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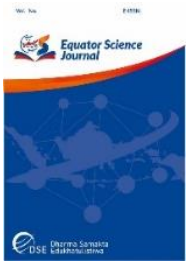

Macrozoobentos Diversity as A Bioindicator of Water Quality in Poso Lake, South Pamona District, Poso Regency and Its Utilization as A Learning Media

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ABSTRACT
Macrobenthos are animals that live at the bottom of waters, both freshwater and seawater. This study aims to describe the diversity of macrobenthos as a bioindicator of water quality in Lake Poso and its use as a learning medium. This study uses a purposive random sampling method with a sampling technique using free collection with a roaming path method of ± 100 m per station. While the data analysis technique uses quantitative descriptive. The results of the study showed that the macrobenthos diversity index was obtained at station I (2.51) and then followed by station II (2.44) and station III (2.19). While the macrobenthos diversity index in Lake Poso is 2.26 and is categorized as a moderate level of diversity. The high macrobenthos diversity index at station I is because the macrobenthos habitat is still maintained and surrounded by forest vegetation so that the macrobenthos found are quite diverse. The development of research results as a learning media in the form of a pocket book, from the validation results including media validation, content validation, and design validation conducted by 3 expert lecturers and the feasibility test tested on 20 students obtained a percentage of 79.6% and is worthy of being used as a learning media.

INTRODUCTION

Lake Poso is one of the natural treasures owned by Poso Regency. Being the 3rd largest lake in Indonesia, Lake Poso is approximately 32 km long and around 16 km wide. The waters stretch for around 127 km around the waters of this lake. With the deepest point of around 510 meters and an average depth of approximately 195 meters, Lake Poso is also one of the deepest lakes in Indonesia. Located at an altitude of approximately 657 meters above sea level. Poso Lake is also one of the tourist attractions in Poso Regency which has very beautiful and interesting tourist attractions, so the role of the government and local community is very important in maintaining this natural tourist attraction (Talimba et al., 2020).

Lake Poso is the largest volcanic lake in Indonesia and has high ecological and economic value. Human activities around lakes such as agriculture, fishing and tourism can pollute lakes and affect public health. Macrozoobenthos are invertebrate animals that live at the bottom of lakes and are animals that are susceptible to changes in water quality and can be used as bioindicators of lake health quality (Nurainah & Hanafiah, 2022). This preservation can help identify sources of pollution, monitor the effectiveness of lake management programs, and develop strategies to preserve lakes (Winarti & Harahap, 2021). Supporting lake conservation such as encouraging management and sustainability programs to manage Lake Poso and conducting outreach to encourage public awareness to preserve the lake (Fadilla et al., 2021).

Water quality parameters can be divided into three parts, namely physical, chemical and biological parameters. Physical indicators can include temperature, depth and turbidity. Chemical indicators can be pH, DO (Dissolved Oxygen), BOD (Biochemical Oxygen Demand), and COD (Chemical OxygenDemand). Chemical indicators can be macrozoobenthos (Santoso et al., 2021).

Macrozoobenthos are organisms that live at the bottom of the waters and are filtered by filters with a mesh size of 1.0 x 1.0 millimeters which at maturity measure 3-5 millimeters . Macrozoobenthos are organisms that have a size between 0.1-1.0 millimeters, for example the large Protozoa group, small worms, very small Crustacea, for example Ostracoda (Fernita, 2007).

Macrozoobenthic animals that inhabit aquatic environments for long periods of time and have a relatively sedentary lifestyle will be able to respond to existing water quality conditions (Chazana et al., 2020). This ability of macroinvertebrates has been used as a bioindicator for water pollution in several non-tropical countries and is also needed as an alternative bioindicator in Indonesia (Sutanto & Agus, 2000).

Macrozoobenthos can be used as a biological indicator of water quality, because macrozoobenthos is sensitive to pollutants (Ernawati et al., 2023). Low or slow movement or movements, easy to catch and have a fairly long survival rate. Therefore, the role and existence of macrozoobenthos in the balance of an aquatic ecosystem, including rivers, can be used as a current indicator in an area (Santoso, 2017).

The quality conditions of the physical area of the lake and its banks, as well as the condition of the lake water quality are factors that determine what types of life will make up the biota community in the lake. Monitoring lake damage has so far placed more emphasis on measuring lake water quality without paying attention to the effects of changes in water quality on lake biota. Overall lake health assessment, namely by examining 2 components of the lake ecosystem that have not received much attention, namely the physical condition of the lake's original location and the lake biota community represented by biotylics. Biotilik comes from the words bio and tilik which means the use of living things (bio) to study or monitor the environment (tilik) which is synonymous with the term biomonitoring. Biotilics is also an acronym for invertebrate biota, a water quality indicator, which is synonymous with macroinvertebrates (Santoso, 2021).

Knowledge of local communities and in general about macrozoobenthos is still low and the results of research on macrozoobenthos are still very lacking, especially in lakes. Therefore, it is very necessary to carry out research and the results of this research to be disseminated through the media as information. Utilizing learning media regarding the diversity of macrozoobenthos in Lake Poso, South Pamona District, Poso Regency in the form of a pocket book is one way to properly document the diversity of macrozoobenthos in Lake Poso, South Pamona District, Poso Regency (Asmaningrum et

al., 2023). Therefore, researchers are interested in conducting research on "Macrozobenthos Diversity as a Bioindicator of Water Quality in Poso Lake, South Pamona District, Poso Regency and Its Use as a Learning Media".

METHOD

The type of research used is quantitative descriptive research. The research method used is the Purposive Random Sampling method. According to Setyosari (2010), descriptive research is research whose aim is to describe an event, situation, object, or anything related using all variables that can be explained using either numbers or words. According to Sugiono (2017), the Purposive Random Sampling method is taking sample members from a population randomly without paying attention to the strata in that population.

The sampling technique in this research used free collection using the roaming route method. This research will be carried out in three stages, namely location observation, data collection, and data processing. Station placement is carried out based on consideration of the color or condition of the research area. The distance between stations one, two and three is 100 m. Sampling of macrozoobenthos and environmental parameters was carried out in three random repetitions so that it could represent three observation stations.

Data analysis technique for macrozoobenthos diversity in Poso Lake, South Pamona District, Poso Regency using a formula *index Shannon-Wiener* (Magurran, 1988) :

$$\mathbf{H' = -\Sigma\ pi\ ln\ pi\ ;\ pi = \frac{ni}{N}}$$

Information :
H' = Diversity index
ni = Number of individuals of each type
N = Number of individuals of all species
Pi = Chance of dizziness
Criteria:
H' ≤ 1 = Low species diversity
I ≤ H' ≤ 3 = Medium species diversity
H' ≥ 3 = High species diversity

Arikunto (2010) stated that data analysis for assessing learning media can be done using the following formula:

$$Average = \frac{Total\ percentage}{Number\ of\ assessment\ aspect\ items}$$

Table 1. Media Eligibility Percentage Category

Percentage	Interpretation Feasibility
81% - 100%	Very Feasible
61% - 80%	Feasible
41% - 60%	Quite Feasible
21% - 40%	Less Feasible
0% - 20%	Not Feasible

RESULTS AND DISCUSSIONS

Description and Classification of Macrozoobenthos in the Poso Lake Area, South Pamona District, Poso Regency

1. Geothelphusa dehaani

Kingdom Animalia
Phylum Arthropoda
Class Malacostra
Ordo Decapoda
Family Potamidae
Genus Geothelphusa
Spesies *Geothelphusa dehaani*

Description

This crab prefers clear water. Its body color varies into three types, blackish purple, reddish brown, and blue gray, varying according to region. The crab's two front legs are equipped with strong pincers, used for eating and fighting, and this crab has 3 pairs of legs. This crab is mostly active at night, this crab is also omnivorous and eats small insects, snails, and plants or fallen leaves on the edge of the lake. This crab is an important member of the detritus food chain. Detritus is the term for dead plants and animals that fall to the bottom of a river or lake. This crab can be eaten as long as it is processed properly, it is not recommended to eat it directly because it will cause infectious diseases that attack the lungs.

2. Sulcospira testudinari

Kindom Animalia
Phylum Mollusca
Class Gastropoda
Ordo Caenogastropoda
Family Pachychilidae
Genus Sulcospira
Spesies *Sulcospira testudinari*

Description

Sulcospira testudinari is brown to blackish brown in color and some are black. In the part of the furrow under the silk, there is a blackish brown lateral (flame) beam. The length of the shell can reach 24-44 mm with a width of 13-19 mm. Sulcospira testudinari has an operculum that closes the shell mouth (aperture). The shape of the shell mouth (operture) is like the letter D. The shell channel has a shallow curve and a smooth surface texture, the shell is elongated, conical and blunt, dense, and thick. Found in rocky habitats. The benefits, the shell can be used as handicrafts. This snail can be eaten, processed such as in yellow spices, stir-fried, or rica-rica soup, and other food preparations.

3. Gerris marginatus

Kingdom Animalia
Phylum Arthropoda
Class Insecta
Ordo Hemiptera
Family Gerridae
Genus Gerris
Spesies *Gerris marginatus*

Description

Gerris marginatus (anggang-anggang) has a dark or black color. This type has a body size of 10 to 17 mm with middle and back legs longer than the body and the front legs are much shorter and bent. The size of the anggang-anggang's legs ranges from 2 cm. Its life cycle includes insects that experience incomplete metamorphosis starting from eggs, nymphs, and adults. Its benefits as a water bioindicator. This type is found in standing and slow-flowing waters. This species cannot be consumed.

4. Corbicula javanica

Kingdom Animalis
Phylum Mollusca
Cllas Bivalvia
Ordo Venerida
Family Cyrenidae
Genus Corbicula
Spesies *Corbicula javanica*

Description

Corbicula javanica has a black, greenish yellow, yellow to brownish yellow shell color, the more ventral the color is lighter and shiny. The shell is small, oval or slightly triangular in shape. The posterior and anterior parts are symmetrical, each with a rounded tip. The ligament lines between the posterior and anterior parts are parallel. The protrusions are rather high and clearly visible. Its habitat is in calm or fast-flowing waters with a sandy or muddy bottom. The use of this shellfish is that it can be used as a bioindicator of waters, this shellfish also plays an important role in food webs in the ecosystem, and this shellfish also has economic value in some communities that are traded for consumption.

5. Epitonium clathrus

Kingdom Animalia
Phylum Mollusca
Class Gatropoda
Ordo Incertae
Family Epitoniidae
Genus Epitonium
Spesies *Epitonium clathrus*

Description

Epitonium clathrus is shiny white to cream in color, often with brown spots. The conical shell reaches a height of 35 mm. The shell has vertical, knife-like ribs, known as costae. These convex whorls often contain two or three purple bands that are best seen as they pass through the outer lip lamella. The protoconch is usually blunt. This species is hermaphroditic. The shell of this snail is coveted by shell collectors, and its natural population has been decimated by over-harvesting. This snail is edible.

6. Tylomelania toradjarum

Kingdom Animalia
Phylum Mollusca
Class Gastropoda
Ordo Caenogastropoda
Family Pachychiliidae
Genus Tylomelania
Spesies *Tylomelania toradjarum*

Description

Tylomelania toradjarum has a black or brown color. The shell has 7-9 circles. The width of the shell is 16 mm. The height of the shell is 54 mm. The width of the opening is 10 mm. The height of the opening is 15 mm. There are 9 concentric lines on the overkulum. This snail has a high economic value for some people who trade it. This snail can be consumed, some people of Lake Poso believe that the meat of this snail can cure liver disease.

7. Tylomelania sp.

Kingdom Animalia
Phylum Mollusca
Class Gastropoda
Ordo Caenogastropoda
Family Pachychilidae
Genus Tylomelania
Spesies *Tylomelania sp.*

Description

Tylomelania sp. has a greenish brown or dark green shell color usually with shiny white spots. The size of the shell is medium or rather thin. The surface of the shell is 6 ½ -7 ½ cells with edges that are not bulging so that the tendrils are not deep. The mouth of the oval shell is slightly rounded at the base, the edge of the shell mouth is rather thin. The surface of the shell has upright ribs that are not thick and 2 or 3 flat circular ribs that are clearly visible on the scavenger and final cells. The columella is thin, brownish in color. Its habitat is attached to rocks. This snail has a high economic value for some people who trade it. This snail can be consumed, some people of Lake Poso believe that this snail meat can cure liver disease.

8. Anisops sardeus

Kingdom Animalia
Pylum Anthropoda
Class Incesta
Ordo Hemiptera
Family Notonectidae
Genus Anisops
Spesies *Anisops sardeus*

Description

The transparent hemelytra but its color is determined by the color of the body part below it so that it looks yellow, like the entire dorsal side of the body. The Anisops sardeus species can be called a back swimmer that has an oval body shape with three pairs of legs, a black-eyed head. The body length of this species ranges from 4.8–8.4 mm, body width 1.3–2.0 mm, elongated body shape, slightly flattened to the side. The ventral surface is brown or yellowish and the legs are yellow. This species lives in water with calm currents such as stagnant water and this species is sensitive to water pollution. This species cannot be consumed.

9. Neurocordulia michaeli

Kingdom Animalia
Phylum Arthropoda
Class Insecta
Ordo Odonata
Family Corduliidae
Genus Neurocordulia
Spesies *Neurocordulia michaeli*

Description

This type of *Neurocordulia michaeli* has a yellowish brown body with a body axis length of ± 10 mm. The body is divided into the head (caput), chest (thorax) and abdomen. It has a small head with rounded eyes on the right and left sides of the head and has a pair of antennae. The chest is rather slender and has three pairs of legs attached to the thorax and there is a pair of wing buds attached tightly to the back of its body, this species is found in rocky substrates. This species cannot be consumed.

10. Gompphus flavipes

Kingdom Animalia
Phylum Arthropoda
Class Insecta
Ordo Odonata
Family Gomphidae
Genus Gomphus
Speises *Gomphus flavipes*

Description

Gomphus flavipes is a type of yellow-legged dragonfly with a length of 50-55 mm and an average wingspan of 70-80 mm with separate eyes. Gomphus flavipes has small, slightly protruding eyes and has three pairs of legs. This type of dragonfly has a long nymph stage and may depend on the upstream flow of the river, free from fish, dragonfly nymphs are also a bridge between aquatic and terrestrial environments. Nymphs of this species are shallow diggers that depend on certain microhabitats in the water flow as their breeding grounds, living in small flowing waters with a soft base of sandy substrate, living buried underneath by extending the tarsi of the legs to remove sediment under the body, then contracting and vibrating until covered by mud or sand and leaving only the tip of the abdomen outside. *Gomphus flavipes* lives in good waters so it can be considered a bio indicator species. This species cannot be consumed.

11. Nephrotoma appendiculata

Kingdom Animalia
Phylum Arthropoda
Class Insecta
Ordo Diptera
Family Tipulidae
Genus Nephrotoma
Spesies *Nephrotoma appendiculata*

Description

Nephrotoma appendiculata is a type of bird or stork fly with a length of 13-15 mm, which has a yellow body with a wide black line on the dorsal surface of the abdomen and a black line on the chest. This type is a true insect with thread-like horns and wings, this species was found at station II with a sandy substrate habitat. Its benefits as a bioindicator of lake or river waters. This species cannot be consumed.

12. Parapsyche elsis

Kingdom Animalia
Phylum Arthropoda
Class Insecta
Ordo Trichoptera
Family Hydropsychidae
Genus Parapsyche
Spesies *Parapsyche elsis*

Description

Parapsyche elsis has a body size of 11 - 18 mm, we often find it in cool rivers and crawl actively through river rocks and debris. Its presence in a body of water indicates good water quality, this species is quite tolerant of nutrient pollution in water. This species cannot be consumed.

13. Aphelocheirus aestivalis

Kingdom Animalia
Phylum Arthropoda
Class Insecta
Ordo Hemiptera
Family Aphelocheiridae
Genus Aphelocheirus
Spesies *Aphelocheirus aestivalis*

Description

The Ap*helocheirus aestivalis* species has a yellowish head and antennae and blackish eyes. This animal is a wingless aquatic insect with a flat, oval body and a length of between 8.5-10 mm. The chest and abdomen are grayish, have a wide yellowish band and yellowish markings on the abdomen. This species was found at station I which has a rocky substrate. This species cannot be consumed.

14. Ilyocoris cimicoides

Kingdom Animalia
Phylum Arthropoda
Class Insecta
Ordo Hemiptera
Family Naucoridae
Genus Ilyocoris
Spesies *Ilyocoris cimicoides*

Description

This type of *Ilyocoris cimicoides* has a flat oval body with a dark blackish back. It has three pairs of legs with a length of 12-15 mm and a pair of horns. Ilyocoris cimicoides prefers open habitats, rich in submerged vegetation, species found at stations I and II. In addition, this type is a bioindicator because of its sensitivity to water. This species cannot be consumed.

15. *Parathelphusa convexa*

Kingdom Animalia
Phylum Arthropoda
Class Malacostraca
Ordo Decapoda
Family Gecarcinucidae
Genus Paraphelphusa
Spesies *Parathelphusa convexa*

Description

Parathelphusa convexa has a trapezoidal shape with a reddish brown color and there are three antero-lateral teeth on the edge. The characteristics of the eyes are relatively small compared to the size of the body and do not reach the side edge of the carapace. This crab is only occasionally consumed locally, because of its unpleasant odor and taste. This crab can also be made into oil in the traditional way. The crab meat and shell are previously ground finely and then mixed with grated coconut and fermented overnight, then dried and finally squeezed for oil.

Diversity of Macrozoobenthos in Lake Poso

Based on the results of research that has been carried out, 15 types of macrozoobenthos consisting of 14 genera and 14 families. Macrozoobenthos that can be presented in Table 2.

Table 2. Types of Macrozobenthos found in Lake Poso

No.	Family	Genus	Species
1.	Potamidae	Geothelphusa	*Geothelphusa dehaani*
2.	Pachychilidae	Sulcospira	*Sulcospira testudinari*
3.	Gerridae	Gerris	*Gerris marginatus*
4.	Cyrenidae	Corbicula	*Corbicula javanica*
5.	Epitoniidae	Epitonium	*Epitonium clathrus*
6.	Pachychiliidae	Tylomelania	*Tylomelania toradjarum*
7		Tylomelania	*Tylomelania sp*
8.	Notonectidae	Anisops	*Anisops sardeus*
9.	Corduliidae	Neurocordulia	*Neurocordulia michaeli*
10.	Gomphidae	Gomphus	*Gomphus flavipes*
11.	Tipulidae	Nephrotoma	*Nephrotoma appendiculata*
12.	Hydropsychidae	Parapsyche	*Parapsyche elsis*
13.	Aphelocheiridae	Aphelocheirus	*Aphelocheirus aestivalis*
14.	Naucoridae	Ilyocoris	*Ilyocoris cimicoides*
15.	Gecarcinucidae	Paraphelphusa	*Parathelphusa convexa*

Table 3. Number of Macrozoobenthos Individuals in Lake Poso

No.	Species	Number of Individuals			Total
		Forest	Tourism	Community	
1.	*Geothelphusa dehaani*	2	10	1	13
2.	*Sulcospira testudinari*	20	0	0	20
3.	*Gerris marginatus*	3	2	5	8
4.	*Corbicula javanica*	5	5	0	10
5.	*Epitonium clathrus*	5	5	10	20
6.	*Tylomelania toradjarum*	10	2	5	17
7.	*Tylomelania sp*	10	5	10	25
8.	*Anisops sardeus*	8	6	8	22
9.	*Gomphus flavipes*	5	7	0	12
10.	*Nephrotoma appendiculata*	2	3	2	7
11.	*Parapsyche elsis*	2	2	0	4
12.	*Aphelocheirus aestivalis*	10	5	5	20
13.	*Ilyocoris cimicoides*	3	2	2	7
14.	*Parathelphusa convexa*	1	5	1	7
15.	*Neurocordulia michaeli*	5	10	5	20
	Total	91	69	54	212

The results of the research that has been conducted, obtained the diversity index H' = 2.6. The results obtained can be seen in Table 4.

Table 4. Macrozoobenthos Diversity Index in Lake Poso.

No.	Species	Ni	Pi (Ni/N)	Ln Pi	Pi Ln Pi
1.	*Geothelphusa dehaani*	13	0,061321	-2,79164	-0,17119
2.	*Sulcospira testudinari*	20	0,09434	-2,36085	-0,22272
3.	*Gerris marginatus*	8	0,037736	-3,27714	-0,12367
4.	*Corbicula javanica*	10	0,04717	-3,054	-0,14406
5.	*Epitonium clathrus*	20	0,09434	-2,36085	-0,22272
6.	*Tylomelania toradjarum*	17	0,080189	-2,52337	-0,20235
7.	*Tylomelania sp*	25	0,117925	-2,13771	-0,25209
8.	*Anisops sardeus*	22	0,103774	-2,26554	-0,2351
9.	*Gomphus flavipes*	12	0,056604	-2,87168	-0,16255
10.	*Nephrotoma appendiculata*	7	0,033019	-3,41068	-0,11262
11.	*Parapsyche elsis*	4	0,018868	-3,97029	-0,07491
12.	*Aphelocheirus aestivalis*	20	0,09434	-2,36085	-0,22272
13.	*Ilyocoris cimicoides*	7	0,033019	-3,41068	-0,11262
14.	*Parathelphusa convexa*	7	0,033019	-3,41068	-0,11262
15	*Neurocordulia michaeli*	20	0,09434	-2,36085	-0,22272
	Total	212		H’	2,594643

H’ = - Σ Pi Ln Pi
= 2,594643
= 2,6

Description :
1 < H < 3 Diversity of species moderate

Percentage Results of Media Feasibility Assessment in the Form of Pocket Books by the Expert Team

1. Results of learning media assessment by content expert lecturers

The results of the assessment by the validation lecturers, namely, the content experts of the pocket book media are very feasible to be used as learning media with a percentage of 80%, as presented in Table 5.

Table 5. Media suitability presentation by content experts

No.	Assessment Aspect	Scale	Percentage (%)
1.	Title accuracy with pocket book	4	80
2.	Suitability between pocket book title and content of material	5	100
3.	Clarity of image guides	4	80
4.	Image clarity	2	40
5.	Suitability between images and image guides	4	80
6.	Accuracy of species names	5	100
7.	Clarity of research results	4	80
8.	Accuracy of supporting sources that can be used as references for finding sources that are relevant to the material	4	80
Total		32	640
Average		4	80
The percentage obtained shows that the pocket book learning media is Very Suitable for use.			

2. Media Results of Learning Media Assessment by Media Experts

The results of the learning media research in the form of books conducted by media experts, stated that the learning media is suitable for use and can help in the learning process. The percentage obtained was 70.9, as presented in Table 6.

Table 6. Percentage of media eligibility by media experts

No.	Assessment Aspect	Scale	Percentage (%)
A.	**Material Description**		
1.	Font size determination	4	80
2.	Sentence clarity	4	80
3.	Writing systematics	4	80
4.	Attractiveness of the appearance of the material description	3	60
B.	**Image**		
1.	The suitability of the image to the description of the material	3	60
2.	The clarity of the image to be understood	3	60
3.	The attractiveness of the image display	4	80
C.	**Image Caption Text**		
1.	Layout settings	3	60
2.	Text color settings	4	80
3.	Color size settings	3	60
4.	Text attractiveness	4	80
Total		39	780
Average		3,54	70,9
The percentage obtained shows that the pocket book learning media is suitable for use.			

3. Results of Learning Media Assessment by Design Experts

The research by design experts shows pocket book learning media is highly feasible and aids learning, with a score of 82% (Table 7).

Table 7. Percentage of eligibility by design expert

No.	Assessment Aspect	Scale	Percentage (%)
A.	**Title**		
1.	Quality of the pocket book title text	4	80
2.	Suitability of the font size in the title	4	80
3.	Suitability of the placement of the title in the pocket book	4	80
4.	Suitability of the font color	4	80
5.	Suitability between the font of the title and the image	4	80
B.	**Material**		
1.	Suitability between the material and the media used	4	80
2.	Quality of the images used	4	80
3.	Consistency of image size	4	80
4.	Quality of text in the pocket book	4	80
5.	Consistency of font size in the pocket book	5	100
Total		41	820
Average		4,1	82
The percentage obtained shows that the pocket book learning media is very suitable for use.			

4. Percentage Results of the Assessment of the Feasibility of Learning Media in the Form of Pocket Books by Students

The learning media that has been validated by the expert team will then be tested on 20 students of the Biology Education Study Program. The percentage results of the feasibility of learning media in the form of pocket books that have been carried out by students are 85.5%.

Tabel 8. Percentage of eligibility by students

No.	Assessment Aspect	Scale	Percentage (%)
1.	Do you think this pocket book is interesting?	4,3	86
2.	Do you think the contents of this pocket book are easy to understand?	4,1	82
3.	How clear are the images in this pocket book?	4,3	86
4.	How clear is the writing (text) in this pocket book?	4,3	86
5.	Do you think the appearance of the images in this pocket book is interesting?	4,2	84
6.	Do you think this pocket book is interesting overall?	4,3	86
7.	Can this pocket book help make it easier to find out the types of Macrozoobenthos in Lake Poso, South Pamona District, Poso Regency?	4,4	88
8.	Is the Latin writing used in this pocket book correct?	4,3	86
Total		43,2	684
Average		4,2	85,5
The percentage obtained shows that pocket book learning media is very suitable for use.			

5. Validation of Pocket Book Learning Media

This study has conducted validation of learning media in the form of pocket books which includes validation of media, design, and content carried out by 3 expert lecturers and submitted to 20 students. The validation results can be seen in table 3.8.

Table 9. Average Data Analysis of Pocket Book Learning Media Assessment

No.	Validator	Scale	Percentage (%)
1.	Content expert	4	80
2.	Media expert	3,54	70,9
3.	Design expert	4,1	82
4.	Student group	4,2	85,5
Total		15,84	318,4
Average		3,96	79,6
The average value obtained shows that it is suitable for use.			

This research was conducted at Lake Poso which is located in Poso Regency, ecologically it has a different ecosystem form in the area, this difference can be seen from the macrozoobenthos habitat found. Different environmental patterns result in the number of types of macrozoobenthos obtained varying.

The results of the research carried out found macrozoobenthos species in Lake Poso and 15 species were identified, consisting of 14 genera and 14 families, namely: *Geothelphusa dehaani, Sulcospira testudinari, Gerris marginatus, Corbicula javanica, Epitonium clathrus, Tylomelania toradjarum, Tylomelania sp, Neurocordulia michaeli, Gomphus flavipes, Nephrotoma appendiculata, Parapsyche elsis, Aphelocheirus aestivalis, Ilyocoris cimicoides, Parathelphusa convexa, and Neurocordulia* michaeli. The form and life cycle of macrozoobenthos depend on the physical and chemical conditions of the environment in their habitat. Environmental factors found in each research

habitat such as pH, temperature and salinity as well as other factors that can support or hinder the life of an organism, especially macrozoobenthos.

The physical condition of the waters of Lake Poso at stations I, II, and III with rocky, sandy and muddy sand substrates. If we look at the results of research conducted at the three stations, the species found on sandy rock substrates are more dominant. Of the 15 species found on sandy substrates, there are 5 species, namely Corbicula javanica, Parathelphusa convexa, Parapsyche elsis, Nephrotoma appendiculata, and Tylomelania toradjarum. Meanwhile, there are 7 species found in rock substrates, namely Gerris marginatus, Geothelphusa dehaani, Sulcospira testudinari, Aphelocheirus aestivalis, Gomphus flavipes, Neurocordulia michaeli, and Anisops sardeus. Substrate is very influential for macrozoobenthos, as a place for life to take place and a place to find food. Gazali, (2011), stated that the substrate is a very important factor in the life of macrozoobenthos, namely as a habitat or place to live. Differences in the organic material content of the substrate can influence the development of macrozoobenthos. Apart from that, it can also cause differences in macrozoobenthos types because each species has a different tolerance range for the organic substrates contained therein (Barnes, 1994).

Research conducted in the Poso Lake area found 15 types of macrozoobenthos consisting of 2 Phylum, namely Arthropoda and Mollusca. The number and types of macrozoobenthos found from Phylum Mollusca are fewer than the types of macrozoobenthos from Phylum Arthropoda.

Phylum Arthropada is found to have the most types of organisms compared to the group of organisms in the phylum Mollusca. This is in line with the opinion of Welch (1980) who stated that one of the factors supporting the abundance of water insects found is directly proportional to the level of heterogeneity of vegetation that grows around rivers. This is because the overall foliage of the various vegetation will be a varied food source for water insects. . The Phylum Arthropada found consists of 2 classes, namely the Malacostraca class and the Insecta class. Meanwhile, in the phylum Mollusca, the classes Gastropoda and bivalves are found.

Diversity is the number of different types of organisms in a community (Michael, 1994). The macrozoobenthos diversity index was respectively found at station I (2.51) and then followed by station II (2.44) and station III (2.19). This is because the physical and chemical factors of station I waters are better than other stations. Apart from that, it is also influenced by the water substrate, at station I the bottom water substrate is in the form of sandy rocks containing coral/stone fragments. This substrate is the most commonly found macrozoobenthos because sandy rock substrates can provide shelter for macrozoobenthos from water currents. This is supported by the statement of Fadli (2012), that the basic substrate in the form of sandy rocks is a substrate that supports macrozoobenthos because it can protect against current movements. The lowest diversity index value is found at station III, this is because station III has a muddy sand substrate which makes it difficult for macrozoobenthos to shelter from currents, in accordance with Koesbiono's (1979) statement, stating that the bottom of the waters in the form of muddy sand is an unfavorable environment for macrozoobenthic animals. . There are several water quality parameters whose values are not optimal and are a place for human activities such as washing, latrines, and others, thus affecting the high and low diversity of macrozoobenthos. At station II the diversity value is higher than at station III. This is because it is influenced by the presence of several water quality parameters that do not match the optimum value and there are species that dominate at station II, namely Geothelphusa dehaani and Neurocordulia michaeli species, so the values are higher compared to station III.

The macrozoobenthos diversity index in Lake Poso ranges from 2.19 to 2.51 and is categorized as medium level diversity. The level of macrozoobenthos diversity at station I is because the macrozoobenthos habitat is still maintained and surrounded by forest vegetation so that the macrozoobenthos found is quite abundant. According to Handayani & Rahayuningsih, (2022) good and well-maintained conditions can support the existence of macrozoobenthos in an ecosystem. The large variety of species obtained is influenced by abiotic and biotic factors. The biotic factor that can be observed during this research is the abundance of macrozoobenthic food plants found in Lake Poso.

Apart from biotic factors, abiotic factors also influence the existence of macrozoobenthos in an ecosystem. Abiotic factors are water temperature, hydrogen ion content (pH), salinity, and dissolved oxygen (DO). This is based on the theory according to Nugroho (2006) in Infa Minggawati (2013) that the factors that influence the existence of macrozoobenthos in waters are physical and chemical factors

of the aquatic environment such as water temperature, chemical element content such as hydrogen ion content (pH), salinity, and dissolved oxygen (DO).

The results of measuring the physical and chemical factors of waters in this study can be seen in table 4.1. From this table, the factors that have a major role in supporting or inhibiting macrozoobenthos life in the research area are visible. Physical and chemical factors that have a big influence are acidity level (pH), temperature, salt content (salinity), light intensity, current strength, and dissolved oxygen (DO).

Based on the results of measurements of the water temperature at the three stations, it was found that station I was 28oC, station II was 27oC, and station III was 26oC. The temperature measurements at each station also do not have too much difference so they are still in accordance with the temperature range required by the macrozoobenthos. According to (Nurudin, 2013), temperature conditions in waters are a factor that greatly influences the life and development of organisms in waters. Temperature is the main regulator of physical and chemical processes that occur in waters. In general, the normal temperature range for macroozoobenthic life is 25ºC-30ºC, which is a normal temperature. This shows that the temperature values at each research station are still within normal limits to indicate the development of macrozoobenthos.

The results of measuring the salt content (salinity) at each station were 0.018% at station I, 0.016% at station II, and 0.015% at station III. The salt level (salinity) in the waters of Lake Poso is still at a normal level to support the life of macrozoobenthos and organisms in the area. Arisandi (2006) stated that freshwater salinity ranges from 0 to 3%. Changes in salinity also affect aquatic biota, including macrozoobenthos communities.

Based on the results of measurements of the degree of acidity (pH) obtained by measurements at each observation station, the value obtained at station I was 7.5, station II was 7.2, and station III obtained a value of 7.1 (Wardhana, 1995) stating that the pH is a limiting factor for organisms that live in waters. Water with a pH that is too high or low affects the survival of the organisms that live in it. Most aquatic biota are sensitive to changes in pH and prefer a pH range between 7-8.5. The degree of acidity (pH) is very important to support the survival of aquatic organisms because pH can influence the type and composition of substances in the aquatic environment and the availability of nutrients and the toxicity of trace elements. The ideal pH for aquatic organisms is generally between 7-8.5. Water conditions that are very acidic or very alkaline will cause the survival of organisms because they can cause metabolism and respiration, pH values < 5 or > 9 are very unsuitable for macrozoobenthic life. Meanwhile, the pH at each station was obtained at a pH value of 7.0-7.4, this means it is normal for the survival of macrozoobenthos life.

Diversity expresses the variety of species that exist in an ecosystem. When an ecosystem has a high diversity index, the ecosystem tends to be balanced. Conversely, if an ecosystem has a low diversity index then the ecosystem is in a state of stress or degradation. If diversity is moderate then the ecosystem is in a relatively stable condition, but is also experiencing some stress and disturbance.

Learning media where media acts as a tool in the teaching and learning process to make the learning process easier and as a tool to help an educator convey knowledge and material (Junaidi, 2019; Muaziyah et al., 2023). Learning media in education and in the teaching and learning process is very much needed and plays an important role in the development of students at school so that the knowledge and material they get from a teacher can be absorbed well (Desi et al., 2023; Wugaje et al., 2023).

The creation of the pocket book was initially carried out at the preparation, observation and research stages in the Poso Lake area, South Pamona District, Poso Regency. Next, research is carried out on the types of macrozoobenthos, after obtaining the data, we then create a learning media design in the form of a pocket book, then the validation stage of the learning media will be continued by a team of experts, namely content experts, design experts and media experts to find out the weaknesses of the pocket book and then repaired. The improved learning media was then tested on 20 Biology Education Study Program students.

The results of the learning media assessment carried out by a team of experts and students showed that the percentage of design experts was 82%, content experts were 80%, media experts were 70.9%, and the student assessment was 85.5%. Based on the assessments obtained, the book This

pocket is suitable for use as a learning medium. Overall, the average result of learning media validation by a team of experts and 20 students was 79.6%. This is confirmed by Arikunto & Jabar (2018), that the eligibility criteria for learning media with a percentage of 61% -80% state that the pocket book is suitable for use as learning media.

CONCLUSION AND SUGGESTION

Based on the results of the analysis and discussion of the study, it can be concluded that the diversity of macrozoobenthos was found to be highest at station I with a value of 2.51, followed by station II at 2.44, and station III at 2.19. The overall macrozoobenthos diversity index in Lake Poso is 2.26, which is categorized as a moderate level of diversity. Additionally, the study's findings, presented in the form of a pocket book, achieved a suitability rating of 79.6%, indicating that it is suitable for use as a learning medium.

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