The Difference of Macro-Benthic Diversity in Riparian Vegetation and less Vegetation Area

Didin wахyu Agustina *, Wulida Khoirunnisa, Ivakhul Anzila, Catur Retnaningdyah

Department of Biology, Faculty of Mathematics and Natural Science, Brawijaya University, Malang, Indonesia

ABSTRACT

Bedengan a secondary forest area is located in Selorejo village, Dau subdistrict, Malang. Riparian landscape in Bedengan area occur degradation caused by human activities that make areas in Bedengan as citrus plantation and camping area. This study aimed to compare benthic macroinvertebrate community structures between riparian vegetation and less riparian vegetation on camping area Bedengan Stream. The sampling sites were divided into five types of the stream: less vegetation area (pool and current) and riparian vegetation area (pool, current and riparian). There are 21 taxa founded in Bedengan stream that distribute 10 taxa can be found in less vegetation (9 taxa in current area and 6 taxa in pool area) and 20 taxa can be found pada area vegetation (10 taxa in current area, 14 taxa in pool area, and 17 taxa in riparian area). There are 21 taxa founded in Bedengan stream that distribute 10 taxa can be found in less vegetation (9 taxa in current area and 6 taxa in pool area) and 20 taxa can be found pada area vegetation (10 taxa in current area, 14 taxa in pool area, and 17 taxa in riparian area). The habitat character will determine the abundance of benthic macroinvertebrates in this context the more species in a location the better the quality of the habitat.

Keywords: Benthic, diversity, macroinvertebrate, riparian, vegetation

Introduction

Bedengan is a secondary forest located in Selorejo, Dau district, Malang. The riparian landscape in Bedengan area has been degraded due to human activities such as urban development, plantation, grazing and campsite. As a result, many riparian areas no longer perform critical ecosystem functions [1]. Riparians have an important role to preserve the naturalness of aquatic ecosystem. Riparian crop diversity provides organic components, energy and nutrients for aquatic ecosystems and prevents land erosion [2]. Stream side vegetation provides shade necessary for natural temperature regimes and improves stream ecosystem health, in addition riparian also perform as phytoremidiation and benthic habitat, this study was conducted to compare benthic community structure between less vegetation and vegetation area alongside in the Bedengan streams. Bedengan River has an important role for landscape, provide excellent habitat and food for many of the earth's organisms in Bedengan. That’s why this study is important to measurements of ecological patterns are often used as primary biological indicators of river health.

Material and Methods

**Determination sampling location point**

This study located in Bedengan stream. Sampling point recorded by GPS [4] and devided to

---

*Corresponding author:
E-mail: agustina.dhien@gmail.com
two kind of stream site: vegetation site with riparian site (point 1: 07°56′24.1″S - 112°31′47.8″T altitude 1038 m) and less vegetation site (point 2: 07°57′12.3″S - 112°36′44.8″T altitude 977 m). Wide scale of point 1 (V) and 2 (LV) determined based on natural condition which available. Point 1 devide to three sampling site such as riparian area (under hydromacrophyte in riparian are; V-R), pool area (V-P) and current area (V-C). Futhermore, point 2 devide to two samping site such as pool area (LV-P) and current area (LV-C).

**Sampling**

Sampling point was measured first. Sampling in riparian area was using kich sampling with hand net and surber net. All of macroinvertebrate which has been caught, then identified till 100 individuals within two sampling point. Then, samples fixed with alcohol 70% [5]. Physicochemical characteristics from each point such as water temperature, air temperature (°C), pH, conductivity (μS cm⁻¹), dissolved oxygen (mg L⁻¹) and turbidity (NTU) was measured for determine chemical polutan presentation that effected on communty structure of benthic macroinvertebrate [6].

**Data Analysis**

Identification of peripheral benthic macroinvertebrates uses the help of a key book’s determination. Parameter approach used is diversity, saprobik and biotic approach. The diversity index used is Shannon-Wiener (H '), Family Biotic Index (FBI), and Biological Monitoring Work Party (BMWP). Low diversity indicates low water quality and high diversity indicates good water quality [6]. Macroinvertebrate community structures are used as indicators of aquatic conditions. The analyzed community structure includes density (K), frequency (F), relative density (KR), relative frequency (FR) and INP. Statistical analysis of the biological index using Taxa Richness (S), Evenness (E), and Shannon-Wiener (H) diversity index and dominance index (Id) [6,7].

Physicochemical character analysis of water is done by compiling and interpretation of water quality test result data. After that, it is compiled with data of river species species abundance with vegetation and less vegetation using Biplot and Cluster PCA (Principal Components Analysis) analysis through PAST software.

**Results and Discussion**

Results of water quality analysis at poiny 1 (vegetation) and point 2 (less vegetation) are presented in table 1 as follows:

| Parameter          | Unit   | Sampling | 1           | 2           |
|--------------------|--------|----------|-------------|-------------|
| Water Temperature  | °C     | 19.38±0.375 | 20.34±0.058 |
| Air Temperature    | °C     | 22       | 22          |
| pH                 |        | 6.98±0.029 | 6.95±0.041  |
| DO                 | mg L⁻¹ | 1.10±0.010 | 1.07±0.006  |
| Conductivity       | μS cm⁻¹| 107.30±0.954 | 105.93±0.924 |
| Turbidity          | NTU    | 1.86±0.229 | 2.60±0.496  |

Based on the results of water quality analysis, air and water temperatures indicate conformity with the survival of peripheral benthic macroinvertebrates either in streams with vegetation or without vegetation. Benthic macroinvertebrate live in the range 19-30 °C. The results of pH measurements show no significance between water in stream vegetation and less vegetation. pH to support the live of peripheral benthic macroinvertebrates ranges from 6.5 to 8. Dissolved oxygen as a necessity of macroinvertebrate peripheral benthic life is indicated by the value of DO, the DO value is lower, so the less dissolved oxygen. Based on the results of DO analysis, indicating that the stream less vegetation has a lower value. This is due to the absence of riparian plants and hydromacrophytes which then produce oxygen. The conductivity value indicates the mineral abundance in the water so that the higher the conductivity value the more mineral in the water. Based on conductivity values, vegetation stream has a higher value than a less vegetation stream. This is related to the activity of riparian plants and hydromacrophytes that accumulate mineral homeland so can to increase the amount of minerals in the stream vegetation. The range of con-
ductivity values in natural water ranges from 20-1500 μS/μS cm⁻¹ [8]. The turbidity of the water can be known from the turbidity value. Based on the turbidity test results, the stream less vegetation has a higher value than the stream with vegetation. This result shows that the stream less vegetation is more turbid than the vegetation. Plants in riparian stream vegetation areas are able to make water clearer [9].

**Taxa distribution in Bedengan stream**

There are 21 taxa founded in Bedengan stream that distribute 10 taxa can be found in less vegetation (9 taxa in current area and 6 taxa in pool area) and 20 taxa can be found pada area vegetation (10 taxa in current area, 14 taxa in pool area, and 17 taxa in riparian area) (Table 1). Vegetation area has more taxa richness than in less vegetation area, riparian site in Vegetation area of Bedengan stream is the highest comparing between other site. Patterns of the macroinvertebrate assemblage structure in streams are in large part a function of the riparian environments that exist across different spatial scales. This approach leads to the understanding of environmental stressors, which may be a major factor driving the benthic community structure, and provides ecological connection among different spatial boundaries of environmental conditions [2].

Overall there are 2 species, Coenagrionidae dan Perlodidae which have highest important value index (INP) in almost 5 site of sampling area (Figure 1). Coenagrionidae belongs to the Ordonata family live in sediment or bottom stream with pattern of limited migration [10]. Based on life cycle, Oviposition of Coenagrionidae acour in the substrate of plant in streamside then moved into stone substrate after became larva [11].

In Table 1, shows that there are 12 species than’t can’t be found in less vegetation area but can be found in vegetation area. In other hand Tipulidae is the only species that not found in Vegetation area but in less vegetation area. Tipulidae develops in the aerial or semi-aquatic regions and is occasionally found in aquatic regions [12]. Hydrophilidae is species that only found in Current site. Hydrophilidae are True Water beetles, occurring in almost all aquatic habitats, as larvae and adults, and with only a few species being terrestrial [12]. Hydrophilidae is a prey of fish and makes them can be found in current site.
**Benthic macroinvertebrate diversity in Bedengan Stream**

Diversity index can be used as indicator to determine of stream ecosystem health. The higher of value of diversity index (H’) show the better quality of ecosystem health [14]. Both the value of diversity index (H’) and taxa richness (TR) in the less vegetation area is lower than the vegetation area (Figure 2a). This difference is likely due to substrate differences between less vegetation and vegetation areas where less vegetation areas are dominated by large and gravelled rocky substrates, whereas in vegetation areas it is dominated by substrate in the form of hydromicroflora and littery and pebbly. Vegetation area provide food from dead plant for benthic and some taxa lay their eggs (oviposition) on the microhidroflora [15].

**Figure 2.** Diversity Index (a) and Domination and Evenness index (b) in Bedengan stream

Evenness index (E) in the less vegetation area is lower than the vegetation area, because in the less vegetation area there are 2 dominating species. It can also be seen from the dominance index value in the less vegetation area higher than the vegetation area. Dominance in the vegetation area can be categorized as a partial medium and the vegetation area is categorized as a partial low. (Figure 2b).

The Diversity Index value (E) is inversely proportional to the Dominance Index (Id). Vegetation areas have high evenness with low levels of dominance because vegetation is a good area (sheltered, calm and abundant food reserves) for the breeding of most taxa, whereas in less vegetation only certain taxa can settle there was egg like Dugesidae and Hirudinea. This causes the dominance of less vegetation areas.

**Biplot analysis and Euclidean Cluster**

To analyze and compare the influence between locations on benthic macroinvertebrate abundance To analyze and compare the influence between locations on benthic macroinvertebrate abundance (individual/m²) can be analyzed PCA biplot and Euclidean clusters. Based on the five locations, habitat characteristics used were water temperature, pH, conductivity and turbidity (Table 1). Benthic macroinvertebrate species selected include Perlidae, Tipulidae, Trycoptera, Promoresia and Platycnemedidae. In addition, data on diversity index (H), Evenness index, uniformity index (E), taxa richness (TR) and dominance index (Id) were used. This analysis will interpret the existence of certain groupings that share the characteristics and abundance of benthic macroinvertebrates [14].

Based on PCA biplot analysis (Figure 3) and Euclidean clusters (Figure 4) it can be seen that there are four groups of similarity. The first group has similarity of water temperature character and turbidity with Promoresia abundance at LV-C and LV-P sites. The second group lacks the abundance of five species at the V-C site. The third group has a similarity of pH character and...
conductivity with Perlidae abundance at V-P sites. The fourth group has an abundance of Tipulidae, Trygoptera and Platycnemedidae species at the V-R site. The habitat character will determine the abundance of benthic macroinvertebrates in this context the more species in a location the better the quality of the habitat [15].

Figure 3. Biplot analysis between habitat factor and benthic macroinvertebrate in abundance (individual/m²)

Figure 4. Clustering analysis between habitat factor and benthiv macroinvertebrate in abundance (individual/m²)
Conclusion
There are 21 taxa founded in Bedengan stream that distribute 10 taxa can be found in less vegetation (9 taxa in current area and 6 taxa in pool area) and 20 taxa can be found pada area vegetation (10 taxa in current area, 14 taxa in pool area, and 17 taxa in riparian area). The habitat character will determine the abundance of benthic macroinvertebrates in this context the more species in a location the better the quality of the habitat.

Acknowledgment
The author thank to Ecological Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, Brawijaya University for facilitating this research.

References
1. Clausen JC, Guillard K, Sigmund CM, Martin-Dors K (2000) Ecosystem restoration: water quality changes from riparian buffer restoration in Connecticut. J Environ. Qual 29 (6):1751-1761. doi:10.2134/jeq2000.00472425002900060004x.
2. Hawkins CP, Vinson MR (2000) Weak correspondence between landscape classification and stream invertebrate assemblages: implications for bioassessment, J North Am Benthol Soc 19 (3):501-517. doi.org/10.2307/1468111.
3. Sandra L, Rios, Robert CB (2006). Relationship between riparian vegetation and stream benthic communities at three spatial scales. Hydrobiologia 553 (1):153-160. doi:10.1007/s10750-005-0868-z.
4. Ghosh D, Biswas JK (2015) Macroinvertebrate diversity indices: a quantitative bioassessment of ecological health status of an oxbow lake in Eastern India. J Adv Health Res 3 (2):78-90. doi:10.22102/jaehr.2015.40190.
5. Alvial IE, Tapia DH, Castro MJ, Duran BC, Verdugo CA (2012) Analysis of benthic macroinvertebrates and biotic indices to evaluate water quality in river impacted by mining activities in northern chile. J Knowl Manag Aquat Ecosystem 407: 1-14. doi: 10.1051/kmae/2012027.
6. Iniguez-Armijos C, Leiva A, Frede HG, Hampel H, Breuer L (2014) Deforestation and benthic indicators: how much vegetation cover is needed to sustain healthy Andean Streams? PLoS One 9 (8):e105869. doi: 10.1371/journal.pone.0105869.
7. Ghani WMHWA, Rawi CSM, Hamid SA, Al-Shami SA (2016) Efficiency of different sampling tools for aquatic macroinvertebrate collections in Malaysian Streams. Trop Life Sci Res 27(1):115-133.
8. Macharia A, Ndiritu GG, Gichuki NN, Wamicha WN (2004) Impact of water quality on macroinvertebrate assemblages along a tropical stream in Kenya. Afr J Ecol 42(3):208-216. doi.org/10.1111/j.1365-2028.2004.00516.x
9. Pohan DAS, Budiyono, Syafrudin (2016) Analisis kualitas air sungai guna menentukan peruntukan ditinjau dari aspek lingkungan. Jurnal Ilmu Lingkungan 14(2):63-71.doi: 10.14710/jil.14.2.63-71.
10. Ardiansyah (2001) Keaneekaragaman larva insekta pada sungai-sungai kecil di Hutan Jobolaran. J Biodiversitas 2(2): 133-139.
11. Leah K, Gibbons J, Michael R, Frances SC (2002) Habitat requirements and local persistence of three damselfly species (Odonata: Coenagrionidae). J Insect Conserv 6(1):47-53. doi: 10.1023/a:1015754015603.
12. Tokaoka H, Hadi UK (1991) Two New black fly species of Simulium (Simulium) from Java, Indonesia (Diptera: Simulidae). Jpn J Trop Med Hyg 19: 357-370.doi: 10.2149/jtnh.1973.19.357.
13. Nuha, Ulin. Restu MS, Haqiqi A, Ahmad F, Zainul MM, Yakobus M (2001) Explorasi Keaneekaragaman Makroinvertebrata Akuatik di Kawasan Coban Trisula Kabupaten Malang. Malang: Prosiding Seminar Nasional Biologi / IPA dan Pemeliharaannya.
14. Clarke A, Mac NR, Bond N, Lake PS (2008) Macroinvertebrate diversity in headwater streams: a review. Freshwater Biol 53(9):1707-1721. doi/epdf/10.1111/j.1365-2427.2008.02041.x
15. Masak PR, Prizan PAM (2006). Komunitas Makrozoobenthos pada Kawanun Budidaya Tambah di Pesisir Malakosa Parigi-Moutong. Sulawesi Tengah. J Biodiversitas 7(4):354-360.
16. Tobias I, Gaspar S, Oscoz J, Miranda R (2016) Diagnosing stream ecosystem integrity in the Ordesa-Viàfamala biosphere reverse, central Spanish Pyrenees. J Appl Ichthyol 32(1): 229-239. doi.org/10.1111/jai.13026.
17. Viranen LK, Soininen J (2016) Temporal variation in community-environment relationships and stream classifications in benthic diatoms: implications for bioassessment. Limnologica 58:1-6. doi.org/10.1016/j.limno.2016.01.003.