



The diversity of macroinvertebrates as a bioindicator of water quality in the Amprong River, Kedungkandang District

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Email: rizkydwioktavia7@gmail.com ^{1,a,*}, titikwijayanti083@gmail.com ^{1,b}, asadsyamsularifin5@gmail.com ^{1,c}, nurmalahindun1964@gmail.com ^{1,d}

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Article Information	ABSTRACT
<p>Article History: Submitted: 2025-07-24 Revision: 2025-12-29 Accepted: 2025-12-31 Published: 2025-12-31</p> <p>Keywords: Amprong river; bioindicator; divercity; Kedungkandang District; macroinvertebrates;</p>	<p>The Amprong River in Kedungkandang District, Malang City, is facing ecological pressure due to dense residential settlements and inadequate domestic waste management. This study was conducted to assess the diversity of macroinvertebrates and to investigate their role as indicators of water quality. A quantitative descriptive method was employed, with samples collected from three stations (upstream, midstream, and downstream) on both sides of the river. Temperature and pH were recorded as key environmental parameters, and the structure of the macroinvertebrate community was analyzed using the Shannon–Wiener diversity index (H'), the evenness index (E), and Simpson's dominance index (C). A total of 633 individuals representing 13 species and 8 families were identified. The results revealed moderate diversity in most sampling points, while one site exhibited low diversity and high dominance by <i>Melanoides plicarius</i>, indicating heavy pollution. Variations in species composition and ecological indices between riverbanks were influenced by habitat differences, namely vegetation type, substrate, and waste exposure. Overall, the results suggest that the Amprong River is classified between moderately and heavily polluted, underscoring the importance of enhanced environmental management and adequate waste treatment facilities to support river conservation in urban settings.</p>
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INTRODUCTION

River ecosystems constitute part of the lotic freshwater ecosystem and play a crucial role in supporting various organisms, including macroinvertebrates. Macroinvertebrates serve as bioindicators of aquatic environments due to their limited mobility and sensitivity to environmental changes. Their widespread distribution and long lifespan render them suitable for assessing water pollution levels (Hellen

et al., 2020). The Amprong River, located in Kedungkandang District, Malang City, is significantly impacted by anthropogenic activities, especially those related to the domestic activities of the local community. Many settlements lack sanitary facilities and wastewater treatment plants (WWTPs), compelling residents to dispose of domestic waste improperly (Andini, 2019). Environmental pollution results from various human activities that lead to a decline in environmental quality, thereby threatening the sustainability of ecosystems, biodiversity, water resource availability, and human well-being (Farhan et al., 2023; Nurbaya & Sari, 2023; Riyanto et al., 2025).

Research conducted across various rivers, including the Badung River (Rustiasih et al., 2018), Sumber Maron (Muhaimin, 2019), and the Code River (Hellen et al., 2020), has demonstrated a significant correlation between macroinvertebrate diversity and water pollution levels. Nonetheless, the majority of these investigations were performed outside Malang City or were confined to the Poncokusumo District of the Amprong River (Ubaid, 2019). The current state of research indicates that studies about the Amprong River in Kedungkandang District, Malang City, a densely populated area with a high risk of domestic pollution, remain limited. The novelty of this study resides in the application of macroinvertebrates as bioindicators of pollution through an ecological index approach (including diversity, uniformity, and dominance), specifically focusing on rivers experiencing high anthropogenic pressures within urban environments. Additionally, this research provides visual documentation of macroinvertebrate identification, thereby enhancing public and stakeholder comprehension of aquatic ecosystem conditions in a practical and educational context, which can support river conservation and management initiatives within urban areas. Consequently, this research holds significant importance as a scientific foundation supporting water quality management policies and preserving local aquatic biodiversity in Malang City. Therefore, this study aims to evaluate the diversity of macroinvertebrates and to determine the level of water pollution in the Amprong River, Kedungkandang District, Malang City, using macroinvertebrates as bioindicators. These findings can provide essential guidance for enhancing river basin management in support of long-term ecosystem sustainability.

RESEARCH METHODS

This research employs a quantitative descriptive methodology. The population examined in this study encompassed all macroinvertebrate species within the Amprong River, located in the Kedungkandang District of Malang City see figure 1. Samples comprised all macroinvertebrate species collected from each plot at every sampling point across three designated stations. Sampling was carried out at three strategic locations: upstream, midstream, and downstream of the river. The sampling procedure involved several stages: (1) determining the locations of each station, with a distance of 50 meters between stations; (2) For each observation station, two sampling sites were established, established on the right and left banks of the river, with distinct plots designated for macroinvertebrate sampling; (3) water sampling was performed at each point to assess the pH level; (4) measurements were also taken of the river at each sampling point.

Sampling in this study employed a purposive sampling technique based on the topography, environmental conditions, and land use surrounding the river flow. Samples were collected during the dry season when the river discharge was relatively low (Robbi, 2022). Sampling was carried out in the morning from 08:00 to 11:00 AM (WIB), when the river water level was low, thus facilitating sample collection and minimizing interference from water currents and surface waves (Juwita, 2017).

Macroinvertebrate sampling was carried out with 10 repetitions in different plots at each station and sampling point (Djumanto et al., 2013).



Figure 1. Sampling Location Map

For sample collection, a hand net with a mesh size of 5 mm² was utilized. The collected macroinvertebrates were rinsed under running water while being sieved to remove mud and other fine particles. The specimens were then placed into sample jars and preserved with 70% alcohol to prevent dehydration and fragility, making them easier to identify and label (Sudia et al., 2020; McGraw, 2025). The macroinvertebrate samples were then observed and identified using references from previous studies, including journals, articles, e-books, the Global Biodiversity Information Facility website, and Wikimedia Commons. The identification results were recorded and entered into the macroinvertebrate observation data table. Ecological indices were applied in the analysis of the data, specifically the diversity index (H'), the evenness index (E), and the dominance index (C). Calculations were performed using Microsoft Excel by utilizing mathematical functions such as SUM and LN. The counts of individuals for each species were recorded in a table to assess their proportion compared to the total population. These values were then used to automatically generate the H' , E , and C index values.

Water temperature and pH measurements of the Amprong River were conducted in the morning between 08:00 and 11:00 AM (WIB) at three stations for each sampling point. Temperature was measured in situ by immersing a thermometer in the river water and waiting for approximately 2 minutes or until the reading stabilized. The recorded temperature data were then entered into a temperature measurement table. pH was measured ex situ by collecting river water samples in labeled plastic cups. These samples were taken to the laboratory of Universitas Insan Budi Utomo Malang, where pH measurements were conducted by immersing a pH meter into each water sample for about 2 minutes or until the reading stabilized. The pH measurement results were then recorded and entered into the pH measurement table.

$$H' = - \sum \frac{n_i}{N} \ln \frac{n_i}{N} \quad (1)$$

Description:

H' = diversity index

n_i = the number of individuals of each species

N = the total number of individuals of all species

The analysis of macroinvertebrate data to determine water pollution levels in the Amprong River included the calculation of the diversity index (H'), evenness index (E), and dominance index (C). Diversity Index (H') The species diversity of macroinvertebrates was determined using the Shannon-Wiener index (Hermayani, 2022). The index is applied to assess the degree of macroinvertebrate diversity present in the Amprong River ecosystem.

According to (Rustiasih et al., 2018), the benchmark values for the Shannon-Wiener diversity index (H') are as follows: if $H' < 1.0$, it is classified as low, indicating low biodiversity, very low productivity, signs of severe environmental stress, and an unstable ecosystem. If $1.0 < H' < 3.322$, it is categorized as moderate, meaning moderate diversity, sufficient productivity, a fairly balanced ecosystem condition, and moderate ecological pressure. If $H' > 3.322$, it is considered high, indicating high biodiversity, excellent ecosystem stability, high productivity, and resilience to ecological stress. According to (Prasiwi & Wardhani, 2018) Shannon-Wiener diversity index can be used to determine pollution levels, where $H' < 1$ indicates an unstable biotic community and heavily polluted water. If $1 < H' < 3$, it reflects a moderately stable biotic community and moderately polluted water. An H' value greater than 3 indicates a stable biotic community and clean water quality

Evenness Index (E)

According to (Hermayani, 2022), the calculation of the evenness index was performed using the formula below:

$$E = \frac{H'}{\ln S} \quad (2)$$

Description:

E = species evenness index

H' = Shannon-Wiener diversity index

S = total number of species

According to (Hermayani, 2022), an evenness value (E) between 0.0 and 0.50 indicates a stressed community; a value between 0.51 and 0.75 indicates an unstable condition; and a value between 0.76 and 1.00 reflects a stable community structure

Dominance Index (C)

According to (Hermayani, 2022), to obtain the dominance index, Simpson's Dominance formula was utilized, as indicated below:

$$C = \sum \left(\frac{ni}{N} \right)^2 \quad (3)$$

Descripton:

C = dominance index

ni = number of individuals of each species

N = total number of individuals

According to (Hermayani, 2022), a dominance index (C) value between 0 and 0.50 is classified as non-dominant, indicating that no single species exerts dominance within the community. Conversely, a value

between 0.51 and 0.75 is categorized as dominant, suggesting that one or more species exert ecological dominance within the observed habitat.

FINDING AND DISCUSSION

The presence of macroinvertebrates is influenced by various physicochemical factors in the environment, including light penetration, which impacts the temperature of the water, the hydrogen ion concentration (pH), and the levels of dissolved oxygen. These physicochemical parameters also play a role in determining the abundance and diversity of macroinvertebrates in aquatic ecosystems (Kusumawardani et al., 2023). The results of temperature and pH measurements in the Amprong River, Kedungkandang District, Malang City, are presented in Table 1.

Table 1. Results of Water Temperature and pH Measurements at Observation Sites

Parameter	Station I		Station II		Station III	
	Right bank	Left bank	Right bank	Left bank	Right bank	Left bank
Temperature (°C)	24.1	24.4	24.1	24.2	23.9	24
pH	7.05	7.07	7.09	6.90	7.08	7.06

Based on the table above, it can be observed that the water temperature at each sampling point remains within a safe range for the survival of macroinvertebrates. This agrees with the findings of Ruswahyuni (2010), who identified 25°C to 30°C as the optimal temperature range for macroinvertebrates.. (Hermayani, 2022) also reported that macroinvertebrates generally prefer a temperature range of 24°C to 26°C. An increase in water temperature can accelerate the metabolic and respiratory rates of aquatic organisms, leading to a higher demand for oxygen (Novita et al., 2023). Elevated temperatures exceeding the normal threshold for macrozoobenthic life may result in a decline in species diversity within the ecosystem of aquatic (Bai'un et al., 2021). The recorded temperature range of 23.9°C to 24.4°C falls within the optimal range for macroinvertebrates, such as *Parathelphusa convexa*. This freshwater crab species can survive in temperatures ranging from 12°C to 35°C, with optimal growth occurring between 23°C and 32°C (Siahaan et al., 2018). Moreover, the ideal temperature range for crustaceans lies between 18°C and 29°C (Rahayu et al., 2017).

Regarding pH, the values recorded in the table ranging from 6.90 to 7.09 are also within a safe range for macroinvertebrate life. Natural freshwater systems typically exhibit pH values ranging from 4 to 9 (Krisnanda, 2023). A normal pH range that supports aquatic biota is generally between 6.5 and 7.5 (Sakinah, 2023). Marine organisms exhibit susceptibility to pH fluctuations and are commonly adapted to a range of 7.0 to 8.5 (Septiarila, 2021). This is supported by the presence of *Parathelphusa convexa* in the study area. The freshwater crab is known to tolerate a pH range of 6.7 to 7.5 (Susilo et al., 2020), and the genus *Parathelphusa* has an optimum pH range of 4.54 to 7.6 (Idola et al., 2018). In addition, *Macrobrachium lanchesteri* was also found during the sampling. This is in line with the statement by (Nurasiah et al., 2017), it was reported that freshwater prawns thrive within a pH range of 6.5 to 8.5, while values below 7 may result in a reduction of macrozoobenthic diversity. (Kusumawardani et al., 2023). Acidic or alkaline conditions in aquatic environments may threaten the survival of aquatic organisms, as they can interfere with metabolic and respiratory processes (Novita et al., 2023).

A total of 633 macroinvertebrate individuals were collected from the three stations across all sampling points, representing 8 families, 10 genera, and 13 species. The macroinvertebrate data for the three stations are presented in Table 2.

Table 2. Macroinvertebrate Findings in the Amprong River, Kedungkandang District, Malang City

Order	Family	Genus	Species	Station	Station	Station
				I	II	III
Caenogastropoda	Pachychilidae	<i>Sulcospira</i>	<i>Sulcospira testudinaria</i>	39	10	11
Caenogastropoda	Pleuroceridae	<i>Elimia</i>	<i>Elimia acuta</i>	5	0	8
Caenogastropoda	Thiaridae	<i>Tarebia</i>	<i>Tarebia granifera</i>	73	4	171
Caenogastropoda	Thiaridae	<i>Melanoides</i>	<i>Melanoides plicarius</i>	46	30	92
Caenogastropoda	Thiaridae	<i>Melanoides</i>	<i>Melanoides punctata</i>	0	0	43
Caenogastropoda	Thiaridae	<i>Melanoides</i>	<i>Melanoides admirabilis</i>	1	0	17
Caenogastropoda	Thiaridae	<i>Thiara</i>	<i>Thiara scabra</i>	4	3	13
Caenogastropoda	Thiaridae	<i>Thiara</i>	<i>Thiara rudis</i>	1	0	1
Neogastropoda	Nassariidae	<i>Anentome</i>	<i>Anentome helena</i>	3	2	4
Decapoda	Palaemonidae	<i>Macrobrachium</i>	<i>Macrobrachium lanchesteri</i>	25	6	6
Decapoda	Gecarcinucidae	<i>Parathelphusa</i>	<i>Parathelphusa convexa</i>	8	1	2
Hemiptera	Nepidae	<i>Ranatra sp</i>	<i>Ranatra sp</i>	0	0	1
Odonata	Lestidae	<i>Lestes sp</i>	<i>Lestes spp</i>	2	1	0

The abundance of macroinvertebrates at the three stations in the Amprong River, Kedungkandang District, Malang City, can be observed and presented in the following bar chart in [figure 2](#):

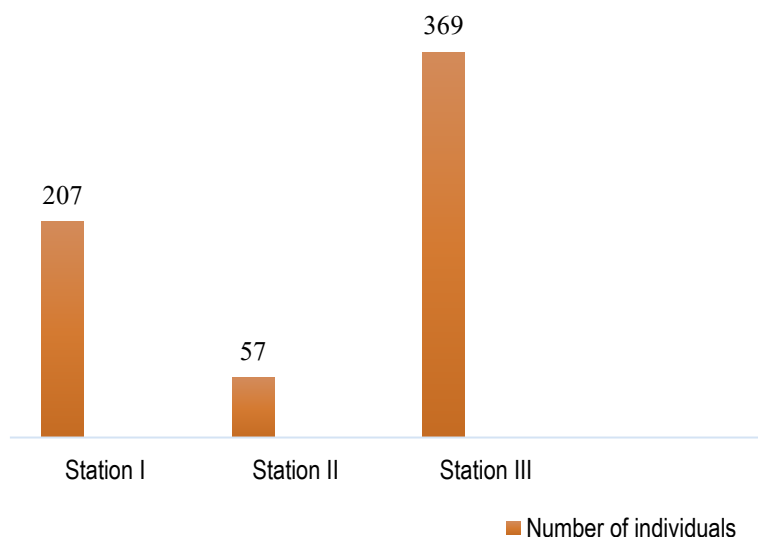


Figure 2. Diagram of Macroinvertebrates Diagram

The species composition of each macroinvertebrate class at the three sampling stations in the Amprong River, Kedungkandang District, Malang City, is as follows: at Station I, the class *Gastropoda* consisted of 172 individuals, class *Malacostraca* had 33 individuals, and class *Insecta* had 2 individuals. At Station II, the class *Gastropoda* comprised 49 individuals, the class *Malacostraca* had 7 individuals, and the class *Insecta* had 1 individual. At Station III, the class *Gastropoda* included 356 individuals, the class *Malacostraca* had 8 individuals, and the class *Insecta* had 1 individual.

The species composition of each class across the three stations is presented in the line chart below in [figure 3](#):

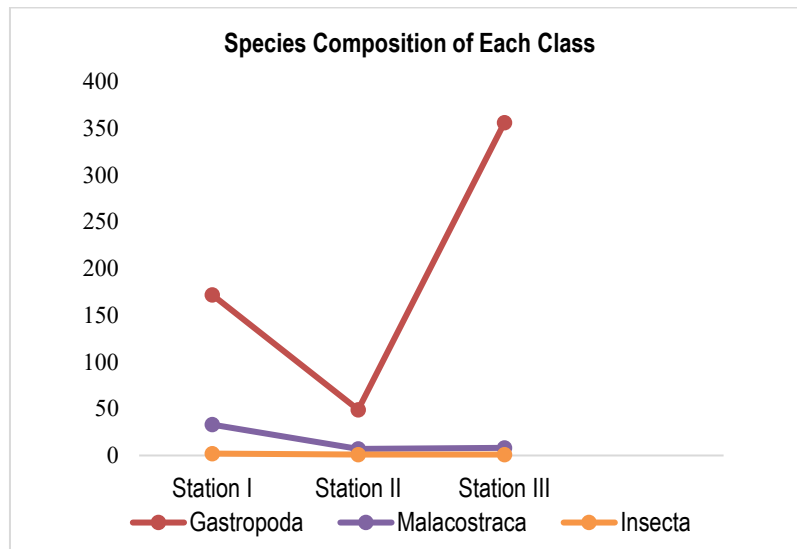


Figure 3. Diagram of Species Composition for Each Class

The percentage of species found at the three observation stations along the Amprong River in Kedungkandang District, Malang City, can be seen and presented in the following chart in [figure 4](#):

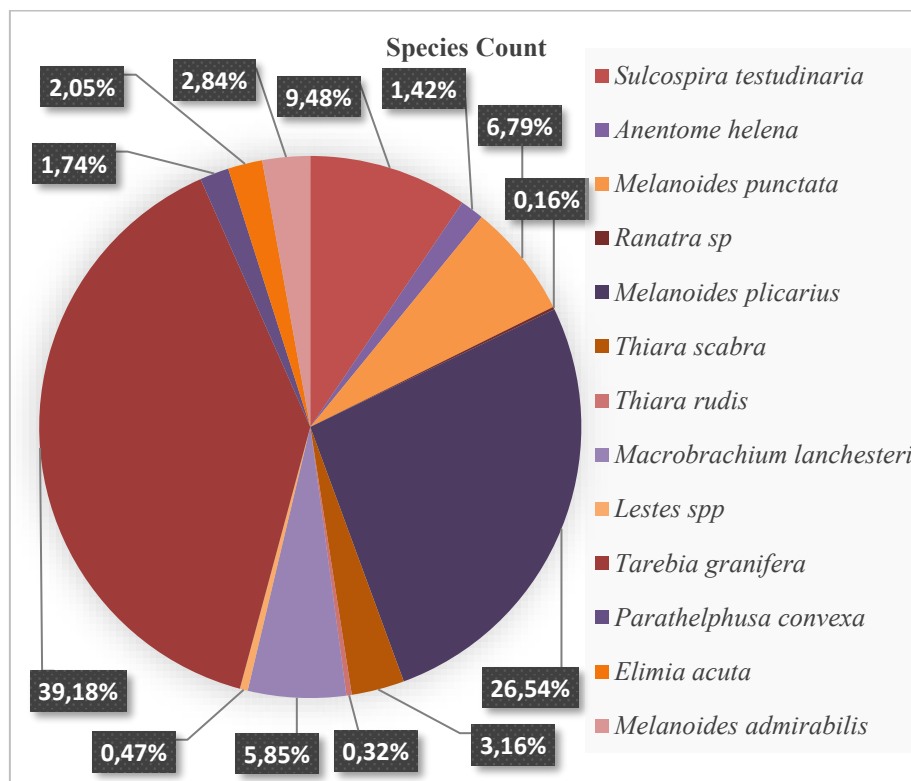


Figure 4. Presentage of Species Composition

Based on the identification results of macroinvertebrate samples from the Amprong River in the Kedungkandang District, Malang City, several species from various phyla and orders were found. These species were collected from three observation stations consisting of sampling points on both the right and left banks in the upstream, midstream, and downstream sections of the river. The species identified in the Amprong River, Kedungkandang District, are presented in [Figure 5](#).

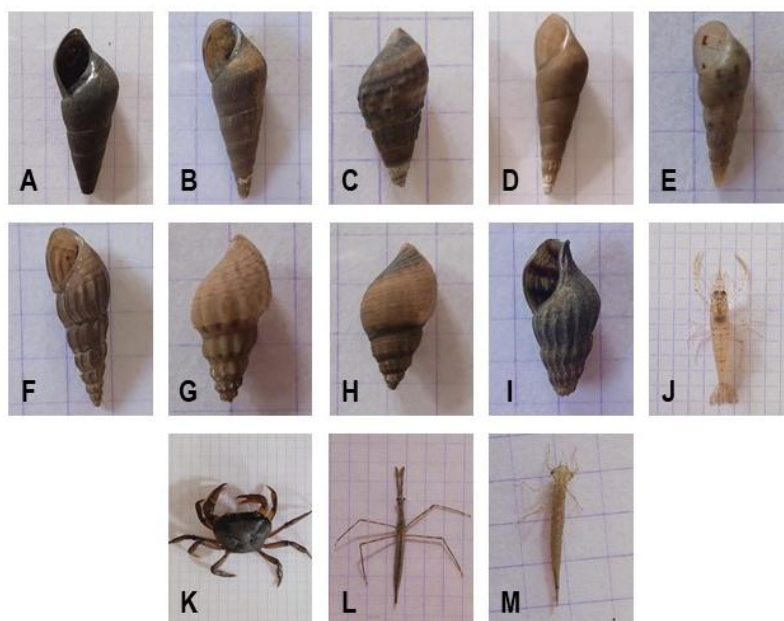


Figure 5. Macroinvertebrate Species Found in the Amprong River, Kedungkandang District, Malang City. (A) *Sulcospira testudinaria*; (B) *Elimia acuta*; (C) *Tarebia granifera*; (D) *Melanoides plicarius*; (E) *Melanoides punctata*; (F) *Melanoides admirabilis*; (G) *Thiara scabra*; (H) *Thiara rudis*; (I) *Anentome helena*; (J) *Macrobrachium lanchesteri*; (K) *Parathelphusa convexa*; (L) *Ranatra sp* dan (M) *Lestes sp.*

Habitat variation, such as differences in riparian vegetation, muddy substrates, and slow water flow, enables species from various phyla, such as *Mollusca* and *Arthropoda*, to coexist. The locations of Station I Right Bank, Station II Right Bank, and Station III Right Bank are situated near residential areas and public parks, characterized by muddy substrates, calm currents, and riparian vegetation such as shrubs and water spinach (*Ipomoea aquatica*). These conditions are highly supportive for infaunal macroinvertebrates like *Macrobrachium lanchesteri*. This species is commonly found in shallow waters ranging from 0.3 to 2.5 meters (Said et al., 2012). This is further supported by (Johnson, 1961; Maulina et al., 2020), who stated that *Macrobrachium lanchesteri* is more tolerant and better adapted to stagnant or open waters with muddy substrates. The presence of shrubs, grasses, and water spinach provides optimal conditions for their survival (Nurasiah et al., 2017). According to (Tjahjo & Purnamaningtyas, 2014), freshwater shrimp mainly feed on plants and algae, with insects and mollusks functioning as additional dietary components. At Station II Right Bank, a significant amount of organic waste was also found, which is highly preferred by shrimp since most freshwater shrimp are scavengers or detritus feeders and are not active predators. Therefore, their ecological role is essential in recycling organic matter in aquatic ecosystems (Wowor et al., 2018). Meanwhile, Station I Left Bank, Station II Left Bank, and Station III Left Bank are located near agricultural areas, with riparian vegetation dominated by grasses, and are exposed to both organic and inorganic waste from agricultural activities. The presence of waste contributes to microhabitat variation, which influences the distribution and dominance of macroinvertebrate species between the two riverbanks. This is in line with the findings of Mushthofa et al. (2014), who stated that there is a positive correlation between organic matter content and macroinvertebrate abundance higher organic content leads to higher abundance of macroinvertebrates. Consequently, *Parathelphusa convexa* was found in these locations due to its role as a detritivore or

decomposer organism (Eprilurahman et al., 2015). This species is well adapted to muddy substrates and slow-flowing waters, as freshwater crabs typically lack swimming appendages (Susilo et al., 2020). Based on the study results, the ecological indices calculated were the Shannon-Wiener Diversity Index (H'), the Evenness Index (E), and the Simpson Dominance Index (D). The outcomes of macroinvertebrate analysis from the three observation stations, assessed using these indices, are summarized in Table 3.

Table 3. Analysis Results of Macroinvertebrates Based on Ecological Indices

Station	Diversity Index		Evenness Index		Dominance Index	
	Right bank	Left bank	Right bank	Left bank	Right bank	Left bank
I	1,32	1,61	0,63	0,56	0,35	0,49
II	1,56	0,75	0,80	0,54	0,27	0,63
III	1,58	1,22	0,68	0,58	0,29	0,36

Based on the Diversity Index (Shannon-Wiener Index) analysis, Station I Right Bank, Station I Left Bank, Station II Right Bank, Station III Right Bank, and Station III Left Bank are categorized as having moderate diversity levels (1.22–1.61), which indicates moderate biodiversity, moderate productivity, a relatively balanced ecosystem condition, and moderate ecological pressure. Consequently, the water quality at these locations is classified as moderately polluted. However, Station II Left Bank shows a low diversity level (0.75), which indicates very low productivity, heavy environmental stress, and an unstable ecosystem, categorizing the water quality at this location as heavily polluted. Based on the Evenness Index analysis, Station I Right Bank, Station I Left Bank, Station II Left Bank, Station III Right Bank, and Station III Left Bank are classified as unstable (0.54–0.68). However, Station II Right Bank is considered stable with an evenness value of 0.80. According to the Dominance Index (Simpson's Index) analysis, Station I Right Bank, Station I Left Bank, Station II Right Bank, Station III Right Bank, and Station III Left Bank showed no dominant macroinvertebrate species (0.27–0.49). However, at Station II Left Bank, a dominant species was found (0.63), identified as *Melanoides plicarius*. *Melanoides plicarius* is frequently encountered in habitats characterized by limited environmental stability (Hartoto & Marwoto, 1986). Members of the genus *Melanoides* are known for their high tolerance to pollution and are commonly found in both low and highly polluted environments. This adaptability is attributed to their resilience across a broad spectrum of environmental conditions (Sofiana et al., 2023).

The presence of species dominance indicates that not all macroinvertebrates possess the same level of adaptability and survival ability in a given environment (Kusumawardani et al., 2023). The predominance of *Melanoides plicarius* observed at Station II, Left Bank, is attributed to the abundance of organic matter in the habitat. Elevated levels of organic matter can shape the abundance of certain taxa, especially facultative species with high tolerance to organic enrichment, thereby promoting dominance within the community (Mushthofa et al., 2014). Aquatic ecosystems that receive nutrient inputs from activities such as domestic wastewater discharge and agricultural runoff are often characterized by increased organic matter, which significantly affects the presence of organisms, especially macroinvertebrates (Kusumawardani et al., 2023). As the level of organic matter increases, the abundance of macroinvertebrates also tends to increase (Kusumawardani et al., 2023). Benthic organisms are closely associated with the organic matter contained in the substrate, as it serves as a nutrient source for most bottom-dwelling organisms. However, when the concentration of organic matter exceeds natural thresholds, it is considered a pollutant (Mushthofa et al., 2014).

CONCLUSION

The water temperature and pH of the Amprong River fall within the normal range, providing suitable conditions for the survival of macroinvertebrates. A total of 13 macroinvertebrate specimens were identified, representing 8 families: *Pachychilidae*, *Pleuroceridae*, *Thiaridae*, *Nassariidae*, *Palaemonidae*, *Gecarcinucidae*, *Nepidae*, and *Lestidae*. The analysis indicates that the Amprong River is in a polluted state, ranging from moderate to severe pollution levels. Therefore, environmental management efforts and the provision of domestic waste treatment facilities are necessary in the surrounding river area.

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