The community structure of Gastropods as bioindicators of water quality in Krueng Aceh, Banda Aceh

To cite this article: A Afwanudin et al 2019 IOP Conf. Ser.: Earth Environ. Sci. 348 012122

View the article online for updates and enhancements.
The community structure of Gastropods as bioindicators of water quality in Krueng Aceh, Banda Aceh

A Afwanudin¹, M A Sarong², R Efendi³, A Deli⁴, M Irham⁵*

¹Department of Graduate Study of Coastal Area, UniversitasSyiah Kuala, Banda Aceh. Indonesia
²Faculty of Teacher Training and Education, UniversitasSyiah Kuala, Banda Aceh, Indonesia and Faculty of Fisheries, UniversitasTeuku Umar, Aceh Barat, Indonesia
³Faculty of Natural Sciences, UniversitasSyiah Kuala, Banda Aceh, Indonesia
⁴Faculty of Agriculture, UniversitasSyiah Kuala, Banda Aceh, Indonesia
⁵Marine and Fisheries Faculty, UniversitasSyiah Kuala, Banda Aceh, Indonesia

*E-mail: irham@unsyiah.ac.id

Abstract. Gastropods have an important role in an ecosystem that is directly involved in the food chain system and can be used as a bioindicator of water quality because it is sensitive to water pollution. This study was conducted to analyze the quality of the waters of Krueng Aceh by identifying the diversity of the Gastropod community and analyzing the COD and BOD content in the waters. The study used a purposive sampling method by applying 5 sampling stations along the study area. Gastropod samples are taken using Ponal Grab, which is 23cm x 23cm and sieved from the substrate using a mesh filter. The results showed that the highest abundance index was obtained at station 1, which is 15 ind/m². The results of identification in the study area are 15 Gastropod Species. Furthermore, the most widely found Gastropod species is Snail tiger, while the least is Margarites. This result informs that the highest diversity index is found at station 1, which is 2.51 categorized as moderate pollution and on the other hand the dominance index level is less than 0.50 or no one dominates at each station.

1. Introduction
Location of Banda Aceh City Waste Treatment Site is located in Krueng Aceh River Watershed. This landfill produces waste that can affect the quality of the Krueng Aceh waters. The decline in quality of the Krueng Aceh waters may be seen from the muddy waters of the rivers with high turbidity. Saifulah¹ states that the decline in river water quality can be caused by various activities carried out along the river stream. Therefore, it can lead to changes in river water quality which includes changes in the nature of chemical and biological physics. Along with the rapid development of residents living in the vicinity of Krueng Aceh, there are quite complex problems. The water quality of Krueng Aceh continues to decline which can be seen from the color and smell in some downstream parts of the Krueng Aceh River. Thus, the condition of Krueng Aceh waters has implications for the downsides of the existence of present organisms in the waters.

The Krueng Aceh River, which is part of a residential area, is often used as a source of water for the use of washing vessel, the disposal of household waste water and other small industrial wastes. In this condition there will be potential accumulation of heavy metals in the Krueng Aceh River. Heavy
metals in certain concentrations are one of the pollutant groups that are dangerous if they enter into aquatic ecosystems [2, 3].

One organism that lives in the ecosystem of Krueng Aceh is a gastropod class organism. Gastropod is a community that lives on the bottom of the water. In ecosystems, gastropods have an important role directly as a food chain system for other organisms. In addition, gastropods are used by humans as a source of animal protein [4]. Gastropod community structures in the waters can be influenced by biotic and abiotic factors, especially the condition of the aquatic environment, food availability.

Gastropods usually live attached to a hard, muddy and sandy substrate. Gastropoda is also incorporated into benthic animals which utilize organic ingredients containing detritus organisms from seagrass and seaweed [5, 6, 7]. Gastoptopod is an organism whose life is very sensitive to changes in quality in a water, so it can be used as a bioindicator to measure water quality. Therefore, according to Rong and Shan and Geerdinka et al. [8, 9], the entry of chemical organic substances into a water can cause the quality of the waters to experience biological function degradation which causes death for gastropods [10, 11]. Gastropod demise can also be caused by the presence of toxic substances produced by community activities around the Krueng Aceh River.

Considering the current condition of the Krueng Aceh River is quite worrying, there is a decrease in water quality so that it cannot be utilized by the community and lack of water quality information in the Krueng Aceh River. Therefore, research on the quality of Krueng Aceh waters is necessary. Consequently, this study aims to analyze the abundance of benthic Gastropods together with analyzing the content of BOD and COD in Kreung Aceh, Banda Aceh City. It is expected that the results of the study will be an information decision-making in the context of the management and preservation of the Krueng Aceh Watershed in Banda Aceh City.

2. Method
2.1 Time and location of study
This research was conducted in March 2019. Gastropod sampling was carried out in the waters of the Krueng Aceh River. Gastropod samples were identified at the Integrated Laboratory of the Faculty of Marine and Fisheries of Syiah Kuala University by using identification books for Indonesian Snails and shellfish. Map of research location can be seen in Figure 1.
2.1.1 Sampling of gastropods. This research was conducted with a purposive sampling method. The area of the Krueng Aceh River in Banda Aceh City. This research area is divided into 5 location, namely; Station 1 (Control), Station 2 Community Settlement, Station 3 TPI, a Fish Landing Place/Fish Port site, Station 4, Final Management site and station 5 an estuarial area.

The Gastropod sampling was carried out by establishing three sampling plots, each measuring a 1 m x 1 m located along the transect line and within 5 meters between the plots. Gastropod sampling was selected on the left bank, centre and right bank of the Krueng Aceh River.

2.1.2 Identification of gastropods. Gastropods that have been obtained from the field were brought to the Syiah Kuala University Faculty of Marine and Fisheries Laboratory and identified by referring to the basics of species identification according to Van Banthem Jutiing's manual (1956).

2.1.3 Measurement of physical and chemical parameters.

a) Temperature (°C) and salinity

Temperature was measured using a water thermometer. This measurement was done on the surface of the water by dipping the thermometer into the water, then reading the value printed on the Thermometer. The salinity was measured by using refractor meters carried out directly in the field. Water samples were taken using a dropper pipette and dripped in the refractometer and the current values listed on the Hand Refractometer was read.

c) Dissolved oxygen (DO)

The DO was measured using DO Meter which is carried out directly in the field. The probe was dipped in water or surface water samples and wait a few moments. Next the scale shown on the DO meter tool was read.

d) Acidity of water (PH)

Measuring the temperature of the water is measured using a pH meter device that is carried out directly in the field. The instrument measures the acidity of the water dipped in the measured water sample, then looks at the scale printed on the pH meter tool.

e) Biological Oxygen Demand (BOD)

Water samples are taken for BOD determination, samples are diluted first, then the DO was measured using DO meters which are considered as DO₀. Then the sample was put in a dark colored bottle and incubated in a dark place for 5 days at 20°C, after 5 days the DO₅ was measured using DO meter.

f) Chemical Oxygen Demand (COD)

The measurement of COD was tested using filter photometry method. The water sample was taken and inserted into a dark bottle to avoid the sunlight. No incubation needed for COD tested.

2.2 Data analysis

Abundance of Gastropod types

The calculation of gastropod abundance(Ind./m²) or density of bivalves using formulas.

\[ D = \frac{N_i}{A} \]

where \( N_i \) is number of individuals Gastropods and A is the total area (m²).

Diversity index

Determination of indicator species is done through Gastropod diversity with the following diversity index formula:

\[ H' = -\sum_{i=1}^{n} \left( \frac{N_i}{N} \right) \ln \left( \frac{N_i}{N} \right) \]

Where \( N_i \) is number of types of individuals and \( N \) is Total number of individuals.

Uniformity index

The uniformity index is calculated using the Evenness-index formula.
E = \frac{H'}{\ln S}

Where H' is the index of species diversity and S is the number of types of organisms. The result of the analysis was then classified as shown at Table 2.

### Dominance index (D)

The dominant index is calculated using dominance of Simpson formula as:

\[ C = \sum \left( \frac{n_i}{N} \right)^2 \]

Where \( n_i \) is the number of individuals for each type and \( N \) is the total number of individuals.

### Determination of the biological oxygen demand (BOD)

The determination of BOD uses the formula of

\[ DO (mg/L) = \frac{V \times \text{Thiosulfate} \times N \times \text{Thiosulfate} \times 1000 \times \text{Be} \times O_2 \times \text{p}}{V} \]

\[ \text{BOD} (mg/L) = (DO_0 - DO_5) \]

Where \( D_5 = \text{Value of dissolved oxygen sample after incubation for 5 days (mg/L)} \) and \( p \) is the dilution factor.

### Determination of chemical oxygen demand

Determination of the value of Chemical Oxygen Demand using:

\[ COD = \frac{(A - B) \times NFAS \times 100 \times \text{Be O}_2 \times p}{V \times \text{Sample}} \]

where:

- \( A = \text{mL blank titrant} \)
- \( B = \text{mL sample titration} \)
- \( N = \text{Normality of FAS} \)
- \( \text{Be O}_2 = 8; p = \text{Dilution} \)

## 3. Results and Discussion

### 3.1 The abundance and diversity index (H') of gastropods

Based on the results of sampling, the gastropods found in station 1 were obtained as many as 45 individuals from 6 species, at station 2 obtained as many as 35 individuals from 6 species, station 3 obtained as many as 11 from 2 species, station 4 obtained as many as 17 individuals from 5 species of species, and at station 5 there were 13 individuals from 3 species of species. The overall results can be seen in Table 3 for gastropods abundance and the results of the Diversity Index can be seen in Table 1.

The abundance of ind/m² in this study obtained the highest number of ind / m² at station 1 (control), that is, 15 ind/m² while the lowest level of ind / m² was found at station 3 (fish landing site), namely, 3.67 ind/m².

The Diversity Index as listed in Table 2 states that highly polluted areas are at station 3. Station 3 is a fish landing port area which is also used as a washing place for fishing boats. In this area, the activities cause pressure on the surrounding environment which may generate the destruction of the biotic system, triggering the quality of the waters to decline as also stated [12][13]. Besides that, the substrate at station 3 is a muddy substrate which is also a factor that influences the presence of gastropods because the substrate in the form of mud has less oxygen than sand. Abdullah [14] in their study stated that the mud fraction has little oxygen circulation which results in a decrease in the abundance of gastropods.
Table 1. The amount of gastropod abundance

| Species                  | Station 1 | Station 2 | Station 3 | Station 4 | Station 5 |
|--------------------------|-----------|-----------|-----------|-----------|-----------|
| Snail Tiger              | 10        | 10        | 8         | 8         | 7         |
| BathtbembixMacdonaldi    | 4         | 0         | 0         | 0         | 4         |
| BtoriaSwinhoci           | 8         | 0         | 0         | 0         | 0         |
| PomassaConaliculata      | 5         | 0         | 3         | 0         | 2         |
| MelanoidesTuberculata    | 8         | 0         | 0         | 5         | 0         |
| Thiaridae                | 10        | 3         | 0         | 0         | 0         |
| MelanoidesRequeti        | 0         | 6         | 0         | 0         | 0         |
| Goniobasis Virginia      | 0         | 6         | 0         | 0         | 0         |
| ThiaraScabra             | 0         | 8         | 0         | 0         | 0         |
| Littorina Saxatillis     | 0         | 2         | 0         | 0         | 0         |
| BattilariaSp             | 0         | 0         | 0         | 2         | 0         |
| TympanotenesTrochlerispina | 0   | 0         | 0         | 1         | 0         |
| Margarites               | 0         | 0         | 0         | 1         | 0         |
| **Total**                | **45**    | **35**    | **11**    | **17**    | **13**    |
| **Abundance**            | **15**    | **11.67** | **3.67**  | **5.67**  | **4.33**  |

Table 2. Abundance Gastropods ind/m²

| Station | Total Gastropods | ind/m² |
|---------|------------------|--------|
| 1       | 45               | 15     |
| 2       | 35               | 11.67  |
| 3       | 11               | 3.67   |
| 4       | 17               | 5.67   |
| 5       | 13               | 4.33   |

Table 3. Table of Diversity Indexes

| Station | H⁠¹ | Ecology Category | Water quality | Category          |
|---------|-----|------------------|---------------|-------------------|
| 1       | 2.51| Medium           | Light pollution|                   |
| 2       | 2.41| Medium           | Light pollution|                   |
| 3       | 0.84| Very poor        | Heavy pollution|                   |
| 4       | 1.87| Poor             | Moderate pollution|               |
| 5       | 1.42| Poor             | Moderate pollution|               |

3.2 Results of measurement of BOD₅, COD dan TSS

The results of this test can be seen in the following Table 4. BOD₅ results in these waters range from 0.90 mg/l - 2.60 mg/l, this value is still in the class 1 category according to Government Regulation concerning water quality management and water pollution control. The resulting value is classified as an aquatic condition that is good for the growth and development of aquatic organisms including macro-zoobenthos. Unlike the diversity index results which state that station 3 is highly polluted due to the muddy substrat and lack of oxygen circulation, but the quality of the water column based on the BOD test is still relatively good. Scientifically, it can be explained that the river flow that always carries water from the upstream to downstream causes the content of BOD at station 3 always
be circulated which depends on how fast or slow the flow of the river. While the river substrate in station 3 does not move so that there is no circulation substrate but only oxygen circulation occurs and that too is difficult to occur because the substrate is muddy. The highest COD test results were obtained at station 3. The high concentration of organic matter at station 3 was thought to be due to the large input of organic pollutants from the rest of the fishing vessel washing and fish wastes which were directly dumped into the river. While the results of total suspended solid (TSS) sampling ranged from 22-36 mg/l which are classified into the relative category affecting water quality. Although there are still suspended solids in this water and high values are also present in station 3, it is assumed that one of the sources of these suspended solids comes from inorganic and organic solids and insoluble liquids such as fats and oils originating from fish vessel waste disposal.

| Test Parameters | Station 1 | Station 2 | Station 3 | Station 4 | Station 5 | unit |
|-----------------|-----------|-----------|-----------|-----------|-----------|------|
| \( \text{BOD}_5 \) | 0.90      | 1.10      | 1.70      | 2.60      | 2.10      | mg/l |
| COD             | 14.73     | 18.02     | 39.32     | 37.68     | 24.58     | mg/l |
| TSS             | 32        | 32        | 36        | 36        | 22        | mg/l |

3.3 Physical and chemical water quality factors

In general, the parameters of physical and chemical factors in a water become a determining or controlling factor for the life of organisms in the Krueng Aceh river. Water quality measurement results can be seen in the following Table 5.

| Parameter        | Station 1 | Station 2 | Station 3 | Station 4 | Station 5 |
|------------------|-----------|-----------|-----------|-----------|-----------|
| Salinity         | 0       | 0 %       | 0 %       | 0 %       | 5 %       |
| pH               | 7.59 %   | 7.63 %    | 7.74 %    | 7.65 %    | 7.70 %    |
| DO               | 6.7 mg/l | 6.8 mg/l  | 7.0 mg/l  | 6.6 mg/l  | 6.9 mg/l  |
| Temperature      | 25 °C    | 25 °C     | 29 °C     | 28 °C     | 30 °C     |
| Water flow       | 0 m/s    | 0.13 m/s  | 0.16 m/s  | 0.25 m/s  | 0.30 m/s  |
| Water depth      | 5 m      | 4.2 m     | 3.3 m     | 2 m       | 3 m       |
| Turbidity        | 26 cm    | 30 cm     | 35 cm     | 50 cm     | 55 cm     |

The results of the physical and chemical water quality test, it can be stated that the water quality of Krueng Aceh is still normal and in good condition. Generally, the value of the test results in Table 4 can still be tolerated by organisms especially gastropods. Especially for water temperature, the highest tolerance limit for the balance of the structure of benthos animal populations at temperatures close to 32°C, the water temperature is still suitable for the life of gastropod organisms where Abdullah[14] stated the optimum temperature range to support gastropod life from 28°C to 32°C.Meanwhile the depth of the water ranges from 2-5 m which is still normal for the abundance of gastropod organisms. Soad[15] state that increasing depth can affect the abundance of macro-zoobenthos and organism abundance is higher in shallow waters. The turbidity of the river is still normal and the flow of the river is relatively fast ranging from 0.1-1.0 m/s.

4. Conclusion

The highest abundance of gastropod species in the Krueng Aceh River is found at station 1, namely, 15 ind/m² and the lowest number is at station 3 which is 3.67 ind/m². The level of pollution through
the index shows that station 3 is categorized as highly polluted while in station 1 the pollution is categorized as mild pollution, while in other stations it is still normal condition.

References

[1] Saifullah, Dodi H, Brillyan H P 2015 Jurnal Perikanan dan Kelautan 5(1) 1-4
[2] Suhendrayatna, Ohki A, Gultom A C 2011 Mercury Levels and Distribution in Organs of Freshwater Organisms from KruengSabe River, Aceh Jaya, Indonesia Proceedings of the 6th Annual International Workshop & Expo on Sumatra Tsunami Disaster & Recovery 2011 in conjunction with 4th South China Sea Tsunami Workshop, TS-417
[3] Irham M, Fadla Y, Setiawan I 2018 IOP Conference Series: Earth and Environmental Science 106(1) 1–6
[4] Cappenberg H A W 2006 Jurnal Oseonologi dan Limnologi di Indonesia 39 75-87
[5] Nugroho K D, Chrisna A S, Irwani 2012 Journal of Marine Research 1(1) 100-109
[6] Bouchet P, Rocroi J, Hausdorf B, Kaim A, Kano Y, Nützel A, Parkhaev P, Schrödl M, Strong E E 2017 Malacologia 61 121-256
[7] Brio F D, Commendatore M, Castro I B, Costa P G, Fillmann G, Bigatti G 2016 Marine Biology Research 12(6) 608-620
[8] Rong N, Shan B 2016 China Environmental Science and Pollution Research 23(13) 13438–13447
[9] Geerdinka R B, van den Hurk R S, Epemaa O J 2017 Analytica Chimica Acta 961 1–11
[10] Tobajas M, Verdugo V, Polo A M, Rodriguez J J, Mohedano A F 2016 Environmental Technology 37(6) 713-721
[11] Smith J A, Dietl G P 2016 Journal of Biogeography 43(4) 791–400
[12] Reguera P, Couceiro L, Fernández N 2018 Ecotoxicology and Environmental Safety 148 593–600
[13] Savić A, Ranđelović V, Đorđević M, Pešić V 2016 Acta Zoologica Bulgarica 68(2) 235–242
[14] Abdullah A T, Sumaili I A, Gathmy M Y, Awaf A 2018 Life Science Journal 15(1) 51–55
[15] Soad S, Gawad A 2018 The Egyptian Journal of Aquatic Research 44(2) 77–82