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Macrozoobenthos Diversity as an Indicator of the Water Quality of the Salusu River in Ogomatanang Village, Central Sulawesi and Its Use as a Learning Media

Syech Zainal[1*], Raya Agni[1], Dayu Mahardika[1], Supriyadi[2], Andriyanto[3], Isnawati[4]

[1]Departement of Biologi Education, Universitas Tadulako, Palu, Indonesia.
[2]Departement of Physics Education, Faculty of Teacher Training and Education, Universitas Musamus, Merauke, Indonesia.
[3]Department of Biomedical Science and Environmental Biology, Kaohsiung Medical University, Kaohsiung City, Taiwan.
[4]Departemen of Science Education, Universitas Pendidikan Indonesia, Bandung, Indonesia.

*Email: syechzainal97mpd@gmail.com

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Abstract. The diversity of macrozoobenthos plays an important role as an indicator of water quality. The purpose of this study was to describe the level of macrozoobenthos diversity in the waters of the Salusu River, Ogomatanang Village, Central Sulawesi as an indicator of pollution levels and to produce suitable learning media. The type of research is descriptive. The sampling technique used systematic random and used a subber net using a zig-zag transect line and analyzed the diversity index value. The results of the study found 9 species, divided into 8 families including *Baetis* sp., *Alloperla* sp., *Parathelphusa convexa*, *Heptagenia solitaria*, *Orthetrum sabina*, *Nemoura* sp., *Tylomelania arabica*, *Tylomelania* sp., *Planaria* sp. The diversity index (H') was consecutively at station III (upstream) which was 2.14 with a light level of pollution, the H 'index at station II (ecotone) was 1.91 and the H 'index at station I (downstream) was 1.28 with a moderate level of pollution. The research results obtained were used as validated learning media by a team of content experts by 80%, design 78.6%, media 80%, large group student group trials 85.5% and small group 89.0%. Learning media is very feasible to use with a result of 82.62%.

Keywords: Diversity, Macrozoobenthos, Water Quality, Learning Media.

Introduction

Indonesia has a larger water area than land area. In terms of aquatic ecosystems, it can be divided into freshwater ecosystems, marine ecosystems, and brackish water ecosystems such as those found in large river estuaries. Marine ecosystems and brackish water ecosystems are the largest part, which is more than 97%. The rest is fresh water with limited quantities and conditions, but which is needed by humans and many other living organisms for life needs (Barus, 2004). Central Sulawesi Province is one of the provinces in Indonesia which has around 26 rivers and 5 lakes and has a variety of flora and fauna, some of which are specific, some are even endemic which are not found in other areas (General Fisheries Research Institute, 2018).

Tolitoli Regency is one of the regencies in Central Sulawesi Province. On the map of Sulawesi Island, Tolitoli Regency appears to extend from east to west with an area of 4,079.77 km² and is located north of the equator in coordinates 0.35º - 1.20º north latitude and 120º - 122.09º east longitude. Tolitoli has 10 sub-districts and 103 villages (Central Statistics Agency, 2017).

Tolitoli has several rivers. One of them is a river located in Salusu Pande Hamlet, Ogomatanang Village, Lampasio District. The river in Salusu Pande Hamlet is 4 km long from upstream to downstream and is used by the local community to meet their daily needs such as a source of drinking water, for irrigation of plantations and rice fields, the Batu Melam waterfall tourist attraction and as a means of transporting wood and rattan by the company and others.

A river is a water flow whose main source comes from the highlands to a lower place and then flows into a lake or sea. Rivers are ecosystems that play an important role in the lives of living things. In general, rivers have a dual function in life, such as providing clean water, generating electricity, means of transportation, sports facilities and as a means of recreation/tourism. In addition, rivers are also a habitat for aquatic biota such as fish, shrimp, crabs and benthos (Paimin et al., 2006 ; Zainal et al., 2017). Macrozoobenthos are organisms that inhabit the bottom of waters and live in or on sediments at the bottom of waters (Selvianita et al., 2024). Macrozoobenthos are animals that spend most or all of their lives on the bottom of waters, either settling, crawling or digging holes. These animals are more commonly found in stagnant waters (lentic) than in flowing waters (lotic) (Wahikun, 2016).

Macrozoobenthos has a very important role in the nutrient cycle in bottom waters (Lestari & Rahmanto, 2020; Pelealu et al., 2018). Furthermore, macrobenthos are crucial components of the food web, serving as predators, suspension feeders, detritivores, and parasites (Jhonatan et al., 2016). Benthic animals live relatively sedentary lives so they are good to use as indicators of environmental quality because they are always in contact with waste that enters their habitat (Wahyuni et al., 2022). This group of animals can better reflect changes in environmental factors over time. Because benthic animals are continuously exposed to water whose quality changes (Wahikun, 2016)

Initial observations showed that at the research location in the Salusu River, Ogomatanang Village, Central Sulawesi there were many types of macrozoobenthos. However, human activities such as logging around the river carried out by companies, waste from people who go on excursions/picnics at Batu Melam Waterfall and agricultural waste, household waste and livestock waste dumped into the river can threaten the diversity of macrozoobenthos (Jhonatan et al., 2016; Pelealu et al., 2018). On the other hand, information on the types and diversity of macrobenthos that can be used as indicators of water quality in this area is still very minimal or even non-existent (Lestari & Rahmanto, 2020). Information on the diversity of macrobenthos is very important to be used as a reference in maintaining the balance of the aquatic ecosystem in the Salusu River and providing information to the public about the condition of the water quality of the Salusu River considering that the role of the river for residents is very important for daily survival. Therefore, it is necessary to conduct research on the types and diversity of macrobenthos in the river and then use it as an indicator of the water quality of the Salusu River in Ogomatanang Village and the results of the study can be used as learning media in the form of posters.

The purpose of writing this paper is to provide input and information to the Ogomatanang Village government about the condition of the Salusu River waters so that it becomes an initial step in efforts to overcome the damage that has occurred. For the research team, it is to be information and additional knowledge as well as dissemination of knowledge and scientific consumption for the wider community in relevant fields. Based on the description above, it is necessary to conduct research on macrozoobenthos diversity as an indicator of the water quality of the Salusu river in Ogomatanang Village, Central Sulawesi and its Use as a learning media.

Method

The research used is descriptive. The researcher intends to describe or describe a symptom, event, or event that is happening now without any special treatment for the event. This research was conducted on the Salusu River which is located in Ogomatanang Village, Central Sulawesi. The population of this study is all types of macrozoobenthos in the Salusu River in Ogomatanang Village, while the samples are the types of macrozoobenthos that were sampled during the research.

The sampling technique uses a systematic random sampling method using 3 stations, namely the downstream, ecotone and upstream areas and measuring environmental parameters, namely temperature, dissolved oxygen in water, pH, depth and light intensity. Macrozoobenthos sampling at all stations using *subber net*. At each station, 3 transect lines are made with a length of 50 m. On each transect line, 5 net sources will be placed in a zig-zag manner with a distance of 10 m between the net sources. Macrozoobenthos samples were taken using a 30×30 cm source net with a net hole diameter of 5×5 mm. Next, the macrozoobenthos samples obtained were identified at the Biology Education Laboratory and grouped based on taxon level, class and order using identification books used by, among others, (Borror et al., 1992; Dharma, 1988; Gerber, 2002; Ozcoz, 2011).

To determine the diversity of Macrozoobenthos in the Salusu River Waters in Ogomatanang Village, the Shannon-Wienner species diversity index formula was used (Bengen, 2000; Fadilla et al., 2022):

$$H\hat{}' : -\sum[n_i/N] \ln [n_i/N] \quad (1)$$

Where:

H^' : Shannon - Wienner diversity index
ni : Number of individuals of each species
N : Total number of individuals

The Shannon - Wienner diversity index value category has a certain range of values, namely:

$H' < 1$: Low diversity
$1 < H' < 3$: Medium diversity
$H' > 3$: High diversity

According to Wilhm and Dorin (1968) and Sugondo (1993), there is a relationship between the diversity index and water pollution status. Siahaan (2012) stated that river water quality is determined based on macrobenthic diversity. Wilhm and Dorin (1968) and Sugondo (1993) divided the level of pollution based on the H' index value into four levels, namely:

H' = 3.0 - 4.5: very lightly polluted
H' = 2.0 - 3.0: lightly polluted
H' = 1.0 - 2.0: moderately polluted
H' = 0.0 - 1.0: heavily polluted

The next, the research data on diversity is then made into learning media by following the steps, namely designing, validating, revising, testing (large and small groups). Percentage of media suitability using a percentage formula formulation (Arikunto, 2013; Listiyani & Widayati, 2012).

$$P = \frac{\Sigma x}{\Sigma xi} \times 100\% \qquad (2)$$

Symbol meaning:
Q: Percentage
Σx: Number of assessment answers
Σxi: Highest number of answers

The percentage value obtained is then interpreted in a sentence with criteria. Look at Table 1.

Table 1. Media Eligibility Percentage Criteria

Media Eligibility (%)	Criteria
81-100	Very Worth
61-80	Worthy
41-60	Decent Enough
21-40	Not worth
0-20	Not feasible

Results and Discussion

Ogomatanang Village is located between 0º52'26.66' North Latitude and 120º23'48.66' East Longitude. Administratively, the Ogomatanang Village area is flanked by four villages. To the north it borders Lampasio Village, to the east it borders Janja Village, to the South it borders Kinapasan Village, to the West it borders Silondou Village. In the middle of Ogomatanang Village, the northern and western parts are crossed by a large river with a river length of ±4 km. This river with clear water is used by the local community as a source of drinking water, washing clothes, and for irrigation of residents' plantations and rice fields. The eastern and southern parts of Ogomatanang village are hilly areas (Figure 1).

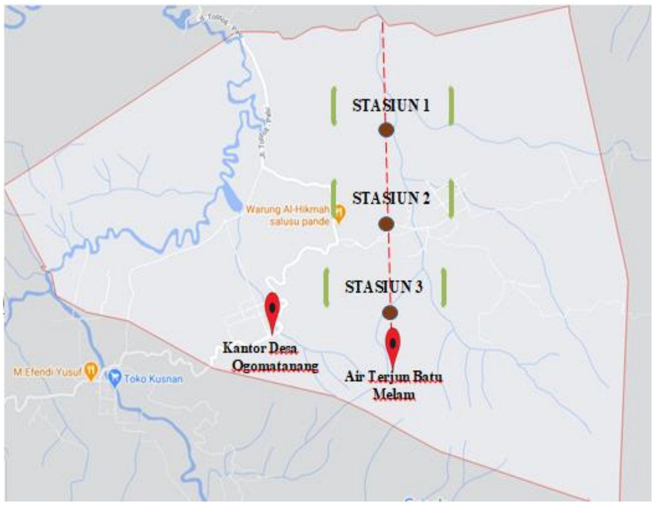

Figure 1. Location of Ogomatanang Village

Macrozoobenthos sampling in this study was carried out at three stations created in the upstream, ecotone and downstream parts of the river. Station I (downstream) has a width of 4.90 m, with clear water conditions and slow flow with a muddy sand substrate. At the observation location, sunlight can penetrate down to the river with a light intensity of 2.400 lux. Station II (ecotone) has a width of 5.60 m, with clear water conditions and fast currents with a rocky sand substrate. At the station II observation location, sunlight only illuminates part or a few places because there is a canopy of plant vegetation around the river body and has a light intensity of 1.500 lux. Meanwhile, station III (upstream) has a width of 2 m, with clear water conditions and fast currents with gravel and rocky substrates. At station III, sunlight does not illuminate the entire river body because of the plant canopy and has a light intensity of 1.400 lux.

Measurement of environmental physical-chemical conditions.

Measurements of the physical conditions of the environment include temperature, dissolved oxygen, pH and depth at each observation station. Based on Table 1, there are four types of physical-chemical parameters measured, namely temperature, dissolved oxygen, pH and water depth. The data is presented in Table 2.

Table 2. Measurement of Environmental Physical-Chemical Conditions

Num	Stastion	Parameter Temperature (^oC)	Dissolved oxygen (mg/L)	pH	Depth (cm)
1	I	25.5	0.57	6	50
2	II	25.0	0.54	7	36
3	III	23.8	0.53	7	24

The environment is the main factor that forms an ecosystem in an area. Conditions in an area are greatly influenced by two factors, namely biotic and abiotic factors which are related to each other. In an ecosystem, interdependence does not only occur between biotic components. Interdependence also occurs between biotic and abiotic components. Nontji (2002) stated that the physical properties that directly influence macrozoobenthos are depth, water temperature and bottom substrate. Meanwhile, the chemical properties that have a direct influence are the degree of acidity and dissolved oxygen content. These physical and chemical properties do not stand alone but are interrelated with each other, forming a complex unity of influence that occurs simultaneously. This research is closely related to the correlation between biotic and abiotic components at the research location. In this research, macrozoobenthos is a biotic component which is a biological parameter for water quality in the Salusu River in Ogomatanang Village, while physical-chemical parameters such as temperature, dissolved oxygen, pH and water depth are abiotic components which influence the survival of macrozoobenthos in the research location. Based on Table 1, there are four types of physical-chemical parameters measured, namely temperature, dissolved oxygen, pH and water depth.

The results of water depth measurements at each station in this study were different. The water depth at station I (downstream) is 50 cm, the water depth at station II (ecotone) is 36 cm and the water depth at station III (upstream) is 24 cm. In this research, the research areas of station I, station II and station III include waters with shallow water depths. Shallow rivers are rivers that can be crossed on foot and can even be crossed by vehicle (Wikipedia, 2024). The research results obtained Table 2) show that station III, which has a depth of 24 cm, has a greater number and types of macrozoobenthos compared to station II and station I. The types of macrozoobenthos found at station III were 9 species with a total of 52 individuals. This was followed by station II with a depth of 36 cm and 9 macrozoobenthos species were found with a total of 50 individuals. As for station I with a depth of 50 cm, a smaller number of species were found, namely 4 macrozoobenthic species with a total of 32 individuals. Odum (1998) and Irmawan, et al., (2010) stated that water depth influences the number of macrozoobenthos types. The depth of a body of water is related to the abundance of macrozoobenthos, where an increase in water depth is followed by a decrease in the abundance of macrozoobenthos, conversely the abundance of macrozoobenthos is higher in shallow waters (Sulistiyarto, 2008). Thus, the research results obtained are in accordance with the theory which states that the deeper the bottom of a body of water, the fewer the number of macrozoobenthos types, and vice versa.

Temperature is a physical parameter that has a major influence on the metabolism of aquatic organisms. In this research, the temperature measured is the water surface temperature. In this research, different temperature measurement results were obtained at each station. The temperature at station I is 25.5 °C, the temperature at station II is 25 °C and the temperature at station III is 23.8 °C. Stations I and II are located in community plantation areas, while station III is located in protected forest areas. The lowest water surface temperature is at station III. The location of station III which is in a protected forest with little agricultural activity by the people around the area is one of the factors causing the temperature of station III to be ± 2°C lower compared to stations I and II. Station III is in a protected forest area, so the intensity of sunlight reaching the water surface is less because of the plant canopy in the river body. Even though the three research stations have slightly different temperatures, this temperature is still within the normal temperature category for aquatic biota, especially in this case the macrozoobenthos at the research location. Agustinaningsih (2012) stated that the optimum temperature for macrozoobenthic life is around 20 – 30˚C. Based on Table 2, it can be seen that the species found at each station are dominated by insect larvae with a total of 5 species. Damos and Savopoulou-Soultani (2012), states that in general the effective temperature range for insects is 15°C minimum temperature, 25°C optimum temperature, and 45°C maximum temperature. So the temperature at the three stations is very optimal for macrozoobenthic life, especially insect species.

Another environmental parameter that was also measured in this study was dissolved oxygen (DO) levels. In this study, measuring oxygen levels obtained different results at each station. Station I has a dissolved oxygen level of 0.57 mg/L, station II has a dissolved oxygen level of 0.54 mg/L and station III's dissolved oxygen level is 0.53 mg/L. The measurement results obtained show that temperature and dissolved oxygen at all research stations have a unidirectional relationship. Based on Table 1., it can be seen that station I, which has the highest temperature, also has high oxygen levels compared to station II. Station III, which has the lowest temperature, also has the lowest oxygen levels compared to stations I and II. Agustinaningsih (2012) stated that temperature and dissolved oxygen on surface waters have a unidirectional relationship where when the temperature rises, dissolved oxygen levels increase. On the other hand, in deep water, temperature and dissolved oxygen are in opposite directions. In this study, the overall data shows that all research stations have very low dissolved oxygen levels which do not comply with the quality standards of PP No. 82 of 2001 , namely a minimum DO level of 3 mg/l. Community activities in the agricultural sector around the riverbank can be one of the factors causing low levels of dissolved oxygen in this river. This situation causes several types of Macrozoobenthos which are intolerant of unfavorable environmental conditions, such as *Baetis* sp., *Nemoura* sp., *Heptagenia solitaria*, *Alloperla* sp., which are only found at stations II and III, even in small numbers. Setyaningthias (2007) states that This group of insect larvae can live well in an environment with DO levels of 4-14 ppm. Nybakken (1988) stated that dissolved oxygen is a chemical variable that has an important role as well as being a limiting factor for the life of aquatic biota. Each species of aquatic biota has a different tolerance range for dissolved oxygen concentrations in a body of water. Species that have a wide tolerance range for oxygen are widely distributed and species that have a narrow tolerance range are only found in certain places.

The pH value of waters is one of the important parameters in monitoring water quality. Aquatic organisms have different abilities in tolerating the pH of waters (Santika, 2001). Aquatic animals such as macrozoobenthos are very sensitive to decreases or increases in acidity or pH. Changes in pH values can disrupt the metabolic processes of aquatic biota (Azimah et al., 2021; Gazali et al., 2011). Based on the results of pH measurements at each station, different data was obtained, where the lowest pH value was pH 6 at station I, while stations II and III had the same pH value, namely 7. In this study, the species Planaria sp was found, although it was only found at station III with total of 3 individuals. Planaria sp is a species that is susceptible to chemical changes in water, one of which is pH, so that to occupy a certain place, the environmental conditions must be suitable for its survival, namely waters that have clean water quality. This condition shows that the pH of the water in the Salusu river in Ogomatanang Village is still in the normal category and in accordance with the water quality standards in PP No. 82 No.1, where the pH limit is 6 to 9.

The physical and chemical parameter data obtained as a whole shows that the results of measuring physical indicators, in this case water temperature, are still in the normal category so that they can support the survival of macrozoobenthos in the Salusu River in Ogomatanang Village. On the other hand, the results of measuring chemical parameters provide different results for each type of parameter. The results of pH measurements show that the condition of the Salusu River is still in accordance with water quality standards decree No. 82 of 2001 and the condition of the water according to pH is not polluted, while the results of measuring dissolved oxygen levels show that the condition of the river does not meet the water quality standards.

Variety of Macrozoobenthos

There are 9 species of macrozoobenthos found and identified in the waters of the Salusu River in Ogomatanang Village which are divided into 8 families including the families Baetidae (Baetis sp.), Chloroperlidae (Alloperla sp.), Gecarcinucidae (*Parathelphusa convexa),* Heptageniidae (*Heptagenia solitaria*), Libellulidae (*Orthetrum sabina*), Nemouridae (*Nemoura* sp.), Pachychilidae (*Tylomelania* arabica., and *Tylomelania* sp.), and Planaridae (*Planaria* sp.). The number of each species found at each station varies. The variety of Macrozoobenthos can be seen in Table 3 and Figure 2.

Table 3. Variety of Macrozoobenthos

Num	Familia	Spesies	Sum			Total
			St1	St2	St3	
1.	Baetidae	*Baetis sp.*	-	5	4	9
2.	Chloroperlidae	*Alloperla sp.*	-	-	5	5
3.	Gecarcinucidae	*Parathelphusa convexa*	7	9	8	24
4.	Heptageniidae	*Heptagenia solitaria*	-	7	6	13
5.	Libellulidae	*Orthetrum sabina*	3	5	3	11
6.	Nemouridae	*Nemoura sp.*	-	6	6	12
7.	Pachychilidae	*Tylomelania* arabica	9	10	7	26
8.	Pachychilidae	*Tylomelania* sp.	13	8	10	31
9.	Planaridae	*Planaria sp.*	-	-	3	3

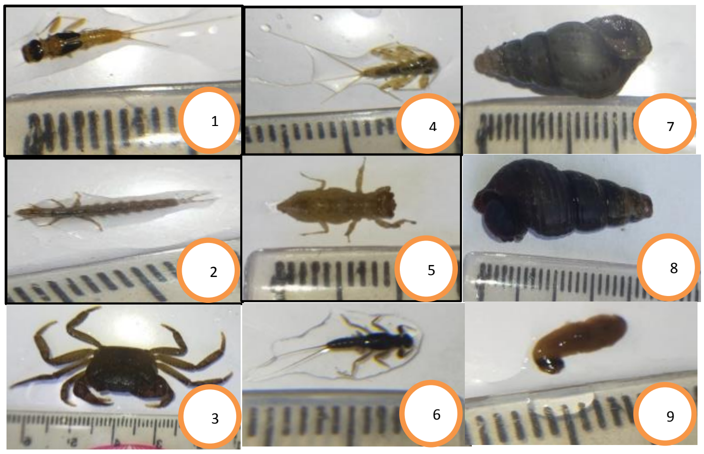

Figure 2. Variety of Macrozoobenthos

A comparison of the calculated values of the Shannon-Wienner Diversity Index (H') at station I, station II and station III can be seen in Table 3.

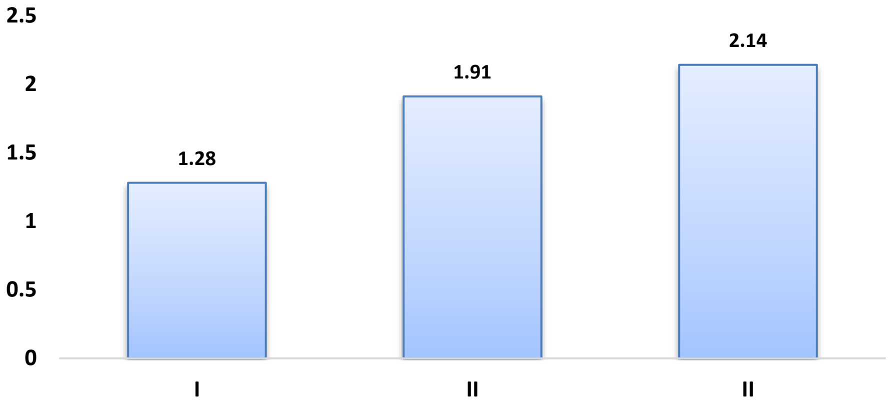

Figure 3. Macrozoobenthos diversity diagram

The diversity and richness of macrozoobenthos at each station is closely related to environmental factors in each environment. The existence of macrozoobenthos found at each research station comes from adaptation to environmental conditions (Noortiningsih et al., 2008). Based on the results of research on macrozoobenthos diversity in the Salusu River, Ogomatanang Village, 9 species of macrozoobenthos were obtained which were divided into 8 families. Data on the types and numbers of macrozoobenthos found can be seen in Table 2. In this study, the number and type of species greatly influenced the diversity index value.

The diversity index value is based on the results of the analysis which can be seen in Table 4. and the diagram of the diversity index value shows that the macrozoobenthos at the research station decreased from station III to station I. The H' index of the macrozoobenthos respectively at station III (upstream) is 2.14, index H' at station II (ecotone) is 1.91. Ramadani et al., (2021) stated that the higher the river diversity index value, the lower the level of pollution. stated that the classification of the degree of water pollution based on the diversity index can be classified into four levels, namely H' = 3.0 – 4.5, including the very lightly polluted category, H' = 2.0 – 3.0 is in the lightly polluted category, H' = 1.0 – 2.0 is moderately polluted and H' = 0.0 – 1.0 is in the heavily polluted category. The criteria above show that the condition of the river at the upstream part, namely at station III, is lightly polluted, while the condition of the river at station II which is the middle part of the river and Station I which is the downstream part of the river is included in the moderately polluted category.

Station III has the highest diversity index value, namely H'= 2.14 because it is located upstream of a river and is in a protected forest area. Its location in a protected forest area means that the upstream part of this river experiences little pollution. The surrounding environmental conditions are still quite natural and support macrozoobenthos life in that place. However, Station III at the upstream of this river is still included in the polluted category even though it is very lightly polluted. Meanwhile, station II has a diversity index value in the second place (H'= 1.91), one of which is caused by the river body around the residents' plantations. Agricultural waste entering rivers causes changes in the physical and chemical conditions of the river and cause unstable environmental conditions and this of course causes living creatures, especially macrozoobenthos in that place, to not be able to survive if they have a low level of tolerance to environmental conditions. Station I is included in the moderately polluted category with the lowest diversity index value, namely H'= 1.21. This is because station I is located in the downstream area of the river where there is an accumulation of chemicals from the use of pesticides in the agricultural areas of residents downstream of the river and from the middle of the river which are carried by the water current. This situation means that most macrozoobenthos cannot survive, so the level of diversity is very small.

The results of the research show that station III, which is upstream of the river and is included in the protected forest area, has the greatest diversity index value, followed by station II, namely the middle part of the river which is around residents' plantations, while station I is downstream of the river and is a place for accumulation of materials. pollutants have the smallest diversity index value. Odum (1994) explained that macrozoobenthos is one of the biota that can be used as a biological parameter in determining the condition of waters. Changes in water and substrate quality affect the abundance and diversity of macrozoobenthos. This abundance and diversity depends on its tolerance and sensitivity to environmental changes consisting of biotic and abiotic (Purnomo, 1989 in Fachrul, 2007). Good quality waters usually have high species diversity and conversely, poor or polluted waters usually have low species diversity.

Macrozoobenthos Diversity Index Value and Water Pollution Levels

Macrozoobenthos obtained from sampling samples at each station were identified and counted to determine the diversity index. Next, the level of water pollution is determined, which according to Selvianita et al., (2024) the level of pollution based on the H' index value is divided into four levels, namely very lightly polluted (H' = 3.0 – 4.5), polluted lightly (H' = 2.0 – 3.0), moderately polluted (H' = 1.0 – 2.0) and heavily polluted (H' = 0.0 – 1.0). Based on the sampling results as presented in Table 4.2 from station I to station III, different types and amounts of Macrozoobenthos were found. The value of the Shannon-Wienner Diversity Index (H') and the status of the Salusu river water pollution level in Ogomatanang Village obtained based on the results of data analysis (Appendix 1) can be seen in Table 4.

Table 4. Diversity Index Values and Pollution Level Status

Station	Mark H’	Category	Pollution level
I	1.28	Medium diversity	Moderately polluted
II	1.91	Medium diversity	Moderately polluted
III	2.14	Medium diversity	Lightly polluted

The distribution of macrozoobenthos found at the research location is quite varied. Based on data on the number of macrozoobenthos at each station in Table 4., the largest type of macrozoobenthos individual is Tylomelania sp. with a total of 31 individuals, then Tylomelania arabica with a total of 26 individuals and Parathelphusa convexa with a total of 24 individuals. On the other hand, the fewest types of macrozoobenthic individuals found were *Planaria* sp. with 3 individuals and *Alloperla* sp. totaling 5 individuals. The species found at each research station were *Tylomelania* sp., *Tylomelania arabica*, *Parathelphusa convexa* and *Orthetrum sabina* while *Planaria* sp. and *Alloperla* sp. only found at station 3. The species only found at stations 2 and 3 were *Baetis* sp., *Heptagenia solitaria* and *Nemoura* sp.

The species Tylomelania sp 1 and Tylomelania sp 2, which are members of the gastropod class, are the species most frequently found at each station, starting from station III which has very lightly polluted water quality to stations II and I which have moderately polluted water quality. This indicates that these two species have a wide life range so they are classified as facultative species because they can survive in waters with a lot of organic material and are able to withstand certain levels of pollution. According to Selvianita et al., (2024) the Gastropod class group can be included as a tolerant group. The habitat conditions preferred by Gastropods are at a pH ranging between 6.7–9.0 and dissolved oxygen levels between 0.5–14 ppm (Setyaningthias, 2007). The conditions of the research location are suitable for gastropod habitat with an oxygen level range of 0.53 – 0.57 and a pH of 6-7 which strongly supports their survival so that they can be found at each station in greater numbers compared to other macrozoobenthic species. These two species are mostly found in stations II and III which have rocky gravel substrates (station III) and rocky sand (station II). This type of rocky substrate is a very suitable place for gastropods to attach themselves to rocks to survive water currents. In addition, the body's endurance and hard shell adaptations enable gastropods to survive compared to members of other classes, so there are quite a lot of them in the study area.

Other species that are often found besides Tylomelania sp. and Tylomelania arabica is Parathelphusa convexa. This species is found at every research station which has various physical and chemical conditions with different substrates. Riady, et al. (2014), stated that this species is tolerant and has a wide distribution of habitats ranging from flowing waters such as streams in mountains, rivers and sea coasts to relatively calm waters such as lakes, ponds, swamps and canals. Apart from that, Eprilurahman, et al. (2015), stated that this species can be found in habitats with various substrate types such as rock, sand and mud. This shows that this species has a wide distribution from upstream to downstream rivers and has the ability to adapt and has a high level of tolerance to the environment. Its tolerant nature towards environmental conditions means that Parathelphusa convexa can survive even though abiotic factors at the research station are not included in the water quality standards. Therefore, this species can be found at every research station in quite large numbers.

The least common species found in this study was Planaria sp. which was found at station III which is an upstream river with lightly polluted water quality status. Surtikanti (2013), stated that Planaria sp. prefers habitats with low light intensity, low conductivity and high oxygen content. Maftuah et al. (2002), stated that each organism has a specific ecological niche, as well as Planaria sp. will occupy a certain place with environmental conditions suitable for its survival, namely waters that have clean water quality. The conditions at station III are quite suitable for planarian habitat where the light intensity is low due to the covering of the river body by the canopy of the surrounding trees and the large number of trees upstream of the river which is a protected forest area providing high levels of oxygen so that oxygen needs for survival are met. However, the small number of Planaria sp. What was found shows that even in upstream rivers with little direct pollution activity by humans, the river is starting to become polluted. Surtikanti (2013) stated that currently it is very difficult to obtain truly clean water. Even water flows from mountains that are thought to be the cleanest will carry minerals, dissolved gases from organic substances from plants or animals that live near or in the flow.

Several Macrozoobenthos aquatic insect larvae were also found in this study. Aquatic insect larvae can be used as bioindicators of water pollution because they can respond to environmental changes (Marpaung et al., 2014). Aquatic larvae belong to the intolerant macrobenthic group. Insect larvae found included *Baetis* sp., *Alloperla* sp., *Heptagenia solitaria*, *Orthetrum sabina* and *Nemoura* sp. Among the five insect larvae found, *Heptagenia solitaria* species with the highest number of individuals, namely 13 individuals found at stations II and III, followed by *Nemoura* sp. totaling 12 individuals and were found at stations II and II. Next, there were 11 *Orthetrum sabina* individuals and were found at stations I, II and III. As for *Aloperla* sp. only found at station III and numbered 5 individuals and *Baetis* sp. Only found at stations II and III. Based on these results, it can be concluded that most of these insect larvae were found at stations II and III. Setyaningthias (2007) stated that insect larvae from the orders Ephemeroptera and Plecoptera can live well in an environment with an oxygen level range of 4 - 14 ppm, while the results obtained from measuring oxygen levels at the research station were very low, namely 0.53 - 0.57 ppm. This condition causes very few insect larvae to be found. The accumulation of waste, especially at station I which is downstream of the river, means that insect larvae cannot survive so they are only found in very small numbers. The water quality status downstream of the river which is included in the moderately polluted category does not support the development of insect larvae in that place.

In the final stage, learning media has an important role in supporting the quality of the teaching and learning process. Learning media is also able to motivate students to seek knowledge, provide experience in solving problems and make it easier for students to understand the material presented. Learning media plays an important role in making learning activities more effective and efficient.The average percentage of the results of the assessment of the feasibility of learning resources in the form of posters by the expert team (content, design and media) and student groups can be seen in Table 5.

Table 5. Assessment of the feasibility of learning resources by the expert team

Num	Expert	%
1	Content Expert	80.00
2	Design Expert	78.60
3	Media Expert	80.00
4	Small Group Student Response	89.00
5	Large Group Student Response	85.50

The research results obtained in this study were applied in the form of learning media in the form of posters. Posters are made with an attractive appearance so that they attract readers' interest in reading them. In it there are pictures, classifications and descriptions of the types of macrozoobenthos found at the research station on the Salusu river, Ogomatanang Village.

Making learning media in the form of posters was initially carried out by taking samples in the form of macrozoobenthos types at the research location, namely at the Salusu River research station, Ogomatanang Village. Data was obtained by taking photos and identifying and describing them. The next process is designing and printing learning media. After the poster is printed, it is then validated by expert lecturers including content experts, design experts and media experts to determine the strengths and weaknesses of the learning media. After going through the validation process, a trial of the learning media was carried out on 20 large group students and 10 small group students.

Validation by the validation team provides the percentage score results for the poster learning media assessment which shows the suitability of the poster. Validation of learning media by content experts obtained a feasibility percentage of 80% (feasible category), design experts obtained a feasibility percentage of 78.6% (feasible category) and media experts obtained a percentage of 80% (feasible category). The test results in the large group obtained a percentage of 85.5%, while in the small group it was 89%. The feasibility percentage results show that the poster learning media has appropriate, interesting and clear content so it is suitable for use as a learning media.

The percentage of eligibility obtained is expected to be able to fulfill the role of learning resources in the learning process for students as stated by (Pavešić and Koršňáková (2019), namely (1) generating learning productivity by accelerating the pace of learning and using time better, developing passion for learning, providing more interesting activities. individual direction and provide opportunities to develop according to their abilities; (2) providing a more scientific basis for teaching by planning more systematically and developing teaching materials based on research based on facts in the environment; (3) Strengthen teaching by increasing abilities with various communication media facilities, presenting information and data more concretely and reducing the verbalistic and abstract nature with real reality.

Conclusion

Based on research and data analysis, it can be concluded that the results of the study found 9 species, divided into 8 families including Baetis sp., Alloperla sp., Parathelphusa convexa, Heptagenia solitaria, Orthetrum sabina, Nemoura sp., Tylomelania arabica, Tylomelania sp., Planaria sp. The diversity index (H ') was consecutively at station III (upstream) which was 2.14 with a light level of pollution, the H 'index at station II (ecotone) was 1.91 and the H 'index at station I (downstream) was 1.28 with a moderate level of pollution. The research results obtained were used as validated learning media by a team of content experts by 80%, design 78.6%, media 80%, large group student group trials 85.5% and small group 89.0%. Learning media is very feasible to use with a result of 82.62%.

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