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COMPOSITION AND ECOLOGY OF THE MACRO-ZOOBENTOS COMMUNITY FEEDING GROUP AND THE RELATIONSHIP WITH THE WATER QUALITY OF LAKE MANINJAU, WEST SUMATERA

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ABSTRACT

Information on the ecological status of inland waters is important to know in the framework of management and conservation purposes, including the biota elements of the Macro-zoobenthos community. This study aims to determine the composition and ecology of feeding acro zoobenthos and its relation to the water quality of Lake Maninjau. Lake Maninjau is one of the priority lakes that has an important role both economically and ecologically. Data were collected from journal literacy. There are 34 types of acro zoobenthos with a low diversity index (H= 0.34-0.82). The distribution of each *Taxa* was less to nearly even (E= 0.30-0.93). The Macro-zoobenthos found belonged to Molluscs, *Oligochaeta*, *EuHirudinea*, *Insect Larvae*, and *Crustaceans*. Molluscs were the most abundant, spread over 70% of locations and dominated by *Corbicula* species. The highest abundance is in the Sigiran location. A total of 26 *Taxa* were characterized by temperature, TDS, and conductivity variables, while the other 8 were characterized by DO and ORP based on CCA results. The feeding Collector ecology group (especially the filter collector) dominates. This indicates that the waters of Lake Maninjau are rich in fine particulate organic matter (FPOM).

Keywords: Maninjau Lake, Feeding Ecology, Water Quality, Macrozoobenthos.

INTRODUCTION

Community ecology has been used as an approach to determine the condition of an ecosystem and the organisms in it. One of them is macrozoobenthos. Ecologically, Macro-zoobenthos have an important role in the system in the inland water food chain, especially fish. Therefore, Macro-zoobenthos are important for the natural fish food supply. Ephemeroptera (aquatic *Insect Larvae*) for example, is a source of food for fish (Yule & Sen, 2004). *Bryconamericus iheringii* (*Caracidae*) is a type of fish that preys on Macro-zoobenthos Molluscs *Pomacea canaliculata* (*Ampullaridae*), and *Diplodon delodontus* (*Hyriidae*) which are known from tracing with C-isotopes in their digestive tract (Oosterom et al, 2013). In addition, the dynamics of the Macro-zoobenthos community can be a parameter for other aquatic biota. The presence of salmonoid *Oncorhynchus mykiss* as an introduced species in the rivers and lakes of Patagonia, Argentina resulted in a decrease in the diversity of Macro-zoobenthos (Buria et al, 2007).

Macro-zoobenthos are also often used to determine water quality, habitat quality, and sediment conditions. In addition, Macro-zoobenthos are used to assess water quality and evaluate the influence of anthropogenic stresses at various levels of biological organization, from molecular to ecosystem (Carter, 2006). Macro-zoobenthos have also been used as a model to determine the productivity or tropical status of waters (Hanson & Peters, 1984; Rasmussen & Kalff, 1987; Nalepa, 1989). The Macro-zoobenthos community itself consists of groups of worms, Molluscs, *Crustaceans*, and *Insect Larvae*. They range in size from²00-500 m (Odum, 1993; Rosernberg & Resh, 1993). Its habitat includes both littoral and deep zones, but the diversity, abundance, and productivity of Macro-zoobenthos are higher in the littoral zone. Meanwhile, in the deep ecological zone, feeding is more limited due to the decreasing concentration of dissolved oxygen in the waters (Horne & Goldman, 1994).

The declining quality of inland waters (lakes) is a threat to the balance and health of the lake ecosystem itself. On a larger scale, it can cause economic losses. Based on the results of the National Lakes Indonesia Conference I (KNDI I) in 2009, 15 lakes were prioritized to be saved, one of which was Lake Maninjau, West Sumatra. Lake Maninjau has a surface area of ±99.5 km², Agam Regency. Lake Maninjau is a volcanic lake with a maximum depth of 165 m (Makmur & Muthmainah, 2020). The lake's water source comes from ±88 rivers (inlet) and has an outlet. The potential of Lake Maninjau, among others, as a source of biodiversity, aquaculture production sources, irrigation, hydropower, and ecotourism. The fishery system with floating net cages that has developed since 1992 has great potential in fish production. This shows that Lake Maninjau has a high economic value. On the other hand, the amount of fishery cage waste that is disposed of causes microalgae explosions and decreases the quality of lake waters as happened in 2011 (Tanjung, 2013). High fishery potential should be supported by a stable ecosystem. The ecological potential of Macro-zoobenthos in Lake Maninjau related to feeding ecology has not been widely disclosed. Its role as a component of the food chain is also supported by the condition of the lake. Thus, it is necessary to know and conduct an inventory of the ecological potential of Macro-zoobenthos in Lake Maninjau. This paper aims to determine the composition and *ecology of the feeding group* of the Macro-zoobenthos community in Lake Maninjau, considering the important role of Macro-zoobenthos in aquatic systems. The results of this study are expected to be a *database* and input in the management and conservation of Lake Maninjau.

RESEARCH REVIEW FINDINGS

2.1 Location descriptions

Macro-zoobenthos sampling was carried out at seven locations, most of which were near the inlet, namely Sigiran, Bayur, Muara Tanjung, Sungai Batang, and one location near the outlet in the Muko-muko area. Benthos samples were taken at various depths from 0 to 5 m according to the conditions of the research site. The research locations are presented in the research map Fig 1 and Table 1. The locations, of them, are close to the KJA. In general, all locations have a silt-sand bottom substrate character. Sigiran station base substrate consists of 90% silt and 10% sand; Bayur (Sungai Limau Hantu) consists of 30% mud and 70% sand; Muara Tanjung consists of 70% mud and 30% sand, Muko-muko consists of 50% mud and 50% sand, while the Batang River is the mostly rocky bottom substrate.

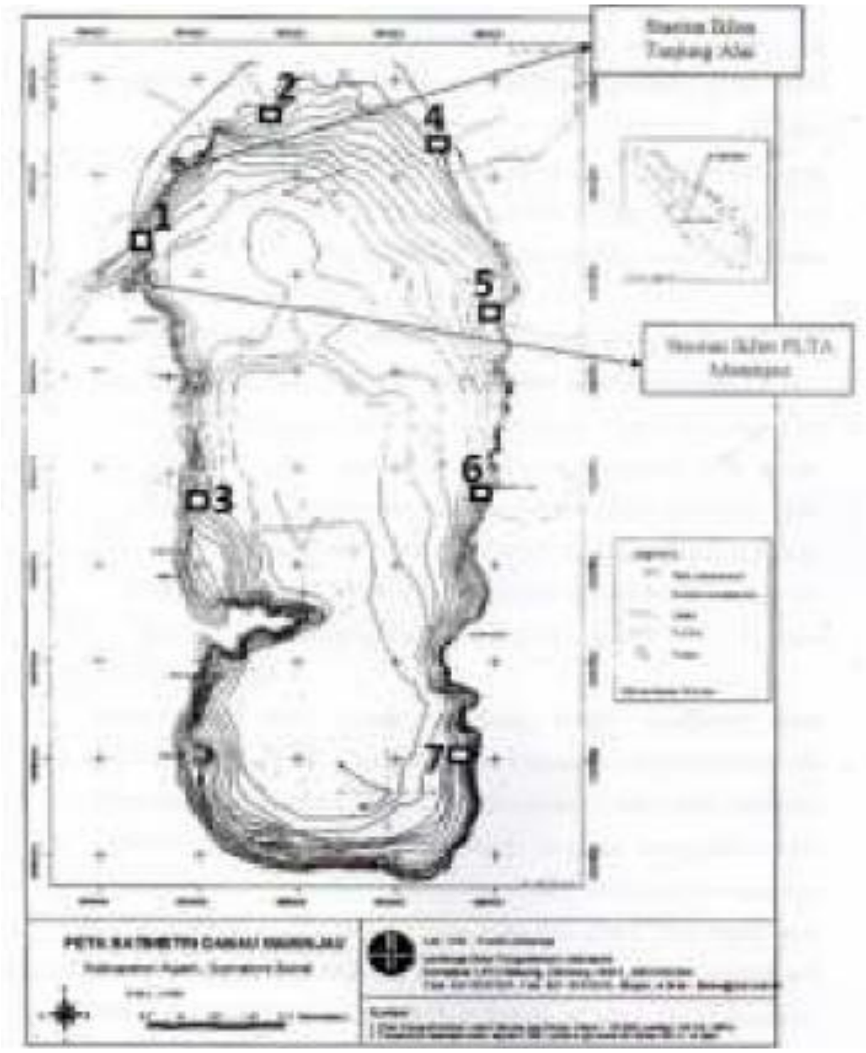

Figure 1. Map of research location in Lake Maninjau.

Table 1. Research locations in lake maninjau

Locations	Code	Description
St.01	Outlet Muko-muko	There is a hydropower intake Lake Maninjau outlet Tourist area
St.02	Muara Tanjung	There are several residential areas Rice fields There are few KJA
St.03	Sigiran	There are several residential settlement Rice fields There are few KJA
St.04	Bayur-1 Sungai Limau Hantu inlet	Sungai Limau Hantu inlet KJA cage center There is a residential area
St.05	Bayur-2 Gasang	There are KJA There are residential areas There are hotels, homestays and restaurants
St.06	Batang river	There is a pier and a traditional market Residential settlements Many KJA
St.07	Pandan	There is a rice field area KJA a little

2.2 Composition, diversity, and abundance

There are 34 types of Macro-zoobenthos belonging to 25 families from the sampling results at seven research sites in Lake Maninjau. The Macro-zoobenthos community consisted of *Gastropods*, *Bivalves*, *Oligochaeta*, *Turbelaria*, *EuHirudinea*, *Insect Larvae*, and Small *Crustaceans*. Aquatic insects are the most diverse benthic group, both in the number of families (10) and the number of species/species (11). The second group by *Gastropods* (6 families and 10 species). *Oligochaeta* although only 2 families consists of 6 species. *Bivalves*, *EuHirudinea*, and small *Crustaceans* both consist of 2 families and 2 species. Meanwhile, *Turbelaria* only consisted of 1 family and 1 species (Table 2). Families *Naididae* and *Thiaridae* have the highest number of *Taxa* (4) compared to others. Both in addition to the variety of types, are also found in quite abundant quantities. On average, there were 10 *Taxa* at each observation location.

Table 2. Composition and ecological group of feeding Macro-zoobenthos in Lake Maninjau

Class	Family	*Taxa*/type	EFG
Bivalves	*Unionidae*	*Anodonta sp.*	CF
Bivalves	*Corbiculidae*	*Corbicula sp.*	CF
Gastropod	*Ampullaridae*	*Pomacea sp.*	SC
Gastropod	*Thiaridae*	*Brotia sp.*	UN
Gastropod	*Thiaridae*	*Melanoides sp.*	SC
Gastropod	*Thiaridae*	*Tarebia sp.*	UN
Gastropod	*Thiaridae*	*Thiara sp.*	UN
Gastropod	*Lymnaeidae*	*Lymnaea sp.*	SC
Gastropod	*Bithyniidae*	*Bithynia sp.*	SC
Gastropod	*Planorbidae*	*Gyraulus sp.*	SC
Gastropod	*Planorbidae*	*Ameriana carinata*	SC
Gastropod	*Viviparidae*	*Bellamya* sp.	SC
Oligochaeta	*Naididae*	*Branchiodrilus sp*	UN
Oligochaeta	*Naididae*	*Nais* sp.	CG
Oligochaeta	*Naididae*	*Pristina sp.*	CG
Oligochaeta	*Naididae*	*Dero* sp.	CG
Oligochaeta	*Tubificidae*	*Limnodrilus sp*	CG
Oligochaeta	*Tubificidae*	*Branchiura sowerbyi*	CG
Hirudinea	*Glossiphoniidae*	*Placobdelloides* sp.	PR
Hirudinea	*Erpobdellidae*	*Barbronia* sp.	PR
Turbellaria	*Planariidae*	*Dugesia* sp.	PR
Insects	*Psephenidae*	*Psephenus* sp.	SC
Insects	*Elmidae*	*Stenelmis* sp	SC
Insects	*Ecnomidae*	*Ecnomus* sp.	CF
Insects	*Naucoridae*	*Pelocoris* sp.	PR
Insects	*Corixidae*	*Micronecta* sp.	PR
Insects	*Coenogrionidae*	*Pseudogrion* sp.	PR
Insects	*Gomphidae*	*Hagenius brevistylus*	PR
Insects	*Corduliidae*	*Neurocordulia* sp.	PR
Insects	*Chironomidae*	*Tanytarsus* sp.	CF
Insects	*Chironomidae*	*Polypedilum* sp.	SH
Insects	*Baetidae*	*Diphetor* sp.	CG
Crustaceans	*Atyidae*	*Caridina* sp.	CG
Crustaceans	*Cyclestheridae*	*Cyclestheria* sp.	CF

Note: EFG= Ecology feeding group; SH= Shredder; SC= Scrapper; CG= Collector gather; CF= Collector filters; PR= Predator, UN= unidentified

Macro-zoobenthos were more diverse at depths <1 m. In general, the number of *taxa* decreases with increasing depth. At a depth of 0-1 m on average, there are 7-12 types of macrozoobenthos, 8-11 species at a depth of 2 m, and 5-8 species at a depth of 5 m. Several types of Macro-zoobenthos are only found in shallow areas. *Gastropods* of *Pomacea, Thiara, Tarebia, Turbelaria Dugesia,* most insect larvae such as *Polypedilum, Psephenus, Stenelmis, Ecnomus, Pelocoris, Micronecta, Pseudogrion,* and *Dipethor,* and small crustaceans*, both Caridina* and *Cyclestheria, were* only found at a depth of 0-1 m. *The Bellamnya Gastropods* and *Barbronia Euhirudinea were* found to a depth of 2 m. In terms of the percentage of group presence, bivalve molluscs were generally abundant to a depth of 2 m and decreased to a depth of 5 m. The groups that are often found as the depth increases are from the group *Oligochaeta*. The lakeside area is richer in *allochthonous* nutrient input from the mainland compared to the middle of the lake.

The diversity index (H) of Macro-zoobenthos in Lake Maninjau ranged from 0.341 to 0.821, thus the sampling location had an H index <1. Based on the *Shannon-Wiener* diversity index value, in general, the diversity of Macro-zoobenthos in Lake Maninjau is classified as low, according to the criteria that H <1= low diversity, 1 <H <3= moderate diversity, and H> 3= high diversity (Sudarso & Yusli, 2015). Pandan is the location that has the highest average diversity index, followed by Muara Tanjung, Sungai Batang, Muko-muko, Bayur, and Sigiran. A high diversity index indicates that the ecosystem is healthy and conducive and taxa can adapt to their environment (Orwa *et al*, 2014). On the other hand, the diversity index in Lake Maninjau is low. The distribution of species in the community was relatively less to almost uniform (E= 0.30-0.93). However, most of the locations (75%) showed a uniformity index value that was close to an almost even condition. The uneven distribution indicates that the community is under stress (stress) and is characterized by the presence of dominating species (Sudarso & Yusli, 2015). This can be seen from the Mollusk group that dominates Lake Maninjau. This group *predominates* in (70%) of sampling locations. Of all Mollusks, 40% are *Corbicula* or known locally as Pensi. *Corbicula* almost dominates in every location, especially in Sigiran. The abundance of this *Corbicula* is very prominent compared to other macrozoobenthos. It is suspected that the low level of diversity of Macro-zoobenthos is one of the reasons for the dominance of a certain species such as this *Corbicula*, but further studies are needed regarding this matter. *Corbicula* is one of the benthos that has economic value for the surrounding community which is used as a source of food. The potential for catching *Corbicula* is quite high, namely 221 tons of bkba/years, and is considered to exceed the limit of its sustainable potential (Lukman, 2015). Based on the results of spatial abundance, pensi fishing especially in the Bayur and Sungai Batang locations needs to be considered because the abundance is much smaller than the other four locations.

Individual abundance at each location is relatively variable. Sigiran besides having a low diversity of benthic species, its distribution is also uneven (<0.5), but in terms of abundance it is abundant. Sigiran was the location with the highest benthic abundance (10225 individuals/m^2), followed by Pandan (4542 ind/m^2), Muara Tanjung (3462 individuals/m^2), Bayur- Sungai Limau Hantu (1670 individuals/m^2), Muko-muko (1553 individuals/m^2), Bayur-gasang (7782 individuals/m^2), and Sungai Batang (145 individuals/m^2). Another abundant Macro-zoobenthos is *Limnodrillus* from the *Oligochaeta* group. These species generally prefer a substrate in the form of fine sediment (grain <0.21 mm). Most of the base substrate at the observation station is silt (fine). Fine sediment is a very supportive habitat for *Limnodrilus reproduction* because it can be used to wrap *cocoons* (eggs) during reproduction.

Some *Gastropods* experience an increase in abundance with increasing depth. Most of those found were from the families of *Thiaridae*, *Viviparidae*, *Bythinidae*, *Ampullaridae* which are a group of *Prosobranchia*, namely *Gastropods* that breathe using gills. *Prosobranchs* are less tolerant of low dissolved oxygen (DO) concentrations and are unable to carry out anaerobic metabolism when oxygen conditions are very limited (Ridwan et al., 2014a b; Dewata & Putra, 2021). DO concentrations at the time of observation ranged from 3.15-7.71 mg/L with a mean of 4.82 mg/L, and almost every location had to DO <7 mg/L except Bayur Sungai Limau Hantu. Thus, a low DO factor has little impact on abundance.

2.3 Ecology *Feeding Group*

In the grouping based on feeding ecology, the Macro-zoobenthos in Lake Maninjau are mostly *Collector filters* (CF) as much as 67%, followed by Collector gather/CG (21%), Scrapper (6%), Predator (4%), and Shredder (2%). The group was found in almost all locations except Muko-muko, where no predators were found. The filter collector group includes *Corbicula*, *Anodonta*, *Tanytarsus*, *Ecnomus*, and *Cyclestheria*. In terms of species, CF is less than other groups such as CG, scrappers, and predators but is in abundance. Collector gather includes *Nais*, *Pristina*, *Dero*, *Limnodrilus*, *Branchiura Sowerby*, *Dipethor*, and *Caridina*. CG is mostly from the *Oligochaeta* group.

The *Scrapper* consists of *Pomacea*, *Melanoides*, *Lymanea*, *Bithynia*, *Gyraulus*, *Ameriana*, *Psephenus*, and *Stenelmis*. *Scrappers* are mostly from the *Gastropod* group. Predators *Placobdelloides*, *Barbronia*, *Dugesia*, *Pelocoris*, *Micronecta*, *Pseudogrion*, *Hagenius*, and *Neurocordulia*. Most of the Macro-zoobenthos found were collectors (CF and CG). Meanwhile, *shredder is the* least feeding ecological group in Lake Maninjau both in terms of species and abundance, because it only consists of 1 type of macrozoobenthos, namely *Polypedilum*. The presence of predators in an aquatic ecosystem is generally characterized by clear water habitat (low turbidity). Regarding their role as predators, predators not only need large amounts of prey but also need clear water because the prey can be seen clearly (Orwa *et al*, 2014). In contrast, Lake Maninjau has few predators. The water looks cloudy, physically the level of brightness (Secchi) is low (<3 m), and it is suspected that it contains organic particles/microalgae that are in the upper layer of the lake waters originating from *Allochtonous* influx. The *scraper group* are mostly members of *Gastropods* with *Melanoides* sp being the most common. *Scrapers* get their food by scraping the surface of the substrate/rock (Ridwan et al., 2014a b; Dewata & Putra, 2021). The existence of this species is usually closely related to the abundance of algae such as periphyton in the waters. *Gastropod* groups were found in almost all observation locations.

2.4 Canonical Correspondence Analysis (CCA)

Based on the results of the CCA ordination analysis between Macro-zoobenthos and water quality parameters (temperature, conductivity, TDS, DO, and ORP) using 2 axes, the DO and ORP variables correlated with axis 1. While the variables temperature, TDS, and conductivity correlated with axis 2. The eigenvalues of the ordinance are 0.61 and 0.35. The explained cumulative percentage was 74%, and the correlation value between Macro-zoobenthos species and environmental variables was 0.98 and 0.99. There are 26 types of Macro-zoobenthos namely *Anodonta* (Ano), *Brotia* (Bro), *Tarebia* (Tar), *Thiara* (thi), *Lymanea* (Lym), *Bithynia* (Bit), *Gyraulus* (Gyr),*Ameriana* (Ame), *Branchiodr* *ilus* (Bra), *Nais* (Nai), *Pristina* (Pri), *Limnodrilus* (Lim), *Dugesia* (Dug), *Polypedilum* (Poy), *Tanytarsus* (Tany), *Psephenus* (Pse), *Stenelmis* (Ste), *Ecnomus* (Ecn), *Pelocoris* (Pel), *M icronecta* (Mic), *Pseudogrion* (Pse), *Hagenius* (Hag), *Neurocordulia* (Neu), *Dipethor* (Dip), *Clycestheria* (Cyc), and *Caridina* (Car) were closer to axis 2 which were characterized by variables of temperature, conductivity, and TDS. While the other 8 species, namely *Pomacea* (Pom), *Corbicula* (Cor), *Melanoides* (Mel), *Bellamnya* (Bel), *Dero* (Der) , *Branchiura sowerby* (Sow), *Placobdelloides* (Pla), and *Barbrionia* (Bar), are closer to axis 1 which is characterized by DO and ORP variables. For more details, you can see Fig 2 below.

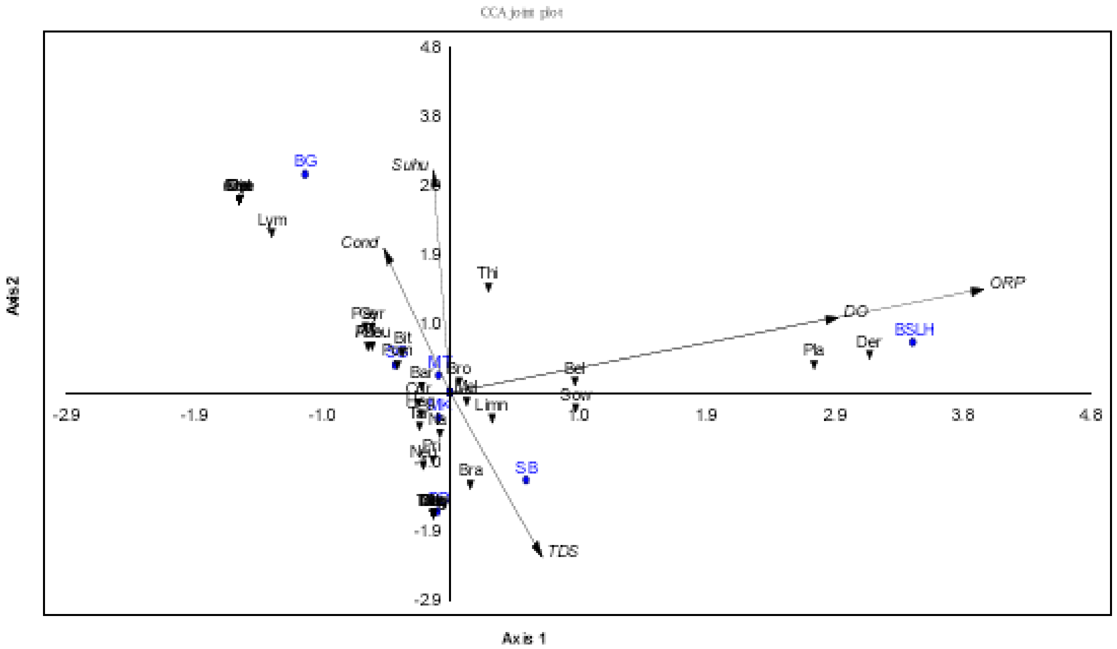

Figure 5. Graph of CCA Macro-zoobenthos ordination results with water quality variables in Lake Maninjau.

CONCLUSION

The level of diversity of Macro-zoobenthos in Lake Maninjau is low with less to almost even distribution. Insect larvae are the most diverse group, while *Corbicula bivalves* are the species that dominate the waters. Most of the Macro-zoobenthos belong to the collector group based on feeding ecology, this shows that Maninjau Lake is rich in fine organic particles (FPOM). Lake Maninjau at a depth of 5 m still found macrozoobenthos.

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