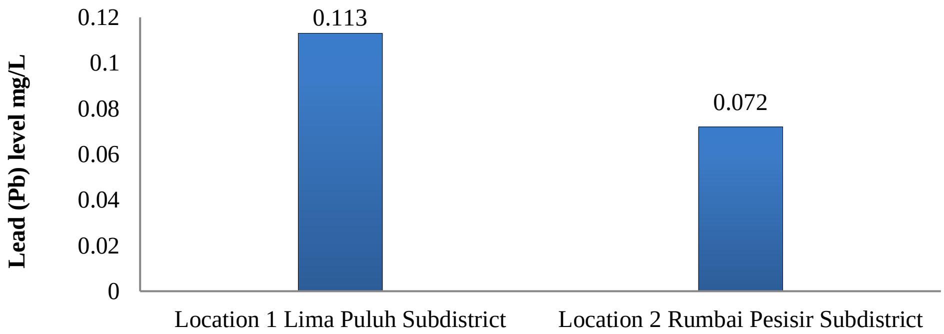

FIGURE 6. Histogram of Lead (Pb) Level Measurement in the Siak River Waters of Pekanbaru City, Lima Puluh and Rumbai Pesisir Subdistricts.

Pb levels in the Siak River waters of Pekanbaru city continue to increase. In 2016, the Siak River contained heavy metal Pb ranging from 0.06 - 0.09 mg/L (Yuliati et al., 2017), and in March 2024, it was 0.072 - 0.113 mg/L. The increase in Pb levels in the Siak River is caused by waste generated from the large number of ships that dock to load and unload cargo, fuel discharges from docked ships and fishing boats, and household waste from the increasingly dense surrounding population.

Research by Safitri et al. (2019) found that *baung* caught by fishermen in the Musi River contained Pb levels in the kidney organ of 0.672 mg/kg, gills 0.305 mg/kg, liver 0.323 mg/kg, and meat 0.084 mg/kg. Pb levels in the organs of *baung* in the Musi River

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may be caused by several factors, such as EDTA from detergents or acid pollutants, many boats docking, and the presence of Pb-containing fuel discharges from fishing boats or docked boats that settle at the bottom of the waters. Heavy metal Pb can enter the body of fish through the food chain, skin, and gills. Pb metal that enters the body through the digestive tract can increase if there is an increase in heavy metal concentration in the water. Long exposure and high concentrations of Pb can interfere with fish growth and damage liver structure (Marlinda et al., 2020).

Heavy metal levels in water can accumulate in fish through ingestion of food and suspended substances in water, as well as the exchange of several ions in gills. The rate of bioaccumulation of heavy metals in aquatic organisms depends on the ability of fish to metabolize metals and the concentration of metals in the water. The impact of heavy metal accumulation on fish includes decreased gonadal fertility, closing of gill membranes resulting in oxygen deprivation, and growth retardation. Additionally, the meat of fish affected by heavy metal accumulation is not safe for consumption. Unsafe food can cause foodborne diseases, which are symptoms of illness such as nausea, vomiting, and diarrhoea due to consuming toxic materials or compounds, and pathogenic organisms (Sucipto, 2016).

Pb levels in waters are influenced by several factors, one of which is the intensity of rainfall. High rainfall can accelerate the purification process. Discharge is a dilution factor, the higher the river flow discharge, the lower the concentration of dissolved heavy metals. A decrease in river water discharge results in an increased concentration of pollutants. (Hanifah et al. 2019). Therefore, the lower the rainfall intensity, the lower the river water discharge, so the levels of heavy metal Pb in the waters are also high.

CONCLUSIONS

Even though the Pb level in Siak River has exceeded the normal standard, leading to high levels of Pb accumulation in the body of *baung*, which can damage the structure of fish liver tissue, macroscopic and microscopic organ observations showed slight and moderate *baung* liver damage.

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AUTHOR CONTRIBUTIONS

O.Y.H. project conception; O.Y.H. methodology; O.Y.H.: data analyses; O.Y.H. original manuscript draft; O.Y.H.,Y.: manuscript review and editing.

CONFLICTS OF INTEREST STATEMENT

"There are no conflicts to declare".

DISCLOSURES AND ETHICS

As a requirement of publication author(s) have provided to the publisher signed confirmation of compliance with legal and ethical obligations including but not limited

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to the following: authorship and contributorship, conflicts of interest, privacy and confidentiality and (where applicable) protection of human and animal research subjects.

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